MAGAZINE
Lab Manager®
Run Your Lab Like a Business

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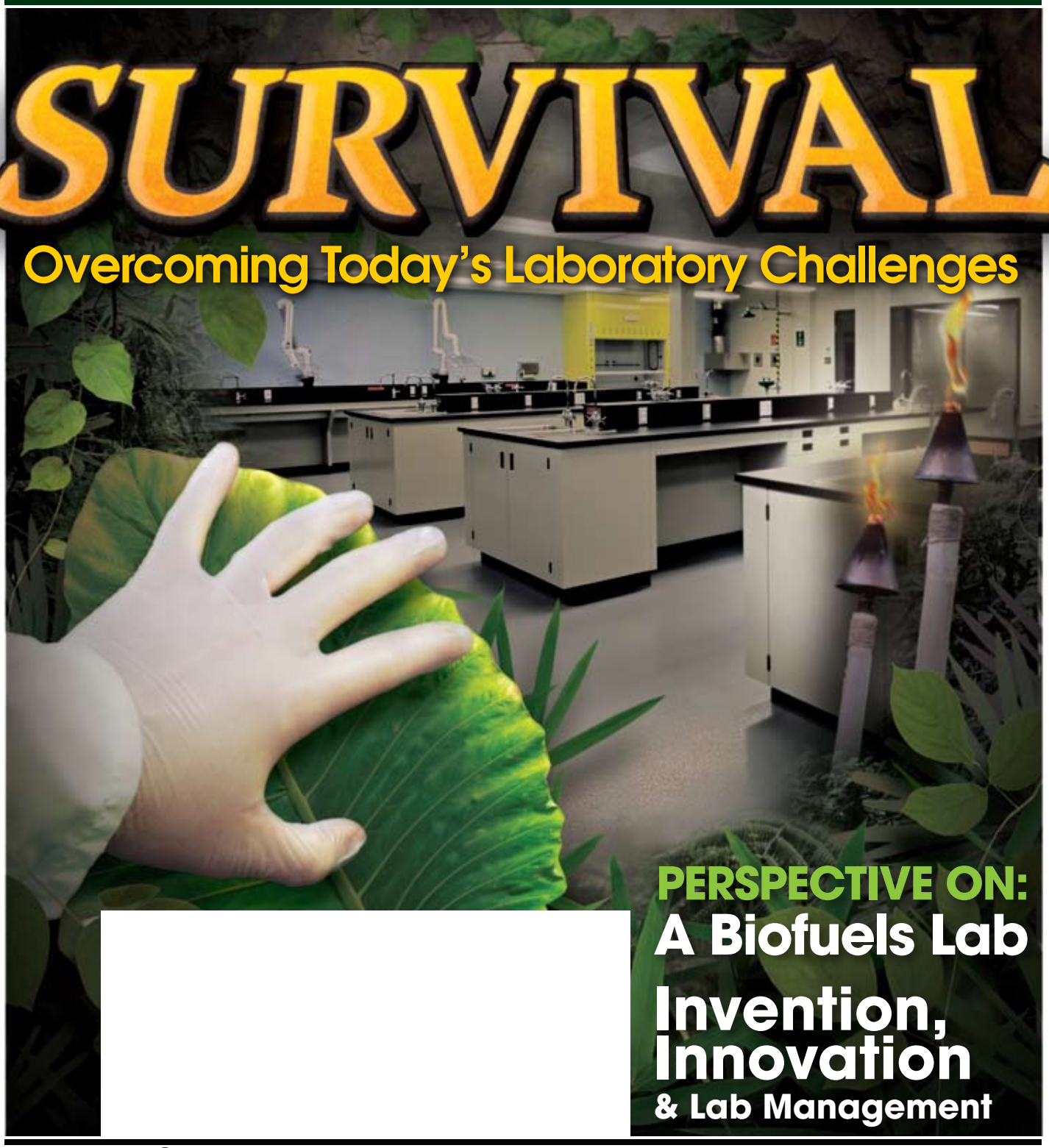

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Lab Manager MAGAZINE

Run Your Lab Like a Business

CONTENTS

Based on a recent report featured on our web site (Seven Steps to Riding Out a Downturn), companies' resiliency strategies for difficult economic times should include the following: Build a "partnership culture"; create, communicate and then exhaust "rings of defense" before downsizing; focus on the local behavior of immediate supervisors and managers; pay more attention to high-potential employees who are most likely to leave during difficult times; create ways for all employees to contribute to the company's efficiency and effectiveness goals; don't exclude employees from assisting with possible solutions; and don't stop performing periodic employee assessments.

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When the Going Gets Tough...

"How a lab manager anticipates and responds to the constant and turbulent change that envelops an organization is frequently the difference between commercial and personal success and failure," says Sam Liggero in this month's cover story. Turn to page 10 for some time-tested and valuable managerial tips that focus on reducing your staff's uncertainty, replacing undesirable attributes with facts, and clarifying group goals and objectives. He also outlines 10 personal behavior tips that will serve you well during good and bad times.

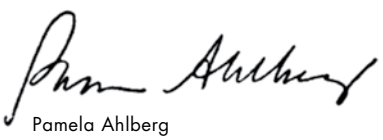
In addition to good management, survival also depends on business decisions that deliver efficiencies and savings. E-procurement, Tom Russell argues on page 28, is one such decision, providing value, impacting the bottom line and modernizing the research function. He asserts that strategic procurement offers "real-time visibility into enterprise-wide spending, enabling professional buyers to negotiate better terms and conditions with suppliers, based not on the purchasing power of a single lab, but the entire organization."

Going beyond mere survival, Dr. John Lienhard on page 14 recommends that lab managers instill in their staff the fearlessness needed to be inventive. Making a clear distinction between invention and innovation, Lienhard is not encouraged by the trend toward multidisciplinary teams in R&D, saying they are "more likely to be the vehicle for design and development than invention and original research." His bold recommendations provide a refreshing antidote in these tremulous times.

At this year's Pittcon in Chicago, *Lab Manager Magazine* will host a boot camp designed to help managers improve their skills and learn new methods for handling the day-to-day challenges of running a lab. Unique to the program will be a technique created and presented by John Galland of the Laboratory Management Institute at the University of California, Davis. On page 17, Dr. Galland offers a glimpse into this novel approach, which allows managers to practice their skills in a safe, simulated live experience.

Introduced to the magazine this month is a new feature called "Perspective On" (page 44). This month we look at the specific challenges of a biofuels research laboratory. The article examines the science, personnel, funding and equipment required to carry out this particular kind of research. Future features will examine a variety of research facilities as well as other specialized topics.

As always, we hope you find value in everything this month's issue has to offer. If there's a topic of particular interest that we haven't covered, please let me know. I look forward to hearing from you.



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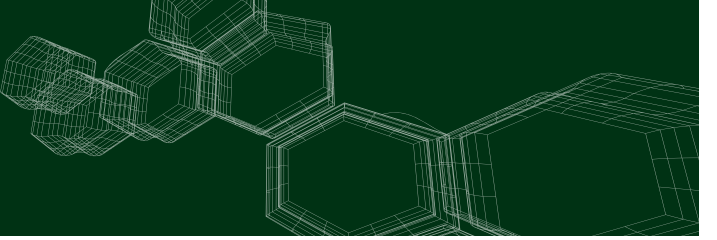

SURVIVING CHALLENGING TIMES

GUIDELINES AND BEHAVIORAL TIPS TO MITIGATE ORGANIZATIONAL UNCERTAINTY AND MOTIVATE YOUR WORKFORCE ***by Samuel H. Liggero, Ph.D.***

One constant that technical managers can count on is change—constant change. Change in technology, change in organizations, change in competition, change in supervision and, yes, change in the economic climate. How the technical or lab manager anticipates and responds to the constant and turbulent change that envelops an organization is frequently the difference between commercial and personal success and failure.

In this article I offer several thoughts on leadership challenges in turbulent times and techniques to address and overcome these challenges. Many of these suggestions can be implemented immediately and have been successfully tested during my 30-year career leading and managing large and small groups of scientists, engineers and technicians.

Most technical and business people dislike uncertainty. Uncertainty breeds distrust, fear, loss of confidence, anger, rumors, and all the attributes that complicate and usually retard progress and success in the lab or the office. Therefore, the first priority for the manager should be to reduce uncertainty in the workplace and replace the undesirable attributes mentioned above with facts, sensitivity to employee concerns, and clarity of the group goals and objectives.

Here are four managerial guidelines to follow at all times, especially in times of uncertainty and turbulence:

1. *Establish clear goals for all employees with clearly defined areas of responsibility and accountability.*
2. *Communicate, motivate and inspire.*
3. *Get out of the way.*
4. *Invest in your employees.*

Guideline #1 is all about ensuring that employees have meaningful work to do and personally identify with that work. They should take pride in their work and assume ownership and accountability for their results. This guideline is designed to establish clarity in the workplace and minimize redundancy. Guideline #1 should be revisited with employees several times a year to make sure that it is relevant and delivering the desired results. During turbulent times, it is essential that employees are gainfully employed and are not in stall mode.

"Uncertainty breeds distrust, fear, loss of confidence, anger, rumors, and all the attributes that complicate and usually retard success in the lab."

Guideline #2 addresses communication. During times of stress and uncertainty it is vital for the manager to communicate frequently and honestly with the workforce. Communication takes many forms. In addition to staff meetings, small group meetings and town hall meetings, periodic written communication will help stabilize and motivate an organization. Also, the manager should continuously improve and employ keen listening skills. Employees need to be heard, and their issues should be discussed and resolved. By practicing these various communication skills, a manager can find a pathway to motivate and even inspire the workforce. One of

the best ways to establish or regain trust with employees is by having frequent, honest and effective communication. This guideline cannot be overemphasized.

Guideline #3 means the manager must not micromanage. A micromanaged workforce is a demoralized, cynical workforce. During troubled times, it is common for managers to micromanage. What sometimes motivates this behavior is self-preservation. Managers may feel that the best way to preserve their jobs during troubled times is to appear to do the work of everyone else. This behavior must be avoided, because it is transparent, unproductive and debilitating for the employee. If Guideline #1 is in place, managers should focus on their own personal managerial goals and make it clear that they are always available when needed to support employees who seek support.

"Managers should encourage and applaud employees who participate in and initiate positive change processes."

Guideline #4 encourages managers to support their employees. The underlying principle here is that managers get work done through their employees. Accordingly, employees are the most important asset of a lab or company. Support in this context includes financial support as well as moral support. Most people like to be recognized for a job well done. Recognition takes many forms, and the successful manager deploys many types of recognition, including financial recognition that appears in a paycheck or bonus and verbal or written recognition that is given in a public or private setting. The key benefit of this guideline is that employees will feel that their work is important and is appreciated and valued by their managers.

"During turbulent times, it is essential that employees are gainfully employed and are not in stall mode."

Consistently practicing of these four managerial guidelines, during good times and bad times, will help establish a stable and motivated workforce. These guidelines work best when the senior manager practices them and requires direct reports to also use them. One of the performance measures of the senior manager's staff should be how well they are able to implement these guidelines in the workplace. In addition to these guidelines, I would also like to offer several personal behavior tips that, when adopted throughout an organization, can transform the organization and better enable it to survive and thrive in turbulent times. The initial burden of modeling and articulating these traits lies with the manager. Only then will the rest of the organization embrace some or all of these behaviors.

Below are 10 personal behavior tips that have been found to be effective as catalysts for discussions about individual and group performance improvement and as a road map to help guide scientists, engineers, technicians and managers. Consider adopting some or all of the following tips in accordance with the needs of your organization.

1. Relentlessly pursue growth…both business and personal.

Without growth, a business dies. Without personal growth, employees stagnate and lose their value in the marketplace. Since most employees are likely to change jobs multiple times throughout their careers, it makes sense to develop new skills every year. These skills should be transferable and consistent with the business and technical goals of the organization. Each year, as part of the employee's performance appraisal, a section addressing personal development goals should be jointly discussed and pursued. Most employees will find this exercise motivational and view it as a strong signal that management values and depends on their contributions.

2. Make sure whatever you do adds value to the customer.

The assumption here is that employees recognize the link between their work and end users. This tip is very important for increasing productivity. As the global economy forces increased competition, organizations have to deliver more with less. One way to achieve this difficult goal is by eliminating useless or marginal work. Often a significant percentage of work time is spent writing reports that no one reads, having meetings that are not necessary or running experiments that are off strategy. The mindset of the organization should be to routinely eliminate work that doesn't benefit the customer.

3. Embrace and help shape change in your company.

After suitable discussion and debate around change initiatives in your group, embrace change and be a part of it. There is no longer any room and even less tolerance for spectators in the challenging times all organizations face today. Without frequent change, growth will dissipate. Managers should encourage and applaud employees who participate in and initiate positive change processes. The organization and the employee will both be strengthened by actively participating in change processes.

4. Learn to manage ambiguity and uncertainty.

It would be wonderful if everything in the workplace were clear and predictable. It is not and never will be. Therefore, employees must understand that if they want less ambiguity in company or group issues, they should seek information from the many resources that are commonly available, such as the Internet and personal networks of friends and colleagues. Also, managers should anticipate issues that may be unclear or not well defined in the workplace or marketplace and address them swiftly, honestly and professionally.

5. Understand what high-quality leadership is all about and become a leader.

A well-run organization offers ample opportunities for employees to grow into leadership positions and to practice situational leadership as conditions dictate. That is, sometimes a lower-level employee can assume the leadership role for a given problem or task if that employee is best qualified to solve the problem. Managers should encourage situational leadership to evolve, and employees should actively pursue such opportunities. By observing, studying and emulating effective leaders in all occupations, employees will be better prepared to rise to leadership positions.

6. Always remember that the uninformed inflame.

In times of stress and turbulence in the workplace, rumors often spread and the results can be toxic and cause needless disruption. Rumors will often originate from people who have little or no information about a particular topic. That is, they are uninformed. By communicating often with the workforce, the effective manager can arrest the spread of rumors quickly and encourage employees to consider the source of a rumor before allowing that rumor to become disruptive.

7. Manage your energy budget.

At the end of a busy day, or even in the middle of a busy day, especially in times of uncertainty, it is easy to be fatigued or listless and unproductive. This feeling is often due to depletion of one's energy. Like a bank account, one's energy for a given day is finite. Therefore, this valuable energy must be invested wisely. Unnecessary arguments, unfocused work and lack of direction will frequently lead to large expenditures of valuable human energy that are unproductive and unfulfilling. Employees who are able to manage their personal energy budget will be more productive each day and be a source of inspiration to others in the workplace.

8. When in doubt, rely on the facts.

In a laboratory setting, scientists, engineers and technicians are trained to work with facts. If the facts relating to a particular situation are not available, usually they are sought out and eventually revealed. This is an excellent behavior to practice in all phases of business. When faced with a problem, rather than speculate or fabricate an answer, it is best to start with what facts are known about the problem at hand and then build a solution upon your foundation of facts.

9. Support your manager.

One of the first signs that an organization is in trouble is when employees are openly critical of their manager. It is best to reconcile differences with one's manager in private during a one-on-one conversation. If differences cannot be resolved, an option may be to look for employment under a different manager. Otherwise, organizational effectiveness becomes undermined and further stress builds in the workplace. To better understand one's manager, it is helpful to role-play and try to put yourself in the manager's position.

10. Be a team player.

No one can succeed alone. The successful manager and employee should quickly learn the value of giving support and accepting support, depending on the circumstance. Good managers are accustomed to giving support. Great managers can both give and accept support. Accepting support is a sign of a confident manager who is striving to use all the talent in the group in ways that advance the mission of the group. It is a sign of strength and good judgment to be able to support employees and embrace their support.

In summary, the combination of the four managerial guidelines and the 10 personal behavior tips described in this article will enable a technical organization to better function during marketplace and economic turmoil such as we are experiencing in these times. Most of the suggestions in this article can be initiated within a few weeks and positive results can be expected within a few months. The concepts within the four managerial guidelines are well established and in part, or in total, practiced by many successful technical and business managers. The 10 personal behavior tips are a subset of many more tips that I have found to be effective.

Samuel H. Liggero *was corporate vice president and program fellow at Polaroid Corporation, where he led R&D and Product Development teams for many years. He is a co-founder and the CTO of AirPrint Networks, a software startup in the telecommunications industry, and Professor of the Practice at the Gordon Institute of Tufts University. He can be reached at sliggero@aol.com.*

INVENTION, INNOVATION AND LAB MANAGEMENT

DR. JOHN LIENHARD ADDRESSES HOW BEST TO NURTURE INVENTION WITHIN THE RESEARCH COMMUNITY ***by John K. Borchardt***

"Teams are more likely to be the vehicle for design and development than invention and original research."

"Invention and innovation are quite different things," declares John Dr. Lienhard, emeritus professor of technology and culture at the University of Houston. A student of the development of technology and the role of invention in human life, he has a daily show, "Engines of Our Ingenuity," that has been a staple on many National Public Radio stations since 1988 and describes how human culture around the world is formed by human creativity.

What is this difference? Invention is "new technology that really changes things, that is radical disruption," explains Dr. Lienhard. One reason for this disruption is that invention is cumulative, as noted by Merton Flemings, director of the Lemelson-MIT Program, a nonprofit organization that celebrates inventors and inventions: "Side effects or limitations of an invention create new opportunities." Invention can result in the creation of entire new industries. An excellent example is the invention of the digital computer in 1939. It took a while, but this invention resulted in the creation of information technology industry: computers and software. Similarly, the invention of the airplane resulted in the development of the airline industry and greatly increased personal mobility, which resulted in a vast expansion of the hotel and travel industries. It also resulted in a new dimension for warfare: aerial combat.

In contrast, "Innovation is seldom accompanied by major disruptions," says Dr. Lienhard. "Innovation literally means renewing something. Innovation is the result of wanting to be just a stitch ahead of the competition. And American industry likes to use it for a kind of incremental tinkering of something already there. Innovation is safe, while invention is dangerous."

Ebb and flow of invention

"I'll claim flatly that freedom is the nurturing mother of invention. Invention always flourishes when people are free—when they enjoy intellectual permissiveness. Every time personal liberty opens up in a society, invention flourishes," states Dr. Lienhard. "We are in a trough now, whereas we were in very high points in the late 18th century and the early 20th century."

Despite the huge amount of money spent on academic and industrial research, Dr. Lienhard does not see recent times as an outstanding period of invention. "The great period of U.S. invention was in the early 20th century. The radio, airplane, television and digital computer were all invented before 1939. Since then we've gotten very cautious."

Role of lab managers

Can lab managers increase the invention productivity of the people they supervise? Can they independently and successfully increase the invention productivity of their staff even if other laboratory managers do not? Dr. Lienhard responded to these questions by saying, "I think that invention is a fundamental expression of mental freedom. It requires a kind of carefree hedonistic ability to step off the edge. People who know they'll get slapped down for stepping out of line won't invent. Yes, I'm certain that kind of freedom can be bestowed 'locally' even when it is not done so 'globally'—at least to some extent. I think the lab manager has to have the confidence to be wrong—to bounce ideas around, to get in and tangle as a mental equal."

To promote invention, a lab manager has to devise methods of instilling a sense of freedom in the research staff. One way to do this is to allow staff

members to challenge conventional thinking, as Dr. Lienhard suggests above. Another is to not punish staff members for failing—stepping off the edge and falling off the cliff—when taking risks, provided that these risks are calculated ones. To the extent that corporate rules permit, allowing staff members to work flexible hours, attend conferences (provided that the budget allows this and staff members don't abuse the privilege), and publish or present their research findings can provide another dimension of personal freedom. In doing so, lab managers need to be sure that the employer's interests are not compromised.

In providing a sense of personal freedom, lab managers need to realize that people respond differently to various incentives. For example, a certain percentage of laboratory technicians may be motivated by an opportunity to attend a conference or serve as coauthor on a paper. To motivate staff members and discover what gives them a sense of personal freedom, lab managers have to know their staff members well. Visiting labs and offices at the beginning of the workday and going to lunch with staff members are two ways to do this. Another is to carpool with staff members if your schedule allows. An occasional social event at your home can also be helpful. Discovering what motivates staff members helps the manager create a flexible work environment while fostering a sense of freedom.

"To promote invention, a lab manager has to devise methods of instilling a sense of freedom in the research staff."

Coaching can include encouraging staff members to take courses and participate in activities that increase their abilities. Many lab staff members, particularly recent hires, may not be aware of continuing education options offered by their employers.

Are current trends in industrial and academic research promoting development of a great new period of invention? What are some of these trends and their likely impact on invention?

Role of teams

Multidisciplinary teams are playing an ever-increasing role in industrial R&D. Do they play a role in invention?

"Sometimes invention is the work of a team, but more often it is the work of an aggregation of people working independently," says Dr. Lienhard. For example, Dr. Lienhard notes, that at his Menlo Park laboratory Thomas Edison "built a small coterie of bright engineers, scientists, and technicians… He lost the chemistry of that cadre of geniuses and craftsmen" when he opened a new lab in Orange, N.J., according to historian Thomas Parke Hughes (*American Genesis: A Century of Invention and Technological Enthusiasm,* 1870-1970," University of Chicago Press, 2004).

In his book *How Invention Begins* (Oxford University Press, 2008), Dr. Lienhard notes that thousands of people applied their combined inventive genius to each of three inventions: airplanes, railroad engines and automobiles. Each of these was really a concatenation of many independent inventions and innovations.

In contrast, Dr. Lienhard observes, "Teams are more likely to be the vehicle for design and development than invention and original research." In today's period of high innovation and relatively low invention, it's not surprising that much R&D is performed by teams. These teams capitalize on previous inventions.

"Sometimes invention is the work of a team, but more often the work of an aggregation. Teams are more likely to be the vehicle for design and development than invention and original research."

Project management and invention

Project management techniques are useful in managing innovation projects. However, the constraints and discipline imposed by project management that are so helpful to timely innovation can be deadly to the inventiveness of your research staff by reducing their sense of freedom.

Project management usually involves managing six key dimensions and measuring them against set targets. These are:

Time *– Measured against the project schedule. Progress is measured in terms of project milestones and their target completion dates. This requires action items to be completed on schedule.*

Cost *– Measured against the project budget and planned spending for various phases of the project.*

Resources *– Measured against the originally budgeted resources.*

Scope *–Measured against the original scope of the project. Is the scope becoming narrower due to limitations in resources or funding?*

Quality *– Are quality issues being addressed and solved in a timely way?*

Responsibilities *– A particular person should be made responsible for successfully completing each action item.*

Clearly project management is a very disciplined process. Each of these six dimensions can restrict the freedom of researchers to follow up on unexpected results, which often is so important in making an invention.

Academic patenting and invention

What is the impact of the trend of faculty members patenting their inventions? This patent activity is often accompanied by the formation of start-up companies to develop and commercialize the technology. Alternatively, the technology is licensed to existing firms that commercialize the technology.

Dr. Lienhard comments, "Less of this goes on than we might wish. It really is an effective way to pursue new ideas that would be rejected in an established company. It might cause more inventions to occur than would otherwise. However, academic patenting does not increase the pace of invention…I'm skeptical that there's much connection between patents and inventiveness. Patents are all about ownership."

Industrial funding of academic research

The role of industry in funding and guiding academic research continues to grow.

Do industry/academic research partnerships increase the pace of invention or do they lead to an increased focus on innovation as compared to true invention? "Again that word 'pace,'" comments Dr. Lienhard. "The pace of invention has a peculiar inexorability. However, industrial funding of academic research does foster in-house incremental improvement. I've also seen lots of cases where an academic will want to sprint ahead and will sever his or her association with a company and strike out alone."

Working on a project funded by industry means the student is working on someone else's idea and trying to answer someone else's questions. Dr. Lienhard says, "I think what research funding does is often cast a huge wet blanket on student inventiveness."

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ACTING OUT

A UNIQUE MANAGEMENT WORKSHOP ALLOWS LAB MANAGERS TO RESOLVE ISSUES IN A SIMULATED AND SAFE ENVIRONMENT ***by John C. Galland, Ph.D.***

Most laboratory managers are trained to run a laboratory by working in the labs of others and by their own trial and error. While much can be learned from the growing management literature for scientists, there is no substitute for practical experience. Or is there?

At the Laboratory Management Institute (LMI) at the University of California, Davis, educational programs provide laboratory managers with the opportunity to practice managing a laboratory in a simulated live experience called LabAct. Participants in the workshop bring real, everyday problems they face in their labs and practice resolving them in a safe environment before implementing the solutions back in their own labs. Often, theatrical professionals (LabActors) are incorporated in the practice.

▲ *Professional LabActors Art Grueneberger (right) and Matt Tabora-Roberts enact a scene suggested by participants at an LMI workshop. Photo by Joseph Rodriguez, U.C. Davis.*

For instance, if there is a conflict between two people in the laboratory about noise, one LabActor might play "Chatty Cathy," a "Type-A" noisy employee, and another LabActor might play "No-nonsense Nate," a "Type-B" employee who is annoyed with Cathy and has come to the laboratory manager, to resolve it. What would you do?

Whatever you decide, without judgment a LabActor plays you trying to resolve the issue. "How did that work for you?" the LabActor asks you. The other LabActor says, "OK, try it another way and then another way until you find a way of resolving the issue that resonates with you."

Whatever the issue, a LabAct simulation can be constructed to enhance your competence and confidence as a laboratory manager. Other participants in the workshop will help find alternate solutions, which the LabActors will play out as well. The literature can be consulted right there to determine whether your solutions are grounded in leadership and management theory and what others before you have discovered; for instance, that we interact with people and not the labels sometimes given to them, such as "Type-A" or "Type-B." In fact, the learning method used at LMI workshops is based on something you already know very well—the scientific method.

Throughout the workshop, participants formulate testable (or, more precisely, falsifiable) hypotheses for solutions to management problems and then make observations as those hypotheses are played out in a LabAct experiment. Additional data is gathered from the literature and from others at the workshop. Analyzing all the observations and data, participants draw their own inferences as to the success or failure of the proposed and now practiced management solutions.

Issues that workshop participants have explored include dealing with problem employees, getting laboratory employees to write and follow standard operating procedures precisely, showing favoritism, giving and receiving credit, coping with absentee managers or micromanagers, research misconduct, managing the budget, using shared equipment, and so on.

Can't attend or afford to attend a workshop? Soon you will be able to get much of the educational material free from the Department of Health and Human Services' Office of Research Integrity (ORI) web site at http://ori.dhhs.gov. LabActs covering many of the issues experimented with by workshop participants are on the site. Supplemental educational material also is available.

"Building laboratory management upon a strong foundation of basic and scientific-discipline skills will lead to enhanced laboratory operations as well as breakthrough science and distinguished careers."

In addition to LabAct, other methods are used at the workshops. For instance, most laboratories don't come with an instruction manual, so participants are encouraged to create one for their lab. Preparing a laboratory manual that includes more than just standard operating procedures (SOPs) for laboratory methods, but also SOPs for managerial procedures, such as training new employees, can go a long way in preventing "issues" from arising later. An exercise called LabTrek helps participants practice leading teams in such activities as preparing protocols, developing grant proposals, preparing and managing projects and laboratory budgets, equipping a new laboratory, and choosing collaborators.

"Usually, there is no single right strategy, but many that can work for the specific situation and people involved."

A growing number of institutions recognize that investing in educational programs that help make their researchers better managers also helps the managers better advance science, their careers and the reputations of the institutions. An increasingly important reason for investing in further professional development of researchers is that it helps mitigate institutional risk. As a result of LMI's efforts to provide scientists with a more formative education in laboratory leadership and management, a curriculum has been developed that is organized into five categories (pillars): leadership; management; best practices; integrity; and health, safety and security (see box). Building these pillars of laboratory management upon a strong foundation of basic and scientific-discipline skills will lead to enhanced laboratory operations as well as breakthrough science and distinguished careers.

Best practices

From all this practicing, participants rediscover what they have known all along about doing science: Be fastidious about record keeping; be above reproach ethically; be good stewards of research resources; and never compromise the safety and security of personnel, research participants and subjects, or the environment. They also discover that playing nicely with others can be done scientifically.

The overriding lesson from this curriculum is that handling issues in the laboratory requires the same skills as those for doing good science—make observations, then step back and observe not only the immediate facts of the situation that are presented, but also the emotions being expressed by the people involved and the underlying, possibly long-term, reasons behind those emotions. If the facts, emotions and concomitant variables are not fully revealed, as a scientist you need to ask questions until they are known. Essentially, you are building a database that will help you understand the problem better and devise solutions for it. After carefully reviewing the data, plan the best strategy to implement a solution, vet that plan with others you trust and then try it out. If that strategy does not work, try another or enlist others to help you resolve the issue. Usually, there is no single right strategy; rather, there are many that can work for the specific situation and people involved. The strategies that work tend to be the ones that are thought through thoroughly, consider not only short-term but also long-term consequences, and ring true for you.

While some issues will be easy to resolve, others will not and sometimes the end result will not, please everyone. What is important is that everyone involved understands why that particular solution was selected over others. Some other best practices rediscovered through this educational program are to value others and let them know that you do; communicate openly and often; be honest, be authentic; be transparent in your decision making; police yourself, not others; trust and be trusted. Sound familiar and simple? The best practices usually are.

Conclusion

Scientists not only must be innovative in their scientific discipline, but increasingly must be innovative in how they make greater use of dwindling resources, communicate their science to the public and to funding agencies that will sustain their research programs, and lessen the impact of their research activities on the environment. Therefore, investments in educational programs in laboratory management can pay high dividends.

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Web box Dr. Galland and the LabActors will conduct a half-day workshop sponsored by *Lab Manager Magazine* at Pittcon in Chicago on March 10, 2009. For more information visit: *www.labmanagerbootcamp.com.*

Pillars of Leadership

The LMI curriculum outlined below is designed to provide scientists with a more formative education. It is organized under the categories of leadership; management; health, safety and security; best practices; and integrity and compliance.

Leadership

- Vision
- Mission
- Goal setting
- Strategic planning
- Creativity and innovation
- Communication and marketing

Management

- People (conflict resolution, mentoring)
- Money (budget)
- Time
- Materials
- Facilities
- Project
- Quality
- Information
- Risk
- Diversity
- Waste

Health, Safety & Security

- Employees
- Laboratory animals
- Human subjects
- Environment
- Emergency preparedness
- Lab security
- Lab hygiene

Best Practices

- Documentation
- Laboratory notebooks
- Training records
- Equipment maintenance/use
- Standard operating procedures (SOPs)
- Quality assurance/control
- Good laboratory practices (GLPs)
- Environmentally sound (green) practices
- Calibration/validation/verification

Integrity & Compliance

- Authorship
- Research misconduct
- Academic freedom
- Ownership
- Policies and procedures
- Regulations
- Technology transfer
- Conflicts of commitment/time
- Conflicts of interest
- Intellectual property
- Patents/copyrights/trademarks
- Contractual requirements
- Societal responsibilities
- Controlling for bias
- Stewardship of resources
- Collaboration and collegiality

DESIGN HURDLES, DESIGN SOLUTIONS

INNOVATION IN ELECTRONIC PIPETTORS MAY OVERCOME SHORTCOMINGS OF THE PAST ***by Rob Zier and Marc Hamel***

"An electronic pipettor provides two highly accurate tools while reducing workplace motion-related injuries common with the repetitive use of manual pipettors."

In the Guest Spotlight section of the November 2007 issue of *Lab Manager Magazine* (Vol. 2, No. 11, p. 10), Ned Gravel said, "If we treat people as resources we may get maximum 'use' of them, but we will not get maximum 'benefit' from them." If viewing people (personnel) as "resources" is counterproductive to successful lab management, how then do we increase efficiencies, standardize procedures and improve the workplace, and still accept (and account for) individual variability and idiosyncrasies?

One answer lies in using proper and productive lab equipment, which produces standardized results regardless of the technician involved. Electronic handheld pipettors are one type of equipment that can achieve that goal.

Electronic pipettors have been around for 22 years and were spurred on by the success of manual handheld pipettors, which preceded them. Yet their acceptance by the research community as a whole has been a challenge for instrument designers and manufacturers. Since they comprise only 10 to 15 percent of the total in-use pipettor market, if electronic pipettors meet so many of the modern lab's needs, why has their use been so limited?

The good

While all pipettors rely on the same principles of air displacement and hydraulics to move liquids and, if properly manufactured and maintained, deliver the same accuracy and precision at a given volume, user variability can and often does account for less than optimal performance. This is especially true with manual pipettors, for which the aspiration and dispensing of samples are predicated on the user's ability to push and release a plunger the same way, at the same angle, and at the same speed every time a sample is delivered. Compounding these issues are factors such as fatigue, distraction, general carelessness, variability in the quality of consumable tips being used, and viscosity or density of the samples being manipulated by bench scientists and laboratory technicians.

Electronic pipettors are designed to overcome these issues with the use of a microchip-controlled motor that moves the pipettor's piston in a highly reproducible manner. They also allow the user to vary the speed of aspiration and dispensing such that they can be preset or changed on the fly to accommodate differing protocols and samples or reagent types. Fatigue and distraction issues are greatly reduced by virtue of the fact that a simple press of a button initiates piston motor movements, eliminating the numerous thumb and arm motions required with manual pipettors. Additionally, because of the instrument's ability to aspirate a large amount and then dispense portions of that amount, the pipettor doubles as a repeat dispenser capable of delivering a series of equal or differing smaller aliquots in an extremely repeatable way to multiple plate wells or individual tubes. This bodes well for lab managers looking to alleviate repetitive strain disorders brought about by long-term manual pipetting activities. The goal for many laboratory managers is to reduce the total pipetting duration, and electronic pipettors certainly help in attaining this goal. An electronic pipettor provides two highly accurate tools while reducing workplace motion-related injuries common with the repetitive use of manual pipettors.

The ultimate advantage provided by pipettors is that they enable center-to-center tip spacing to be adjusted for pipetting applications that involve multiple sample transfers between various labware formats or into gels. These types of pipettors are available from three companies: Viaflo, Rainin Instruments and Matrix/Thermo Fisher.

Two companies supply expandable spacing pipettors that require manual manipulation to set and affect tip spacing. One pipettor features one-handed tip spacing adjustments at the press of a button. This is accomplished by employing a small motor in the pipettor's lower end, which serves to expand and contract tip spacing when desired. Tip spacing can be altered on the fly from 4.5 mm to 14.0 mm. Adjustable tip spacing translates into significant efficiency gains, especially for multichannel sample transfer and gel loading applications typically performed with single-channel pipettors that require strenuous repetitive arm motions and often result in frequent transcription errors.

The bad

The trouble with electronic pipettors is threefold. First, they come with manuals and as a result are not typically user friendly or intuitive. This means some patience and practice are required in order to become proficient. Second, many have serious battery issues. As with early cell phones, the batteries and charging capabilities are problematic and can result in a shortened battery life cycle and potential frustration for the user. And third, boot-up times can be excessive. Waiting for an electronic pipettor to "go live" can frustrate even its most ardent supporter. Generally, it is considered faster to pick up an old manual pipettor and get right to work. All three of these factors contribute significantly to the slow acceptance of electronic pipettors and have fueled the need for more inventive products to overcome the shortcomings of past products.

And the ugly

Price. A two-in-one instrument is great—even better is one that adjusts to various labware types, unless, of course, it costs twice or three times as much as expected. Unfortunately, many electronic pipettors do.

One solution

The Vision and Voyager ranges of electronic pipettors recently introduced by Viaflo address pipetting challenges in today's modern laboratory. The company cites recent advances and widespread acceptance of electronic devices in the consumer electronics and personal entertainment industries as significant drivers behind their innovations. Additionally, the company sought to deliver to the market a next-generation class of products that address a broad spectrum of health and safety concerns as well as best-in-class pipetting performance.

▲ *Pipettors are available in single-, eight- and 12-channel configurations.*

▲ *Eight- and 12-channel pipettors feature adjustable tip spacing, enabling fluid ttransfer between differing labware formats.*

The resulting range of products incorporates an intuitive and highly recognizable user interface navigated by a unique touch wheel that provides the fastest volume and speed settings in the industry. Products also feature full-color display with active help files (multilingual) to assist in programming. A fast-charging, lightweight lithium ion battery offers long-lasting power with minimal weight. The Voyager models feature motorized tip spacing adjustments supporting efficient transfer of eight or 12 samples regardless of the labware used. Other firsts include Bluetooth wireless PC communication, electronic calibration reminder clock, simple calibration for pipette or repeat dispense applications, and a tip-fitting design that requires the industry's lightest tip load and ejection forces while ensuring that tips remain sealed and never fall off, thus enhancing the overall pipetting experience. Finally, the pricing of these "two-for-one" pipettors is only slightly more than that of a quality manual pipettor.

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PRODUCTIVITY IN A VACUUM

ELECTRONIC VACUUM CONTROL PAYS FOR ITSELF IN COST SAVINGS AND LAB PRODUCTIVITY GAINS ***by Peter Coffey***

"When equipped with self-adjusting feedback control, motor-speed-controlled pumps offer the ultimate in automated vacuum management and productivity."

With lab staffing squeezed and no relief in project deadlines, improved lab productivity is your only hope. You're already working as hard as you can. Where can you find these elusive productivity gains? One often overlooked source is electronic control of vacuum applications. In fact, effectively using modern vacuum technology in a lab can make a big difference in your lab productivity, stretching critical staff resources by freeing hardworking Ph.D.s and technicians to do real science instead of control equipment.

A hot analogy

Suppose I gave you two options for keeping water at 60°C for two hours.

Option 1: Put a thermometer in a flask with the water. Then light a Bunsen burner under the flask, and heat until it reaches 60°C. Turn off the Bunsen burner, but stay close; you'll need to light the Bunsen burner again as the temperature starts to drift lower. Watch the thermometer for two hours, lighting and extinguishing the Bunsen burner, all the while thinking about the education you are wasting.

Option 2: Put the water on a hot plate, set it for 60°C, and go do something creative for the next two hours.

Now suppose you need to maintain an evaporative application at 20 mbar for two hours. You have two choices:

Option 1: Attach your vacuum application to an electronically controlled vacuum pump. Set the desired vacuum at 20 mbar, and go do something creative for the next two hours.

Option 2: Attach your uncontrolled vacuum pump or central vacuum system (CVS) port to the vacuum application. Turn on the pump or open the vacuum port of the CVS. Pump until you reach the desired vacuum conditions. Turn off the pump or close the vacuum valve. When evaporation stops, turn the pump back on. Keep this up for two hours, several times a week, all the while thinking about the education and intelligence you are wasting on equipment control instead of discovery.

Why, in the first example, would you think it crazy to control temperature manually, yet you would treat electronic vacuum control as a lab luxury?

Why vacuum control?

Besides being used for fluid movement (aspiration and filtration), vacuum is most frequently used in labs to provide control over evaporation, typically to initiate or accelerate evaporation at temperatures below a solvent's normal boiling point. To do so most effectively and efficiently, conditions should be kept as close as possible to the vapor pressure at operating temperatures; exceed it, and you will get "bumping" or boil-over. As the temperature and vacuum conditions approach the solvent's vapor pressure, the flow of vapor changes rapidly. In complex mixtures, this happens at several different points in the evaporation. Under such conditions, the relationship between the vapor flow from the application and the pump's pumping speed leads to sudden changes in vacuum level. Control—whether manual or electronic—is needed to compensate in an attempt to maintain optimum conditions.

Not every lab vacuum application needs electronic vacuum control. In simple fluid movement applications, just enough vacuum control is needed to manage the process. Many labs still use rotary vane pumps—operating well below 1 mbar/Torr—for filtration applications. This is much more vacuum than needed and causes a series of problems. The oil-sealed rotary vane pump has to be "dumbed down," often using an air bleeder valve—effectively introducing a controlled leak to prevent boiling in the collection

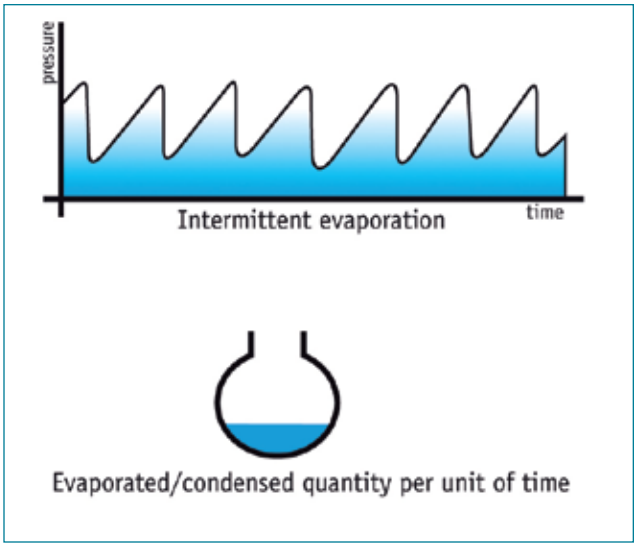
vessel. All that air not only makes the vacuum application noisy, but can create a lab hazard by continuously mixing air with what may be flammable process vapors, much like a car's carburetor. The pump operates very inefficiently in this vacuum range, and all that excess air creates oil mist, which contaminates the lab atmosphere unless a mist filter is added. This is the lowest form of vacuum control: compensating for the use of the wrong pump for the application.

"The most common electronic control is 'two-point' control, which works like hot plate temperature regulation."

Oil-free (dry) diaphragm pumps, with a typical vacuum range down to about 1 mbar, operate efficiently in the vacuum range needed for most evaporative and fluid movement applications. Even so, control is needed to optimize vacuum conditions. The simplest approach controls the vacuum manually with either an air-bleeder valve or a flow restrictor. Using an air-bleeder valve on a dry pump has the same noise and hazard risks as those associated with similar technology on a rotary vane pump. A flow restrictor works by increasing or decreasing the rate at which the vacuum pump removes vapors from the application. Both approaches give rough vacuum control but require human oversight; as vacuum conditions depart from the optimum, direct intervention is needed to avoid either boil-over or excessively long process times.

Two-point control

For more sensitive or critical evaporations, adjustments need to be more frequent and, therefore, will be more time consuming if done manually. For these applications, electronic control keeps the process within prescribed parameters without continuous staff oversight. The most common electronic control is "two-point" control, which works like hot plate temperature regulation. A vacuum controller is programmed with a target pressure level, the application is pumped down to that level, and then the vacuum supply is interrupted. As the pressure rises because of vapor flow from the application or system leakage, pumping resumes and the pressure is brought back within parameters (the "two points" in two-point control). The gap between the two points is referred to as hysteresis, and the control is represented in Figure 1.



▲ *Figure 1. With two-point control, as pressures fluctuate, so do evaporation rates.*

Two-point control can be provided in one of two ways: by cycling the pump on and off, or by using a solenoid valve to intermittently isolate the application from the pump. The former is typically somewhat less expensive up front, since the controller simply operates a switch instead of an electromagnetic valve. The solenoid valve adds some cost but protects the pump from the life-shortening wear of repeated on-off cycles. With a solenoid valve, the pump operates continuously, keeping the pump warm enough to minimize the internal condensation of vapor that can reduce pump performance. In either case, however, the lab has taken a giant step toward efficiency and productivity by using electronics, rather than precious staff time, to operate the system. Two-point vacuum control is the approach commonly built into rotary evaporators.

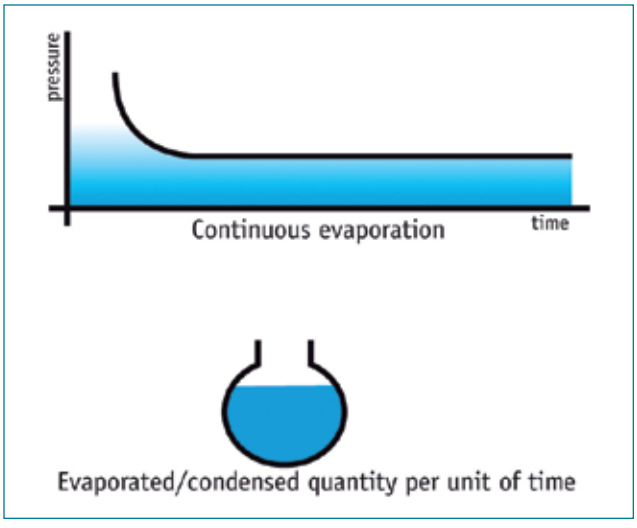
"More sophisticated two-point controllers can program 'ramps' that periodically adjust the pump's operation to expected conditions in the evaporator."

Notice that with electronic vacuum control at one setting, the system does not respond as conditions change. Changing concentrations of component solvents and increasing solute concentration lead to changes in boiling points for which the controller cannot compensate. More sophisticated two-point controllers can program "ramps" that periodically adjust the pump's operation to expected conditions in the evaporator. Following timed development runs, during which conditions are controlled and recorded manually, the electronic controller is programmed with parameters that keep the application close to optimum for subsequent runs, provided all starting conditions are replicated. While time consuming initially, programmed operation of later runs is another big productivity booster.

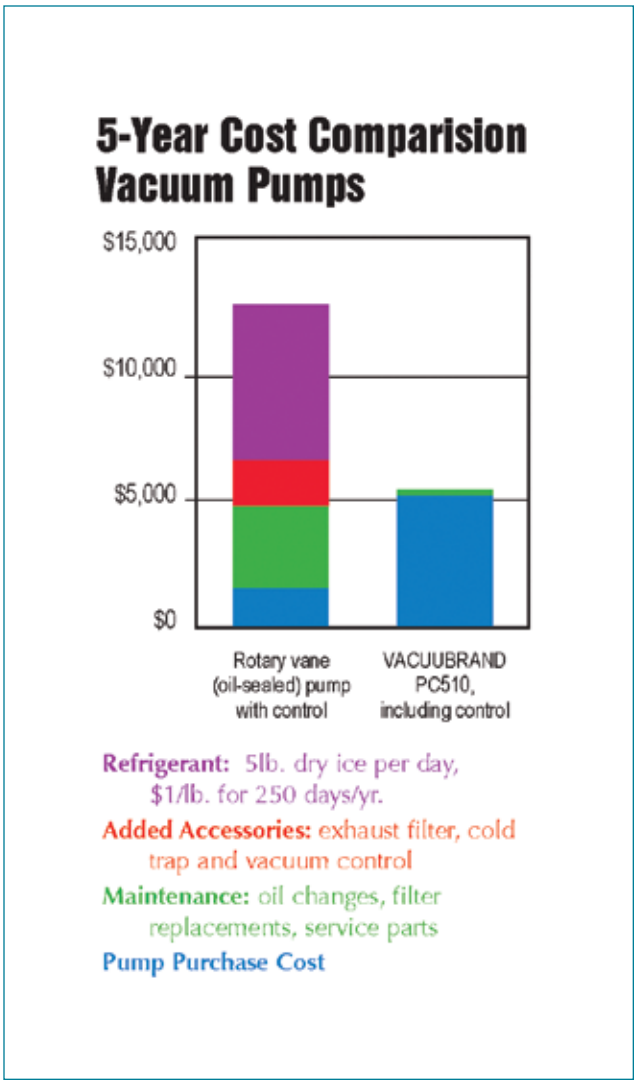
Continuous control

As advantageous as two-point control is over uncontrolled vacuum, it still falls short of optimal productivity in three ways: (1) development runs are needed to determine optimum vacuum conditions before programming the controller; (2) the benefits accrue only from repetitive runs of the same application conditions; and (3) the programmed control is still an approximation of optimum conditions, since conditions change continuously (and often nonlinearly). All these drawbacks can be addressed with pumping systems that use motor-speed control to respond to changing vacuum conditions, although some pumps use motor-speed control merely as an alternative to turning the pump on and off, and still require development runs and programming.

When equipped with self-adjusting feedback control, motor-speed-controlled pumps offer the ultimate in automated vacuum management and productivity. Such systems (1) detect vacuum conditions in the evaporative applications several times a second; (2) instantaneously adjust pumping speed and vacuum in response to changing conditions; and (3) maintain optimum conditions automatically. A two-hour vacuum run can proceed unattended and without development runs or programming, virtually eliminating over-boiling (bumping) and protecting samples (Figure 2). This continuous optimization even corrects for hysteresis in other parts of the system, such as water bath temperature control. And because conditions are continuously optimized, evaporations are typically completed 30 percent faster than those managed with two-point control.



▲ *Figure 2. With self-adjusting continuous control, evaporation rates are optimized.*



▲*Figure 3. Operating cost savings alone recover the price premium for c ontrolled vacuum.*

A small investment in productivity

Given all the benefits, the only real objection to vacuum control has to be cost. There's no question that adding electronic control to a pump also adds to its cost, but the productivity gains more than offset the cost increases. One point of comparison is between an oil pump—often seen as an economical choice—and a corrosion-resistant, oil-free pumping system with two-point control. As Figure 3 illustrates, the operating cost savings of using a controlled oil-free pump more than pay for the convenience and productivity benefits in just a few years. Consider the benefit of time savings. A scientist who is paid $50,000 per year costs about $25 per hour, excluding benefit costs. Saving just two hours a week in avoided pump-oversight time, 50 weeks a year, amounts to annual savings of $2,500 in scientist time. Much more important to lab productivity are the avoided costs of manual pump control, namely the critical thought and creative work that don't get done while the scientist serves as a human pump controller. Extending this analysis to self-regulating pumps, the lab further avoids all the time lost to trial-and-error process development needed before programming two-point-controlled evaporation, and each run is completed up to 30 percent faster.

The savings are real and significant and reward the insightful lab manager with productivity gains for years to come. So next time you see a hot plate controlling temperature electronically, ask yourself: Why don't I use electronic controls on my vacuum pumps for the same benefits? Your lab may end up so productive that you'll qualify for extra staff!

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Relocation, Relocation, Relocation

CAREFUL PLANNING AND SMART PARTNERING PROTECT ASSETS AND MINIMIZE DOWNTIME AND DISRUPTION *by Joe Tehrani, Ph.D., and Shawn Laymon*

"An experienced lab relocation resource first seeks to understand the background of the relocation, the culture of the work environment and important issues that will affect the overall project."

In today's turbulent laboratory business environment, change is inevitable. Whether triggered by downsizing, offshoring or growth, the frequency of lab relocation has increased dramatically. Overall this dynamic has proven positive for lab managers faced with the need to contemplate both domestic and international lab moves now that a host of services such as RFID asset tagging and asset disposition are available as part of the relocation process. That said, the challenge of moving an entire laboratory remains a cause for angst. Regardless of the reason for a lab move, minimizing cost, downtime and overall disruption to business is paramount.

Selecting the right laboratory relocation partner

Safely moving high-end laboratory instrumentation, precious samples and hazardous materials efficiently is not a job for a standard moving company. Add the complication of operating within GLP/GMP guidelines, and the need for an experienced technical resource quickly becomes apparent.

Selecting a qualified lab relocation provider means doing a thorough audit of the provider's experience, processes, capabilities and resources.

- *Does the provider have defined processes that can be tailored to your specific requirements?*
- *Does the provider subcontract most activities or can it perform all or most tasks?*
- *Can the provider access additional resources rapidly or deliver the resources appropriate to the scale of the move?*
- *Does the provider have international capabilities, including knowledge of local regulatory requirements and local resources?*
- *Can the provider present case studies and references that demonstrate its ability to overcome unique obstacles?*
- *Does the provider offer any value-added services such as RFID tagging or surplus asset disposition services that can improve your relocation outcome?*

The initial meeting with a prospective lab relocation provider should include a checklist that takes into account these issues as well as the critical aspects of the move as outlined by internal stakeholders.

From the provider's perspective, an experienced lab relocation resource first seeks to understand the background of the relocation, the culture of the work environment and important issues that will affect the overall project. Developing relationships with stakeholders and ensuring that their concerns are highlighted within the project plan means most of your time is spent not in the actual act of moving but in the exhaustive measures required for move preparation.

As a result of the initial meeting, a lab relocation provider should be able to craft a preliminary project plan for evaluation. The preliminary project plan should demonstrate clear ownership and accountability by use of a high-level map of resources and checkpoints. Appointing a project leader who takes ownership for the entire relocation and is responsible for creating a project plan in partnership with the client company should also take place. The performance of the project leader can mean the success or failure of the move.

Planning, planning, planning

The project plan should include every operational aspect of the move in detail, complete with timetables, ownership and logistics. An equipment inventory audit must be carried out to verify what equipment needs to be moved and to address any shipment issues. Each instrument's location, configuration, operational condition and usage are documented. Any sensitive instrument or samples that require specialized transportation are identified. Then all assets are tagged systematically. Identification and resolution of logistical obstacles must also be addressed as part of the project plan.

The project plan should include a new location readiness status verification methodology, a process to help ensure that all site preparation activities are

accomplished in tandem with the relocation to avoid costly delays. The lack of utilities specifically can delay the entire operation. In addition, there should be enough flexibility built into the plan to account for any potential additions to the equipment inventory list.

The very essence of laboratory relocation is the safe and efficient move of laboratory assets. In many labs this typically entails working in a hazardous materials environment. Working in conjunction with Environment Health and Safety staff and Radiation Protection Services personnel, a deliberate stepwise approach is applied for the safety of all personnel. Procedures for the disposal of all hazardous materials prior to the move are first communicated. Chemical, biohazardous and carcinogenic inventory needs to be characterized and reduced before relocation. Packing, labeling, and storage of these materials must be in compliance with local, state and federal regulations. Safety procedures in the event of an emergency are reinforced.

Execution

A lab relocation provider should employ an experienced relocation team made up of specialists who have experience working with varied instrumentation and software platforms and are well versed in current regulatory requirements (for both transport and GLP/GMP environments). Having a team staffed with life and analytical science instrumentation specialists means that the relocation does not depend on the original equipment manufacturers to conduct these services. This consolidated approach to relocation saves time and money and improves the quality of service delivery.

On the day of the move, equipment is broken down systematically in a documented fashion and then prepared for shipment. After the instruments complete the journey, the lab relocation team handles the unpacking and reinstallation. When possible, the same members of the lab relocation team work both ends of a move.

Once at the new site, the equipment is reinstalled according to the system map established during disassembly. Alternatively, equipment can be reconfigured according to customer specification and value-added services such as RFID asset tagging—a technology that allows lab managers to accurately track instrument location—can be installed. In a GLP/GMP environment, the installation qualification/operational qualification (IQ/OQ) is conducted immediately.

The logistics challenges of any laboratory relocation can be overcome as long as the provider has the ability to tailor services that are also scalable. Today, the global economy fuels a need for intercontinental moves, so country-specific customs and licensing knowledge must be leveraged.

From complexity to opportunity

The logistical complexity of a laboratory relocation also represents a great opportunity to evaluate the current status of all laboratory assets. The thousands of pieces of equipment—from the simplest centrifuge to NMR systems—represent millions of dollars in asset equity that may be underutilized. Additional steps in the equipment inventory audit can include:

- *Obtaining existing service records, history, current preventive maintenance (PM) and validation schedules.*
- *Checking with OEMs to determine current parts inventory for older instrumentation*
- *Appraising all assets and making determinations for efficient deployment, or disposition in the case of underutilized assets*
- *Delivering findings and recommendations so that informed decisions can be made*

The activity allows for identification of surplus laboratory equipment so that it can be used where it is most needed within a customer's organization. Redeploying idle laboratory equipment can positively offset forecasted capital expenditure. Having this asset management step integrated into the actual laboratory relocation planning process ensures that the correct equipment is moved and deployed for the highest utilization. The redeployment or disposition of idle assets is only a part of the overall benefit for customers. Challenge lab relocation service providers to:

- *Conduct a life cycle analysis of currently utilized equipment to facilitate planning for future capital expenses*
- *Sell surplus equipment that represents an untapped source of revenue and frees up valuable laboratory real estate.*
- *Dispose of unwanted laboratory equipment in accordance with EPA guidelines*

Keys to success

The future productivity and profitability of a company in transition is directly impacted by its ability to execute relocation efficiently. Choose your lab relocation provider carefully. Challenge its track record, check its references and audit its resources.

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Strategic Procurement

LONG CONSIDERED A BACK-OFFICE FUNCTION, PROCUREMENT HAS EMERGED AS AN IMPORTANT ASSET IN EFFECTIVE LAB MANAGEMENT ***by Tom Russell***

"A strategic approach to procurement and associated enabling technologies is leading labs' efforts to control costs and equip researchers to succeed."

The importance of running an effective and efficient lab has never been greater, and today's pharmaceutical lab managers face a dizzying array of challenges. From a need to orchestrate the myriad tasks required for day-to-day operations to the growing demand for cost containment and a clear return on research and development investments, lab managers are continually faced with overcoming the realities of an increasingly challenging environment.

As many of the world's largest pharmaceutical companies move to implement a strategic and technologically enabled approach to obtaining R&D supplies and managing materials, research lab operators and procurement managers are already seeing firsthand that the benefits of procurement reform dramatically impact operations, budgets and even core missions. With a proven track record of rapid ROI in the pharmaceutical industry's most sophisticated R&D operations, a strategic approach to procurement and associated enabling technologies is leading labs' efforts to control costs and equip researchers to succeed.

The real costs of traditional procurement and sourcing processes

In research, the need for specific supplies often becomes apparent only as experiments evolve. Researchers and their assistants search paper catalogs and web sites, fill out purchase orders, acquire signatures for approval and wait. For the researcher who makes ad hoc purchases on urgently needed reagents, supplies and assays, the only choice often is to complete paperwork, pay extra for rush shipment and hope for on-time delivery.

For most lab managers and research procurement staff, the process rarely ends there. There are phone calls made and e-mails sent to the procurement department and suppliers to confirm contract pricing and determine when orders will arrive and if they will be on time, and calls back to researchers to confirm possible substitutions. On receipt of product, additional backtracking may be needed to determine why the wrong supply was received, followed by more research to determine if another lab has the needed supply—such as an important compound or reagent—in stock. Waste is rampant.

Enabling technologies alone have not provided the complete answer. Some labs have equipped researchers with internal purchasing tools that are supported by structure-based electronic catalogs and/or p-card purchasing capabilities, only to find that efficiencies gained in one area create increased costs and process delays in another.

Not surprisingly, most lab managers find it difficult to manage their labs' manual systems, which can be cumbersome and don't address the fast-paced nature of the lab environment. Perhaps most important, these manual systems do not provide for real-time monitoring of where money is being spent and even what is being purchased.

"Considering the broad accessibility of e-procurement systems and the very strong advancements in functionality made over the past five or six years, I continue to be surprised by the percentage of enterprises that utilize a fully or partially manual requisition-to-order process," says Andrew Bartolini, vice president of Global Supply Management Research at Aberdeen Group. "These enterprises are leaving money on the table by continuing their off-line strategies."

Today's strategic e-procurement technologies address the realities of lab work and fundamentally redefine how pharmaceutical researchers obtain the goods and services they need to bring tomorrow's drugs to market.

Fundamentals of strategic research procurement

A strategic approach to research procurement—one that returns hard cost savings on investment as well as empowers and assists researchers—rests on two primary tenets: leveraging the value of supplier relationships and empowering researchers to make the best possible sourcing decisions.

Leveraging strategic supplier relationships for sourcing requires aggregation of buying power—suppliers offer more favorable pricing, terms and conditions in exchange for greater market share. With researchers selecting goods and services from a variety of different suppliers, catalogs, etc., even the purchase of identical items is rarely done as a collaborative effort.

Without the data needed to keep volume discounts top of mind or the ability to aggregate spending across the lab, the opportunity to leverage the lab's buying power is lost.

With strategic procurement, labs can direct R&D spend to key suppliers and, at the same time, gain real-time insight into spend data. Spend is categorized consistently across purchases and supported by powerful analytical reporting to enable clear, fact-based identification of opportunities to put more attractive contracts or agreements in place. This real-time visibility into enterprise-wide spending enables professional buyers to negotiate better terms and conditions with suppliers, based not on the purchasing power of a single lab, but of the entire organization.

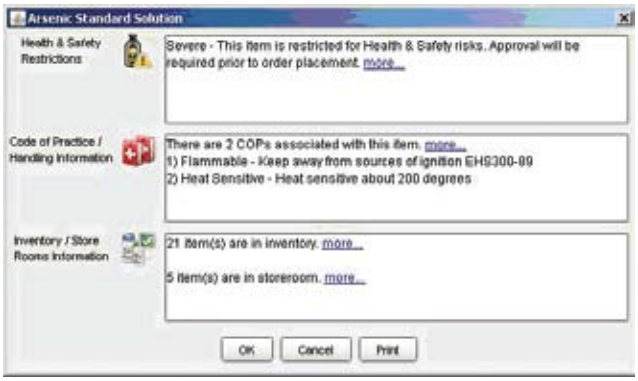
"Manual systems do not provide for real-time monitoring of where money is being spent and even what is being purchased."

The contracts that result often result in savings of up to 20 percent on items that are commonly purchased; for example, by directing purchases of solvents toward a preferred supplier in exchange for preferential pricing, invoicing and delivery terms.

Gregg Brandyberry, vice president of procurement for GlaxoSmithKline's (GSK) Global Systems and Operations, is widely known in the procurement profession as a pioneer and influential advocate for strategic procurement. Under Brandyberry's leadership, GSK won an ROI Baseline Award in 2005 from *Baseline* magazine for achieving the highest ROI ever verified in the competition—a 100 percent return every four business days.

Leveraging supplier relationships and achieving the associated benefits requires disciplined day-to-day compliance with strategic sourcing agreements. Some organizations have attempted to achieve compliance by placing lab management and procurement staff in rigid, bureaucratic roles, as overseers to catch and correct noncompliant behavior. Those efforts have generally achieved limited success, often with a severe impact on speed. In contrast, when procurement is seen as strategic rather than merely tactical, researchers are empowered to make the best possible sourcing decisions, coupling complete and accurate information with their knowledge of scientific requirements.

In particular, the best strategic sourcing decision may be to not make a purchase at all. Researchers with an urgent need for a particular material often purchase it without knowing that it is already in stock on-site. In most research labs, at least two-thirds of all on-hand chemical reagent inventory is distributed across several labs, with little or no visibility for researchers looking for chemicals. Because the fastest sourcing alternative is generally the container already on hand, and because each chemical container potentially carries handling and disposal costs that exceed its purchase price, this lack of visibility represents a major lost opportunity for cost and time savings.



Strategic procurement solutions provide a full profile of information for the user prior to placing the order, including whether the item is already in-house and where.

A strategic, empowering procurement approach instead gives researchers a complete view of available in-house inventories and purchase options—including electronic alerts that notify researchers when an item they want to purchase is already available in-house. Inventory information is accurate and reliable. Purchase options are presented with rich, descriptive information, accurate contract pricing, and clear identification and promotion of preferred suppliers. Information is standardized for streamlined flow through purchasing systems. Applicable health and safety risks are clearly identified prior to purchase confirmation and automatically trigger required approvals in the e-procurement workflow.

Perhaps most important, the resulting information is seamlessly integrated with ERP systems—ensuring that senior leadership and financial departments maintain a clear view of where money is being spent, how it is being used and how research ties into organization-wide systems and processes.

Enabling researchers to make the best possible sourcing decisions has dramatic benefits. SciQuest's clients have consistently achieved savings of 10 to 20 percent of total annual chemical spend by avoiding redundant purchases, and have reduced average delivery times by one to two days without incurring additional shipping costs.

"Without the data needed to keep volume discounts top of mind or the ability to aggregate spending across the lab, the opportunity to leverage the lab's buying power is lost."

Adoption – Focus on the researcher first

Achieving the promised benefits from e-procurement processes and technologies requires pervasive end-user adoption. Effective organizations achieve high adoption rates by focusing on the researcher's experience.

Users enjoy an online experience as simple and easy as ordering items from their favorite e-commerce site.

Where traditional procurement processes hindered researchers and lab managers with time-consuming paperwork, strategic e-procurement solutions present the same

online shopping experience consumers have come to expect on popular e-commerce sites. Utilizing an online shopping platform that enables researchers to quickly find the items they need in hosted electronic catalogs or "punch out" to suppliers' web sites, these solutions automate the entire procurement process.

Researchers log in, browse for needed items, add them to a virtual shopping cart and click "send." A purchase order is created, automatically routed electronically for the proper approvals, and delivered to the supplier, at which point invoicing and payment are likewise handled electronically.

"Real-time visibility into enterprise-wide spending enables professional buyers to negotiate better terms and conditions with suppliers."

The benefits of a researcher-focused e-procurement process aren't confined to pharmaceutical labs. John Riley, executive director of Purchasing and Business Services at Arizona State University, credits a new approach to procurement and e-procurement technology with helping the university attract world-class research talent to its more than 1000 labs.

"If you're a researcher in academia, you have a six-year window to set up your lab, bring together your staff, conduct your work, get published and attain tenure. When you consider how many purchases are required to get a lab up and running, it's not surprising that we receive inquiries from researchers who want to know what kind of procurement process we offer before deciding on which institution to work with. Automation can take months off the set-up process and ensure that researchers gain from greater efficiency."

One of Brandyberry's initiatives to empower researchers was to implement SciQuest's Enterprise Reagent Manager (ERM) at GSK. ERM, which allows researchers to use chemical structures in a "one-stop shop" for inventory and managed catalogs, is now in use or being rolled out at eight of the company's nine major research and development sites around the globe.

"Effective organizations achieve high adoption rates by focusing on the researcher's experience."

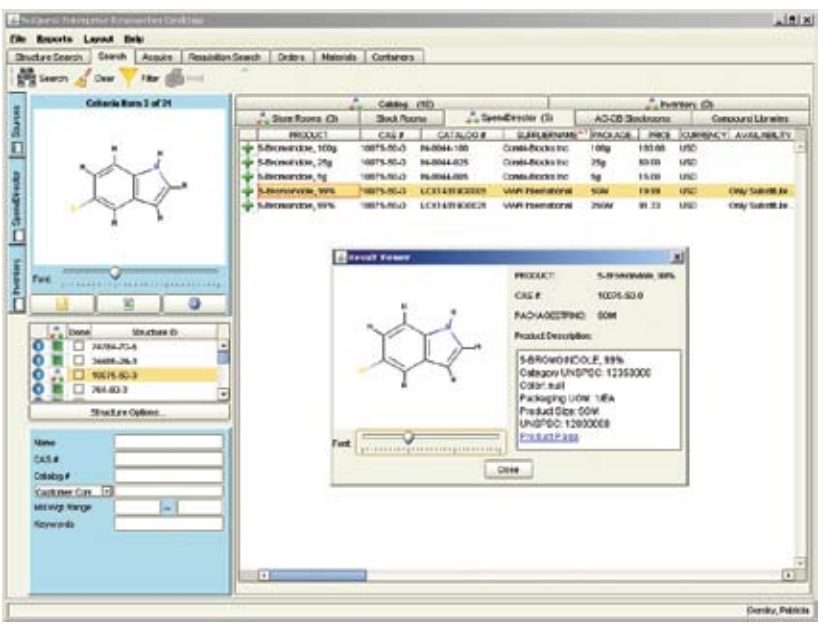
"A chemist can draw chemical structures and know exactly what he or she wants, but transforming that information into a request that the procurement department or most purchasing systems can understand or process can be difficult," Brandyberry says. "ERM takes that guesswork and frequent source of misunderstanding out of the equation. The researcher draws what he or she wants and the technology takes care of the rest."

While Brandyberry was quick to prove e-procurement's value and impact on the bottom line, he is equally proud of how procurement reform is modernizing the research function.

"The reality is that everything we do in the pharmaceutical industry starts and ultimately ends with the ability of our researchers to create new ways to combat disease and suffering," says Brandyberry. "There is no more important work. New procurement technologies and the efficiencies that result from them won't deliver tomorrow's innovative new drugs, but they do ensure that researchers have quick access to the materials they need and are freed from as many administrative interruptions as possible."

The promise (and threat) of emerging technologies

Other developments promise to extend the value of ERM and e-procurement technologies further; one currently available option is integration with compound libraries. While most pharmaceutical companies manage well-populated libraries of proprietary compounds, it can be difficult for researchers in disparate labs to quickly determine what is available on-site. As a result, researchers are forced to resynthesize needed compounds—a process that can add weeks to the discovery process. Integrating global compound library search and request capabilities with ERM greatly simplifies and streamlines searching and avoids unnecessary synthesis.



▲ *Researchers gain the ability to perform searches by chemical structure rather than by name, which can often lead to errors.*

Web services and mobile computing promise further opportunities and end-user benefits by making key capabilities portable and interoperable. Imagine a researcher using an e-lab notebook to plan an experiment, and searching for and requesting the required materials without leaving that application, or scanning an empty bottle with a mobile device to request a replacement. These technologies offer exciting potential to streamline researcher operations and drive adoption; however, unless they are rooted in core strategic procurement capabilities, including keeping an accurate inventory and managing catalog content with accurate contract pricing and promotion of preferred suppliers, these technologies can just as easily create more downstream issues, costs and delays.

"When procurement is seen as strategic rather than merely tactical, researchers are empowered to make the best possible sourcing decisions."

Given the advancements and innovations now shaping how pharmaceutical labs purchase the materials they need, one would think that procurement reform would be a top-of-mind issue in the research community, but Brandyberry cautions that procurement, when done right, is simply accepted as a matter of course.

"Leveraging supplier relationships and achieving the associated benefits requires disciplined day-to-day compliance with strategic sourcing agreements."

"For years, labs have operated with little thought given to how they procure crucial materials. It's only when researchers have the opportunity to utilize new technologies for themselves that the laborious nature of existing systems becomes so evident. Technology is like that. We thought fax machines were highly efficient until the Internet came along. E-procurement is no different."

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WHAT'S SO SPECIAL ABOUT SPECIALTY GASES?

KNOWING THE ANSWER CAN MAKE A BIG DIFFERENCE IN ANALYTICAL TEST RESULTS **by Mike Lee**

"Trying to replace a specialty gas with an industrial gas in order to save a few dollars at the onset will surely cost the buyer considerably more money downstream."

Laboratory gases will always play a significant role in the everyday life of anyone working in any lab. A gas chromatograph (GC) or a mass spectrometer (MS) is just a sizable paperweight without gases. But with the myriad gases and gas grades to choose from and gas company representatives who are not always up to speed on the upper end of the specialty gas spectrum, how does one make the best choice?

Industrial gases versus specialty gases

Standard gases that are used in tasks such as welding or metal cutting are called "industrial gases." Tanks are filled with the gas of choice for the application and shipped out to the customer. When the tank comes back empty it is simply refilled, and out the door it goes again.

This is not the case with specialty gases. A specialty gas must meet or exceed a particular set of specifications and should never be allowed to leave the gas company's gas lab until the cylinder in question has proven its worth under great scrutiny. Using ultra-high-purity (UHP) helium as an example, let's walk through the process involved in earning the coveted "ultra high purity" status. First, the cylinder is fitted with a positive open/closed valve that ensures a high level of leak integrity. Second, the cylinder must be treated to a baking process to remove any contaminants from the inside of the cylinder walls. The tank is placed in an oven and baked for eight hours at 140°F. During the baking process, the tank is purged with an inert ultra high purity gas and then quickly placed under vacuum. This purge/vacuum sequence is repeated seven times during the eight-hour baking period.

"Dirty gas delivered to equipment that is expected to utilize ultra high purity gases will cause adverse results."

▲ *Bakeout oven*

The purpose of this process is to break the polar bond of any existing moisture molecules that have affixed themselves to the inside of the cylinder walls. This thermal energy transfer frees the molecules from the cylinder walls and the purge/vacuum process removes the contaminants from the tank. Trapped within these moisture molecules are other harmful contaminants such as hydrocarbons and particulates. When this process is complete, the cylinder is clean enough on the inside to accept and maintain the integrity of an UHP gas. We can introduce our prepared cylinder (now under vacuum) to its new occupant, the UHP helium. Once the cylinder is filled it goes to the lab, where chemists put the cylinder through a battery of tests to check for contaminants such as moisture, total hydrocarbons and oxygen. Once the cylinder has passed that test, it moves on to the gas chromatograph to again prove its worth. Passing the analysis by the GC earns the tank a shrink-wrapped valve and a place within the "specialty gas" family. If these procedures are not followed, it is akin to putting clean milk in a dirty thermos—you are going to get dirty milk out. Dirty gas delivered to equipment that is expected to utilize UHP gases will cause adverse results.

"A specialty gas must meet or exceed a particular set of specifications."

Buyer beware

Trying to save a few dollars on gas purchases might seem like a frugal thing to do, but it can come back to bite the unsuspecting buyer. If a gas company is not quite up to speed with specialty gases and their applications as well as the adverse results to the customer's equipment, it may very well deliver an industrial gas to a life science or R&D lab. The results can be very damaging for the end users. Industrial-grade helium used in a GC will jam the columns with moisture in the hundreds or thousands of parts per million (PPM) level and render the test results useless. Another contaminant that will wreak havoc is hydrocarbons, which will surely be in excess and cause additional problems. This scenario always results in a repeat of the failed analysis, repeat processes, replacement of the gas tank and repair work to the GC along with a considerable dose of aggravation. Any gas that needs to meet a particular specification is a specialty gas and is truly special. Trying to replace a specialty gas with an industrial gas in order to save a few dollars at the onset will surely cost the buyer considerably more money downstream.

Ultra-high-purity helium must meet the following specifications:

Moisture (H^2O).....1.0 PPM

Total hydrocarbons (THC).....<0.5 PPM

Oxygen .....<1.0 PPM

By contrast, industrial-grade helium may have many hundreds or even thousands of PPM of each contaminant.

Gas-related equipment is critical

Even with the right UHP helium in your lab, you are not yet ready to deliver it to your process. The gas pressure regulator that goes on the tank is as important as the gas grade itself. If an industrial-grade regulator is put on an ultra high purity gas cylinder, the gas will be contaminated right back down to an industrial grade quality. Industrial-grade regulators commonly have neoprene diaphragms, and neoprene is a hydrocarbon (contaminant). They also have a very low leak integrity and can draw moisture (contaminant) into the gas stream along with a dose of oxygen (contaminant) from the air.

◀ *Analytical panel*

A good choice for UHP helium is a pressure regulator that has a leak integrity of 1×10^{-9}. It will also have stainless steel diaphragms and Teflon and Tefzel seats and seals. This regulator will maintain the integrity of the UHP helium and deliver it to your process as intended, with no issues.

Don't forget the process line either. We would hate to go through all the trouble above just to have someone put a rubber-based hose on the regulator to deliver the gas to process. UHP helium requirea stainless steel hose with a stainless steel core. A standard stainless steel pigtail is commonly Teflon lined, and very fine helium molecules will find their way right through the Teflon and out into the atmosphere. Go the last step to ensure the integrity of the gas by purchasing the right hose.

▲ *Gas process system*

Hassle-free operations

Now you have the right grade of gas, the right regulator and the right hose to deliver the gas to process. What is left to do? Enjoy your analytical test results without fear of contamination from the gases or gas-related equipment.

Partner your business with a gas company that has the answers to your questions and has the right people in the field with a broad knowledge base regarding the products they sell and the equipment you use. Be sure there is an elevated level of service that goes along with your gas purchases.

Mike Lee *is specialty gas manager at Middlesex Gases & Technologies. He can be reached at MLee@middlesexgases.com or by phone at 617-733-5946.*

OPTIONS DRIVEN BY SPECIALIZED APPLICATIONS, COST OF CONSUMABLES AND USE OF WORKSPACE

by Tanuja Koppal

Manual pipetting, even using multichannel pipettes, is slow, monotonous and variable, and has the potential to cause repetitive stress injuries to laboratory workers. Automated liquid handling systems, on the other hand, are precise, accurate, fast and consistent. They also decrease errors within and between operations, help conserve expensive reagents and rare or hard-to-produce samples, and save time.

"For specialized applications, the liquid handling systems are often coupled to or integrated into other robotic systems."

Liquid handling systems are very diverse in their applications and cater to the throughput and speed of automation that the user needs. They range from single-channel pipetting systems to those with 8-, 96- or 384-channel pipette heads. Modules are also equipped to handle a wide range of volumes, from nanoliters to microliters. Generic operations performed by a liquid handler include serial dilution, plate reformatting, plate replication and array printing. Specialized applications include PCR setup, whole genome amplification, high-throughput screening, high-density array printing, cell culture and more. For such specialized applications, the liquid handling systems are often coupled to or integrated into other robotic systems. "We have liquid handling aspects integrated into a few of our microplate readers," says Joseph Machamer, product manager of Market Development at Molecular Devices (now part of MDS Analytical Technologies). "In some assays there is so little time from when the reagent is added to when the signal is generated that you need to have the plate and the optics in close proximity."

In cell culture, the liquid handler is often integrated into the microplate handler and washer to facilitate proper dispensing of reagents and washing of cells. "Washers and dispensers to do cell-based assays need to have features and controls that are different and above those that are typically used for biochemical assays," says David M. Donofrio, director of market development at Molecular Devices. "For cell-based assays the cells have to be kept intact, since the signal intensity is intimately tied to the number of cells in a well." Hence, the speeds at which reagents are being dispensed and aspirated become very important. There are systems currently on the market designed specifically for use in either cell-based or biochemical assays. These systems have the appropriate software programs that can control and fine-tune such variables as dispensing pressure, aspiration pressure, probe height and position, all of which can affect the integrity of the cell layer. However, having one system that can work well for both types of assays would be ideal and is something that is currently being worked on.

Some other factors to consider when choosing a liquid handling system are the system's expandability and its ability to operate in an x, y and/or z direction, fixed or disposable tips and their configuration, volume range, individual channel control, layout flexibility, size, and budget. Budget is, of course, one of the biggest considerations, and while the cost of the robotic instrument is certainly important, the cost of consumables for long-term use cannot be overlooked. Most users need to decide up front whether to purchase a liquid handling system that uses fixed or disposable pipette tips. Fixed tips are reused again and again, so while they might seem like the most cost-effective option, they can cause erroneous results due to sample carryover and are expensive when the entire array must be replaced. While carryover is not a concern for disposable tips, which are replaced after each assay or pipetting function, there is the matter of quality, fit, range, availability and price. Hence, when choosing fixed over disposable tips, the types of samples that will be used, the accuracy and precision needed for specific applications, and the length of time the pipettes will be used are all factors that have to be carefully evaluated.

"While the cost of the robotic instrument is certainly important, the cost of consumables for long-term use cannot be overlooked."

Another factor is the availability of laboratory space. Some liquid-handling workstations are compact enough to be used on a benchtop or inside a laminar hood. Some systems also offer flexibility and multiple configurations for setup and are more efficient in their use of the available workspace. There are also modular and scalable liquid handling systems that can meet the needs of the laboratory now, as well as in the future as user needs increase.

Tanuja Koppal, Ph.D., *is a freelance science writer and consultant based in Randolph, N.J.*

For a complete list of liquid handling manufacturers and suppliers, go to www.LabX.com.

BECKMAN COULTER

Biomek Laboratory Automation Workstations are offered in multiple versions—the Biomek NX^{P}, FX^{P} and 3000—that have in common a flexible design and integrated pipetting, dilution, dispensing and integration in a single system. Applications that have been implemented on the various platforms include automated PCR and sequencing reaction setup, cytokine detection, genomic DNA purification from whole blood, human IL-8 assay, plasmid purification, sample preparation and ADME toxicity assays. The Biomek FX^{P} can serve as the central component in a Biomek Assay Workstation—a complete automation system, including labware storage, incubation, plate washing, plate reading and other components.

www.beckmancoulter.com

BIOTEK INSTRUMENTS

The EL406™ 1536-well Microplate Washer Dispenser offers fast and efficient microplate washing in 1536-well microplates—for even complex washing routines. Accurate and precise dispensing is available from both peristaltic and microprocessor-controlled syringe-drive reagent dispensing technologies. Additionally, the EL406 1536-well Microplate Washer Dispenser is backwards compatible with 96-well and 384-well microplates for increased versatility. All functions are controlled via Liquid Handling Control™ PC software or the instrument's onboard keypad, and the unit is BioStack™ Microplate Stacker–compatible for high throughput requirements.

www.biotek.com

THERMO FISHER SCIENTIFIC

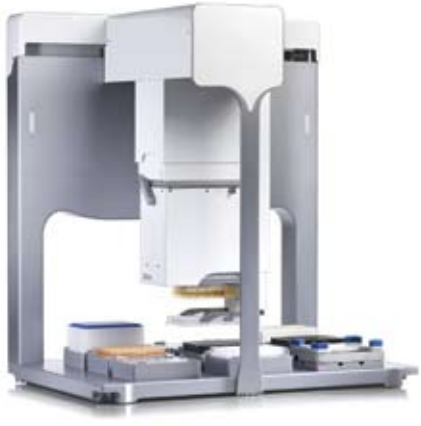
The liquid handling module for the ArrayScan VTI HCS reader offers synchronous dispense-while-imaging capability combined with kinetic image capture, a range of image analysis algorithms, and "on the fly" processing, which allow real-time capture of cellular phenotypes and rapid biological responses. Multiple aspirate/dispense options enable dye loading, media replacement, incubation and stimulus addition to be fully automated. Integration with the ArrayScan software allows full use of intelligent acQuisition, multiple protocols and automated plate handling. All functions are easy to use, and multiple aspirate, dispensing and mixing options are available from four deck locations for simple and highly flexible experimental setup.

www.thermo.com/cellomics

VELOCITY11

The Bravo automated liquid handling platform is a versatile, small-footprint liquid handling system capable of dispensing from 100 nL to 200 µL in 96-, 384- and 1536-well formats or to a column, row or single well of any of these plate types. Its space-saving, nine-plate position footprint can fit inside a standard laminar flow hood, enabling automated liquid handling for cell-based assays or hazardous reagent handling. The deck is easily customized to meet a wide range of assays, with numerous plate pad options. Additionally, the open design of the platform permits access from all sides for simple integration with other devices and unencumbered stand-alone use.

www.velocity11.com



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CELL CULTURE EQUIPMENT GETS SMALL AND "APPLIANCE-LIKE"

by Tanuja Koppal

For high-throughput, multi-user laboratories that are involved in running diverse assays and demand high capacity and walk-up capabilities, investing in the right robotic systems becomes critical. Several factors come into play when choosing the right system to adopt. Cost and availability of space are always important considerations. Expandable capacity, ease of use and integration of multiple systems are particularly important for labs looking to grow significantly. Reliability and technical support are critical to labs dealing with multiple users and round-the-clock use. Options for automating are often expensive and labor intensive, and customization is not always feasible. Hence, making the right choices early on is critical.

"Pharma is now moving toward biopharma, which is driving the need for cell culture automation."

A lot of processes involved in cell culture that were once performed manually by skilled technicians, are now being automated by robotic systems connected to each other by software programs that help coordinate all the various activities. The use of cells in the drug pipeline has also increased in recent years.

"Pharma is now moving toward biopharma, which is driving the need for cell culture automation," says Graham Threadgill, director of life science automation, Discovery Products Business Center, Beckman Coulter Inc. Cells are used for primary and secondary screening from early discovery all the way to drug manufacturing. Hence, the systems designed to automate cell culturing are both plate-based and flask-based to accommodate small- and large-cell volumes. Particularly in drug discovery, more companies are migrating from biochemical to cell-based assays.

"There is a continuing trend toward more cell-based assays, and we are observing this trend in the large number of requests that we are receiving for environmentally controlled systems for assays and plate-based cell maintenance," says Debra Toburen, senior product manager of integrated systems at Velocity11 (now a part of Agilent Technologies). "Fifty to 80 percent of the assays that some of our customers are running are cell-based."

The robotics for cell culture automation range from the large, motion-controlled tabletop systems that incorporate several robotic components and can perform multiple washings, incubations and readings all in one run to those that consist of only the basic components needed for an assay, such as the dispenser, washer and reader. The trend being observed is the replacement of large automation platforms with smaller workstations that are individually managed by a few people, as companies shift their strategies from shotgun approaches with large libraries to screening with smaller and more targeted libraries.

"Five years ago we saw giant rooms full of automation, and we now find that it is trending down to more individually managed laboratory systems," says David M. Donofrio, director of market development at Molecular Devices (now part of MDS Analytical Technologies).

Automation is also becoming less specialized and being incorporated in various labs within the same organization. "In the past, researchers wrote their own methods, programmed and tested them. But now, all they are looking to do is push a few buttons to change a few variables," says Threadgill. "You no longer have the automation expert in the organization, and so you need to make the automation systems much easier to use, more simple and 'appliance-like.'" The automation systems for cell culture are specially designed to offer a protected, contamination-free work area that can be controlled for temperature and humidity. Hence, software control is turning out to be a critical aspect.

"For cell culture, seeding and feeding cells can takes days if not weeks, and the robotic systems are often running overnight. The software has to be able to handle and coordinate all those processes throughout the long time period," says Threadgill. The software also manages data handling and sample tracking to determine what is happening to each sample throughout the entire process.

Users are also looking to vendors for more service and technical support, and many companies have started offering multiple levels of customer training. "We provide on-site, end-user training on how to write a protocol and access the system," says Toburen.

However, for those customers looking to become their companies' resident experts on the use of the platform, Velocity11 provides more extensive technical training. "They [customers] will come on-site and get trained on all instruments and software to help them gain the necessary expertise."

Tanuja Koppal, Ph.D., *is a freelance science writer and consultant based in Randolph, N.J.*

For a complete list of cell culture automation manufacturers and suppliers, go to www.LabX.com.

AUTOMATION PARTNERSHIP

The CompacT SelecT automated cell culture and assay-ready plating system is suitable for smaller medium-throughput laboratories. The system grows cells from multiple cell lines in T-flasks for cell line maintenance and expansion. It can generate assay-ready plates on demand for cell-based screening and assay development. From standard CHO stable cell lines to embryonic stem cells, most adherent mammalian cell lines can be easily grown in the system, with minimal change from the standard manual flask-based processing. HYPERflask and triple-flask processing options can be added to increase the incubation capacity and allow rapid output of bulk cell suspensions. These can be used directly in assay systems or for freezing into cryovials as part of a frozen cell screening strategy.

www.automationpartnership.com

TECAN

Based on the Freedom EVO® liquid handling workstations, these flexible platforms can be tailored to automate most cell biology processes, with options to allow passaging, isolation, suspension handling, counting and incubation of cells in a protected environment. Intuitive software controls and automatically schedules the optimal time course for transfection, expansion, harvesting and plating to grow assay-ready cells at the user's request. A range of cell processing solutions have been proven in numerous applications in academia, small biotech and large pharma alike.

www.tecan.com

MATRICAL

The MACCS™ automated cell culture system features a modular, expandable design and the ability to work with Roboflasks, T-flasks, shaker and spinner flasks, microtiter plates, and roller bottles. The system can hold cryovials at -80°C and then bring those cells up in any plasticware currently available. It also has full shaker capability, thus allowing automated hybridoma production. Online cell monitoring ensures consistent cell supply every day. Vaporized hydrogen peroxide (VHP) sterilization and HEPA filtration ensure a continuously sterile environment. A six-axis robotic arm provides high throughput, industry-leading reliability, and sophisticated motion control for gentle processing of cell cultures and various consumables. The incubator module design ensures uniform temperature, CO^2 and humidity control.

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COST PRESSURES DEMAND RELIABILITY AND ROBUSTNESS

by Tanuja Koppal

For a laboratory involved in routine assay development and screening, achieving higher throughput depends on the ability to process multiple batches of assay microplates accurately and swiftly. Hence the need for a microplate management system that provides efficient and less erroneous handling of plates. "We have systems in place for high-throughput primary screening, where you need to process a large number of microplates, as well as for secondary screening, where you are doing a large number of different assays," says Debra Toburen, senior product manager of integrated systems at Velocity11 (now a part of Agilent Technologies). "You need these systems where you want to automate repeatable tasks and ensure reproducible results."

Microplate management systems include a variety of robotic instruments that are designed to perform very specific functions, such as microplate handlers, stackers, washers, dispensers and plate readers. Some are designed to perform even more specific functions, such as plate piercing, sealing, barcoding and centrifugation. All these instruments are equipped with the appropriate software programs to help them function seamlessly and accurately.

Automated, unattended, reliable operation seems to be what most users demand from their microplate management systems. That is often driven by the constant pressure to drive down the costs per assay while generating better quality data. "It's the same mantra that has been chanted for years—do it faster, do it better, do it cheaper," says David M. Donofrio, director of market development at Molecular Devices (now part of MDS Analytical Technologies).

"Automated, unattended, reliable operation seems to be what most users demand from their microplate management systems."

In order to drive down reagent costs, most labs in industry have migrated from screening in a 96-well format to screening in a 384-well format. A few have also moved to an even more miniaturized platform, using 1536-wells. "But 1536-well microplates have been slower to adopt and use because of issues relating to infrastructure, evaporation of liquids and surface tension that are still being worked out," say Donofrio. There are also challenges working with 1536-well plates for cell culture. Washing cells and performing media exchanges become difficult when dealing with small volumes and well surfaces.

There are a few other considerations when choosing a microplate handling system to run assays that are cell-based, and most of them are dependent on the robustness of the cell. The hardware and software have to be designed to enable manipulations that minimize disturbance to the cell layer and provide a controlled, sterile environment for handling longer incubation times and multiple plate movements. "We have a customer working with stem cell–based assays, and that adds another level of fragility to the cells and [hence] to the assay," says Toburen.

"1536-well microplates have been slower to adopt and use because of issues relating to infrastructure, evaporation of liquids and surface tension that are still being worked out."

Most microplate handlers available in the market today are designed to meet standardized plate configurations and enable rapid scale-up to allow automated handling of thousands of samples and plates. Most systems are also very flexible, in that they can accommodate all different types of plates—microplates with and without lids, pipette tip boxes, deep-well microplates and low-profile microplates, and sometimes even vials and tubes. Microplate stackers work in conjunction with the microplate handlers to offer a convenient and reliable solution to stack, store, retrieve and deliver multiple microplates, and most come with options to expand their capabilities. Most equipment providers also have partnerships that allow them to integrate components from other vendors to fulfill the customer's needs and preferences.

Tanuja Koppal, Ph.D., *is a freelance science writer and consultant based in Randolph, N.J.*

For a complete list of microplate management system manufacturers and suppliers, go to www.LabX.com.

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Perspective On: A Biofuels Lab

THE U.S. DEPARTMENT OF ENERGY'S BIOENERGY RESEARCH CENTER DOES EVERYTHING FROM CHEMICAL AND BIOCHEMICAL ANALYSES TO BIOENGINEERING TO PROCESS SCALE-UP TO MICROBIAL STRAIN DEVELOPMENT ***by Sara Goudarzi***

Powering businesses, homes and cars with fossil energy—such as coal, oil and natural gas—has been a source of increasing concern for years, mainly because of the consequences of human-produced climate change and global warming from greenhouse gases, primarily carbon dioxide.

The U.S. Department of Energy's Bioenergy Research Center at the National Renewable Energy Laboratory (NREL), in Golden, Colorado, has zeroed in on the goal of producing liquid transportation fuels that are derived from renewable resources such as plant biomass and algae to alleviate and ultimately eliminate the addition of more carbon dioxide to the earth's atmosphere.

"In the short term we're focused on producing ethanol from lignocellulosic biomass, the parts of the plants that are used to provide their structure," says Mike Cleary, National Bioenergy Center director.

"This is unlike the way we produce ethanol today, which is either from the starches that are found in corn or the sugars in sugar cane," he adds. "So, our

goal is to work on technologies that allow us to break down all the plant's matter rather than just the starchy parts of the plant."

The process

Mother Nature produces a complex multilaminated material to make plants stand up straight. The main component of this material is cellulose, the most abundant of all naturally occurring organic compounds. Cellulose is built of the same sugars that go into starches, but with a single change in the chemical bond—from an alpha to a beta in a 1, 4 linkage—it becomes a material that is much more difficult to break down by most living organisms.

Inside the human mouth, for example, there is an abundance of enzymes that can break down starches, but there are only a few organisms in the world—fungi, termites and microorganisms in a cow's stomach—that can break down cellulose. The break-down product from both of these processes is the same as from starch: glucose, a simple sugar.

"Our goal is to break down lignocellulose and turn it into sugars so that we can ferment those sugars, back into alcohols the same way you would with starch or malted barley in a brewery to make beer, or grape sugar to make wine," Cleary explains.

But this process is complicated by the fact that the cellulose is wrapped with a lot of other non-readily digestible materials, mainly hemicelluloses and lignin. Lignin is a complex phenolic material that acts as a glue to hold the strands or fibers of cellulose together to give rigidity to the plant material.

▲ *The thermal pretreatment of lignocellulosic biomass disperses the glue-like lignin into droplets of varying sizes. In this false-color image from NREL's Biomass Surface Characterization Laboratory, the lignin droplets, shown in orange, range from 50 to 10,000 nm in diameter.*

Cleary and his team have the task of figuring out how to open up this structure so that enzymes can be added to break it down into sugars that can be fermented into ethanol and other biofuels using an economically viable proces

Two routes

There are actually two ways to break down lignocellulose: biochemical conversion and thermochemical conversion.

With biochemical conversion, scientists take biomass, for example agricultural waste such as corn stover—leaves and stalks—and chemically treat it to open up the structure before enzymes do their job and break it down into sugars.

"Once you've achieved the ability to make sugars cheaply, there are lots of organisms [and] lots of companies working on making fuels from them," Cleary says.

By contrast, the thermochemical route involves taking the plant biomass and cooking it in the absence of oxygen, which, instead of burning it, breaks it down partially to a liquid or completely into a gaseous state—a product known as synthesis gas.

▲ *Currently, ethanol is primarily produced from the starch in kernels of field corn. NREL researchers in the DOE Biofuels Program are developing technology to also produce ethanol from the fibrous material (cellulose and hemicellulose) in corn stalks and husks or other agricultural or forestry residues.*

"The focus is on producing gas that is heavily concentrated in carbon monoxide and hydrogen," Cleary explains. "Those are really the ultimate gas break-down products that you're looking for from biomass.

"This synthesis gas can then be used as the starting point to synthesize hydrocarbon biofuels using technologies that were developed as far back as World War II, when Germany was producing synthesis gas from coal to make diesel."

"WHEN IT COMES TO THE SCIENCE DISCIPLINES THAT ARE REQUIRED FOR RUNNING A LAB SUCH AS THE BIOMASS RESEARCH CENTER, A MAIN INGREDIENT IS DIVERSITY."

Germany was not a gasoline producer during World War II; therefore, its entire army was dependent on diesel. The country generated thousands of barrels of diesel a day from coal. But Cleary's center is focused on using plant biomass, not coal or natural gas, as the starting material.

Another method of producing fuel using the thermochemical route is to cook down the biomass and stop when it turns liquid, before it becomes a gas. The oil-like compound, called pyrolysis oil, has the potential of being purified into something known as a biocrude, a crude oil substitute that can then be processed into transportation fuel using existing oil-refining technologies.

"It's not anything like crude oil, because it has a lot of different chemical properties, including more oxygen and other 'contaminants' not found in crude oil. So it needs to be upgraded to eliminate them. But if that is accomplished, it's much more energy dense and then can be used just like crude oil as an intermediate for the production of fuels," explains Cleary.

Range of disciplines

In order to accomplish the goals of the center, Cleary looks for a very broad range of scientific disciplines, including biochemistry, enzymology, microbiology, molecular biology, chemical catalysis and bioengineering, for his workforce.

For research and development involving the biochemical and thermochemical routes for developing biofuels, he looks for researchers with strong analytical capabilities and a good understanding of the compositional analyses of biomass.

"One of the things we need to do is to characterize this material," he says. "It's a complex, heterogeneous material, so we do a lot of wet chemical analysis to determine the composition in terms of how much is cellulose, how much is hemicellulose and how much is lignin.

"We then employ more efficient spectrometric methods, such as near-infrared [NIR] spectroscopy to rapidly produce analyses of thousands of samples."

The center also looks for specialized chemical engineering personnel who can identify the kinds of equipment required to break this material down or pretreat it under specific temperature, pressure and pH conditions.

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Researchers are also needed to study those specific enzymes most useful for breaking down the biomass and to identify and genetically manipulate the microorganisms that convert the sugars into ethanol in order to improve their conversion efficiency.

"We work with bacteria and yeast that have been genetically engineered to not just metabolize glucose from the cellulose into ethanol but can also take pentoses such as xylose and arabinose from the hemicelluloses and convert them to ethanol as well," Cleary explains.

The center does everything from chemical and biochemical analyses to bioengineering to process scale-up to microbial strain development.

The Thermochemical Users Facility (TCUF) is equipped with sophisticated data monitoring and operation control systems. This control room monitors all key operating parameters simultaneously.

"We have everything from molecular biologists and microbiologists to biochemical engineers, chemical engineers, analytical chemists and NMR spectroscopers," Cleary explains. "If you pick a discipline in one of those areas, we have at least one or two Ph.D.s working in that area."

Approximately 40 employees of the 120 who make up the Biomass Research Center are Ph.D. researchers. After the Photovoltaic Research Center, the Biomass Research Center is the second largest within NREL.

Biochemical Processing Pilot Development Unit

Clientele

Approximately 80 percent of the Biomass Research Center's funding comes from the Department of Energy (DOE). Additionally, the center relies on grants from other government agencies as well as cooperative research and development agreements (CRADAs) with industrial companies.

"So we have various sources of funding that drive our R&D laboratory, but the primary one is the Department of Energy's Biomass program," Cleary says.

"The only small jobs that we take are associated with compositional analysis of different kinds of biomass, whether it is agricultural wastes—primarily corn stover—bagasse, which is the residue from sugar cane, and wheat straw or other herbaceous or woody biomass feedstocks, such as switchgrass and poplar."

Switchgrass and poplar are not yet produced in commercial amounts, but are expected to be among the dedicated bioenergy crops of the future.

Unique challenges of an alternative energy lab

When it comes to the science disciplines that are required to run a lab such as the Biomass Research Center, a main ingredient is diversity.

"We need people who are algal microbiologists," Cleary explains. "We need process engineers who understand the scale-up of getting from the shake flask to the fermentor. And we need people who understand how to get from the bench scale to the pilot scale.

"We have two large pilot facilities that allow us to thermochemically break down up to a half-ton a day of biomass into synthesis gas or pyrolysis oil, and biochemically break down up to one ton a day of biomass to sugars that can be fermented to ethanol. So we have not just a breadth of disciplines but a range of scales at which we work."

One of the unique challenges for Cleary and his team is how the money used for research is passed down to the Center. Because most of the

funding comes from the DOE, the Biomass Research center primarily functions as a government-directed research laboratory. However, the operating company that oversees the management and operations of the laboratory is an independent nonprofit organization.

"We are managed and operated under a new contract with the DOE by a company called the Alliance for Sustainable Energy, which itself is an LLC formed by a joint commitment of Battelle Research—one of the world's largest nonprofit research organizations—and the Midwest Research Institute.

"So our funding and revenue for conducting research is not directly handed to us through the government appropriations system," explains Cleary. "It's actually given to a managing organization that controls how we spend that money ultimately."

Another unique challenge is that the center is run as a hybrid organization. There's a university feel with some of the research and development work for the DOE, but it's also similar to a commercial research entity where the team receives an annual budget and sets up yearly research plans to achieve specific economic process targets.

"Our emphasis is on doing research that is cost driven," Cleary explains. "So we're focused on taking discovery science products and [performing] transitional research that ultimately can be taken by industry and commercialized and deployed."

Project management

The Biomass Research Center is a matrixed organization, and Cleary is responsible for line management of the operation, including oversight of the research personnel and its facilities. In addition, the center has a lab program manager who is responsible for management of DOE research.

"He's responsible for setting the milestones, the research goals and the requirements needed in terms of human and scientific resources," Cleary explains.

Cleary works closely with the program manager and the people who are responsible for the work break-down structure and for all the resources that the lab needs in order to address those research goals and targets.

"So we're not a traditional hierarchical lab, we're a highly matrixed organization where people sometimes wear two hats," he says. "I wear one hat in the sense that I'm responsible for management of the organization, which means dealing with people and their performance, and facilities, improvements and all the scientific equipment and acquisition of instrumentation necessary for us to achieve our research goals."

Instrumentation

Two of the many analytical instruments used in Cleary's lab are gas chromatography (GC) systems and mass spectrometers. Both of these types of instruments are heavily used to analyze input materials, intermediate while converting biomass to biofuels and output.

For example, if a group were analyzing the input feedstock of biomass, they'd be responsible for providing the process engineers with information on the original composition and the intermediate products.

"If we take a material and pretreat it, we want to know how we've changed the composition and the biochemical properties of the material," says Cleary. "We also use [these instruments] in process engineering to understand how we've changed the material in the process of converting the biomass to biofuels."

Purchasing and maintenance

Both maintenance and purchasing are broadly overseen at the center. The center counts on the manufacturers of the instruments to provide maintenance.

For purchasing, Cleary relies heavily on the knowledge and expertise of his research staff to identify what exactly is required to carry out the work.

"We work pretty much like any other lab in the sense that, on an annual basis, we determine what kind of instrumentation is required for our program needs, which are critical for what we're doing in terms of our major projects or are required in terms of general capabilities, and where that fits depends on who pays for it," Cleary says.

If the instrument is required for general facilities capabilities, the money used to pay for it comes from the center's technical overhead. But if an instrument is required for specific aspects of the biomass/biofuels program, it's paid for with program funds that were acquired from the DOE or industrial partners.

"The decision making of purchasing ultimately runs through my office, but all the decisions in terms of what's required and the negotiations in getting the funding and prioritizing are a joint effort," Cleary says.

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

WHEN DISASTER STRIKES, DON'T BE CAUGHT UNPREPARED!

EFFECTIVE EMERGENCY MANAGEMENT REQUIRES PREPAREDNESS, MITIGATION, RESPONSE AND RECOVERY TO PROTECT PERSONNEL, SAMPLES, RECORDS AND OPERATIONS

by Glenn Ketcham and Vince McLeod

The graphic stories of the aftermath of Hurricane Katrina in 2005, wildfires in California and flooding in the Midwest provide images not soon forgotten. As of the writing this article, there have been 74 federally declared disasters in the United States in 2008. Earthquakes can strike in many areas of the country without warning, and increased tropical storm activity is forecast for the next couple of decades. Floods, earthquakes, tornadoes, blizzards, ice storms, fire, heat waves, loss of utilities, and terrorist or activist activities can all have major effects on laboratory operations.

While it is the catastrophic disasters with their alarming headlines that grab everyone's attention, professional emergency managers have long recognized that, regardless of their size or cause, the impacts at a local level are often similar. Because of this, emergency managers have long emphasized adopting an "all-hazards" approach to emergency planning and recovery. An all-hazards approach focuses on preventing the likely detrimental effects of any type of disaster and reducing the consequences of these effects. Emergency plans should use function-based planning and not incident-based planning. Power loss, for example, may be the result of many potential incidents (a windstorm, a downed tree, an ice storm or even a car hitting a power pole). Regardless of the cause, there are actions that must be taken to ensure the protection of employees, samples, records and operations within the facility.

One can think of emergency management as having four primary phases:

- **Preparedness** – The planning and preparations required to handle an emergency or disaster
- **Mitigation** – The steps and activities related to preventing future emergencies or minimizing their effects
- **Response** – The actual activation of the emergency plan when the need arises
- **Recovery** – The actions needed to restore normal operations

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Let's briefly touch on each of the four phases of emergency management. It should be pointed out that each approach, as described, is scalable from the operation of an entire research campus to the management of a small biotech company or a large clinical facility down to an individual research laboratory.

Preparedness

This is perhaps what is traditionally thought of as emergency planning. It includes developing written plans and procedures to ensure that critical operations are maintained. One recognized approach is to develop an emergency management structure that has elements common to all emergencies (e.g., a command structure, defined critical operations, operations) and then develop a set of specific annexes to deal with unique problems. Preparedness includes identifying essential supplies and actions, critical positions and specific roles and responsibilities; determining orders of succession (who's in charge when the boss is away?); delegating specific authorities; communicating; and, of course, ensuring the safety of staff. Facilities should be assessed for potential vulnerabilities and strengths. Issues as mundane as elevator or loading dock access can become very important when use of these elements is denied.

"Emergency plans should use function-based planning and not incident-based planning."

One plan does not fit all, and plans should be customized to your operations, region and potential hazards. In other words, don't just pencil-whip a plan from some template you find on the web (though these can serve as a good starting point), but really consider your specific circumstances. In areas that can be struck by catastrophic hazards without any warning, such as earthquakes in the West or along the New Madrid fault, it may be necessary to store a supply of drinking water and food if personnel could become stranded. In other areas where events can be reasonably foreseen, such as blizzards in the North or hurricanes along the Gulf and East coasts; where storms can sometimes be tracked for days before impact, fewer reserves may need to be kept on hand but different preparations may need to be made.

The most important aspect of emergency planning is to ensure the safety of the staff during an emergency and afterward. Most organizations will not want people staying in the facility unless they are tied to some essential function. However, if there are critical operations that require staffing, one or more secure locations should be identified for personnel who must work during an emergency. In some circumstances it may be advisable to offer refuge for the families of essential staff. Workers are often more apt to volunteer for extended work or to work during an emergency if they are not worried by thoughts of their families' safety.

"Plans should be customized to your operations, region and potential hazards."

Mutual aid agreements with other labs or institutions and emergency aspects of vendor contracts should also be reviewed as part of this process. This action might be required at an institutional level, but it is also necessary to know that those empowered to take action have reviewed the agreements and contracts. It is also very important to exercise all sections of your plan. This can be accomplished through a variety of approaches—from tabletop drills to full-scale exercises. One word of caution: Limit the scope of each exercise so meaningful information can be learned. If the exercise is too ambitious and too many failures occur too early in the process, valuable lessons may be lost.

Mitigation

This key aspect helps keep problems from occurring in the first place or limits their severity. These are typically engineering-type solutions to address vulnerabilities identified in the planning process. Examples might include an emergency generator to power critical equipment, earthquake strips for shelving, portable heaters or air conditioners, flood control and even protection of computer-based information by using frequent backup and off-site storage of data and records. Once vulnerabilities are identified, it is important for organizations

to budget toward solutions. In some cases grant monies from state or federal sources are available for certain types of hazard mitigation.

Response

First and foremost during a disaster is the safety of personnel, followed by the protection of the science. The staff should be in secure quarters and not take action until they can do so safely. In some instances this means not entering damaged structures until they are assessed by engineers or emergency personnel. Lines of communication must be maintained throughout the event.

"Mutual aid agreements with other labs or institutions should also be reviewed as part of this process."

Recovery

One will generally want to restore normal routines as soon as possible after the event. However, it is likely that not all issues can receive equal attention, especially following a major event. This may be a time of competing needs. Staffing shortages are likely, and those who are able to work may be overwhelmed by the tasks they must complete. As in the old sports adage, "you play like you practice," the same holds true in incident response. It is imperative to have developed and exercised a plan in which position assignments were made in advance and a clear command structure exists. This allows for the most effective use of resources and reduces wasted time and effort when it can least be afforded. Actions such as assessing damage, making emergency repairs, clearing immediate hazards and contracting with vendors for assistance may all be required following a major event. In certain circumstances, especially for public institutions, some costs may be recoverable from FEMA. The rule here is document, document, document! If you cannot prove that a cost was incurred, FEMA will probably not pay. Insurances, including business interruption insurance, if applicable, should be reviewed for adequacy.

An important related consideration that is often included as a separate plan is called a "business continuity plan" (BCP) or "continuity of operations plan" (COOP). A COOP address those critical functions that must be carried out in the short term should the normal business location become unusable. The foundation of this plan relies on identifying the critical "business" functions that must be sustained and selecting potential alternate facilities in advance. Associated with identifying the alternate facility is developing a system to move critical operations, tasking and training of essential staff for plan activation, and securing the equipment and supplies needed to accomplish this effort. Using the power loss example above, if a major transformer is damaged and power is unavailable for a particular facility for several days to weeks, lab operations and samples may need to be quickly relocated or otherwise protected.

This discussion just scratches the surface of emergency and disaster planning. Adequate planning and practice can make even a large-scale event more manageable and help speed recovery efforts. There is a wealth of information available from federal and state resources. Local emergency planning officials are often happy to lend assistance and review plans. The return on investment will more than pay for this effort should a disaster ever hit your facility.

Glenn Ketcham *is a certified industrial hygienist with 25 years of experience in the health and safety field. He is currently the risk manager for the University of Florida, with responsibility for the general liability and insurance programs, loss prevention, ergonomics, emergency management, and the occupational medicine surveillance program. He has managed the laboratory safety programs for the University of California, San Diego, and the University of Florida. In addition, he served as an industrial hygienist with federal OSHA compliance and has a Master of Science degree in environmental engineering sciences with a health physics concentration.*

Vince McLeod *is a certified industrial hygienist and the senior IH with the University of Florida's Environmental Health and Safety Division. He has over 20 years of occupational health and safety experience in academic research, with a focus in the research laboratory. His specialties are in hazard evaluation and exposure assessment.*

HOW IT WORKS

Microwave-Assisted Extraction

Problem: Extracting compounds from various samples using traditional methods involves some give and take. You can choose to use Soxhlet, which is relatively inexpensive for equipment but uses a tremendous amount of solvent and takes hours to run. Sonication is fast, but it also requires copious amounts of solvent and banks of individual sonicators (which also adds to the cost) if your lab handles more than a few samples a day. Pressurized solvent extraction uses much less solvent, but only processes six samples per hour and the equipment is costly.

Solution: Microwave extraction has been used for many years to extract compounds from plastics, biological samples, foods, animal feeds, paper, wastewater and many other types of samples. In early 2008, the U.S. Environmental Protection Agency (USEPA) approved Method 3546 for microwave extraction of organic compounds from soils, sludges and sediments. It is a proven technique that is fast, uses significantly less solvent than traditional techniques and is cost-effective.

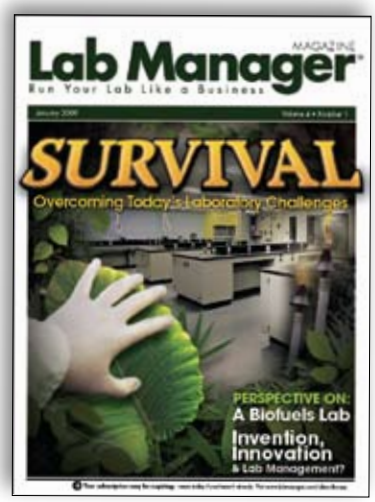
With the capability to process 40 samples simultaneously and a patented Xpress technology that provides optimum control for high-pressure extractions, the MARSXpress™ (CEM Corporation) microwave reaction system provides a fast, reliable platform for busy analytical laboratories, allowing 80 extractions and filtrations to be performed in less than four hours. The system uses 90 percent less solvent than Soxhlet, making it a much more environmentally friendly technique.

MARSXpress Microwave Extraction System

The advanced technology of the MARSXpress system makes it remarkably easy to use. The IR temperature sensors and the advanced design of the MARSXpress vessels allow the system to accurately measure the internal temperature of each vessel virtually instantaneously. The dual, NIST-traceable, calibrated temperature system provides unmatched control that you can rely on for the extraction results you need.
First, the sample is weighed into a patented MARSXpress vessel and solvent is added. Microwave extraction is much more efficient than other methods, so you use significantly less solvent than with other techniques. The vessel is then capped and loaded into the carousel. The MARSXpress vessel features a simple screw-on cap and does not require the use of special tools. The carousel is then placed in the microwave, the appropriate method is loaded and the system is started. The MARSXpress comes with a pre-loaded library of USEPA-approved methods, though you can always program your own. Finally, the "start" button is pressed and your extractions are under way. It's that simple. The SynergyPrep™ software displays and records temperature readings for all the vessels, so you will know for certain how well each sample performed. This is especially helpful when running samples from different sources on the same carousel.

Chemists in busy testing labs need accurate, dependable results in a timely manner. The MARSXpress system provides those results with a method that can help significantly reduce solvent usage and is also cost-effective.

For more information, go to www.cem.com.



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○ Automotive
○ Petroleum
○ Security/Forensics
○ Fine and Specialty Chemicals
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○ Principal Investigator
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○ No

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○ Identify Strategic Problems/Opportunities Relating to Research Projects
○ Have Business Responsibilities Related to Research Projects
○ Plan for Change/Growth in Research Projects
○ Determine How to Gain Competitive Advantages Via Research Initiatives
○ Determine the Impact of Research Activities on Company's Business Strategy
○ Select Areas of Investment to Enhance Research Operations
○ Evaluate and Make Capital Equipment Purchase Decisions
○ Other

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HOW IT WORKS

Point-of-Use Ultra Pure Water

Problem: Slow production of laboratory-grade ultra pure water necessitates storage in large carboys. Many lab technicians will fill carboys up to 30 liters to locally store and dispense ultra pure water. High purity water stored in such large volumes will quickly degrade in quality. Water storage has become necessary due to the low-dispense flow rates of most lab water-purification systems.

Point-of-use laboratory water-purification systems typically have flow rates of about 1 L per minute. Filling a carboy can take up to 30 minutes and the process is often left unattended. Manual filling operations lead to spills and potential flooding of the laboratory. Carboy filling is a waste of valuable laboratory time and resources.

Ultra high purity water stored in large containers will quickly degrade in quality due to exposure to the atmosphere. The carboys themselves will contribute impurities to the water as they age, degrade and become dirty. Also of concern is biological contamination due to the stagnant, ambient storage conditions of these containers.

Faster flow rates and PLC controls are needed to allow technicians to dispense deionized water on demand. Volumetric dispensing is needed to allow for repeated filling of containers in a variety of sizes.

Gemini-MB Point-of-Use Polisher

Solution: The Gemini-Mini Basin (Gemini-MB) is a wall-mounted, high-flow, point-of-use polisher that can dispense ultra pure water at a rate of 3.7 lpm. The flow rate is more than three times faster than that of traditional polishing systems. The system is a true water polishing unit that can produce large volumes of ultra pure lab water between filter replacements when fed with deionized or reverse osmosis treated feed water. With PLC control, the Gemini-MB can be intuitively programmed to automatically fill and stop at precise volumes to eliminate the need for continual supervision.

Flexible dispensing features include:

- Standard ability to program four independent batch volumes. The user can program one batch to fill 100 ml beakers and another to fill 30 L carboys.
- Remote dispensing gun with full recirculation and submicron filter.
- Direct feed of equipment downstream.

Filtration technology:

- Multi-pass UV system provides sterilization of the flow path as well as the dispensing port.
- TOC UV destruction unit reduces the total organic carbon content of the product water.
- Submicron filtration removes bacteria and viruses.
- Ultra filtration for RNase, DNase free water.
- Ion-exchange technology features high purity, low TOC demineralization resins.

The Gemini-MB provides an easy and cost-effective solution for quick filling of containers or small vessels with ultra pure water and eliminates spills and flooding with automated control. The extremely high water-production rate can eliminate the need to store water at all.

For more information, go to www.arieswater.com.

HOW IT WORKS

Multicolor Flow Cytometry

Problem: Flow cytometry is a powerful technology that allows researchers and clinicians to perform complex cellular analysis quickly and efficiently by analyzing several parameters simultaneously. The amount of information obtained from a single sample can be further expanded by using multiple fluorescent reagents. The number and combinations of fluorescent reagents that can be used by a flow cytometer depend on the types of lasers, filters and detectors with which each instrument is equipped. The more lasers and detectors an instrument has, the more simultaneous detection of colors it is capable of. However, by increasing the number of colors (reagents), researchers are also incorporating additional levels of complexity.

Solution: Multicolor flow cytometry enables more data to be gathered about a sample in a shorter amount of time, giving researchers not only enhanced efficiency and high-quality data, but also more data from less sample than what would be required for serial analysis. There are several factors researchers should consider before developing a multicolor flow cytometry assay with more colors in a single tube.

Instrument type: The type of instrument that the researcher has access to, and its availability, will define how many and what colors can be used in the experiment.

BD FACSAria™ II

Experimental need: Some simple assays require only two to four colors, so researchers would not need to consider more colors.

Availability of reagents: Once a researcher knows which colors his or her instrument supports and which antibody markers are required, he or she will need to identify reagents conjugated to an appropriate fluorochrome.

Expertise in multicolor panel design: Many researchers do not have the experience or technical understanding to put the ideal or most appropriate color combinations together that will maximize their chance at success. This can lengthen the time it takes to get results.

Advanced flow cytometry tools are being developed that will allow researchers to use multiple colors more effectively. BD Biosciences offers a comprehensive set of multicolor solutions, including cutting-edge flow cytometry instruments and software, high-quality reagents and knowledgeable technical applications support.

BD FACS™ (fluorescence-activated cell sorter) brand flow cytometry instruments support a growing number of multicolor applications and are ideal choices for multicolor flow cytometry. BD flow cytometers, including the BD FACSCanto™, BD FACSAria™ II and BD™ LSR II systems, provide the reliability and versatility needed for use today and in the future. In fact, the BD LSR II benchtop flow cytometer processes 70,000 events per second, measuring up to 18 fluorescent colors.

BD FACS DIVA 6.1 software includes a CS&T (cytometer setup and tracking) feature that, in combination with the BD CS&T Beads, automatically sets up and tracks the day-to-day performance of the cytometers and adjusts automatically to ensure reduced variation and reproducible results in your multicolor flow cytometry assays over time.

For more information, go to www.bdbiosciences.com/colors.

YOUR LABORATORY FAILED AN IMPORTANT SAFETY INSPECTION...

NOW WHAT?

1 Is there an immediate safety hazard that must be addressed?

If the safety inspection revealed an immediate hazard, fix it now. A serious safety violation poses a very real threat to your lab, your equipment and your staff. Do not delay in doing whatever is required to correct the situation.

2 Is there a deadline for the corrections to be made?

Other than immediate hazards, if you have two weeks or a month to get the rest of the issues resolved, don't wait for the deadline. If you have two weeks, do it in one. Make a list and fix things right, paying close attention to actual safety, not just following the technical requirements of safety. Following the rules is not enough to keep you safe. The lab must be engineered so that it's easy to be safe there. This means clear pathways, no clutter, and organized supplies and tools.

3 Is there a budget for the correction?

If time and money have been budgeted for this improvement, your job just got a lot easier. But in these tough economic times, that might not be the case. Do not despair. Since your safety is not only important to you, but up to you, budget time every day to fix at least one area of your lab. If that means you have to stay late or come in early, do it.

4 Are you working alone or with a team?

If you have several people to help, assign tasks that each person can complete on his or her own or with a helper. Most cleanup and organizing jobs can be tackled by one or two people at a time. Smaller groups make the decision making easier as the project unfolds. Use these three steps: 1) Assign the task; 2) Clearly define the goal; 3) Set a deadline. A chart or graph showing the progress of each task is a great motivator for those doing the work and a valuable tool for management. Communicate your progress. This not only lets people know what is going on but also heightens the awareness of safety.

web box For an article on controlling clutter in the lab, visit: *www.labmanager.com/january/cclinks.*

5 Do you know exactly what to do and how to do it?

If you are an expert in safety and organization, your task is easy. If you are not, it's time to do the research that will ultimately save you both time and money. There are plenty of how-to articles and data on lab cleanup, lab safety and lab organization. As with any lab project, research spent up front will pay off enormously later on. Chemical hygiene is a vast subject, and although your lab has its own specific needs, the plans in place at industrial, medical and academic labs are readily available on the Internet. No need to reinvent the wheel. Take the best from the best and make it work for your lab.

6 Why be clean and organized anyway?

First of all, clutter is one of the major causes of accidents in the lab and second, it's a space hog. Spillage, breakage and cross-contamination are common side effects of a cluttered lab bench. Not only are contamination and clutter bad for experiments and general scientific results, they make a bad impression on resident workers and guests.

7 Does your lab have a mission statement?

Just like walking into a classroom and balancing an unbalanced organic equation left on the blackboard which must be done to ensure creation of the right molecule, your lab needs a mission statement to ensure that it creates the right results. A mission statement not only clarifies your lab's goals to you and your associates but lets management know that you know where you are going. Safety and overall lab success rely on communication and performance, but they need to be measured in real results. So write a short, clear mission statement for your lab.

8 What's new?

Read. Read. Read. There is no substitute for spending at least 10 percent of your time keeping up with new developments and technology. No matter what field of science you are in, it is always changing. Even if what you read does not pertain specifically to your area of science, it will stimulate you to think and make changes you would not otherwise.

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PARTING POINTS

Takeaways from this month's issue:

Surviving Challenging Times, p. 10

Samuel Liggero offers the following managerial guidelines to follow at all times, but especially in times of uncertainty and turbulence:

- Establish clear goals for all employees with clearly defined areas of responsibility and accountability.
- Communicate, motivate and inspire.
- Get out of the way.
- Invest in your employees.

Invention, Innovation and Lab Management, p. 14

Dr. John Lienhard, emeritus professor of technology and culture at the University of Houston, offers the following suggestions to help lab managers increase the invention productivity of their staff:

- Devise methods of instilling a sense of freedom in the research staff.
- Allow staff members to challenge conventional thinking.
- Do not punish staff members for failing when they take risks.
- Allow staff members to work flexible hours.
- Get to know staff members well.

Strategic Procurement, p. 28

A strategic approach to procurement and associated enabling technologies is leading labs' efforts to control costs and equip researchers to succeed. Benefits include:

- Leveraging the value of supplier relationships.
- Empowering researchers to make sourcing decisions.
- Directing R&D spend to key suppliers.
- Having real-time insight into spend data.
- Giving researchers a complete view of available in-house inventories.

What's So Special about Specialty Gases? p. 34

Laboratory gases will always play a significant role in the life of any lab. Making the right choice means knowing that:

- A specialty gas must meet or exceed a particular set of specifications.
- The gas cylinder should prove its worth under great scrutiny.
- The gas pressure is as important as the gas grade itself.
- The integrity of the gas also depends on the quality of the processing line.

When Disaster Strikes, Don't Be Caught Unprepared! p. 50

Emergency plans should use function-based planning and not incident-based planning. The four primary phases of emergency management are:

- Preparedness – Preparations required to handle an emergency or disaster.
- Mitigation – Steps related to preventing future emergencies or minimizing their effects.
- Response – Activation of the emergency plan when the need arises.
- Recovery – Actions needed to restore normal operations.

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Laminar Flow Hoods

Vertical Laminar Flow Station includes PLC control over motorized shield, FFU and lighting to meet Class 100 standards.

Starting at $5,970

Laboratory Ovens

Dozens of models available. Large-capacity forced-air oven (shown) provides stable heating to 220°C.

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