Lab Manager MAGAZINE®

Run Your Lab Like a Business

July/August 2009 Volume 4 • Number 6

VALUING DIVERSITY

CHALLENGES IN DEVELOPING AND MANAGING LABORATORY WORKFORCE DIVERSITY

Journey to the Efficient Lab

Performance Reviews

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Run Your Lab Like a Business

www.labmanager.com July/August 2009

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SURVEY SAYS: In a recent *Lab Manager Magazine* survey on purchasing water purification systems, we learned that 40 percent of respondents did not know what type of ASTM Standard Type system they were using. Of those that did know, 20 percent use Type I, 10 percent use Type II, and 10 percent use Type III. When asked which purity level of ASTM Standards lab water they required, 66.67 percent said ASTM Type I, while a full third said they were not sure. When asked how satisfied they are with their systems, 36 percent are very happy, 27 percent happy, 18 percent satisfied, and 18 percent not happy.

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The Perfect Mix

A number of years ago, after I graduated from college but couldn't yet bear to leave the academic nest, I took an administrative job in one of the campus research labs. My memories of that brief experience circle around a cast of colorful characters who could have very well made up a United Nations roster. First there was Wang (I never knew his first name), a 6' 3" graduate student from China who did joint research with 5' 7" Moty (short of Mordehei), from Israel. Whatever the research was they were doing (I can't recall) involved shouting, bickering over methods, and much laughter. I also recall Debra, married with two children, whose PhD eventually earned her a stellar career in the pharmaceutical industry. There was also Dimitri from Greece, Karim from Iran, Alex from New York and Karen from Texas, whose sweet, slow drawl was the perfect auditory antidote to Alex's heavy Brooklyn accent, which stood out in this northern California research setting. I remember cake and cookie celebrations for everything and anything, good humor, affection and lots of banter. These were serious researchers from every corner of the earth doing very important work in an environment that was as productive as it was delightful.

This month's cover story takes a look at the issue of diversity; specifically, the challenges and rewards of welcoming those with very different backgrounds into your lab. Whether state or federally mandated or not, Scott Page, professor of complex systems, political science and economics at the University of Michigan, says, "The more diverse group has more problem-solving tools at its disposal and therefore more power to design solutions." So, go ahead, mix it up.

Like them or hate them, performance reviews are not going away any time soon. While not everyone agrees on their usefulness, the author of this month's Leadership & Staffing article argues that in order to achieve organizational goals and improve performance, "staff members need to know what is expected of them," and that "performance reviews provide a way for lab managers to communicate these expectations while motivating staff members to meet them."

Fume hoods are important and critical pieces of equipment in many labs; however, they don't lend themselves to proper operation. This month's Technology & Operations article makes a case for hiring a fume hood certification company to provide technical expertise, keep track of equipment and service due dates, and expertly perform all necessary tests.

"Journey to an Efficient Lab" on page 40 shares the first hand experience of one lab manger who, reluctantly at first, allows a team of outsiders to set his lab on a path toward decreased cycle times and increased savings. In the article, Mark Gibson shares other lessons learned, saying, "I have realized that there are times when the lab manager must stand alone, maintain a commitment to a chosen path of action, and be patient while colleagues develop their own understanding and conviction about new processes."

Lastly, with summer upon us, I hope you all make time to relax, enjoy friends and family and refuel for your research efforts ahead.

Kind regards,

Pamela Ahlberg
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VALUING DIVERSITY

CHALLENGES IN DEVELOPING AND MANAGING LABORATORY WORKFORCE DIVERSITY

by John K. Borchardt

"Diversity drives innovation," writes Scott Page, professor of complex systems, political science and economics at the University of Michigan[1]. Lab management would suffer without the multiple perspectives and experiences afforded by a diverse workforce. "The key to innovation, in economic terms, resides inside the heads of people—the more diverse the better," notes Page.

However, the latest data from the National Science Foundation (NSF) indicates that in many fields American citizens of African, Hispanic and Native American descent are substantially underrepresented compared to their population in the overall U.S. workforce. Women have made substantial progress in representation in many scientific fields.[2]

"BEING DIVERSE IN A RELEVANT WAY OFTEN PROVES HARD. BEING DIVERSE AND IRRELEVANT IS EASY."

For lab managers to achieve diversity in the laboratory workplace and use it to enhance innovation and productivity, they must go beyond meeting the legal mandates of not only federal equal employment opportunity laws and regulations but also those mandates of their respective states. While mandates are still the most important steps to achieving diversity in the workplace, diversity is a broader concept than ethnicity, race, gender and age. Other dimensions of diversity include disability; religion; nationality; sexual orientation; and veteran, military, marital and citizenship status.

Importance of diversity

"Innovation—once the solitary pursuit of genius—has become a collaborative enterprise, understandably, since the types of problems we must address these days are too complex for one or two or three people, or a whole lab, or even the resources of an entire company," says Irving Wladawsky-Berger, chairman emeritus, IBM Academy of Technology.[3]

"The more diverse group has more problem-solving tools at its disposal and therefore more power to design solutions. Moreover, those diverse perspectives can be super-additive," observes Page. "Diverse groups of problem solvers outperformed the groups of the best individuals at solving problems. The reason: The diverse groups got stuck less often than the smart individuals, who tended to think similarly."

"Diverse perspectives—seeing the world differently—provides the seeds of innovation. …The right perspective can make [solving] a problem easy," observes Page.[1] For example, Tony Montana, vice president of scientific operations for Garden State Nutraceuticals, notes, "Our structural analysis team consists of five members, each of a different cultural background. Their backgrounds and education are quite diverse from each other. Nevertheless, they communicate quite effectively as a team, and the diversity of their backgrounds allows each to present [his or her] own different views and opinions in regard to problem solving. They have established themselves as one of the most productive and innovative teams within our organization."

Lab managers working with their human resources departments can institute practices that promote hiring and maintaining a diverse workforce. What are some of these practices?

Achieving a diverse workforce

Achieving a diverse laboratory workforce is very challenging. Data from the NSF indicates that the U.S. science and engineering workforce is substantially less diverse than both the U.S. workforce as a whole and the portion of the workforce that has earned college degrees.[2] Data from the last eight years indicates a slow progress in achieving a more diverse science and engineering workforce in terms of racial and ethnic diversity, although significant progress has been made in achieving gender equality in terms of employment.

This is consistent with the latest available data from NSF surveys for the entire science and engineering workforce. Figure 1 indicates that, considering all degree levels, women now constitute more than half the full-time employed science and engineering workforce, aged 29 years and less. However, what is perhaps most disturbing from the NSF data is that, with the exception of the growing percentage of scientists and engineers of Asian extraction, minority groups have made little progress in the last decade in terms of representation in the full-time employee science and engineering workforce. For example, when comparing the 16 million full-time employed scientists and engineers under the age of 75 years with the youngest full-time employed cohort, the 2 million aged 29 and under, the percentage of African Americans actually declined slightly from 6.0 to 5.6 percent, while the corresponding percentages for Hispanics are 5.6 and 6.9 percent (Figure 1). For the youngest age cohort, these percentages are less than one-third of the number of people of the same age group in the general U.S. population. Comparison of other age cohorts presents a similar picture; the diversity of the science and engineering workforce is not increasing substantially.

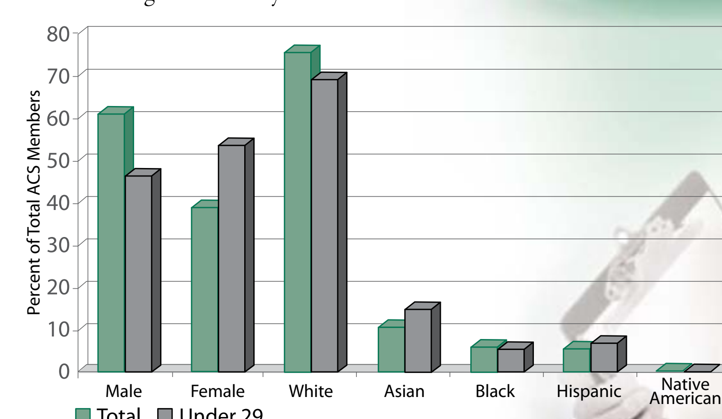

Figure 1. Comparison of group representation for all ACS members versus those under age 29. This comparison indicates that with the exception of women and chemists of Asian descent, the relative number of under-represented minority groups is not increasing among younger ACS members.

This lack of diversity traces back to the relatively low number of minority students earning their degrees in science and engineering. According to National Institutes of Health Deputy Director Raynard Kington, the 2000 U.S. census data indicates 40 percent of U.S. 18-year-olds were African American, Hispanic or Asian.[4] This group will become a majority by 2050. Yet, NSF data for graduate students indicate that underrepresented minorities in the science and engineering workforce will not increase substantially in the near future.

"LAB MANAGERS MUST GO BEYOND MEETING THE LEGAL MANDATES OF NOT ONLY FEDERAL EQUAL EMPLOYMENT OPPORTUNITY LAWS AND REGULATIONS BUT ALSO THOSE MANDATES OF THEIR RESPECTIVE STATES."

In the reference section, number 5 reviews possible causes of the continued low representation of most minority groups in the science and engineering workforce. One cause of limited workforce diversity cited was that students and faculty are often poorly informed about the full array of science and engineering career options available outside the academic research sector. Constance Thompson, manager, Diversity Programs for the American Chemical Society, suggests that laboratory managers set up visits to local high schools, colleges and graduate schools. There they can discuss career options—including management and other positions that are located at or away from the lab bench—with students and faculty.

"STUDENTS AND FACULTY ARE OFTEN POORLY INFORMED ABOUT THE FULL ARRAY OF SCIENCE AND ENGINEERING CAREER OPTIONS AVAILABLE OUTSIDE THE ACADEMIC RESEARCH SECTOR."

Given the limited diversity of the talent pool, lab managers have to not only look hard to find suitable minority job candidates, but also must compete with each other to hire and retain them.

Hiring and onboarding

"Though hiring managers are well aware of EEO practices, they tend to hire based on how well a scientist will fit into a department from an interpersonal perspective rather than hire the best person for the position," says Montana. "This tends to limit diversity since the hiring manager will tend to fill a position with a scientist with a cultural background that is similar to that of the existing team members."

Should this "fit factor" be less emphasized when deciding whether to make a candidate an offer? Perhaps, in the case of making a decision between two otherwise equally qualified candidates, lab managers should sometimes select the candidate who seems less of a fit with the laboratory workplace culture.

Effective onboarding is particularly important for new employees having diverse backgrounds and who initially may feel uncomfortable in an unfamiliar workplace culture. Mentors are particularly important for these new employees. Some experts believe that a critical factor in assigning a mentor to an employee is to match the gender or racial or ethnic backgrounds of the mentor and new employee. However, given the limited diversity of the laboratory workforce, this can be difficult or impossible, particularly at small laboratories that have a limited pool of employees from which to choose mentors.

Managing a diverse lab workforce

Even after achieving a diverse laboratory workforce, challenges remain for lab managers. "Being diverse in a relevant way often proves hard. Being diverse and irrelevant is easy," Page notes.[3] Managing a staff and keeping it focused can be more difficult when the workforce is more diverse than it is homogeneous. For example, Montana notes, "It is customary for scientists of different cultures to interact more with individuals from their own culture rather than with those from different cultures. This results in the formation of subgroups within the laboratory and is a detriment to the formation of high-performance work teams within the lab." Of his own firm Montana says, "The language of the lab is English, and all team members are [required] to speak and write in the English language to ensure that they can understand and communicate with each other."

"LAB MANAGERS HAVE TO NOT ONLY LOOK HARD TO FIND SUITABLE MINORITY JOB CANDIDATES, BUT ALSO MUST COMPETE WITH EACH OTHER TO HIRE AND RETAIN THEM."

Understanding the outlooks and motivations of their diverse coworkers is challenging for both lab managers and staff members. The only model that young staff scientists have for managing technicians reporting to them is their old professor-graduate student relationships. Consequently, recently hired researchers often make incorrect assumptions about what will motivate lab technicians that report to them. For example, graduate students are highly motivated by the prospect of having their work published in research journals and presented at conferences. This is a common feature of the scientific culture in nearly all countries and thus shared by graduate students of diverse backgrounds. Some technicians may share these motivations. However, some other excellent technicians will not because of their different cultural background. Consequently, rewarding them with a co-authorship on trade journal papers or attempting to get them excited about being the co-inventor on a patent isn't effective. The researcher and laboratory manager must find other ways to motivate these individuals.

So, where can laboratory managers go to find more information on how to manage a diverse staff, particularly in difficult situations such as staff reductions? The minority programs of professional science societies (see sidebar) are one option. Thompson suggests that the Society for Human Resource Management (SHRM, www.shrm.org) can provide the laboratory manager with useful resources for managing diversity. SHRM can be particularly useful when lab managers are interested in onboarding new minority employees or when downsizing.

Wrap-up

In order to be productive, lab managers and staff members must be open to the diverse viewpoints and cultures of each other even if sometimes they may not understand them. Besides, diversity certainly makes for a more interesting laboratory workplace!

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THE ROLE OF PROFESSIONAL SOCIETIES

By John K. Borchardt

Some professional societies offer programs to encourage young individuals of diverse backgrounds to become scientists and engineers and to succeed after becoming laboratory scientists. For example, Project SEED, an ACS program, has successfully encouraged economically disadvantaged high school juniors and seniors to major in science or engineering in college. Project SEED does this by placing and paying them to work in academic laboratories over the summer and experience what it's like to work in a laboratory. In addition, Constance Thompson notes that several ACS units exist as communities in which minority members can learn from each other and from experts. These include the Women Chemists Committee, Younger Chemists Committee, Committee on Minority Affairs, Committee on Chemists with Disabilities, and the recently formed Senior Chemists Task Force focusing on the needs of chemists over 60 years of age. When laboratory managers are interested in making contact with members of these groups, Thompson recommends they contact them directly. They can also contact ACS local sections and the ACS offices of Career Services, Diversity Programs and Undergraduate Headquarters at ACS national headquarters in Washington, DC. (Telephone: 1-800-227-5558).

She also observes, "Contacting local faith based institutions in communities of color, fraternity and sororities and organizations like The Urban League, NAACP, and La Raza affiliates, can be effective as they have long standing programs aimed at preparing students for careers.

The American Academy for the Advancement of Science works with the National Science Foundation on the HBCU-UP Research Conference. The AAAS holds this meeting to "as a means to teach students (and some faculty) at mostly undergraduate historically black colleges and universities (HBCUs) the ins and outs of a research meeting" according to Richard Weibl, Director of the Center for Careers in Science and Technology for AAAS. "They do posters, presentations, and other professional development activities…MySciNet is a community space where scientists and students can network and make connections on the basis of their own self-identified race, ethnicity, gender, disability, and sexual orientation as well as on the basis of specific career and scientific interests," explains Weible.

The AAAS Entry Point! internship program (http://ehrweb.aaas.org/entrypoint/) recruits, places, and assists students with disabilities. Working with IBM, Pfizer, Merck, NASA, NOAA, Google, Lockheed Martin, CVS, NAVAIR, Infosys, and university science departments, AAAS identifies and screens undergraduate and graduate science and engineering students with disabilities and places them in paid summer internships. AAAS also participates in the Collaborative for Enhancing Diversity in Science (http://www.cossa.org/diversity/diversity.html).

Programming at national science society conferences provides specialized information for their minority members. Depending on the program, managers may also benefit by attending. For example, the Pittsburgh Conference organizes Science Week for precollege students and often sponsors diversity sessions. The ACS Division of Professional Relations, Women's Chemist Committee and other society units often sponsor symposia at ACS national meetings.

There are also professional societies specifically for minority scientists and engineers. These include the National Organization for Black Chemists and Chemical Engineers (NOBCChE), National Society of Black Engineers (NSBE), Society for Advancing Hispanics/Chicanos & Native Americans in Science (SACNAS), American Indian Science and Engineering Society (AISE), Association for Women in Science (AWIS), Women in Engineering Programming Advocates Network (WEPAN), and Society of Women Engineers (SWE).

Thompson of ACS views these groups as complementary to ACS and other large technical societies. "ACS meets the technical needs of chemical professionals while these other organizations focus on their career needs as members of specific minority groups. "Their local and national meetings provide a cultural specific forum for members to discuss and address career needs, challenges and meet potential mentors. While mentors need not share one's minority status, a shared culture can help scientists "negotiate the web of success," she notes.

MEET THE AUTHOR

To see an interview with Lab Manager Magazine contributing writer, John Buie, visit www.qorpak.com/labmanager.

John Buie is fast becoming the laboratory equipment guru for the magazine. He is the author of last month's Water Purification purchasing guide and this month's Incubator purchasing guide. Future contributions to the magazine include "The Evolution of Pipettes" in September and other technology-focused pieces throughout the remainder of the year. To learn more about John and the inspiration behind these unique laboratory purchasing "roadmaps," visit the link above.

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LEADERSHIP & STAFFING

PERFORMANCE REVIEWS

TECHNIQUES FOR GETTING THE MOST FROM AN OFTENTIMES DREADED AND MISUNDERSTOOD PROCESS by John K. Borchardt

"Annual performance reviews are usually a waste of time," says executive F. John Reh, contributing author to the book "Business: the Ultimate Resource."[1] He believes performance reviews are "something managers feel they have to do, not something they see as a tool to improve the performance of their group." Samuel Culbert, professor of management at the UCLA Anderson School of Management, stirred up much discussion in human resources circles when he wrote in a recent Wall Street Journal article, "I see nothing constructive about an annual pay and performance review…. It destroys morale, kills teamwork and hurts the bottom line."[2]

"PERFORMANCE PREVIEWS ARE RECIPROCALLY ACCOUNTABLE DISCUSSIONS ABOUT HOW BOSS AND EMPLOYEE ARE GOING TO WORK TOGETHER MORE EFFECTIVELY THAN THEY DID IN THE PAST."

It doesn't have to be this way. These authors were discussing *poor* performance reviews, not performance reviews themselves. Other authors have expressed the same viewpoint. This author, on the other hand, believes that performance reviews can be developed into very useful tools that can help employees focus their efforts, enhance their performance and contribute to improving their employers' bottom lines. Done well, performance reviews can even improve staff motivation and morale.

Improving employee performance

Coaching to improve performance often receives short shrift in performance reviews. Yet, from the employer's perspective, this is the most important part of a performance review. It is more effective to conduct this coaching in a separate session, suggests Culbert. He calls these "performance previews" and says, "Performance previews are reciprocally accountable discussions about how boss and employee are going to work together more effectively than they did in the past." Previews focus on the future while annual performance reviews tend to focus on the past. "Previews weld fates together," he says. Whose fates? The fates of both the staff member and the manager.

Cascading goals are a way to ensure that each employee's goals contribute to the overall goals of his/her work unit and to the overall goals of the organization. Cascading goals mean that the lab manager must break down each organization goal into individual goals for each laboratory work unit—departments and teams. This ensures that each work unit's goals clearly and directly contribute to the overall goals of the organization. In turn, work unit goals must be broken down into more narrowly focused goals for each individual whom the lab manager supervises. Then managers must work with each employee to ensure that his/her individual goals are tied to work unit goals and in turn to the overall goals of the entire organization. The performance previews suggested by Culbert are a good way to do this. These are best conducted at the beginning of the organization's fiscal year.

During the performance preview the manager works with each staff member to define what the employee needs to do better and devise strategies to do this. This phase of the preview also includes agreeing upon the skills the employee needs to develop to be qualified for a promotion or coveted transfer.

Once improvement areas are selected, the manager and employee should work together to define how the employee can achieve this improved performance. Doing so may involve self-study, taking short courses, going to night school or taking on specific assignments that help the employee develop new capabilities. Then the manager and employee must agree on how to determine when the employee has achieved adequate mastery of the new skills.

The staff member and manager must agree on defining the improvement process, how long it will take, what fraction of the employee's time will be needed to achieve the desired improvement and how much it will cost.

The best way to ensure that both manager and employee understand what was agreed upon during the preview meeting is for the staff member to write a short review of the discussion and include the action items and a timetable for accomplishing them. Then if the manager and staff member are not in complete agreement, they can correct the situation in a timely manner.

Annual performance reviews

Annual performance reviews are best held at the beginning of the calendar year or the organization's fiscal year. Lab managers can discuss project assignments for the coming year and review what skills are required on the part of the staff member. The two can work together to propose a professional development program for the employee that will enable him/her to achieve high performance levels (making the later performance review a more pleasant experience for both the lab manager and the staff member). The disadvantage of this approach is that lab managers are often faced with conducting a large number of performance reviews in a very limited time span, which can result in managers not devoting enough thought and preparation to each review.

Some labs still conduct annual performance reviews on employees' service anniversaries. This often has the advantage of spacing out reviews so the lab manager doesn't have to conduct a large number in a short time span.

To be effective, performance reviews should be held more frequently than annually. Quarterly reviews may serve the purpose when working with experienced staff members. For newly hired staff members, perhaps the best way to help them get off to a good start is to have them work with a mentor and hold reviews one month after employment, followed by quarterly reviews and consultation with their mentors before the review.

Culbert notes that a major problem of many performance reviews is that managers and staff members approach them with much different mindsets. Managers usually focus on areas in which performance needs to be improved. Staff members are focused on raises and career advancement and therefore are eager to discuss past accomplishments in detail.

This difference in mindsets can result in communication problems during the performance review discussion as the manager and the staff member each focus on their own concerns and don't really listen effectively to each other. Poor communication and insufficient manager preparation can derail a performance review discussion, resulting in loss of staff member motivation and a drop in morale. In addition, the manager can leave the discussions feeling frustrated with the employee.

"MANAGERS SHOULDN'T WRITE ANYTHING IN AN ANNUAL PERFORMANCE REVIEW THAT THEY HAVEN'T ALREADY DISCUSSED WITH THE EMPLOYEE."

LEADERSHIP & STAFFING

Limitations of conventional performance reviews

Managers should not use annual performance reviews as an excuse to delay confronting performance problems when they develop. Many managers have no problem citing and praising good performance but are reluctant to confront problems with employee performance. Often they may see problems developing but fail to discuss them with the employee until the annual review. The result is an extended period of lower-than-optimum performance and a higher level of frustration during the performance review than otherwise would be the case.

Sometimes the manager, wanting to avoid a stressful discussion, will not confront the employee's performance issues. This creates disconnects between what the manager writes in the performance reviews and the reality of how well employees are helping the organization achieve its goals. This scenario seldom does employees any favors. Without discussing performance inadequacies, action plans to improve performance are not developed. Should a layoff occur, staff members with nonconfronted performance issues are much more likely to lose their jobs.

"POOR COMMUNICATION AND INSUFFICIENT MANAGER PREPARATION CAN DERAIL A PERFORMANCE REVIEW DISCUSSION, RESULTING IN LOSS OF STAFF MEMBER MOTIVATION AND A DROP IN MORALE."

Another problem that shouldn't wait until the annual performance review is when an employee performs his/her work very well but misdirects efforts so that the work has little to do with the overall work group goals. This problem is more frequently seen with recent hires who cling to an academic mindset and pursue intellectually interesting results that do not contribute to achieving the work group's goals.

Performance reviews should contain no surprises. Reh advises that managers shouldn't write anything in an annual performance review that they haven't already discussed with the employee. This includes the overall evaluation of an employee's performance and how that performance compares to that of his/her peers.

The role of teams

Team meetings can be used to assess employees' performance on a much more frequent basis than annually. As team members discuss both their progress in achieving project milestones and how they help each other achieve these milestones, team leaders can assess individual performance on a frequent, often monthly, basis and supply this input to each team member's manager. Alternatively, lab managers may wish to occasionally sit in on team meetings so they can form their own opinions regarding a staff member's performance.

The end of the process

By the end of this process, the manager should have given the employee feedback on his/her performance and on how the employee is helping the work group achieve its goals. Each employee should understand in a general sense how his/her performance compares to that of others in the work group. If the employer uses a system in which the employee is assigned a performance grade, each employee should know what his/her grade is. Finally, the manager should prepare the appropriate written report and give a copy to the employee. The performance grade should motivate an employee to improve his/her performance.

Assigning a performance grade is in part a subjective process, no matter how objective a manager tries to be. Some managers are easy graders; some are hard graders. Yet in deciding how to award raises, bonuses and promotions, grades for one's staff members will be compared to the letter grades other managers assign their staff members. Therefore, lab managers should make every effort to ensure that their letter grades meet the organization's criteria for each grade assignment. Then one manager's performance rating of "average" will not equal what another manager calls "outstanding." To accomplish this goal, each lab manager should work with his/her supervisor.

Wrap-up

To focus their efforts in ways that help achieve overall organizational goals while improving their individual performances, staff members need to know what is expected of them. Performance reviews provide a way for lab managers to communicate these expectations while motivating staff members to meet them.

Conducting performance previews and performance reviews throughout the year reduces the stress both staff member and manager experience during the annual performance review. Stress is reduced because both will already know how the employee is doing. Keeping records of these discussions makes the annual performance review less time-consuming, an important consideration if the manager has to conduct many performance reviews in a short time.

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360-DEGREE PERFORMANCE FEEDBACK

By John K. Borchardt

At some laboratories, part of the annual performance review is 360-degree feedback. In this process, subordinates, peers, fellow team members and even the employer's customers provide information on the staff member's performance as part of the performance review process. To promote honesty in these evaluations, they are provided anonymously.

The goal of 360-degree feedback is to give those who are most familiar with the employee's performance an opportunity to provide input into the performance review process. However, much of this feedback is done by people without training in carrying out performance appraisals. As a result, their input may be colored by personal relationships with the employee and other nonperformance factors even though they are trying to be honest and impartial. So if 360-degree performance appraisal is used, the individuals involved should receive coaching in performance evaluation.

STANDING OUT IN A CHALLENGING ECONOMY

In spite of society's dependency on the sciences to maintain a high quality of life, science professionals are not immune from the realities of the current economic downturn. While the challenges of holding on to scientific positions are greater today than they have been in decades, it is certainly not impossible for scientists and managers to remain in their positions long term. By applying certain ideals daily, you can maintain your job well into the future as you build your career.

"IT IS IMPORTANT THAT YOU MAINTAIN AND EVEN IMPROVE YOUR OUTLOOK, WORK ETHIC, AND GOALS."

In the meantime, what should you do if you or your employees have had multiple years of experience but are still concerned about layoffs, due not to performances, but to your company's financial situation? It is important that you maintain and even improve your outlook, work ethic, and goals in order to survive and thrive as a science professional, even during the most challenging of times. Your ability to handle today's economic crisis will also affect your employees and impact their job performances.

Maintain positivism

Whatever your organization's current economic condition, your day-to-day positive outlook may be the most important ingredient for your success and growth in the scientific community. While it is certainly understandable that the current times may encourage a pessimistic view, high performers will strive to move forward while focusing on the positives of global situations as well as their current positions and work environments. The most successful individuals are able to look at negative situations as opportunities for personal growth and as challenges to work to the best of their abilities. Positivism will withstand any recession.

Multitask

As a manager during a recession, your ability to multitask is essential to your company's ability to succeed. Managers, along with their employees, must extend themselves beyond their primary job roles and seek out additional responsibilities. As you begin to incorporate more roles into your position, you will be able to expand your skill set and deliver more value to your organization. When you seek challenges to expand your own knowledge and skills, your employees will observe your desire to take on more responsibilities and will be motivated to follow your example. I strongly suggest taking advantage of training to gain fresh ideas and extensive experience.

Increase visibility

As a manager, you are responsible for increasing your organization's visibility in the scientific community. Increased visibility during a recession is necessary in order for a company to stand out among competitors. There are various ways in which you can increase your company's visibility, ranging from the use of existing social networking websites or creation of new websites to the production of monthly public newsletters to involvement in charities. By continually increasing your exposure within the scientific community, you will have an edge over your competitors. This edge will, of course, improve job security for both you and your employees.

Training is an option that managers and employees should consider in order to gain both visibility and experience. Through seminar participation, employees can learn ways in which they can improve their soft skills and public speaking abilities. As employees continually improve their skills, your organization's visibility will increase.

Exceed expectations, strive for excellence

Your goal must be to not only survive during the recession, but thrive as well. In order to not only maintain your current level of employment, but also possibly seek a promotion, your energy level and productivity must exceed the expectations of your managers every day. You must go above and beyond all that is expected in order to earn and keep respect. As you strive for excellence, you must expand your knowledge. Since you are a high performer, no task is too large for you. You want to learn and grow as a person. The difference between individuals who are promoted and those who leave is usually their eagerness for success and learning as well as their acceptance of failure. As you strive for excellence, you will certainly encounter your share of failures as well. The ways in which you handle adversity can impact the course of your career.

"THE MOST SUCCESSFUL INDIVIDUALS ARE ABLE TO LOOK AT NEGATIVE SITUATIONS AS OPPORTUNITIES FOR PERSONAL GROWTH."

While you may have little control over the condition of the economy, you can certainly improve your marketability and thrive in your current position. Maintain a positive outlook, be willing to increase your responsibilities and your organization's visibility, and exceed everyone's expectations, including your own. Tough times never last. However, positive-minded people do.

Rich Pennock is vice president of Kelly Scientific Resources, a leader in scientific staffing solutions. For more information, visit www.kellyscientific.com.

http://twitter.com/richpennock

Websites that offer free online training:

- www.kellyscientific.com
- http://science.thomsonreuters.com/training
- http://ocw.mit.edu/OcwWeb/web/home/home/index.htm
- http://oli.web.cmu.edu/openlearning/initiative

TECHNOLOGY & OPERATIONS

LOCAL IS THE NEW GREEN

INNOVATIVE STEPS TO AN ENVIRONMENTALLY FRIENDLY LAB by Tanya Candia

Almost no one disputes the value of "going green" as a way to improve the health of the planet—it's also good for business. Labs have begun to look at green initiatives as a way to attract top talent as they become more competitive in addressing the world's needs. They are beginning to adopt new models of collaboration, innovative building design and green chemicals. Advice on going green abounds, and recent articles have mentioned a multitude of actions that can be taken to make a lab more environmentally friendly. Much of the advice involves a significant investment in time and money, such as the design (or redesign) of buildings and facilities.

Yet the reality is that one simple approach that is within the reach of any lab is consistently ignored. This valuable approach is "going local." Sourcing products locally, buying products locally and recycling products locally are all ways to reduce one's carbon footprint while reaping important ancillary benefits.

Lab managers everywhere, with tight budgets and limited time on their hands, can take this advice today, to the benefit of their labs, their local communities and the world at large. From buying new products in a more environmentally friendly fashion, to identifying surplus materials and sharing them, to engaging in innovative recycling programs, these steps all have a local angle and benefit the local community. We will discuss each activity in turn and show how each contributes to a greener lab.

Sharing surplus material and supplies with local schools

Look at your bookshelves, under desks and tables, and in closets. How many pieces of equipment do you see that were used in a previous project but are no longer needed? How many bags of pipette tips, microtubes and other plasticware are sitting in corners gathering dust when they could be used by someone else? How many items are out of date but still serviceable?

Now think about the local junior highs, secondary schools and community colleges. Their labs are woefully underequipped, yet they serve as the incubator for future scientists. They are often hungry for the very materials that are sitting idle in labs. It would be great if the surplus materials could make their way to the hands of the students who need them.

"LABS HAVE BEGUN TO LOOK AT GREEN INITIATIVES AS A WAY TO ATTRACT TOP TALENT."

Consider establishing a "giveaway day" for local schools, during which you place surplus items in a central location and then invite representatives to come choose items they need. If this seems like a lot of work, you might be lucky enough to find that a local lab supply distributor or a major supply vendor has already set up donation days in which surplus equipment and supplies, collected by them ahead of time, are donated to representatives of local schools. In the San Francisco Bay Area, BABEC (Bay Area Biotechnology Education Consortium—www.babec.org) and RAFT (Resource Area for Teaching—www.raft.net) partner with distributors and labs to provide surplus supplies at minimal or no cost to educators.

Spending a few minutes identifying and collecting surplus materials will go a long way toward supporting the local community, nurturing future scientists, creating community goodwill and de-cluttering your lab—leading to greater efficiency and productivity.

Local recycling—beyond the basics

Recycling used paper is becoming the norm in many labs. Recycling bins for cardboard, brown glass and electronic waste are being seen more and more. But the possibilities don't stop there. Many plastics can be recycled, most notably empty pipette tip racks.

The choices for recycling are many, but the first step is the same: develop a company-sponsored initiative that supports, encourages and streamlines recycling. Setting out recycling bins, putting up posters and stressing the importance of the program in organizational meetings all have a place in fostering an environment of recycling.

Contact your lab supply distributor to find out if there is a recycling program in place. Some distributors will actually come to your lab to pick up plastics provided by them and take them to a recycling plant free of charge. Check to make sure the recycling plant is local. It makes no environmental sense to ship plastics 3,000 miles to a recycling facility, especially when local plants can do the job just as well.

Perhaps the best way to recycle is not to purchase unneeded supplies at all!

"GREEN PURCHASING CAN IMPROVE BOTH EMPLOYEE MORALE AND SHAREHOLDER VALUE."

Local sourcing and manufacturing

One of the most astonishing aspects of labware purchasing is the great distances many supplies have to travel—often a costly round-trip that could be avoided. Brian Ruf, owner of E&K Scientific Inc. (www.eandkscientific.com), a Santa Clara, California, distributor of lab supplies, had an epiphany one day while visiting a client's lab. He noticed that researchers and technicians were using tremendous amounts of labware that was being shipped from warehouses outside California. Although many of the products were actually manufactured in California, they were sometimes being shipped to warehouses on the East Coast, only to make the journey back when the customer placed an order—leading to more cost, more carbon emissions, more time and 69 percent less money going back into the local economy.

Ruf knew there had to be a better way to avoid this tremendous waste and negative environmental impact. He found a local manufacturing firm known for producing high-quality products. In partnership with the manufacturer, he developed the Accuflow line of products, which are made, warehoused and sold locally. The line even includes a refill system that enables researchers to reuse empty boxes, further reducing waste.

Bolstered by the success of this line, Ruf is now collaborating with other local manufacturers to solve emerging problems such as plate warping, and he will continue to plow proceeds back into the local economy

▲ *Locally manufactured products are reusable and recyclable*

Green purchasing

Green purchasing—also known as environmentally preferred purchasing—embodies the idea of buying sustainable products in a sustainable way. Today there are many products that are cost-competitive and still manage to be environmentally friendly. The U.S. Environmental Protection Agency provides resources to help in establishing a green purchasing program at www.epa.gov/epp. The site also has a list of green products and services. Check the list to find local suppliers that participate, to ensure that you are buying locally and green at the same time. If your preferred suppliers are not on the list, encourage them to take the necessary steps to become environmentally friendly.

There are many benefits to green purchasing. Natural resources are preserved through the use of recycled content. The local economy is supported. And the energy associated with transporting products long distances is saved. Most important, green purchasing can improve both employee morale and shareholder value.

Conclusion

There are some simple steps that laboratory managers can take today to make the workplace greener, improving the research process and the work experience. Sourcing, buying, sharing and recycling locally not only leads to a healthier workplace, these actions can streamline processes, reduce costs and build a stronger local community.

Tanya Candia, *CEO, Candia Communications LLC, can be reached at tcandia@candiacomm.com or by phone at 408-741-5828.*

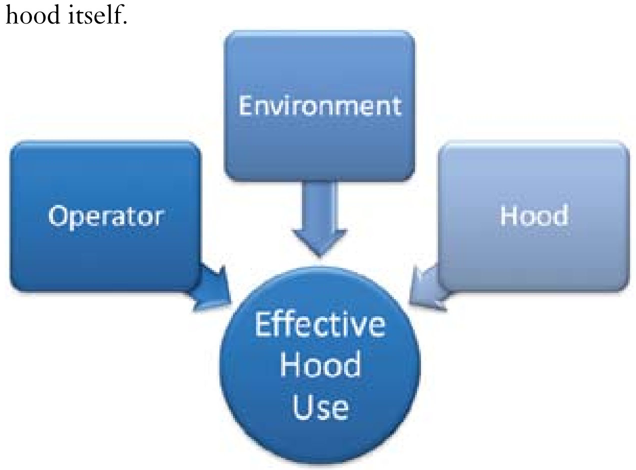
WHAT'S THAT STICKER ON MY FUME HOOD ANYWAY?

A REPUTABLE CERTIFICATION COMPANY TRAINS PERSONNEL, TRACKS SERVICE AND CERTIFICATION DATES, AND PERFORMS APPROPRIATE TESTS by James S. Sigler

Many pieces of lab equipment lend themselves to proper operation. A freezer, for example: Close the door and it will generally perform as expected. And, like most lab equipment, it is linked to the facility in a simple way—through the power cord (and sometimes through an alarm wire).

"Hoods" are important and critical pieces of equipment in many labs, but they don't lend themselves to proper operation. Biosafety cabinets, chemical fume hoods and laminar flow benches are easy to operate *improperly*, and they are susceptible to subtle factors in the laboratory environment.

The "sweet spot" for effective hood use is found at the intersection of three elements: (1) the operator and how he/she interacts with the hood; (2) the laboratory environment and how it impacts the hood; and (3) the hood itself.



The operator

The operator is critical to the effective operation of the hood. It is the operator who has responsibility for turning on the unit, setting the window height and following the procedures for proper hood operation. For the different types of hoods, these procedures include:

Biosafety Cabinet: The operator should follow aseptic procedures, sanitizing materials just prior to placing them in the BSC, maintaining good techniques (changing gloves as needed, not placing hands above open media or plates) and not placing sterile items on the front grate.

"A GOOD TECHNICIAN COMES WITH A CART FULL OF TEST GEAR, NOT A BRIEFCASE!"

Chemical Fume Hood: The operator should promote good air flow by putting larger items (equipment, vessels) up on stands or blocks, and should avoid significant clutter. Hoods in active use should not be used for storage of chemicals or waste.

Laminar Flow Bench: As with the BSC, the operator must follow aseptic procedures, sanitizing materials prior to placing them in the unit and not placing hands upstream of the sterile product. Laminar flow benches can be either horizontal or vertical—neither protects the operator, only the product. Be sure to distinguish between a BSC and a vertical laminar flow bench, as they can look similar but still have very different uses.

The environment

The environment in which the hood operates cannot be overlooked as a critical factor in proper hood operation. The most frequent environmental cause of a hood not performing as expected is the laboratory's HVAC system. Something as simple as the air supply for the lab can be a problem—air blowing onto or across the front of a hood can disrupt the airflow, which is critical to proper operation. Another factor that can affect proper hood operation, specifically exhausted hoods (chemical fume hoods and Type B2 BSCs), is insufficient air supply to the lab. Insufficient air supply can literally "choke off" the hoods, rendering them less effective. This can be due to a design flaw (not enough air supply in the first place), a lack of integration of the various control systems or because something has changed since the lab was built (most commonly, units having been added).

The hood itself

Above all, the unit must be operating correctly. Determining whether the hood is functioning as designed is the goal of the certification process. The units are tested at the factory, upon installation, and then periodically (typically annually in a research setting) throughout their life cycles. The hoods are also tested after they have been moved and after significant maintenance (filter changes, etc.).

The three tables below describe the purpose of each type of hood or cabinet, review the approach to field certification and provide an overview of the most common types of failure.

Type and Purpose of Equipment	Items Inspected and Tested During a Proper Certification	Failure Modes and Other Notes
Biological Safety Cabinet (BSC) Protect the operator from biological hazards. Protect the product or experiment from contamination. Protect the environment from the biological agents being manipulated in the cabinet. Do not provide protection from chemical hazards (fumes/vapors) unless they are specially designed and labeled units!	Supply and exhaust HEPA filters are tested for leakage. Supply and exhaust HEPA filters are tested for loading. (How hard is the blower working? Does it need adjustment?) This affects operator protection because adequate inf ow velocity is the primary protection for the operator. Air f ow rate (feet per minute) and total air f ow (cubic feet per minute) are measured and compared to design standards. Low-volume smoke is used to check for inf ow air containment and external air turbulence and to determine the work area smoke split. Time: 20 to 30 min./unit	Filters can become clogged and require replacement (useful lives of anywhere from three to seven years, depending on cleanliness of the area). Motors, switches and other electrical elements can burn out and require replacement. In almost all instances the unit needs to be decontaminated before it can be opened for filter replacement or motor repair.

The BSC tests described above are considered secondary tests. The primary tests include items such as the pressure leak test and are required in order to qualify for NSF listing (but are not typically performed in the field).

Type and Purpose of Equipment	Items Inspected and Tested During a Proper Certification	Failure Modes and Other Notes
Chemical Fume Hood Provides protection from chemical hazards by running large volumes of air through the hood (past the chemicals and equipment) and out of the building.	Face velocity and total volume are measured and compared to design standards. Low-volume smoke is used to check for inf ow air containment. More complete test includes tracer gas containment testing (a known quantity of tracer gas is released inside the hood while a sensitive detector is running outside the hood). This is a much more quantitative test. More clients are testing a rotating percentage of their fume hoods with this so-called ASHRAE 110 test. Note that the updated standard requires audio and visual alarms (for face velocity), not just a string hanging from the sash, and these alarms must be tested. Time: 10 to 15 min./unit	Flow meters and alarms on these units can sometimes fail (and they are often not calibrated properly to begin with). The blower motor (generally placed on the roof at the end of the exhaust ducting) can sometimes burn out and drive belts can loosen. The need to clean these hoods prior to disposal is dictated by what materials were handled within the units (special steam cleaning is always recommended).
Laminar Flow Bench Protects the product or experiment from contamination (these units do not provide any personal protection).	HEPA filters are tested for leakage. Pre-filters are visually inspected for loading. Air f ow rate (feet per minute) and total air f ow (cubic feet per minute) are measured and compared to design standards. Time: 15 to 20 min./unit	HEPA filters can become clogged and require replacement (useful lives of anywhere from three to seven years, depending on cleanliness of the area). Pre-filters can become clogged. Motors, switches, etc., can burn out and require replacement. These units do not require decontamination prior to servicing.

Choosing a certification company

Good certification is about good service. A reputable certification company will do all the following: 1) send technicians who are uniformed, courteous and able to work comfortably and unobtrusively in a laboratory environment; 2) keep track of your equipment and service due dates, notifying you of upcoming certifications; and 3) perform all appropriate tests. If the technician takes less than 20 minutes to test each BSC, be wary. A good technician comes with a cart full of test gear, not a briefcase!

Beyond the mechanics of hood certification, your certification company can be an important resource. Good certification companies can help you determine what type(s) of hoods are appropriate for your needs as they grow or change. They are able to answer questions about proper usage of your hoods. And they will quickly repair your hood when it is not functioning properly.

Don't hire a certification company that doesn't promise to do all the above. And while most of the certification companies out there will promise to do all these things and will deliver, inevitably there will be a few "bad apples" (as in any industry) who don't deliver. Be vigilant, get to know your certifier and ask questions until you are satisfied that you are getting the services you are paying for and that good laboratory practices demand.

Summary

Proper operation of your hoods depends on your personnel, your facility and the hoods themselves. Field certification confirms that the hoods are operating as designed. A good certification company will competently perform that testing and can also be a resource to help ensure that your personnel are properly trained and your facility is properly configured.

Jim Sigler is vice president of business operations at Air Systems Technologies, Inc., a New England–based certification company. He can be reached at jsigler@airsystemstech.com.

BE COGNIZANT OF HOW BSCs WORK

- Don't block the grates (front or back).
- Don't place pipettes or other instruments on perforated grate; this exposes the instrument to "dirty" room air.
- Minimize quick movements, or anything else that can disrupt airflow, in the vicinity of the cabinets.
- BSCs should not be near a doorway (opening/closing the door disrupts airflow)
- Bunsen burners should not be used in a BSC. The warm air creates airflow eddies.
- Perform all critical work at least six inches into the interior work surface of the BSC.
- Do not leave the hood fan on if you are closing the window to operate the UV lamp. Doing so may cause the incoming "dirty" room air to speed up, and some of it can overshoot the front grate, onto the work surface, exposing anything on the work surface to contamination.
- UV light is a poor substitute for proper aseptic technique. UV light waves must have direct contact with the organism to be effective—this essentially means maintaining a totally clear work surface when utilizing the UV lamp. Note that even dust particles can interfere with the UV light reaching the biological agent that you are trying to kill. Work with a biosafety expert to determine the best procedure to clean and decontaminate your BSC. Remember that you are trying to protect yourself as well as your experiment.

LABORATORY RETROFIT

INSTALLING VARIABLE FREQUENCY DRIVES AND LOWERING THE AIR CHANGE RATE IN TWO LABORATORY FACILITIES ENABLED UC SAN DIEGO TO AVOID PRODUCING 1.38 MILLION KG OF CARBON DIOXIDE EMISSIONS EACH YEAR. **By Trista Little**

As energy prices rise and commitment to sustainability heightens, universities across the nation are developing methods for reducing energy consumption. An analysis of facilities at UC San Diego revealed that retrofitting constant volume (CV) air supply and exhaust systems with variable frequency drives (VFDs) could achieve significant energy savings.

A comprehensive analysis conducted by engineering consultant Kuhn & Kuhn included a design review, spot checking of fan energy and flow readings, a lighting review, and an assessment of control system performance. Cost analysis was performed to determine the simple payback for installing variable frequency drives and upgrading building control systems to direct digital control.

View of Stein Clinical Research Facility.

Photo Credit: Alan Nyiri, courtesy of the Atkinson Photographic Archive.

UC San Diego selected two of its largest and most energy-intensive laboratory buildings for the retrofitting project: Pacific Hall and the Stein Clinical Research Facility. Laboratory buildings require five to ten times more energy per square foot than a typical building due to rigorous ventilation requirements and other health and safety concerns. Additional energy is necessary to sustain the complex research activities that continually take place inside. Both buildings chosen for the retrofit were equipped with constant volume ventilation systems, which further contributed to high levels of energy consumption.

BY FOCUSING ON ENERGY-INTENSIVE LABORATORY BUILDINGS, THE CAMPUS GAINED THE MOST SAVINGS FROM ITS CAPITAL INVESTMENT AND REDUCED THE PAYBACK TIME.

In a CV system, variations in thermal requirements are satisfied by varying the temperature of a constant volume of air being delivered to a space. This works well under uniform heating and cooling requirements. However, when heating and cooling loads vary, CV systems continually supply peak capacity even when the demand is not at peak level. This method consumes a great quantity of energy to maintain peak flow in the central system.

UC San Diego installed variable frequency drives to respond to the laboratory's varying load demands in a more efficient manner. Changing load requirements are now met by adjusting the volume, rather than the temperature, of supply air that enters a space. Variable frequency drives control the frequency of the electrical power supplied to HVAC motors, which changes the motor speed and, subsequently, the speed of fans and pumps in the system. Building owners can save significant amounts of energy by installing VFDs because the power required to drive a centrifugal fan or pump in an HVAC system is proportional to the cube of the fan or pump speed. Consequently, operating fans or pumps at a lower speed when demand is low can produce substantial energy and cost savings.

A second important factor contributing to the considerable savings possible in retrofitting the laboratory facilities was the modification of the campus's air exchange rate standards. When the buildings were constructed, campus design criteria required 15-20 air changes per hour (ACH) in laboratories. Since then the university's Environmental, Health and Safety department revised campus standards to 10-12 ACH, representing a 30 to 40 percent drop in air exchange rates. This adjustment had considerable implications for the supply air volume and, subsequently, the amount of fan energy required to supply it.

THE U.S. EPA ESTIMATES THAT A 30% ENERGY REDUCTION IN HALF OF ALL AMERICAN LABORATORIES WOULD SAVE 84 TRILLION BTU PER YEAR. THIS EQUATES TO APPROXIMATELY $1.25 BILLION IN ANNUAL SAVINGS AND 19 MILLION TONS OF AVOIDED CARBON DIOXIDE EMISSIONS.

Together, Pacific Hall and Stein Clinical Research Facility require a combined air supply volume of 460,000 cfm over the course of a year. A large drop in the air exchange rate, multiplied by the massive volume of supply air moved over an entire year, yields huge horsepower savings at the fan motor. Rebalancing the buildings' HVAC systems and calibrating the VFDs to the new campus standards offered another opportunity to realize large energy savings.

THE ENERGY SAVINGS ACHIEVED IN THIS PROJECT PREVENT 1.38 MILLION KG OF CARBON DIOXIDE EMISSIONS EACH YEAR, WHICH IS EQUIVALENT TO REMOVING 299 CARS FROM THE ROAD.

The university saves 114,000 therms of natural gas and 1.74 million kWh annually since the completion of the retrofit in spring 2005. The resulting utility bill savings of $314,000 each year paid for the cost of implementation in just over two years.

The retrofit included the installation of a 4-channel ultrasonic hot and chilled water BTU metering and monitoring system that provides real-time communication with the campus energy management system. This upgrade enables university staff to compare the energy performance of the laboratories before and after the retrofit, as well as analyze long-term energy use and demand profiling. The system helps ensure that the full benefits of the retrofit are realized, and provide comprehensive performance data that may reveal additional opportunities to improve energy efficiency.

This article was first published as part of the University of California's Green Building Research Center's *Best Practices* Competition, which showcases successful projects on UC and CSU campuses to assist campuses in achieving energy efficiency and sustainability goals. David Lehrer is editor of the *Best Practices* series.

For more information, visit www.greenbuildings.berkeley.edu.

System Features:

- Variable frequency drives
- Air exchange rate reduced 30 to 40% to 10-12 air changes per hour
- Hot and chilled water BTU metering and monitoring system

Annual Energy Savings:

- 114,000 therms
- 1.74 million kWh
- $314,000

Annual CO2 Emissions Avoided:

- 1.38 million kg

Cost:

- $655,000

Contacts:

- Energy and Utilities Manager: John Dilliott, jdilliott@ucsd.edu 858.822.2807
- Director of Engineering: Gerry White, gwwhite@ucsd.edu 858.534.2987

Team

- Initial Engineering Study: Kuhn & Kuhn
- Mechanical Engineering: DEC Engineers
- Electrical Engineering: The Engineering Partners

BETTER TEMPERATURE CONTROL, DECONTAMINATING OPTIONS AND INTERACTIVE USER INTERFACE HELP MEET CUSTOMER NEEDS

by Tanuja Koppal

Laboratory incubators are used to grow and maintain cell cultures and are available in a variety of sizes and types. The incubator market is divided into two main categories: the gassed incubators which are the CO2 incubators, and the non gassed or microbiological incubators. The CO2 incubators are mainly used for cell culture and provide control over factors such as temperature, CO2 for maintaining proper pH levels, and humidity, all of which affect cell growth. CO2 incubators are typically heated to 37°C and maintain 95% relative humidity and a CO2 level of 5 percent. Microbiological incubators are essentially temperature-controlled ovens that work within the biological range of 5°C to 70°C and are mostly used for growing and storing bacterial cultures. Most incubator units are water-jacketed, air-jacketed or use direct heat to maintain the temperature around the culture chamber.

> **"...incubators generally last about 10 years and can be used in a wide variety of applications."**

Available from 1.4 (table-top) to 40 cubic feet (freezer-like), incubators generally last about 10 years and can be used in a wide variety of applications including cell culture, biochemical studies, hematological studies, pharmaceutical and food processing. Shaking incubators are often used for cell aeration and solubility studies. Refrigerated Biochemical Oxygen Demand (BOD) incubators, with a temperature range of 20°C degrees to 45°C below ambient, are commonly used for applications such as insect and plant studies, fermentation studies and bacterial culturing.

"The cell culture market today is thriving predominantly due to new applications in areas like stem cell research and hence there is more potential for growth in these products," says Douglas Wernerspach, Global Product Manager, CO2 Incubation at Thermo Fisher Scientific.

Many manufacturers are working toward addressing some of the common challenges associated with culturing cells, the most important of which is reducing aerial contamination. A number of incubators now offer a high-temperature decontamination cycle that works much like a self-cleaning oven. "With the press of a button, the customer can heat-sterilize the incubator and get rid of any decontaminants or hazardous spills," says Wernerspach. This option also eliminates the need to take apart individual components for autoclaving. "It's convenient, safe, and ensures proper, uniform cleaning that can be recorded as a part of standard operating procedures."

Besides units that can be activated when needed, there are also continuous contamination prevention units that work all the time and do not have to be initiated manually. One technology uses HEPA filtration to continuously cycle the air and remove airborne particulates and contaminants. The other technology that is gaining a lot of interest is the use of incubators that have interiors made of solid copper components. "Solid copper or 100% pure copper is naturally antimicrobial and for the first time the U.S. EPA has also recognized copper, a nonchemical, as an effective antimicrobial agent," says Wernerspach. This has led to a number of companies developing copper-based products.

Incubators also come with options that can further increase user ease and convenience. Thermo Fisher has recently introduced a CO2 incubator with an integrated, interactive touch screen display built into the control panel. "It has all kinds of built-in user prompts and safety features so that you won't mistakenly change settings and damage the cultures inside," says Wernerspach. "It also has the ability to operate in many different languages. Individual users can customize the display to how they want to see it, which helps to minimize user error and training." Additional options include data storage and communications packages that enable data logging to the computer, removable shelves and programmable alarms for temperature set points and duration.

At the end of the day what customers really care about is having a reliable unit in which to grow their cells. Hence, the lab environment, the application and the customer's comfort level with the technology is what plays a big role in the selection of the equipment. "Ultimately you want to go with something that best meets your requirements," says Wernerspach.

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

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

Product Focus: NON-CO_2 INCUBATORS

CARBOLITE

www.carbolite.us

The Peak Series laboratory incubators have been designed and engineered to perform processes ranging from simple drying to more complex and demanding heat treatment processes and long term stability testing of materials or components. They are available in six different chamber sizes, each with a maximum operating temperature of 80°C. They are also available in either a gravity or mechanical convection design. All units have an integral sealed glass door to facilitate product inspection and are designed for long term accuracy and reliability. A wide choice of control and programming and other optional features is available.

DYNALAB CORP.

www.dynalabcorp.com

Stuart Incubators are supplied with a rocker that provides a gentle motion, ideal for low foaming agitation, blotting techniques, DNA extractions, staining and de-staining gels, etc. The blue non slip mat holds vessels in place. The tier system means more platforms can be added to increase the working space. Choice of gyratory action rocker SI70 or see-saw action rocker SI80. A choice of two tier heights is provided with each unit for maximum versatility. The rocking speed is variable and has electronic feed-back control to accurately maintain set speeds. The rocking action is automatically halted when the door is open for maximum user safety. The angle of the rocking platform can be adjusted allowing optimization of the rocking motion.

JEIO TECH

www.jeiotech.com

Lab Companion IB- G Series air jacketed natural convection incubators feature a temperature range of ambient +5 to + 70 C. A tangential fan inside the walls of the incubator circulates warm air around the chamber, creating exceptional temperature uniformity without creating air turbulence inside.A CLS control system assures maximum safety all the time while an auto tuning feature maximizes oven operation to changing external environment. A bias function easily calibrates the temperature difference between display (SV) and actual temperature (PV). Wait On /Wait Off feature allows for unattended startup and shutdown. A side cable port allows power cords to pass and connect to outside power source. Lab Tracer communication software and cables are included.

THERMO SCIENTIFIC

www.thermo.com/hot

Precision incubators feature advanced microprocessor controls and are available with mechanical or gravity convection for applications that require excellent temperature distribution or gentle sample heating between 5°C above ambient to 75°C. They have easy-to-clean, corrosion-resistant interiors and offer highly reliable operation and enhanced safety for both users and samples. Various sizes are available, ranging from entry-level models to high-performance equipment. All Thermo Scientific Precision incubator models feature reliable and proven temperature controllers, supported by a well-insulated chamber. These features ensure uniform conditions throughout the interior for superior sample protection. Additionally, selected models include internal electrical outlets for the operation of shakers, stirrers or rotators, a feature that helps streamline more complex processes.

Product Focus: CO_2 INCUBATORS

NEW BRUNSWICK SCIENTIFIC

www.nbsc.com

The Galaxy® line of advanced CO_2 incubators features a unique fanless design and seamless one-piece chamber to eliminate potential breeding grounds for contaminants, and high-temperature disinfection (HTD) option to further minimize contamination risk. An innovative sealed inner glass door on 170L models allows viewing access while maintaining environmental stability and minimizing costly CO_2 and N_2 consumption. Perforated shelves provide rapid recovery after door opening. An advanced oxygen control system option in three control ranges enables specialized hypoxic or hyperoxic conditions to be maintained. Galaxy incubators are offered in three sizes, 0.5, 1.7 and 6.0L, and come in two model ranges: an R Series with advanced controller, automated 72-hour data logging with trend graph capability; and an economical S Series for standard cell culture applications.

NUAIRE

www.nuaire.com

The DHD AutoFlow NU-5510 CO_2 incubator utilizes a digital, solid-state programmable microprocessor infrared CO_2 sensor; dual temperature sensor probes; and various status alarms that make necessary corrections to the chamber environment supporting chamber uniformity and quicker recovery times. The interior chamber walls are lined with high tech R5 insulation for temperature stability and energy efficiency. The incubator utilizes a 99.99% HEPA filtration system ensuring a Class 100 air quality inside the work chamber. The interior chamber is maintained at a positive pressure similar to an ISO Class 5 Cleanroom. AutoFlow features a small footprint but offers a large amount of usable interior space (6.65 ft3). Dual sterilization cycles, 95°C humidified or 145°C dry, are useful for cell line changes or when working with hazardous agents.

SANYO

www.sterisonic.com

The Sterisonic™ GxP, MCO-19AIC(UVH) cell culture incubator uses the first rapid H2O2 sterilization system, an under three hour decontamination process that is the fastest method available. The use of H2O2 sterilization in biological safety cabinets and barrier isolators is a popular alternative to ethylene oxide (EtO) as it is thought to be a safer, more efficient decontamination method. The documented two-hour in situ H2O2 sequence puts the fully sterilized Sterisonic™ GxP available and ready for use quicker than any other incubator. EtO criteria outlined in ANSI/AAMI/ISO 14937 may be used as a validation guideline. All interior components and CO_2 sampling loop are sterilized in situ with no need for removal or separate autoclaving.

THERMO SCIENTIFIC

www.thermo.com

Combining the intuitive iCAN™ touch-screen user interface for simplified operation with the proven ContraCon contamination control technology, HERAcell i CO_2 incubators provide a reliable, easy-to-use system for valuable cell cultures. The exclusive ContraCon system uses a moist heat process to decontaminate the chamber overnight, without the need to remove components. The HERAcell i range is available with either non-corrosive electropolished stainless steel interiors or 100 percent pure copper antimicrobial surfaces to minimize contamination. Operational prompts, performance feedback and graphical displays are enabled by the iCAN door-mounted, touch-screen control, providing the information necessary to achieve optimal culture conditions while minimizing the risk of user error. Superior parameter recovery times are achieved via an efficient mechanical convection system, and quality in-chamber sensors allow sample humidity recovery to be obtained five times faster than ordinary chambers.

LAB MANAGER MAGAZINE'S INDEPENDENT GUIDE TO PURCHASING A CO_2 INCUBATOR

www.labmanager.com

Lab Manager MAGAZINE

Run Your Lab Like a Business

To learn more about purchasing a CO_2 Incubator, turn to the Product Focus on page 30 in this month's issue.
www.labmanager.com/co2incubators

LAB MANAGER MAGAZINE'S INDEPENDENT GUIDE TO PURCHASING A CO_2 INCUBATOR

*WATER JACKETED

CO_2 Incubator temperature control consists of a separate enclosure around 5 sides of the incubator-- everywhere but the door--that is filled with heated water. The heated water is circulated inside the enclosure, often by fans but also by natural heat convection, to maintain a consistent temperature inside the incubator. One of the benefits of choosing a water-jacketed model is that the water within the jacket not only provides heat, but also acts as an insulator. This means that during frequent door openings or power outages, samples inside the CO_2 Incubator will remain protected at the set temperature. The water jacket also provides consistent temperate over the surface area of the inner walls.

**AIR JACKETED

CO_2 Incubators are heated using a separate isolated air jacket on the 5 walls of the incubator. Some have a heated air chamber on the door as well, creating a full 6-sided heat source. The air inside the jacket is often circulated using a series of small fans. Such a design eliminates the need for fans inside the actual incubator chamber and prevents samples from drying out. One advantage of an air jacketed system is that if the temperature drops below the set point, the unit can ramp back up to its set temperature quickly. Air jacketed incubators do not require much in the way of maintenance, as there are no water reservoirs to fill. Operationally, they are almost "set it and forget it." Air jacketed systems are also lighter in weight than other systems, making them easier to move around the lab if need be. Some manufacturers use a patented technology that is a combination of direct heat and air jacketed, they are also included in this section.

***DIRECT HEAT

Since there is no need for a jacket, direct heat incubators offer greater internal capacity in a smaller footprint than an air or water-jacketed system. Another advantage is that they are often priced at a lower price point than a jacketed system. Heating comes from all six sides of the incubator, including the door, which allows for convection circulation and temperature uniformity without the need for fans.

INTERNAL VOLUME

First, let's take a look at the internal storage size of the incubator you require, measured in cubic feet. There are many different sizes available, but all can be grouped into one of three categories: Bench Top, Floor Standing and Reach In.

BENCHTOP > 0.5 to 6.5 cft.

Ideal for individual use and excellent for completely isolating separate cultures.

TEMPERATURE CONTROL

There are three options available for the temperature control of your CO_2 Incubator. While each will create a suitable environment, the corresponding summary on the left of the guide will explain the unique benefits of each.

WATER JACKETED*

NuAire US AutoFlow NU-4750
http://www.nuaire.com/productsco2_incubators/autoflow_4750/features.htm

NuAire US AutoFlow NU-4850 (RH control)
http://www.nuaire.com/products/co2_incubators/autoflow_4750/features.htm

NuAire US AutoFlow NU-4950 (RH and O2 Control)
http://www.nuaire.com/products/co2_incubators/autoflow_4750/features.htm

NuAire IR AutoFlow NU-8500
http://www.nuaire.com/products/co2_incubators/autoflow_8700/features.htm

AIR JACKETED **

BINDER CB 53
http://www.binder-world.com/us/en/products/co2-incubators-cb-series.cfm?model=422

SANYO MCO-5AC(UV): 1.7 cu. ft. CO2 Cell Culture Incubator w/ SafeCell™
http://sanyobiomedical.com/products_page.php?id=MCO-5AC(UV)

SANYO MCO-17AC: 5.8 cu. ft. CO2 Cell Culture Incubator w/ inCu saFe™ copper-enriched stainless steel
http://sanyobiomedical.com/products_page Php?id=MCO-17AC

SANYO MCO-19AIC(UVH) Sterisonic™ GxP with H202 Decontamination and SafeCell
www.sterisonic.com

DIRECT HEAT ***

New Brunswick Scientific Galaxy® 14 S
http://www.nbsc.com/LMA

NuAire TC PureCell NU-5100
http://www.nuaire.com/products/co2_incubators/purecell_5100/features.htm

New Brunswick Scientific Galaxy® 48 S
http://www.nbsc.com/LMA

NuAire DH AutoFlow NU-5500
http://www.nuaire.com/products/co2_incubators/autoflow_5500/features.htm

New Brunswick Scientific Galaxy® 48 R
http://www.nbsc.com/LMA

NuAire DHD AutoFlow NU-5510 (dual sterilization cycles)
http://www.nuaire.com/products/co2_incubators/autoflow_5510/features.htm

Thermo Scientific Heracell 150i CO2 / O2 Incubators w/ Automated High Temperature Decontamination
5.3 cu ft capacity
www.thermo.com/heracelli

Thermo Scientific Midi 40 Compact CO2 Incubator
1.4 cu ft capacity
www.thermo.com/incubators

Thermo Scientific Heracell 150i CO2 Incubators w/ Automated High Temperature Decontamination
5.3 cu ft capacity
www.thermo.com/heracelli

LARGE CAPACITY < 6.5 - 11 cft.

Ideal for groups of multiple users and often large enough to isolate different cultures within the same unit for different viral studies, pathogenic studies or stem cell applications.

TEMPERATURE CONTROL

There are three options available for the temperature control of your CO_2 Incubator. While each will create a suitable environment, the corresponding summary on the left of the guide will explain the unique benefits of each.

WATER JACKETED *

Thermo Scienitific Forma Series II HEPA Filtered Water Jacketed CO2 incubators
6.5 cu ft capacity
www.thermo.com/incubators

Thermo Scientific Napco Series 8000 HEPA Filtered Water Jacketed
6.5 cu ft capacity
(sold as Thermo Scientific 8000 outside USA)
www.thermo.com/incubators

Thermo Scientific Water Jacketed 3010 Economy CO2 Incubators
6.5 cu ft capacity
www.thermo.com/incubators

AIR JACKETED **

BINDER C 150
http://www.binder-world.com/us/en/products/co2-incubators-c-series.cfm?model=327

BINDER CB 150
http://www.binder-world.com/us/en/products/co2-incubators-cb-series.cfm?model=328

Thermo Scientific Heracell 240i Direct Heat CO2 incubators w/ Automated High Temperature Decontamination 8.4 cu ft capacity
www.thermo.com/heracelli

BINDER CB 210
http://www.binder-world.com/us/en/products/co2-incubators-cb-series.cfm?model=329

SANYO MCO-20AIC: 7.6 cu. ft. CO2 Cell Culture Incubator w/ SafeCell™
http://sanyobiomedical.com/products_page.php?id=MCO-20AIC

DIRECT HEAT ***

Thermo Scientific Cytoperm 2 Direct Heat CO2 incubators w/ Automated High Temperature Decontamination and External Humidification System
8.4 cu ft capacity www.thermo.com/incubators

Thermo Scientific Forma Direct Heat Economy CO2 Incubators
6.5 cu ft capacity
www.thermo.com/incubators

Thermo Scientific Steri-Cult HEPA Filtered Direct Heat CO2 Incubators w/ Automated High Temperature Decontamination & External Humidity System 8.2 & 11.4 cu ft capacities
www.thermo.com/incubators

Thermo Scientific Heracell 240i Direct Heat CO2 / O2 Incubators w/ Automated High Temperature Decontamination 5.3 cu ft capacity
www.thermo.com/heracelli

Thermo Scientific BBD6220 Direct Heat CO2 incubators w/ Automated High Temperature Decontamination & External Humidification System
8.4 cu ft capacity www.thermo.com/incubators

New Brunswick Scientific Galaxy 170 R
http://www.nbsc.com/LMA

New Brunswick Scientific Galaxy 170 S
http://www.nbsc.com/LMA

Thermo Scientific Forma Steri-Cycle HEPA Filtered Direct Heat CO2 incubators w/ Automated High Temperature Decontamination
6.5 cu ft capacity www.thermo.com/incubators

Thermo Scientific Napco Series 8000 HEPA Filtered Direct Heat CO2 Incubators w/ Automated High Temperature Decontamination
6.5 cu ft capacity (sold as Thermo Scientific 8000 outside USA) www.thermo.com/incubators

REACH IN over 11 cft.

Ideal for large groups with substantial room to isolate cultures.
Total volume could be comprised of multiple, stackable, reach-in units.

TEMPERATURE CONTROL

There are three options available for the temperature control of your CO_2 Incubator. While each will create a suitable environment, the corresponding summary on the left of the guide will explain the unique benefits of each.

WATER JACKETED *

NuAire IR AutoFlow NU-8700
http://www.nuaire.com/products/co2_incubators/autoflow_8700/features.htm

AIR JACKETED **

SANYO MCO-34AC: 11.6 cu. ft. CO2 Cell Culture Incubator w/ inCu saFe™ copper-enriched stainless steel
http://www.sanyobiomedical.com/products_page.php?id=MCO-34AC

SANYO MCO-38AIC(UVH) Sterisonic™ GxP with H202 Decontamination & SafeCell
www.sterisonic.com

SANYO MCO-80IC 30.1 cu. ft. Large Capacity, Reach-in CO2 Incubator
http://sanyobiomedical.com/products_page.php?id=MCO-80IC

DIRECT HEAT ***

Caron Products & Services Inc. Model 6024
25 cu. ft. capacity
www.caronproducts.com

Caron Products & Services Inc. Model 6026 Refrigerated CO2 Incubator
25 cu. ft. capacity
www.caronproducts.com

Caron Products & Services Inc. Model 6034
30 cu.ft. capacity
www.caronproducts.com

Wheaton Incubator Model: C2
www.wheatonsci.com

Thermo Scientific Forma Large Capacity Reach-In Horizontal Flow CO2 Incubators
29 cu ft capacity
www.thermo.com/incubators

Thermo Scientific Large Capacity Reach-In CO2 Incubator
28 cu ft capacity
www.thermo.com/incubators

Thermo Scientific Ultra Large Capacity Reach-In CO2 Incubator
34 cu ft capacity
www.thermo.com/incubators

TRENDS IN LIVE-CELL MICROSCOPY

ADVANCES IN OPTICS DESIGN AND THE AVAILABILITY OF INTEGRATED SYSTEMS DRIVE NEW APPLICATIONS FOR CELLULAR MICROSCOPY

by Tanuja Koppal

In recent years there has been a growing trend to work with live cells, for instance, in high-throughput screening for drug discovery, for stem cell research or for such applications as *in vitro* fertilization. "Certainly there is a lot more interest in live-cell imaging for looking at dynamic events, and microscopes are being built to achieve that," says Joseph LoBiondo, product planning manager for Nikon Instruments Inc. "There is a lot of optics design going into achieving live-cell imaging."

Self-contained, fully integrated live-cell imaging systems now come equipped with a built-in cell incubation chamber and a microscopy unit. Such companies as PerkinElmer, Carl Zeiss, Molecular Devices and Nikon all offer imaging systems with environmental controls for temperature, CO_2 levels and humidity in order to ensure that cells can grow and survive for an extended period of time. "Cells stay alive for days in these incubation systems," says LoBiondo. And in some instruments the cells don't ever have to be taken out of the system for observation since the microscope is a part of the controlled environment. Units also come equipped with a full-sized incubator that can hold a variety of chamber slides and well plates. "Nikon's BioStation CT has a motorized arm that pulls out the specified dish or plate, with minimum vibration or disruption to the cells," says LoBiondo. "The unit is very methodical and slow and very carefully picks up the dish and takes it to the microscope." The units also have some level of built-in security provided. "Certain program locks can be put in place so that if [researchers] are doing different experiments, each researcher will have access to only [his or her] cells."

Manufacturers started offering integrated units when interest in live-cell imaging began to grow. Initially researchers, themselves, were integrating such individual components as motorized stages, filter wheels, shutters, cameras and software packages from a number of different manufacturers to create a system that would meet their needs. "Depending on how it is done, there are a lot of components that are needed to work together in order to make an integrated system," says LoBiondo. "Integrated systems also tend to be less expensive. It could be about half to one-third of the costs of buying and putting together individual components." The disadvantage is that an integrated system is less customizable and may compromise certain features, such as speed when switching between wavelengths, or flexibility in terms of number of objectives or software that can be used (the latter being crucial for certain applications). However, integrated systems work well for those laboratories in need of multiple units that can perform in a routine and reliable fashion but lack the time or expertise to build them.

> **"Fully integrated live-cell imaging systems now come equipped with a built-in cell incubation chamber and a microscopy unit."**

Several factors need to be considered when evaluating which system to invest in, the most important factor being the matching of the product to the specific application. "The type of application and the level of complexity of the assays, along with the speed, ease of use and training are some of the important factors to be considered," says Sarah Payne, Ph.D., project manager at TTP LabTech. She works with the Acumen X3 product range, which uses pseudo-imaging for high-content cellular screening. "For instance, the whole well-scanning ability is important for certain applications where you may miss certain information by scanning using a field-based approach," says Payne. "This approach is particularly useful when looking at the entire organism, such as the *C. elegans* or zebrafish."

However, with microscopes now being designed to cater to several different applications and supported by image analysis software and high-end computing hardware systems, matching products to a specific application may soon be a thing of the past. "Microscopes now have multimode capabilities to be used in multiuse facilities," says LoBiondo. "They can now switch between total internal reflection fluorescence, confocal and live-cell imaging, with software control and motorization to do all those modalities."

Soon we may have a system that can do it all.

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

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

AVEN

www.sharpvue.com

The iVue and iScope allow precision optical analysis and image-sharing with plug-and-go simplicity. Each instrument is an advanced video inspection system, while the iScope enlarges from 10X to 44X and has screen magnification up to 166X. By combining a 3-megapixel camera and touch-screen virtual keyboard for annotation and measurement, the self-contained systems eliminate compatibility concerns, reduce clutter and ease portability. No laptop or desktop PC is needed, unlike other video microscope systems. The iVue's tilting head provides not only a top-down view, but also an angled view for increased depth of field. The iScope has a 45-degree fixed 3-D viewer option that rotates for 360-degree views without moving the object being examined. Each offers numerous measurement options in various orientations without requiring additional software. Precise distances between points or geometries are calculated on-screen and saved when an image is captured.

FEI

www.fei.com

The Quanta™ 50 Series is a multipurpose scanning electron microscope (SEM) for labs that require high-performance imaging for a broad range of samples, including those that are insulating, wet, dirty, or dynamically changing, in industries such as materials research, mineralogy, chemicals and petroleum, electronics, pharmaceuticals and biology. Some technologies used in the Magellan™ Extreme High Resolution SEM (XHR SEM) have been adapted to the Quanta system. Specifically, beam deceleration increases the surface imaging capability with lower landing energies, and SmartSCAN™ technologies further improve image quality by reducing noise. This adds high-vacuum, low-landing energy imaging capability to the flexibility of the Quanta's low-vacuum and environmental SEM (ESEM) technology. ESEM, pioneered by FEI, enables the broadest range of *in situ* imaging conditions.

THE MCCRONE GROUP

www.mccrone.com

The Olympus SZX10 stereo-microscope with coaxial illumination module and PAXcam digital camera helps users maximize information available from their samples with a 600 line pairs per millimeter resolution and zoom ratio of 10:1, making analysis more efficient and precise. With the common objective design it is a fully modular system offering a range of options. The coaxial illumination module then enhances contrast, increasing visual detail well beyond the ability of other stereomicroscopes. While the PAXcam digital camera equipped with Microsoft compatible measurement software precisely captures images and analyzes them with grain sizing, particle counting and image stitching. Users are able to fully document their experiments and samples and easily place them into their existing software systems.

CARL ZEISS MICROIMAGING

www.zeiss.com/micro

The LSM 7 MP laser scanning microscope generates high resolution images for a wide range of experiments in biomedical and basic research. Thanks to the use of two scanners in one compact system, two lasers with different wavelengths can be utilized sequentially or simultaneously for specimen imaging and manipulation. The range of detectors and their filter equipment, as well as an extensive line of microscope accessories, allow customization of the microscope system. The system is designed for recording high resolution images of fluorescent structures. The application fields extend from high resolution 3D imaging in long-term observations of development processes and functional imaging in conjunction with simultaneous photo-manipulation right up to imaging in combination with electrophysiological measuring methods.

For more information on lab products, please visit www.labmanager.com and click on Lab Product News. There you will find more lab products and a complete list of suppliers.

MICROSCOPY ACCESSORIES EVOLVE ON SEVERAL FRONTS

FROM OPTICS DESIGN TO IMAGING SOFTWARE, ACCESSORIES ACCENTUATE THE CAPABILITIES OF MICROSCOPY

by Tanuja Koppal

Optics lie at the heart of microscopy, and advances in optics design continue to push the limits of resolution. For instance, the use of motorized microscopes and laser light sources now help in defining the plane of focus, even as microscopes are exposed to routine mechanical and thermal stress. Joseph LoBiondo, product planning manager at Nikon Instruments, Inc., talks about Nikon's Perfect Focus system, which can readjust to the same position on the same specimen and enable the focus to be maintained at a point of interest for long-term imaging. "In the past, in order to do long-term time-lapse imaging, someone had to be sitting at the microscope adjusting the focus," says LoBiondo. "Now all you have to do is set the motorized stage to scan and take images at a certain position and then just leave the instrument alone."

> **"The increased use of fluorescent and time-resolved labeling technologies has also made image quantification programs essential in analyzing microscopic images."**

Automated, hands-free imaging has led to improved speed and ease of use, and now the field is leaning toward miniaturization to enable applications at even higher throughput. "The whole workflow in microscopy—the LEDs, the cameras, the microscopes—has become miniaturizable and user friendly," says Mike Ignatius, Ph.D., product manager of Applied Visualization Technologies at Invitrogen (now a part of Life Technologies). The field of optics is also shifting toward incorporating more instruments that have capabilities for micromanipulation and microinjection. LoBiondo says, "The equipment that we provide is moving toward incorporating smaller devices that are less susceptible to vibration, are more stable and are able to maintain precise mechanical movements." Major advancements in microinjection systems are related to increasing throughput and automation by providing devices that can be programmed. Eppendorf's InjectMan micromanipulator system offers a programmable interface and can be integrated with microinjection products in order to both manipulate and inject samples.

Computational tools and software packages are playing an important role in all aspects of microscopy. Three of the major tasks that image analysis software packages now perform include deconvolution, three-dimensional visualization and image quantification. Deconvolution software improves both contrast and resolution, while reducing image blur from out-of-focus light. Software tools for rendering or visualization of three-dimensional structures—to interpret cellular organelles or arrangement of biological moieties—are being used routinely in life sciences research.

The increased use of fluorescent and time-resolved labeling technologies has also made image quantification programs essential in analyzing microscopic images. The ability to quantitate motion or time-resolved images is an important consideration for end users who are looking to purchase image analysis software for biological applications. MetaMorph is used to analyze and visualize time-resolved and motion data, making the software useful for live-cell imaging applications. Software packages such as MATLAB and Adobe Photoshop are also used to analyze images as more dedicated options continue to populate the image analysis landscape. ImageJ, developed by Wayne Rasband of the National Institute of Mental Health, is an open source application used to acquire, process and analyze images. Other software vendors such as Volocity, Amira and Huygens SVI also offer a variety of packages that can be customized, depending on end users' needs.

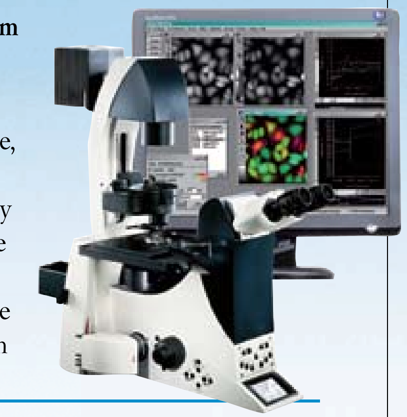
Some other considerations when purchasing imaging software include compatibility with specific hardware systems, ease of use and availability of add-ons. For example, the MetaMorph package supports microscope hardware accessories—such as an automated slide handler—and allows users to create Visual Basic programs to automate and analyze images. A majority of image analysis software programs now available are compatible with multiple operating systems (e.g., MacOS, Windows, Linux). Next-generation software products will probably incorporate more learning algorithms that are capable of pattern recognition, which will have direct benefit for live-cell imaging applications.

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

For a complete list of Microscopy Accessories manufacturers and suppliers, go to www.LabX.com.

LEICA MICROSYSTEMS

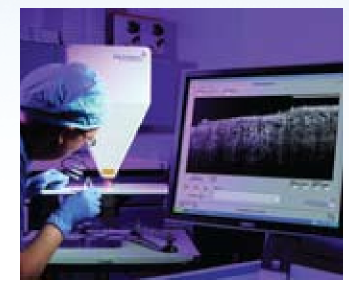
www.leica-microsystems.com



MM AF imaging systems combine Leica's high-tech microscopy and imaging with the breadth of applications and analysis of MetaMorph® software. The product line offers tightly integrated systems based on the excellent ease-of-use and optical performance of the Leica microscope range, giving researchers an efficient platform for many types of imaging experiments. An integrated journaling capability is included that allows flexible customization of the platform for virtually any imaging application. "For many years, the MetaMorph range of products has played a leading role in all aspects of imaging and data analysis," said MDS Analytical Technologies president Andy Boorn. "MDS Analytical Technologies welcomes the opportunity to team up with Leica to add the functionality, flexibility, and market reputation of MetaMorph software to the excellence in design automation and user friendliness of Leica microscopes and cameras."

MICHELSON DIAGNOSTICS

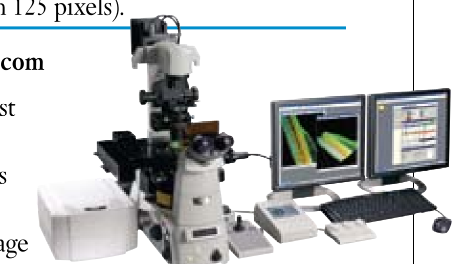
www.michelsondiagnostics.com



High Speed imaging software for the EX1301 OCT (Optical Coherence Tomography) microscope allows images to be captured at up to 40 frames per second, enabling imaging of dynamic processes such as the heartbeat of a fruit-fly. "We believe that this capability will prove very useful for biologists, for example those who are researching the genetic origins of heart disease", said Jon Holmes, MDL's CEO, "The high frame rate, coupled with market-leading optical resolution from our patented Multi-Beam OCT optics, in an off-the-shelf package, will open up new opportunities for the developmental biology scientist" The new high-speed processing software is four times faster than the previous version, and was originally developed for the company's new hand-held OCT scanner. Actual frame rates depend on the image width: from 7.5 fps (image width 1,250 pixels), to 40 fps (image width 125 pixels).

NIKON INSTRUMENTS

www.nikoninstruments.com



VAAS detection is a confocal imaging method for post acquisition recovery of data normally lost during the course of the experiment. This is accomplished by collecting emission photons that normally are rejected by the emission side pinhole, traditionally used at the 1 airy disk size. This unique technology allows for virtual adjusting of the confocality and sensitivity of data post-acquisition, as well as collecting more photons during the initial image acquisition to enable image reconstruction with greatly improved signal-to-noise. VAAS, which stands for Virtual Adjustable Aperture System, uses two pinholes to collect emitted photons: a standard-sized one to enable confocality and one with a diameter three-times larger to capture more of the emitted fluorescence without increasing the out of focus background detection. VAAS is an effective method to reduce the out of focus haze signal without reducing the signal from the focal plane.

FEI

www.fei.com

The Phenom™ Remote Assistant is a service enhancement that allows for remote tracking, diagnostics and repair of Phenom personal scanning electron microscope (SEM) systems. The device is powered by RAPID (Remote Access Program for Interactive Diagnostics), which is FEI's secure infrastructure for remote diagnostics. RAPID provides a highly-secure, encrypted, VPN (virtual private network) connection between the customer and FEI service engineer. FEI service engineers can remotely track key performance metrics over time, run service test diagnostics on the system, check and modify tool settings, and even view microscope images to access quality and provide expert operations advice. The Phenom imaging tool combines light optical and electron optical technologies in one integrated, easy-to-use microscope system. It offers magnification of up to 24,000x and 30 nm resolution (about 100,000 times smaller than the diameter of a human hair) in 30 seconds.

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9210e

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- *Maintains excellent long-term calibration stability, providing accurate and dependable data with minimal maintenance*
- *Created using reagentless electrochemical oxidation technology developed for use on the International Space Station*
- *Efficiently oxidizes organic compounds using hydroxyl radicals, peroxides and ozone*

OI Analytical www.oico.com

FTIR Spectrometer

M4000 Series

- *Durable, reliable instruments for general purpose spectroscopy, QA/QC measurements, service lab and academic applications*
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- *Features 0.5cm – 1 resolution*
- *Offers a choice of DTGS, MCT or dual detectors, industry-standard GRAMS/32-AI software, and an optional beam output port*

MIDAC www.midac.com

Automated Mercury Analyzer

SMS 100

- *Improves the detection and measurement of mercury in solids and liquids*
- *Minimizes the need for complex sample preparation*
- *Helps accurately measure mercury at low levels in a variety of sample types*
- *Enables laboratories to comply with regulations*

PerkinElmer www.perkinelmer.com

HILIC Columns

TSK-GEL NH2-100

- *Well suited for the analysis of all types of hydrophilic compounds*
- *Offers a high ligand density and large surface area, which results in a high retention for very polar compounds*
- *Columns are packed with 3 micron silica particles with 100 angstrom pores, and endcapped with trimethyl silane groups*
- *Expands the selectivity range of HILIC solutions while offering high chemical stability*
- *Now available for sale in the Americas*

Tosoh Bioscience LLC www.separations.us.tosohbioscience.com

High-End Mass Spectrometer

Waters® SYNAPT™ G2 System

- *Features a data acquisition rate of 20 spectra/second with exact mass measurements for qualitative and quantitative analysis*
- *Offers performance in excess of 40,000 FWHM resolution with class-leading sensitivity*
- *Improved ion mobility resolving power up to four times higher than the original SYNAPT system, with reduced ion turnaround times*
- *Detects components, reveals new or subtle features in the data, and provides more efficient data processing workflows*
- *Interchangeable design allows scientists to perform GC/MS and LC/MS experiments on the same instrument*

Waters www.waters.com/synaptG2

BASIC LAB

Multi-Gas Glass Tube Flow Meters

Model xV

- *Feature unique rotatable scale drums for displaying flow rates of five routine gases*
- *Eliminate the need for individual flow meters and calibrations*
- *Easy to read direct reading gradations show dual SCFM and L/min markings*
- *3/8" NPT female in-line or rear connections as well as 316 stainless steel floats are offered*
- *Available in vertical in-line or panel mount models*

Aalborg Instruments www.Aalborg.com

Miniature PCR Plate Spinner Centrifuge

MPS-1000

- *Designed specifically for quick spins of PCR plates*
- *Replaces larger centrifuge models with a compact, 6-inch-wide, benchtop instrument*
- *Accepts 96-well, 384-well, skirted and non-skirted PCR plates*
- *Fast, easy-to-use process ensures proper mixture and a focused location of all reagents*

Labnet International www.labnetlink.com

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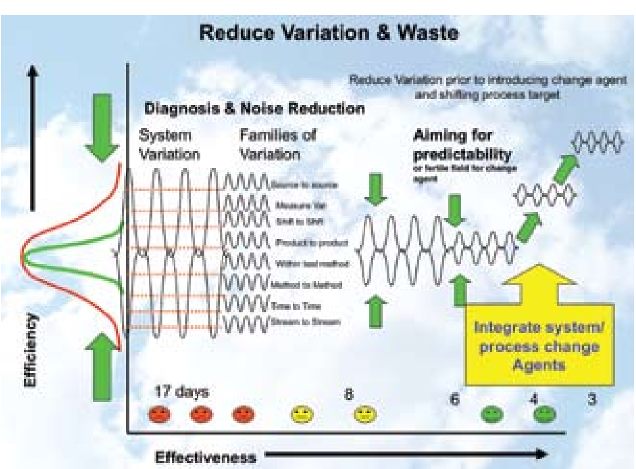
BUSINESS & FINANCE

JOURNEY TO THE EFFICIENT LAB

REDUCING ANALYTICAL CYCLE TIME THROUGH SIX SIGMA MANUFACTURING THEORY IMPLEMENTATION **by Mark V. Gibson**

"WE HAVE TO SHIP THIS TOMORROW! WHY DOES IT TAKE SO LONG TO TEST?"

These are just a few of the dreaded words that every lab manager will hear in the course of his or her day-to-day operations. In the past, my response was either to enjoy the bliss of feigned ignorance or to shift responsibility to the company management sectors that oversaw manufacturing scheduling operations. However, in the spirit of teamwork and professional progress, I began to consider the possibility of improving the cycle times in my lab while maintaining or perhaps even raising the already high level of testing quality. So I decided to cautiously go along with a joint educational improvement project proposed by our top management and a business professor from a local university. I thought that inviting the professor and a group of his students to learn and work in our lab environment would not only be a source of intrinsically motivated, no-cost labor, but would enhance company relations with the local academic community.



The first step in our improvement model to identify sources of waste was to identify the process. Each step in the testing process was analyzed to determine loading versus capacity and to identify opportunities to reduce variation and waste within the testing process.

What has happened, however, has not only radically restructured our traditional laboratory testing environment, but has dramatically reduced our lab release cycle time from an average of 17 days to less than 5 days, resulting in significant monetary savings, happier customers, and reduced overtime for lab personnel.

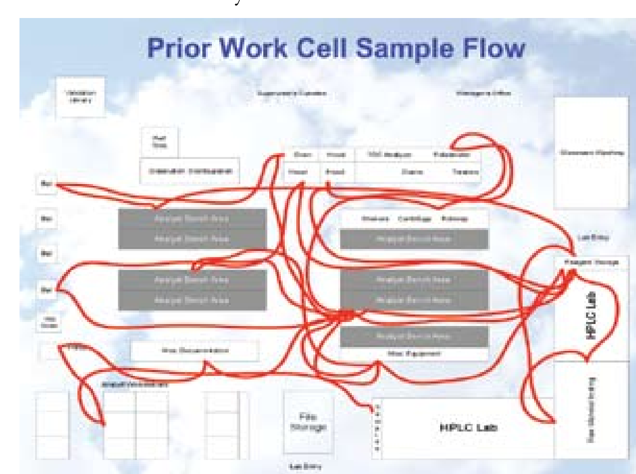
Additionally, testing quality first pass yields have increased from 97.8 to 99.99 percent. This article will briefly elaborate on the conceptual management paradigm shifts required of both the leadership and personnel team as well as outline some of the procedural changes that helped streamline the process while still maintaining a high level of GMP compliance.

"IT SEEMED IMPROBABLE THAT A GROUP OF OUTSIDERS, WHO DID NOT HAVE THE TECHNICAL CHEMISTRY EXPERIENCE AND KNOWLEDGE OF THE LAB PROCEDURES, WOULD BE ABLE TO PROVIDE A REALISTIC SOLUTION."

Although I had agreed to support this local educational adventure, I was initially fairly skeptical about its outcome. The very suggestion that, after 25 years of lab management, I needed outside input from university students and a business professor to solve the issue of slow cycle times in our pharmaceutical testing facility was difficult to accept. It seemed improbable that a group of outsiders, who did not have the technical chemistry experience or knowledge of the lab procedures, would be able to provide a realistic solution. As a lab scientist, however, I realized it was best to allow the data to speak for itself before making a final decision. Thus, I decided to be open to learning some new concepts outside of my realm of expertise, and conveyed to upper-level management my somewhat contrived enthusiasm for the project. Convincing the rest of the lab team, however, was going to take some time and a plethora of supportive data. Furthermore, I realized that the lines of communication and management initiatives coming from my office needed to produce greater team unity without threatening the roles and importance of any of our analysts.

Japanese Toyota executive Taiichi Ohno originally introduced the term "muda" to convey removal of waste. Muda can be defined as types of defective work, not just products. It includes wasted time, motion, and materials (Pyzdek 705). The first step in our improvement model to identify sources of waste was to identify the process. We proceeded by beginning to map our current lab processes. The students, having been classroom trained in process mapping, shadowed our analysts to determine the amount of time that specific lab tasks took and to obtain critical cycle time data. Each step in the testing process was analyzed to determine loading versus capacity and to identify opportunities to reduce variation and waste within the testing process. Our team of students and lab personnel was able to identify the easiest, most productive changes and targeted those for immediate improvement.

Analysis of the data revealed a bottleneck within our instrument lab analysis area.



Prior to work cell, dance chart reveals excessive analyst movement . Analysts were walking ~780 feet per sample.

Initially our staff felt that this was the data we needed to support the allocation of additional personnel resources, which would quickly solve the problem. The obvious solution: We needed more analysts! The request was denied. Site management believed cycle time improvements could be achieved through process/procedural changes that did not require additional staffing.

"ANALYSIS OF THE DATA REVEALED A BOTTLENECK WITHIN OUR INSTRUMENT LAB ANALYSIS AREA."

What initially appeared to be difficult policy, however, actually opened doors for a major paradigm shift.

During a brainstorming session with the university students and Professor DeLoach, we came upon the idea of developing a position that we would call the flex analyst. The flex analyst would be a qualified lab analyst trained to "flex" into the instrument lab, set up basic chromatography analysis on HPLCs, and then return to the main lab. In other words, the task of the individual analyst would alter, or "flex," based on the load in what was called the work cell—another manufacturing concept. We realized that what we primarily needed was an individual geared for specific tasks, and not necessarily someone experienced and knowledgeable about the full spectrum of HPLC theory. As a lab manager and chemist, the idea made me feel a bit uncomfortable, as anything less than a fully trained instrument chemist would increase the opportunity for errors and rework. Yet it was successful. Training our current lab analysts to perform basic process HPLC analysis allowed us to begin balancing our lab workload and enabled samples to move more smoothly through our processes.

"WHAT INITIALLY APPEARED TO BE DIFFICULT POLICY, HOWEVER, ACTUALLY OPENED DOORS FOR A MAJOR PARADIGM SHIFT."

The flex analyst concept was not a quick-fix scheme and was never intended to solve all aspects of our analytical procedures. The success of the flex analyst innovation was contingent upon and integrated with our willingness to adopt a broad array of Six Sigma manufacturing concepts and apply them to the entire lab environment, not just to one area. One of these concepts is called the 5S. This, coupled with other efficiency improvement concepts, has greatly reduced many forms of

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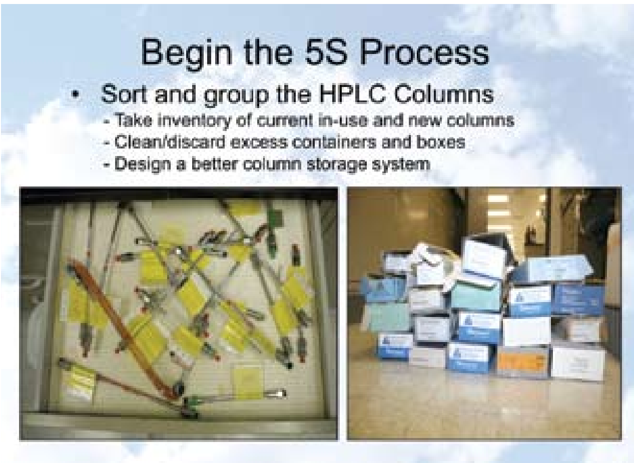
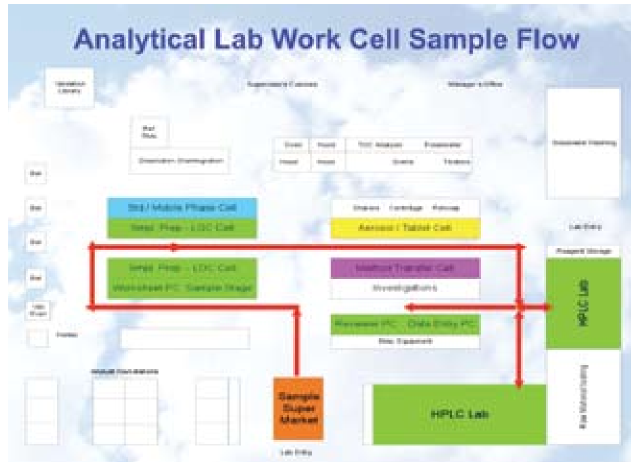


▲*HPLC column storage prior to implementing the 5S process.*

wasted motion and effort by our analysts.

The 5S concept simply refers to five basic manufacturing fundamentals that also have their origin in Japanese manufacturing theory, and which begin with the letter "S." The terms are as follows: sort *seiri*, set in order *seiton*, *shine seiso*, standardize *seiketsu*, and sustain *shitsuke*. Briefly explained, "sort" refers to determining what is necessary to do the job. "Setting in order" is just what it says—putting items in their proper place for easy retrieval and use. "Shine" refers to keeping a workspace clean and free of clutter. "Standardize" is the procedure for keeping the process in the order that has been established. And finally, "sustain" means creating maintenance habits for the work environment (Pyzdek 715). The concepts themselves were certainly not "rocket science" for our lab analysts, yet their revolutionary simplicity has a proven track record in manufacturing. Proper implementation, however, was made possible only by utilizing our cross-functional team and being open to frank and honest input from the consultant and his team.

It was in "sorting" and "setting in order" that design of the work cell, as mentioned earlier, came into play. Instead of every analyst taking each individual product from "cradle to grave," the lab was rearranged into work cells so as to promote continuous flow and improve FIFO (first in, first out). Routine tasks (e.g., HPLC mobile phases and standard preparations) were designated as suppliers to the main work cell configuration. Orchestrated tasks and testing moved from process to process with improved transitions and more clearly defined areas of responsibility instead of each analyst performing all testing on a sample. Then the lab was "set in order": We placed all equipment and machines strategically within the flow of the work cell—not according to the personal preferences of the



▲*All equipment and supplies were strategically placed within the flow of the work cell. Then the lab was "set in order" and the work cell implemented. Analysts now walk ~ 240 feet per sample saving over 1500 miles of walking per year.*

various analysts.

The processes of "sorting" and "setting in order" went fairly smoothly. "Standardizing" was a different kind of challenge. Initial rebellion showed up in the work cell prototype arrangement. Pieces of equipment that had been designated to specific places within the work cell prototype began to mysteriously disappear and reappear in their former locations around the lab. It was clear that the entire group had not "bought into" the work cell concept. So, taking a step back, I encouraged the analysts to decide within the work cell parameters where they wanted some of the equipment placed. I realized how important it was that they not only feel empowered,

▲*New HPLC column storage system allows for column selection within seconds.*

but actually be empowered, as they participated in the restructuring process. Soon, equipment items were being placed back in the most strategic and appropriate areas according to the work cell design.

Another issue in the standardization phase was making sure that work flow was not interrupted between lab team shifts. Since our factory operations work three shifts, six days a week (with a brief pause on the weekends), there was a need to make sure that the various lab teams entering and exiting were exchanging relevant information. With this in mind, we established a shift changeover meeting in order to establish priorities and specific assignments so that we could effectively transition from one shift to another. Thus, communication between the shifts skyrocketed to new levels of collaboration. Additionally, in order to maintain dialogue and focus, we integrated reinforcement of work cell concepts into the content of our weekly lab team meetings so that the laboratory staff might continue to increase their knowledge and comfort level of implementing the various process improvement ideas. We discussed "what's working" and "what's not," allowing the analysts to express their ideas and find solutions to the "what's not working" list. Although not the main agenda of those meetings, the regular repetition of these concepts strengthened the overall paradigmatic shifts in the lab.

The initial lab team response revealed a resistance to change. At this point, my lab manager role needed to expand from that of technical specialist to team leader in order to rally the crew behind the project. The idea of the work cell had produced the most resistance. Some analysts felt that this mirrored an assembly line. Other members of the team were incredulous—just as I had been at first—that a team of students, first shift lab personnel, and a business professor without any actual knowledge of chemical and analytical processes could tell other shifts and the rest of the lab how to do their job better and more efficiently. The older, longer-tenured staff members were most reluctant to embrace the concepts. It was the comment of a younger lab analyst, however, that finally encouraged the team to try the new methods: She pointed out that we were all paid the same regardless of the lab process being used. Additionally, it might even free the staff up from working excessive overtime.

The most difficult leg of the journey to the Efficient Lab has not, however, been the conceptual and procedural shifts. It has been in learning a fundamental lesson about the nature of leadership itself. I have realized that there are times when the lab manager must stand alone, maintain a commitment to a chosen path of action, and be patient while colleagues develop their own understanding and conviction about new processes. Lab management must move beyond overseeing procedures and work toward building a true team approach to innovation and implementation. Overall, the results of the project have been extremely gratifying; not only in the tremendous savings yielded from decreased cycle time, but also in the feeling of success created when a group of hardworking individuals, each gifted and talented in his or her own scientific field, unites to accomplish a challenging goal together.

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More information regarding Lean manufacturing concepts in the pharmaceutical laboratory environment can obtained by contacting Mr. Guy DeLoach, Lean Advantage Consulting Group, at gdeloach@skydancercorp.com or gdeloach@leeuniversity.edu.

PERSPECTIVE ON: AN ACADEMIC RESEARCH LAB

> "FEDERAL AGENCIES HAVE EMERGED AS THE PRIMARY SOURCE OF FUNDING FOR ACADEMIC RESEARCH INSTITUTIONS."

ACADEMIC LABS ATTRACT STIMULUS MONEY BUT FUNDING CHALLENGES REMAIN

by Bernard Tulsi

The Obama administration's $787 billion economic stimulus plan—unveiled in February of this year—included approximately $16 billion for the federal agencies that provide the lion's share of the funding for academic research institutions.

The stimulus package allocated $10 billion to the National Institutes of Health (NIH), made up of $8.5 billion for research and $1.5 billion for university research facilities. The National Science Foundation (NSF) will draw down $3 billion—$2.5 billion for research, $400 million for infrastructure and $100 million for education. Other government agencies receiving funding under the stimulus package include the National Aeronautics and Space Administration (NASA)—$1 billion, including $400 million for climate change research—and the Department of Energy (DOE), which will receive $2 billion for scientific research.

Over the years, federal agencies have emerged as the primary source of funding for academic research institutions, which also enjoy some support from industry. To be sure, industry and national laboratories garner considerably more federal R&D money than universities do. But academic institutions have tapped federal funds quite successfully because of the institutions' unique and essential role in basic research. In addition, they are home to the country's leading science and technology talent and they have an indispensable role in educating the next generation of scientists and engineers.

Case in point—Dartmouth University. The Ivy League institution's Office of Sponsored Projects showed that it received $80.4 million from the NIH, $8.22 million from the NSF, $1.74 million from NASA and $897,698 from DOE for fiscal 2007—the most recent year available—which paid for research at the College, Dartmouth Medical School and the Thayer School of Engineering.

A number of universities have created websites indicating the new sources of funding and the procedures for accessing them. The sites also detail the steps the respective universities' own faculty and researchers must take to be in compliance with the universities' procedures as well as those of the funding sources, and in some cases they even outline the universities' strategies for participating in the recovery (stimulus) programs.

In mid-May this year, the NSF, as part of the American Recovery and Reinvestment Act (ARRA), advertised its $200 million program to support the repair and renovation (and replacement in some cases) of the country's academic research facilities, as part of the Academic Research Infrastructure (ARI) program. According to NSF estimates, the agency expects to support some 100–120 projects, 100 of which will receive $0.25 million to $2 million each, 6 to 10 projects ranging from $2 million to $5 million, and 3 to 5 projects of between $5 million and $10 million. In addition, the NSF's Major Research Instrumentation (MRI) program is expected to make 400 equipment grants ranging from $100,000 to $6 million each.

Such support is seen as absolutely necessary by Steven Beckwith, vice president for research and graduate studies of the University of California system, which operates 10 university campuses and manages three

PERSPECTIVE ON: AN ACADEMIC RESEARCH LAB

national laboratories (since their inception—about seven decades ago) for the DOE—Lawrence Berkeley National Laboratory (LBL), Lawrence Livermore National Laboratory (LLNL), both in California, and the Los Alamos National Laboratory (LANL) in New Mexico, which collectively have some 21,000 workers and $4 billion in annual budgets.

Beckwith says the great universities in the U.S. have had an enormous impact on raising the standard of living and ensuring that the American people are healthy and well fed and have opportunities based on the latest technologies, such as moving into high-tech jobs.

"IN THE MORE RESEARCH-ORIENTED SETTING, FACULTY MEMBERS OPERATE THEIR LABS LIKE SMALL BUSINESSES."

"This will be more important in the future because the economies of all rich countries are moving away from mostly agricultural and industrial economies to more knowledge-based industries, which will require knowledge workers who need to get their training for the most part from the universities," says Beckwith.

Scope and organization

For some time now, academic institutions have organized and managed their laboratories in three broad categories: undergraduate, graduate and research centers or institutes.

Almost every course in the undergraduate science and engineering curriculum has associated laboratory work. This exposes students to the lab environment, where they develop confidence and learn essential techniques as well as fulfill the educational mission of the institutions.

"The bulk of academic laboratory research is at the graduate level and within the research centers," says Professor Cecil Dybowski, Department of Chemistry and Biochemistry, University of Delaware.

Still, educational and career objectives must also be addressed at the graduate or more research-intensive level. "In the research setting, there is a need to provide services, but simultaneously there is a dominant obligation to educate and to provide professional development and career preparation for students," says Dybowski.

In the more research-oriented setting, faculty members operate their labs like small businesses. "The faculty member will set out contracts much like an engineering firm, with one key difference—the deliverables are much more nebulous," he says.

While all disciplines have roughly the same responsibilities, Dybowski says that there is variation in how different interests are approached. "In engineering, the work of the laboratory has a contractual orientation, whereas in science, like chemistry, biology, physics or geology, the motivation is more from the person, and a certain amount of salesmanship is required," says Dybowski.

"You have constantly to be investigating how the subjects you are interested in fit in with particular programs of mission-oriented agencies or foundations," he says, noting that an organization like the NSF offers more undirected funding in a diverse set of areas, and researchers are less restricted to a specific mission, though this is changing too.

▲ *The recently built two-story Magnet Hall at the University of Delaware contains NMR spectrometers at multiple field strengths that are used in chemistry and allied fields. With both solid-state and solution-state capabilities, the multinuclear spectroscopic facility addresses a wide variety of scientific questions.*

Faculty members once operated their laboratories independently, not as part of a group. While this approach still exists, much more cross-disciplinary collaboration is being promoted within universities. The view seems to be that "problems that need to be solved can't be solved by one person anymore," says Dybowski.

As a result, multiple faculty members from different disciplines increasingly work together, an approach that has been common in medical research. This has led to the creation of research centers and institutes involving several faculty members and their students, often led by one faculty member. Such centers concentrate on particular issues, and their names reflect their focus—such as center for renewable energy research, or a particular disease or aspect of it, among others. "These centers seek funding as a group, and the sums involved are often quite large," says Dybowski.

Often these centers concentrate on applied research to create products, and they have been known to spin off into independent companies. In fact, the Bayh-Dole Act enacted by Congress in 1980 encourages innovation by requiring university researchers to spin off marketable products from their grant-supported initiatives.

Dybowski says that this may well be the way science will progress in the future and that while this is a nationwide trend, it is by no means unique to the United States.

He believes that one major drawback to this approach is that the institutions' principal mission—education of students—may suffer from inadequate attention. "It is inescapable that we need to be near the people in our disciplines to form a cohesive unit from the teaching standpoint, and this unit is not necessarily the same as the integrated group for research. This creates tension," he says.

Funding

In keeping with their nonprofit status, universities generally maintain that they put money into the research effort and that laboratories represent a fundamental cost without any monetary return.

But research activities allow money to flow into universities, thereby enhancing the overall economic success of the institutions, according to Dybowski. Research requires equipment and infrastructure, and the university needs to hire qualified personnel to install and operate them. This establishes a strong basis for the universities to request more money from funding sources.

In general, all grants include indirect costs based on a negotiated formula—often referred to as the escalator. Once the direct cost is known, it is multiplied by the escalator to come up with the total amount for the grant. Dybowski says that in the case of his activities at the University of Delaware, the escalator is 53 percent, so a grant with direct costs of $100,000 will end up with total costs of $153,000. The escalator varies by institutions, and in some could be as high as 101 percent. Such funds are used by the institutions to provide overall support.

In the University of California system, the fees from managing the national laboratories are put back into UC's programs for its laboratory researchers. Today that amounts to some $19 million, which is handled through Beckwith's office.

"THE BAYH-DOLE ACT ENCOURAGES INNOVATION BY REQUIRING UNIVERSITY RESEARCHERS TO SPIN OFF MARKETABLE PRODUCTS FROM THEIR GRANT-SUPPORTED INITIATIVES."

He says that there are several types of laboratory research organizations in the UC system. "Some of them require multitalented teams with various kinds of expertise. Sometimes they could be found on a single campus but drawn from different departments. In other cases, they may be drawn from different campuses, in which case they are funded by the UC systemwide office."

With respect to indirect costs, Beckwith says that because the university has to provide laboratory and office space, these are covered in the indirect costs category from grants. "In most cases, what we charge against the research grant is not fully what it costs to support the research, so the university does provide a bit of subsidy for research."

He notes that in the UC system, the typical researcher in a laboratory still has the basic support he or she had before—access to equipment, peer expertise, office and lab space, and guaranteed salaries. This is also true for researchers at the Lawrence Berkeley National Laboratory, which is still a part of the UC system. Lawrence Livermore and Los Alamos researchers operate within limited liability companies and have a different funding arrangement.

Management

There is a sense in some quarters that there is a dearth of information and educational opportunities pertinent to the management of the modern laboratory. This led to the creation of the Association of Laboratory Managers (ALMA) in the 1980s, a time when expensive and complicated analytical instrumentation funded by the NSF needed to be managed centrally in chemistry departments, according to current ALMA Executive Director John Sadowski.

Northwestern University's (Evanston, Illinois) chemistry department (among others) played a central role in raising awareness for the need to focus on laboratory management. One of its professors, Claude Lucchesi (now retired), co-founded ALMA along with Tom Lyttle, who is now affiliated with Water Management Consultants (Ponce Inlet, Florida).

According to Sadowski, the management of the modern laboratory requires both technical and managerial skills. His organization takes the position that while most laboratory heads excel at the technical aspects of their responsibilities, "managerial skills are obtained on the job in a haphazard manner."

Dybowski says that in the university setting, the management of laboratories is really local and there is constant interaction between team members and students. "There is a great deal of administration in university labs, and it is direct. These labs are exceedingly well run in all respects because of the proximity of faculty to the facility," he says.

"In the center setting, on the other hand, the scientists who direct the institute may not necessarily have such direct contact with the people in the laboratories," he says.

Beckwith by and large disagrees with the notion that the labs suffer from management inadequacies. "These are enormous organizations with management at several different levels. The leaders have strong scientific skills, and they set an overall vision and direction for the laboratory. They always surround themselves with people who are versed in professional management techniques to help them carry out their mission."

"I believe that the laboratory directors are often themselves quite good managers and the fact that they have scientific training is only a plus for their overall mission—overall, I believe the labs are quite well managed," he says.

Future prospects

Despite the influx in new stimulus or recovery funding and the general recognition that university labs are essential to the progress of society and the well-being of its people, the future of academic research appears far from rosy.

"In the short run, the public universities are suffering very badly, especially in the state of California, but many other states have been unwilling to support the core teaching functions of the universities as they have in the past.

"So I think that the great public university systems, such as the UC system, must find ways to maintain our quality in the face of decreasing public funds," says Beckwith.

Bernard Tulsi is a freelance writer based in Newark, Delaware. He may be contacted at btulsi@comcast.net or 302-266-6420.

YOU'VE BEEN TOLD TO REDUCE POLLUTANTS IN YOUR LAB…

NOW WHAT?

Under current regulations, all generators are responsible for safely managing their hazardous waste from cradle-to-grave. Laboratories recognize that they must reassess existing chemical waste management to alleviate the pressure of skyrocketing disposal costs, improve worker safety and reduce future liability. The best way to manage waste is prevention. The following Laboratory Practices describe ways that labs can reduce wastes.

1 Microscale or Nanoscale Experiments
These processes are specifically designed to scale down the volume of chemicals used in laboratory experiments and generate less hazardous waste. The scale of analytical material can be reduced immensely, leading to additional reductions in reagents, catalysts and solvents required for these experiments. Microscale or nanoscale practices can decrease fire and explosion hazards, reduce exposure to hazardous chemicals and drastically reduce waste disposal costs.

2 Increase Use of Instrumentation and Alternative Teaching Methods
Modern instrumentation not only achieves more reliable results, but also reduces chemical usage. Alternative teaching methods, such as computer simulation or interactive video chemistry lab, offer an alternative to the traditional "wet" chemistry laboratory, reducing chemical usage and associated potential hazards.

3 Substitute Less Toxic or Hazardous Compounds
and/or use an entirely different experiment is often practical. For example:

- substitute sodium hypochlorite for sodium dichromate
- use alcohol for benzene
- substitute cyclohexane for carbon tetrachloride in the standard quantitative test for halide ions
- replace acetamide with stearic acid in phase change and freezing point depression experiments
- use specialty detergents such as potassium hydroxide or sonic baths in place of chromic acid solutions to clean glassware

4 Utilize Green Chemistry to Eliminate Waste
Redesign experiments to eliminate steps which create hazardous end products, this often results in more efficient processes. This has the additional benefit of teaching students to avoid generating hazardous wastes while improving chemical processes.

5 Pre-Weigh Chemicals
for student use in teaching labs when appropriate. This will reduce waste by spills and other mishandling. Students can participate in pre weighing and handling exercises.

6 Reuse or Recycle Spent Solvent
When cleaning with solvent, reuse spent solvent for the initial cleaning and use fresh solvent only for the final rinse.

7 Employ On-Site Distillation and Reuse
Advantages include reducing disposal costs and purchasing large quantities of new solvent. Distil and reuse solvent for classroom experiments or as a cleaning agent where ultra pure solvent is not required. Small solvent distillers are available. Check with fire and worker safety regulations regarding on-site solvent distillation operation.

8 Segregate Waste Streams
Provide a properly labeled container for each waste stream for better waste management at lower cost. Do not dilute or mix hazardous and nonhazardous waste. Segregate recyclable and nonrecyclable wastes. Segregate solvent in a closed-top drum and recycle. Segregate used oil from other wastes. Include waste segregation as part of the educational process. Segregate precious metal wastes, such as those containing platinum, palladium and rhodium, since they can be recovered using chemical procedures specific to those metals. Send silver containing solutions from photographic and x-ray facilities to commercial firms that specialize in recovering silver. Many local photo shops will take photo waste free of charge.

9 Apply Waste Minimization Technologies
to management of metallic wastes and their solutions. Waste mercury can be easily recycled depending on the type or degree of contamination.

10 Provide a Designated Safe Facility for Waste Storage,
segregation and treatment to promote proper management of hazardous waste and aid in waste reduction.

11 Label Incoming Chemicals
When stocking new chemicals, label with purchasing date and add storage code and safety precautions.

12 Maintain Containers and Labels
Routinely inspect and clean old containers, tighten lids and maintain legible labels. Re-label as needed. Unidentified reagents and wastes cannot be legally shipped for disposal and present a difficult waste management problem.

13 Provide Employee Training
Training programs for those who may generate or handle chemicals should include minimizing chemical hazards, spill prevention, preventive maintenance and emergency preparedness and response.

**The above information comes from the Ohio Office of Compliance Assistance and Pollution Prevention; Laboratory Pollution Prevention; Number 16, November 2005.*

LAB SAFETY

TAKE THIS JAR & SHELVE IT

GOOD RULES OF THUMB FOR CHEMICAL HANDLING & STORAGE IN THE LAB By Glenn Ketcham and Vince McLeod

If there is something that all laboratories have in common, it is bottles and bottles of chemicals. And if we are not diligent in handling and storing these bottles properly, problems will arise. Those problems can run the gamut from mildly inconvenient to life-threateningly serious. Keep reading to learn how to avoid mishaps from mishandled chemicals.

Previous articles laid the groundwork for how to manage chemicals in laboratories. These articles covered understanding the National Fire Protection Association's hazard diamond, deciphering material safety data sheets and constructing a proper chemical inventory for the lab. In this column we provide general safety rules for handling and storing chemicals in the laboratory.

Many federal, state and local regulations have specific requirements that affect the handling and storing of chemicals in labs and stockrooms. Examples include controlled substances and consumable alcohols, covered by the Food and Drug Administration and the Drug Enforcement Agency; radioactive substances, regulated by the Nuclear Regulatory Commission; and hazardous wastes, governed by the Environmental Protection Agency. Requirements range from having locked storage cabinets and specific waste containers to maintaining controlled access for "regulated" areas. If any of your labs use any of these substances, make sure you know which regulations apply and what the specific requirements are.

A more common scenario is having to apply state or local building and fire codes, which are becoming more rigorous each year. Hopefully, these were identified and attended to during design and construction. But we all know how labs evolve and change and that state fire marshals are not shy about pointing out where we have crossed the line.

"BUT WE ALL KNOW HOW LABS EVOLVE AND CHANGE AND THAT STATE FIRE MARSHALS ARE NOT SHY ABOUT POINTING OUT WHERE WE HAVE CROSSED THE LINE."

First things first—proper personal protective equipment (PPE)

Before we start grabbing bottles of chemicals, we need make sure we have the proper PPE. At a minimum, this would include appropriate chemical-resistant gloves and eye protection. Closed-toe shoes are a must and should be a general requirement for working in the laboratory. Lab coats or chemical aprons should be used when needed or required by your laboratory safety policy.

Now that we have covered PPE, there are a couple more things to gather and take note of before we begin moving those chemical containers around. First, survey your surroundings and notice any potential trip hazards and the locations of workstations where others are busy. Make sure exits, passageways and emergency equipment areas (e.g., eyewash and safety showers) are clear and free of stored materials. Locate and have close at hand a full spill kit with appropriate absorbent materials, neutralizing agents, cleanup utensils and waste containers. Finally, check that all chemical containers have complete labels in good condition and that MSDSs are readily available.

"MAKE SURE EXITS, PASSAGEWAYS AND EMERGENCY EQUIPMENT AREAS ARE CLEAR AND FREE OF STORED MATERIALS."

Tips for safe transporting

Here are a few good pointers on moving chemicals safely:

- *First, never move visibly degrading chemicals and containers. Report these to your lab supervisor or principal investigator.*
- *Whenever transporting chemicals, place bottles in appropriate leak-proof secondary containers to protect against breakage and spillage. A good example is using a special plastic tote to carry four-liter glass bottles of corrosives or solvents.*
- *When moving multiple, large or heavy containers, use sturdy carts. Ensure that the cart's wheels are large enough to roll over uneven surfaces without making the cart tip or stop suddenly. If carts are used for secondary containment, make sure the trays are liquid-tight and have sufficient lips on all four sides.*
- *Do not transport chemicals during busy times such as break times, lunch periods or class changes (for academic laboratories).*
- *Use freight elevators to move hazardous chemicals whenever possible, to avoid potential incidents on crowded passenger elevators. Remember to remove gloves when pushing elevator buttons or opening doors.*
- *Never leave chemicals unattended.*

General guidelines for chemical storage

Safely storing chemicals in laboratories or stockrooms requires consideration of many health and safety factors. In particular, proper use of containers and common lab equipment is critical. Here are some general guidelines for safe chemical storage:

- *Do not store large, heavy containers or liquids on high shelves or in high cabinets. A good rule is to store these at shoulder level or below.*
- *Do not store bottles on the floor unless they are in some type of secondary containment.*
- *Do not store chemicals near heat sources or in direct sunlight.*
- *Do not store chemicals in fume hoods. An excess of containers can interfere with airflow and hood performance. Only chemicals in use should be in the hood.*
- *Especially avoid storing anything on top of cabinets. This can interfere with the fire-suppression system. Ensure at least 18 inches of clearance around all sprinkler heads.* >>p.52

CHECKLIST

- [ ] **Label all chemical containers fully. We recommend placing the owner's or user's name along with the date received on each one.**
- [ ] **Provide a specific storage space for each chemical and ensure its return after each use.**
- [ ] **Store volatile toxics and odoriferous chemicals in ventilated cabinets. Please check with your environmental health and safety personnel for specific guidance.**
- [ ] **Store flammable liquids in approved flammable liquid storage cabinets. A small amount of flammable liquids may be stored in the open room. Check with your local authority (e.g., fire marshal or EH&S personnel) for allowable limits.**
- [ ] **Separate all chemicals, especially liquids, according to compatible groups.**
- [ ] **Follow all precautions regarding storage of incompatible materials. Post a chemical compatibility chart in the lab and next to chemical storage rooms for reference.**
- [ ] **Use appropriate resistant secondary containers for corrosive materials. This will protect the cabinets and catch any leaks or spills due to breakage.**
- [ ] **Seal containers tightly to prevent vapors from escaping.**
- [ ] **Use designated refrigerators to store chemicals. Label these refrigerators "CHEMICAL STORAGE ONLY – NO FOOD." Never store flammable liquids in a refrigerator unless it is specifically designed and approved for such storage. Use only explosion-proof (spark-free) refrigerators to store flammables.**

- *Do not use bench tops for storage. These work spaces should contain only chemicals currently being used.*
- *Do not store chemicals indefinitely. Humidity causes powders to cake or harden. Liquid chemicals evaporate. We strongly recommend that all containers be dated when they arrive in the lab. Ensure that all manufacturers' expiration dates are strictly followed. Pay special attention to reactive or dangerous compounds. Dispose of all outdated, hardened, evaporated or degraded materials promptly.*

Following these simple guidelines will get you well on the way to an efficient, organized and safely operating laboratory. Ignore them or become cavalier in their application and you may be picking through ashes or rubble one day. Spend a few minutes going through the lab with this list on a regular basis and you should avoid any major incidents with chemical storage. As always, Safety First.

Additional resources

1) *Standard System for the Identification of the Hazards of Materials for Emergency Response,* National Fire Protection Association, Publication 704. http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=704

2) *NIOSH Pocket Guide to Chemical Hazards,* National Institute of Occupational Safety and Health, Publication 2005-149. http://www.cdc.gov/niosh/npg/

3) *The Merck Index,* an encyclopedia of chemicals, drugs and biologicals.*14th edition. Merck & Company, Inc., Rahway, N.J., 2006.*

4) *OSHA Hazard Communication Standard.* http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10099

5) *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals.*National Research Council. National Academy Press, Washington, D.C.

6) *Laboratory Safety Manual,* University of Florida, Division of Environmental Health and Safety, 2003. http://www.ehs.ufl.edu/Lab/LabSafe.pdf

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

GAS PROCESS AUTOMATION

Problem: Many relatively simple industrial or laboratory processes that require control of flow or pressure can be greatly improved with automation. Using a mass flow controller to control a certain gas flow rate, for instance, is far more precise and has a faster speed of response than manually adjusting a needle valve while consulting a pressure gage.

Such processes can be automated using devices called Programmed Logic Controllers (PLC's). These are digital computers used for automation of electromechanical processes. Such devices typically have a series of digital and analog inputs and outputs, and can be used to control relatively complex processes depending upon the number of these I/O channels and the programmed logic. For simple gas processes, PLC's are generally overkill—being too expensive due to extra capabilities that are just not required.

Solution: Sierra's Compod™ bridges the gap between manual operation and more complex PLC systems to enable simple gas processes like gas mixing and blending, batch control, leak testing, and process monitoring at a fraction of the cost. A Compod, coupled with Sierra's Smart-Trak® mass flow meters (MFM's) and controllers (MFC's), greatly simplifies basic flow control installations and permits networking of multiple instruments using open-source MODBUS RTU protocol. With MODBUS, multiple instruments can be daisy-chained over a single network. Two digital outputs and one analog input can be configured by the end user for a wide variety of process controls. Unlike dedicated PLC's, a Compod is a small device that mounts locally to the face of the Smart-Trak MFC.

One example involves leak testing. In a leak testing process, a component must be checked for leakage. A regulator is set manually to the leak-test pressure. This is usually a pressure above operating pressure of the DUT (device under test). A Smart-Trak MFC is given a setpoint appropriate to fill the DUT at a moderate rate. The MFC's Compod monitors the flow rate. When the flow rate drops to zero, the pressure in the DUT is equal the pressure set by the regulator. The internal software in Compod senses that the flow has stopped and the Compod closes the valve in the MFC and trips an alarm (light) for the operator, telling him the DUT is pressurized and the leak test is ready to begin. The operator sees the alarm light and opens a ball valve manually. The leak test begins and a Smart-Trak mass flow meter with a Compod measures the flow rate. As long as the flow rate is below a pre-determined level, the DUT passes the test. If the flow rate is above this defined level, the Compod sends an alarm indicating the DUT is leaking and the DUT is failed.

Sierra Instruments' Compod™ + Smart-Trak® 2

Another use is in gas mixing and blending. In a typical gas mixing and blending process, a specific gas blend must be produced. For example, a synthetic air composition of 78% Nitrogen, 21% Oxygen and 1% Argon is required. A miniature Human/Machine Interface (HMI) with LCD touch screen monitors and controls the system automatically. The HMI communicates to a pressure transducer mounted inside the tank and three Smart-Trak mass flow controllers, each with a Compod. Each MFC regulates the flow of one gas into the tank. The HMI maintains the exact proportion defined above by constantly monitoring each MFC. When the pressure reaches the set point, the HMI commands the Compod to stop the flow controllers. Should the pressure drop below the set point, the HMI sends a flow command to each controller to resume gas flow into the tank.

For further information, go to www.sierrainstruments.com

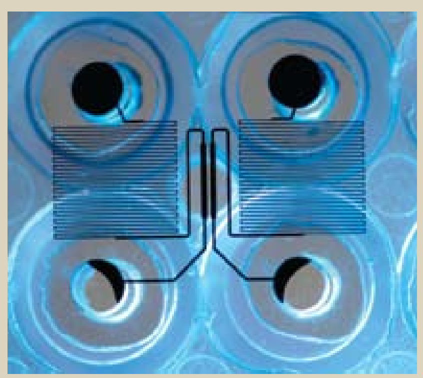
HOW IT WORKS

LIVE CELL ANALYSIS UNDER SHEAR FLOW

Problem: In today's life science research environment, the usefulness and versatility of cellular analysis is growing rapidly. While the evolution of research tools has enabled the generation of more data and increasingly detailed study of cellular function, static, plate-based assays have not been able to closely mimic conditions in the human body. Traditionally this has required moving the assays into *in vivo* studies in animal models, which is time consuming and expensive

Solution: Fluxion Biosciences has developed research tools that bridge the gap between *in vitro* and *in vivo*, allowing advanced cellular study and minimizing the volume of animal studies. The foundation for these systems is cutting edge microfluidic technology, which can control shear flow in individual microplate wells to emulate *in vivo* conditions of the microvasculature and other physiological systems. Many processes behave differently under flow versus static conditions. Shear flow is important in vascular, immune and cardiovascular systems.

Each BioFlux well plate contains up to 24 individual flow cells, which are fully enclosed microfluidic channels for running flow-based experiments. The flow cells are arrayed on the bottom of an SBS-standard well plate with a conduit from the well to the microfluidic path. This enables direct introduction of reagents into the microfluidic path in the well, rather than through tubing or an off-chip reservoir. An airtight interface is then placed on the plate with a series of pneumatic connections to each of the wells. Flow is initiated using a pneumatic controller to move liquid through a flow channel thereby creating shear force within the physiological range. Shear values can also be rapidly switched on the fly, enabling complex flow protocols, such as cyclical waveforms.



BioFlux Plate channels viewed from beneath the well plates. Four wells are shown. Microfluidic flow cells are integrated into the bottom of the plate. Each fluidic channel runs between pairs of wells and has a control viewing window for observation.

Many immunology and cancer applications seek information on cell adhesion, migration and transmigration, which often occur under physiological, shear flow within the blood vessels. Live-cell assays on the BioFlux platform can provide data on growth of endothelial cell layers, rolling velocity measurements, cell adhesion counts, transmigration and high-content imaging. Small molecule assays can also be performed under flow conditions using the BioFlux, for increased physiological relevance.

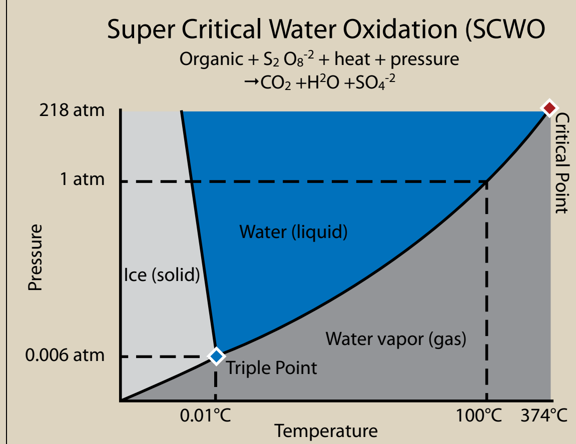
In microbiology, the BioFlux platform can enhance the study of microbial communities, also called biofilms, many of which grow only in the presence of shear flow. Historical flow systems used to study biofilms have lacked the necessary throughput. Fluxion's Well Plate Microfluidics (WPM™) can increase the throughput by as much as two orders of magnitude while the presence of controlled shear flow mimics conditions at the sites of biofilm infection. Anti-microbial efficacy and dose-response assays are also more effective under flow conditions and with WPM can be utilized as a cost-effective secondary screen.

Beyond immunology and microbiology, the BioFlux shear flow system has applications in stem cell research, neuronal cells and other specialized cell cultures. Further expansion of the system will include higher density well plates, alternate fluidic configurations for greater experimental flexibility and alternate detection modalities.

For more information, go to www.fluxionbio.com

SUPERCRITICAL WATER OXIDATION TECHNOLOGY FOR TOC

Problem: Sample matrices are known to create analytical obstacles during routine Total Organic Carbon (TOC) analysis. Until now, interferences from sample matrices have caused calibration curve stability to be sacrificed. Some common aggressive matrices require frequent maintenance and weekly, or even daily, calibration.



Supercritical Water is formed once pressure can no longer be increased to maintain the liquid phase. Beyond 374 °C and 218 atm (3200 psi), the gas and liquid phases merge to form another phase of matter.

Solution By re-engineering the sample flow path and the oxidation technique, one manufacturer has developed a robust TOC analyzer to hold a calibration curve for up to six months for even the most troublesome brine matrices.

The process used is Supercritical Water Oxidation (SCWO). The novel approach to this wet chemical oxidation technique employs both heat and pressure. The increased pressure within the reaction cell dramatically increases the efficiency of the oxidation process, thereby offering better recovery for difficult matrices. Unlike combustion techniques, this process completely removes all oxidation by-products from the sample flow path between every sample run.

When in a supercritical state, water exhibits the characteristics and benefits of both a liquid and a gas. The SCW has a density closer to that of a liquid, but can still diffuse like a gas. Organic material and gases become highly soluble in SCW and, conversely, inorganic salts become insoluble. These conditions are ideal for SCWO reactions.

When measuring TOC, several techniques are used to oxidize the organic carbon in the sample to form carbon dioxide (CO2). Once the CO2 is formed, it can be detected and quantified. The main problem facing TOC analysts is ensuring efficient oxidation of the organic carbon. Using a wet chemical oxidation technique, the process seeds the solution with an oxygen donating reagent. Systems such as GE's Sievers InnovOx employ a 30 percent weight/volume solution of sodium persulphate as the oxidizer. It then heats the sample and oxidizer in a sealed reactor past the critical point and SCWO is achieved.

When water reaches a supercritical state, organic material and gases become highly soluble in SCW, while inorganic salts become insoluble. This is very important, since salts will typically scavenge the oxidizer, resulting in an incomplete organic carbon to carbon dioxide conversion. This SCW medium is the perfect environment for efficient sample oxidation.

By utilizing the fundamental supercritical properties of water, wet chemical oxidation has proven to be significantly more reliable and robust than the original combustion technique. The 375 °C and 218 atm (3200 psi) combination have allowed the process to achieve ultra-efficient conversion of organic carbon to carbon dioxide.

Controlling the purging of reaction by-products and matrix impurities between each analysis, SWCO systems offer something not available before: long-term system integrity. Each analysis starts with a clean sample path that ensures data accuracy, calibration robustness, and extended periods of time between routine system maintenance activities.

SWCO appears to be a very innovative way to perform TOC analysis on what were once considered very difficult or impossible sample matrices.

For more information, go to www.geinstruments.com

ADVERTISER INDEX

Marketplace

PARTING POINTS

Takeaways from this month's issue:

Valuing Diversity, p.10

In order to be productive, lab managers and staff members must be open to diverse viewpoints and cultures, encouraging effective communication between all different ethnic, cultural, and educational backgrounds. To promote a diverse workplace, the author suggests:

- Going beyond the mandates and laws for equal employment opportunity
- Considering diversity as a broader concept
- Hiring staff who seem less of a fit with the workplace culture
- Consulting professional science societies for information on how to manage a diverse staff

Local is the New Green, p. 22

"Going Local" is a simple, valuable approach that is within reach of any lab. Below are some simple steps that laboratory managers can take to make the workplace greener, improving the research process and the work experience:

- Share surplus materials with local schools
- Foster an environment of recycling
- Purchase locally manufactured supplies
- Establish a green purchasing program

Journey to the Efficient Lab, p. 40

When lab manager and author Mark Gibson decided to go along with an improvement project to address slow cycle times in his pharmaceutical testing facility, he was skeptical. However, the results were gratifying and Gibson learned that sometimes lab managers need to:

- Stand alone and maintain a commitment to a chosen path of action
- Be patient while colleagues develop their own understanding about new processes
- Move beyond overseeing procedures
- Work toward building a true team approach

Perspective On: An Academic Research Lab, p. 44

University labs are essential to the progress of society and the well-being of its people, as well as providing the training required for the more knowledge-based industries that economies are moving toward. Despite funding challenges, university research labs continue adapting to research demands. Changes include:

- More cross-disciplinary collaboration
- Multiple faculty members from different disciplines working together
- The creation of research centers that concentrate on particular issues
- Centers focused on applied research seek funding as a group

Take This Jar and Shelve It, p 50

Many federal, state and local regulations have specific requirements that affect the handling and storing of chemicals. By making use of the general safety rules below, labs will be better equipped to meet these requirements.

- Ensure proper personal protective equipment is used
- Transport chemicals according to lab procedure
- Conform to all specifications when storing chemicals

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