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MAGAZINE

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October 2010

Volume 5 • Number 8

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- UHPLC - making the impossible, possible?

Phil Grace is Principal Scientist at HFL Sport Science in Cambridgeshire, UK. He is responsible for a number of areas such as the development of nutritional biomarker and fitness biomarker assays, the improvement and development of screening technologies for the detection of banned substances in nutritional supplements, and the introduction of new technologies.

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Back to Business

Call it the "pencil box syndrome," but something about Fall has many of us taking a fresh look at and making a renewed commitment to our work—be it academic, scientific or managerial. Which makes our October issue well suited to the season and well timed to address some important career issues. We begin with John Borchardt's cover story, which describes the ten attitudes laboratory managers need in order to become successful. The author cites Winston Churchill and University of Pennsylvania psychologist Martin Seligman to support the notion that "attitude is a little thing that makes a big difference," and "that people with positive attitudes are healthier, have better relationships, go further in their careers and earn more money."

We follow the career building article with highlights from our Fourth Annual Salary & Job Satisfaction survey. This year's results align closely with what most of us know—businesses have cut staff, remaining employees are doing more with less and, as a result, there is more stress and unhappiness in the workplace. Be that as it may, this year's survey again confirms that the majority of lab professionals remain happy in their chosen professions—despite the challenges.

For more on career development, Richard Daub this month revisits the state of the Professional Science Master's degree. Familiar to some, unknown to many, the PSM still seeks the recognition and respect it needs to become a meaningful career differentiator among scientific professionals, even though 96 institutions now offer PSM programs and approximately 2,700 students have earned the degree.

In the first of two Technology & Operations articles, Angelo DePalma takes a hard look at ultra high-performance liquid chromatography (UHPLC), calling it "chromatography's crowning achievement." But whether a UHPLC system is right for your lab "depends on your lab's workflow and the relative value you place on performance and cost or familiarity," says DePalma. In our second Technology & Operations article, John Borchardt tells us everything we ever wanted to know about mind maps. If the concept is new to you, turn to page 36 to learn how this simple tool can help you brainstorm, solve problems, and organize ideas and processes in your lab. The article also provides an introduction to our new *Lab Manager Magazine* MIND MAP series, introduced this month. To see the method applied, turn to page 42 for a mind map for improving HPLC analyses in your lab. We plan to feature six new mind maps in 2011. Please let me know what you think.

In the meantime, say so long to summer and welcome to back to business.

Pam Ahlberg
Pamela Ahlberg / Editor-in-Chief

Calling All Photographers: *Lab Manager Magazine* is looking for a few budding Ansel Adamses to share their best photographs of scenes from their labs. Subjects can include the physical plant, staff members at work, the latest amazing instrument, or anything else you'd be proud to share. Photos need to be professional in subject and presentation and of a high quality (original file, 300dpi, 2MB minimum). Winning photos will be featured in our *Lab Manager Magazine* 2011 wall calendar. Please submit your photos (along with photo caption and credit) to me at pam@labmanager.com. **The deadline for submissions is October 15th.**

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CAREER BUILDING

TEN PRINCIPLES TO BECOMING A MORE SUCCESSFUL
LAB MANAGER John K. Borchardt, Ph.D.

While technical ability is essential to becoming a successful laboratory manager, it is not sufficient. Many outstanding scientists or engineers have failed as lab managers. It takes more than just technical ability. What is this “more” that outstanding lab managers have?

“Attitude is a little thing that makes a big difference.”

“Attitude is a little thing that makes a big difference,” according to Winston Churchill. Recent psychology research backs up the famous statesman. Attitude is critical to success, according to University of Pennsylvania psychologist Martin Seligman. In a series of studies, he has discovered that attitude is a better predictor of success than are I.Q., education and most other factors. He found that people with positive attitudes are healthier, have better relationships, go further in their careers and earn more money. There are ten attitudes laboratory managers need in order to become successful.

1 Believe that you are in charge of your destiny

This means taking charge and making good things happen, not waiting for them to happen to you. Sometimes you have to take risks. These should be carefully calculated risks, and you should take steps to reduce uncertainties, and thus risk, maximizing your chances of success. This can require courage, especially in tough economic conditions.

For example, the oil field service industry experienced very difficult economic conditions from 1982 until about 1990. Lab staffs were cut, at some companies cut repeatedly. At my then employer, a chemist (this author) developed a very promising new product. It was described in a newsletter sent to all field engineers, the engineers who worked directly with customers, the companies that operated oil and gas fields. Many field engineers pressed the company to release the product for field testing. The R&D department manager refused to do so. Finally a company vice president intervened and approved the product for field testing. The product was highly successful in field testing and was quickly released for general field use. It resulted in a significant increase in market share for the company and very welcome additional revenues. This situation contributed to the manager being moved to a staff position in which he did not supervise others.

2 Successful managers have positive attitudes

“I am an optimist. It does not seem too much use being anything else,” commented Winston Churchill. Successful managers believe anything is possible in their career advancement. However, if they believe they can’t do something, they probably won’t. Having a positive attitude motivates your staff members, improving both productivity and morale. This author clearly—and fondly—recalls manager Bill Young, whose positive attitude helped me to persevere in a difficult research project and succeed. Bill taught me that positive attitudes contribute to the determination needed to persist and bring projects to successful conclusions.

3 Do everything well

While managers should certainly prioritize their goals and activities, there is really nothing in their job requirements that they can afford to ignore. Attention to detail can be critical to achieving project success that leads to career success.

4 Networking is essential

Networking can provide a mother lode of useful advice. Successful networking is essential to career advancement. For staff members, this begins with establishing good rapport with coworkers, including those in support functions such as information scientists. Maintain these contacts when assigned to management positions. Network with peers and both higher- and lower-level managers. Treat everyone as a key contact. Go to lunch with fellow managers you would not otherwise see very often in your day-to-day activities.

Extend your networking beyond your own laboratory and company. In particular, join professional associations. Meetings and professional society activities are great opportunities for networking and making valuable contacts with people outside your own organization.

5 Find reasons to enjoy your job

Finding reasons to enjoy your job improves your disposition and promotes an optimistic attitude. An optimistic attitude increases your energy level, helping you to get more done. So dwell on the positive aspects of your job. Find ways to fix the negative aspects. If you can’t, then don’t dwell on the negative.

6 Ask “What else can I do?”

Always ask yourself the question, “What else can I do?” Look for ways to enhance the chances of success on your projects. Don’t do their work for them but help make your staff members’ jobs easier. Help coworkers complete their projects and achieve their goals.

7 Learn from your mistakes

There is an old saying, “Learn from your mistakes.” No one succeeds 100 percent of the time. Analyze situations when you did not succeed or did not accomplish as much as you might have. Your analysis will help you avoid repeating your mistakes.

8 Promote yourself and your accomplishments

Don’t just wait for others to recognize your talents and success. Don’t be obnoxious, but do talk about your successes. My mom called it “Toot your own horn.” Observe successful colleagues to learn how some do this without sounding boastful.

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9 Seek out opportunities to succeed

It was Louis Pasteur who said "Chance favors the prepared mind." This axiom applies to management as well as laboratory research. Stay alert for opportunities to advance your career and to succeed in your current projects.

10 Learn new skills

Learn new management and leadership skills and apply them to achieve success in your new management position. There are several ways to do this. One is independent study through reading or taking DVD or online short courses. Another is to take short courses offered by professional societies, junior colleges and other organizations. Consultants also offer some courses. Yet another approach is to take full-semester courses offered

by universities during the day or as evening courses.

When taking these courses, it is important to try to incorporate the important lessons you learn into your job as soon as possible. Otherwise you tend to forget them.

Stay alert for opportunities to learn informally. Identify successful managers in your organization. Use them as role models and observe how they handle their staff members, peers and their own managers. Also observe how they handle management tasks and problems as they arise.

Embrace change

Beyond these ten principles, newly appointed managers need to recognize that their relationships with coworkers must change because they will be supervising former peers. You don't have to abandon friendships, but you do need to put them on a somewhat different basis. Also, you can't appear to be playing favorites with your friends. It can destroy your reputation as a fair-minded leader. Should you do so, some friends may try to take advantage of you.

In your management position, you cannot afford to criticize the performance of other employees in lunchtime or hallway discussions the way you used to do. This can give the impression of bias and is hurtful to the individuals you criticize to others. Managers should practice the adage "Praise in public; criticize in private."

Newly appointed managers also need to manage the disappointment of former peers who did not get appointed to the position. This means finding new opportunities or challenges for them in your work group. It does not mean tolerating a decline in their performance. You may need to quickly sit down with these individuals to discuss any concerns and disappointments they may have over not being appointed to the management position.

"Successful networking is essential to career advancement."

Broaden your mental scope

Staff members are focused primarily on their own job responsibilities and relatively short-term projects and issues. This fosters dedication and hard work. However,

as a manager, you have to be concerned with both the short- and long-range interests of your work group and the entire organization. Managers have to be concerned with all the projects going on in their work groups.

"Stay alert for opportunities to learn informally."

Newly appointed managers must fight any tendency they have to micromanage and to be overly involved with their former projects. Even though a team leader is not considered to be working in a formal management position at many laboratories, this position helps one make the transition from the mind-set of a staff member to that of a lab manager. A good team leader recognizes that progress toward achieving project goals and successfully completing the project moves only at the pace of the slowest phase of the project. Hence the team leader must be certain that each team member has the resources needed to ensure that his or her phase of the overall project is progressing satisfactorily. For example, I have observed large projects reach what was thought to be R&D completion amid much jubilation, only to have team members realize that the next phase of the project hadn't been attended to. For example, the patent attorney on the team didn't have the time to prepare the patent applications that must be filed in order to obtain patent protection in other countries. Consequently, commercialization had to be delayed until this was done.

Project "handoffs" are often aspects of the work that are neglected until the R&D is done. However, having the appropriate people on the team be responsible for these handoffs can reduce this problem. For example, an R&D team could include members from Sales & Marketing or an engineer from the plant where a new project will be run or a new product manufactured.

Team leader assignments can be excellent proving grounds for future lab managers.

Dr. John K. Borchardt is a consultant and technical writer. The author of the book Career Management for Scientists and Engineers, he often writes on career-related subjects. He can be reached at jkborchardt@hotmail.com.

RETURNING TO A STAFF POSITION

By John K. Borchardt

What can senior managers do when outstanding staff members are moved into a management position and don't do well?

The first step is to work with each manager to determine the causes of his or her poor performance and design a program to rectify them. However, often the problem is due to deeply held attitudes that the junior-level manager is unable to change. In this situation, many managers are allowed to remain in place. This can reduce the productivity and morale of entire research groups or departments.

Another option is to assign the manager to a lab bench or other staff position. If this is done, it is best that the manager not be assigned to the group he or she once supervised. This can contribute to an air of failure that could lead to a valuable employee leaving the company. Options to avoid this include creating a new position for the manager or assigning him or her to a different laboratory location or a nonlaboratory position. For instance, some with good interpersonal skills move into sales and marketing positions. Others have become liaisons between the laboratory and the patent department, working on various projects to maximize the value of the laboratory's intellectual property. The growing phenomenon of open innovation¹ may offer such positions. Former managers can become schooled in the patent process and work on facilitating the patenting of laboratory staff members' inventions.

Some former managers returning to research staff positions worry they may have lost the creativity that made them outstanding researchers in the past. This author's observations of and discussions with several former laboratory managers who have returned to the lab bench indicates that while some have performed very well in their new staff positions, others have not and have become quite unhappy. This unsatisfactory outcome emphasizes the importance of making very careful choices when assigning staff members to management positions.

One key factor in making a successful transition back to the lab bench is how long the individual has spent as a manager. Those who return fairly quickly to the bench generally do better than those who are away from the bench for a long time. This indicates the importance of senior managers not letting an ineffective manager continue in his or her management position for very long.

Reference

1. J.K. Borchardt, "Open Innovation Becoming Key to R&D Success," *Lab Manager Magazine*, January 2008 (<http://www.labmanager.com/articles.asp?ID=28>).

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THE FOURTH ANNUAL SALARY & EMPLOYEE SATISFACTION SURVEY

NEW DATA INDICATES REDUCED HEADCOUNTS AND LESS TRUST IN MANAGEMENT by Pam Ahlberg

In reviewing this year's survey results, it is not surprising to discern a noticeable belt-tightening on the part of management and a rise in the subsequent stress felt by lab employees. While salaries have stayed about the same, the headcount in individual labs and larger organizations has shrunk. There has also been less investment in training, equipment and basic resources.

Nevertheless—and similar to past surveys—the majority of those working in the scientific research field enjoy what they do and share a sense of purpose and a commitment to their work and organizations. What's different, however, is the reduced level of trust they feel in the leadership at their organizations. But first, the numbers.

Compared with last year, there has been very little change in compensation. Those making less than \$25,000/year climbed from last year's 6% to 11%, suggesting new hires at the bottom of the pay scale. There was a bit of good news in terms of bonuses, with 44% of respondents saying they were on bonus plans—up

9% from last year. Interestingly, last year 42% reported seeing changes to their benefit plans, compared with only 22% this year, suggesting a leveling-off in more severe forms of cost-cutting.

Reduction in force

The number of respondents working in smaller labs—with one to 10 staff members—rose to 54%, compared with 49% last year. And the number of respondents working in organizations with fewer than 100 people grew from 22% to 32% this year. We also saw that the number of employees in larger organizations has dropped. This year, 8% fewer respondents told us they were working in organizations employing from 1,000 to more than 50,000 people. Based on this, it seems headcounts are dropping—which would make sense given the number of layoffs this past year.

Further evidence that research staffs are getting smaller was the 12% fewer respondents who thought that

staffing levels at their facilities were adequate to provide quality products and/or services. The message seems to be that resources are thinning and, as in many other industries, organizations are trying to get by with less. An interesting footnote, however, is that there has been virtually no change in the number of those working full time vs. part time (97% full time; 3% part time).

Job security and faith in leadership

Changes of note compared with last year's survey were seen in questions concerning job security and other more subtle aspects of the job. For example, 8% fewer respondents said they believed their jobs were secure and 9% fewer said they felt valued at their organizations. Given the economic climate, job insecurity and reduced staffs, it was not surprising that this year nearly 15% fewer respondents were happy with the work-life balance they had at their organizations (78% vs. 64%).

TABLE 1: Length of time working as a full- and/or part-time researcher/scientist

Less than 1 year	3%
1 - 2 years	3%
3 - 5 years	8%
6 - 10 years	14%
11 - 15 years	16%
16 - 20 years	12%
More than 20 years	44%

TABLE 2: Annual salary, not including bonuses

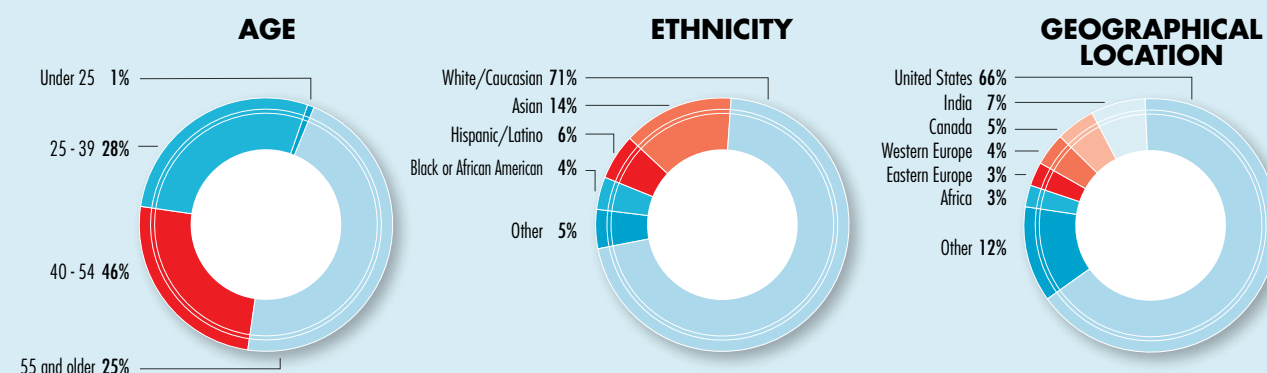
Less than \$25,000	11%
\$25,000 - \$34,999	5%
\$35,000 - \$44,999	7%
\$45,000 - \$54,999	14%
\$55,000 - \$64,999	12%
\$65,000 - \$74,999	13%
\$75,000 - \$84,999	8%
\$85,000 - \$94,999	7%
\$95,000 - \$109,999	11%
\$110,000 - \$124,999	6%
\$125,000 - \$149,999	3%
More than \$150,000	3%

A SNAPSHOT OF OUR SURVEY RESPONDENTS

Lab managers and those in management positions made up 58% of respondents. Scientists—including chemists, microbiologists and biochemists—made up 20% of respondents. The balance included technicians, faculty, engineers, purchasing agents, safety managers and "other." Of the total, 20% of respondents worked in industrial labs, 17% in university or college research labs, 16% in hospital/medical labs, 11% in contract research labs, 5% in government research facilities, 4% in private research labs and 2% in clinical labs. The remaining 25% fell under "other."

The majority of respondents, 39%, hold bachelor's degrees, 27% have master's degrees and 22% have earned their doctorates, which represents a minor uptick from last year in both master's and doctorate degrees. The survey was made up of 62% men and 38% women.

To complete the snapshot, the three pie charts below provide age, ethnicity and geographical information about our respondents.



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TABLE 3: Experience and professional development

	Strongly Agree/Agree	Disagree/Strongly Disagree	Don't Know	Neutral
I feel that my experience and skills are adequate for my current position	94%	5%	0%	1%
I require and desire more on-the-job training for my current position	47%	33%	0%	20%
I am ready and prepared for my next position	68%	4%	2%	24%
I am planning to obtain additional on-the-job training on my own	57%	25%	4%	13%
I am planning to go back to school to obtain my next degree	21%	42%	6%	31%

corporate objectives and 10% fewer than last year saying that the leaders of their organizations were open to input from employees. All of this suggests that in some organizations, management has become more isolated from and less responsive to their employees.

TABLE 4: Employer-provided benefits received

Vacation/Paid Time Off	88%
Childcare Assistance	6%
Contribution to Pension or Retirement Accounts (other than 401K)	50%
Health Insurance	82%
Dental Insurance	62%
Vision Insurance	46%
Life Insurance	63%
Long-term Care Insurance	21%
Tuition Reimbursement	28%
Employer 401K Match	39%
Profit Sharing	16%
Stock Options	11%

Training and support

The greatest and most consistent change for the worse reported in this year's survey concerned training and resources, with a whopping 21% fewer respondents than last year telling us that their organizations provided them with as much initial training as they needed (49% vs. 70%). As for ongoing training, 20% fewer than last year felt they were provided with enough, and 17% fewer said their organizations provided the information, equipment and resources they needed to do their jobs well. If this doesn't speak to belt-tightening and bottom-line concerns, nothing does.

Future plans

Despite all that, the clear majority of respondents still love what they do. In fact, the percentage of those who said they like the work they do rose almost four points from last year to 95.9%.

However, complaints such as not being given enough authority to make decisions rose 4% and those who did not think they were given recognition for work that was well-done rose 6%.

But despite the fact that 10% fewer respondents than last year felt there was room to advance at their organizations and 12% fewer said that their career goals were being advanced through their current jobs, 9% fewer said they would leave their present jobs given the opportunity. This same message of "staying put," despite less than perfect work situations, was reinforced by the fact that 8% more respondents than last year said they expected to be with the same company, in the same position in the next five years.

While the changes from last year look small on the surface, for lab professionals, who are traditionally very content in their chosen profession and secure in their career trajectories, this year's survey results provide evidence that more than a few are feeling less pleased with their situations and less secure about their futures. Next year's survey results should reveal whether this year's data is a blip or a trend.

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SALARY AND JOB SATISFACTION BY REGION

U.S. SCIENCE PROFESSIONALS DESIRE MORE RECOGNITION AND TRAINING

by Alan Edwards

As scientists search for new career opportunities, both within and outside of their present organizations, a recent survey indicates that they are motivated by working for a company that adds value to society. In addition, science professionals view a strong compensation package, a regular recognition program, and advanced training classes as desirable benefits in today's work environment.

According to the 2010 *Lab Manager Magazine*—Kelly Scientific Resources Fourth Annual Salary and Employee Satisfaction Survey, many science professionals are interested in working for reputable organizations that add value to society through the research and products they produce.

A United States regional breakout of survey responses reveals the ways in which scientific organizations regularly influence employees, communities, and society as a whole.

The following survey findings depict science professionals' job satisfaction rates and their desire for more recognition and training programs. The findings are presented according to the following regions: Midwest, Northeast, Southeast, and West.

Midwest

Within the Midwest region of the country, survey respondents appear optimistic about their current positions and futures within their respective industries, despite the ever-changing conditions of the region's economy. According to the survey, 91% of respondents are currently pleased with the type of work they perform on a daily basis. In addition, 71% of respondents believe their jobs will be secure during the coming months and years because they feel valued at their present organizations.

Unfortunately, many Midwestern survey respondents do not always feel recognized for reaching their managers' expectations of achieving established organizational goals. Only 55% of all respondents believe they will be acknowledged, recognized, or promoted for



consistently providing outstanding work and services.

At the same time, some science professionals located in the Midwest are concerned about the lack of advancement opportunities available within their present organizations and laboratories. Currently, 63% of survey respondents feel their organization has advancement opportunities in place for them. In the meantime, 57% believe their career goals are being advanced through their positions.

To retain top talent in the coming years, business leaders will need to develop or improve recognition programs and create career paths for employees. In doing so, managers will ensure that highly talented employees continue to utilize their abilities and knowledge within their organizations.

Northeast

Throughout the Northeast, a vast majority of survey respondents (96%) are pleased with the type of work they perform every day, as well as the value they feel they add to their organizations (76%).

Interestingly, much like their Midwest counterparts, 56% of Northeast employees believe their career goals are being advanced through their current positions. Furthermore, 51% of Northeast survey respondents feel their organizations presently have advancement opportunities awaiting them as they pursue their future career goals.

Recognition is also a significant organizational benefit that many Northeastern managers will likely need to focus on improving in the future. Quite simply, the numbers speak for themselves—54% of all survey respondents believe they are acknowledged, recognized, or promoted for the high quality of work they regularly perform; 46% do not.

Northeastern survey results are rather similar to those from the Midwest—science professionals desire more recognition for their daily work performance and need a wider array of advancement opportunities to achieve their career and life goals.

Southeast

Respondents in the Southeast region are also very satisfied with the type of work they perform on a daily basis. They are eager to obtain recognition for their work performance and to acquire advancement opportunities throughout the duration of their careers. Quite similar to survey respondents from the Midwest and Northeast, an overwhelming majority of Southeastern science professionals (92%) are currently satisfied with their daily roles and influences on other people. In the meantime, 75% of respondents feel valued by their current employers.

The survey found that a majority of Southeastern respondents are pleased with their employers' recognition programs and advancement opportunities. Presently, 60% of respondents are being recognized on a regular basis for the outstanding work they conduct—a figure that shows that many organizations' recognition programs are continuously improving.

Yet, the findings do display some lower figures as well. Currently, a mere 48% of respondents believe their organizations have a variety of advancement opportunities, while only 46% think their career goals are being advanced through the positions they presently hold.

As Southeastern science professionals continuously strive to influence their fellow members of society, they will be motivated to help their current organizations in the future if they receive more job opportunities and performance recognition. Motivated employees tend to have higher morale and greater intentions of helping their employers succeed in the future.

West

With regard to job satisfaction and employee value, Western science professionals are quite similar to their fellow scientists around the country. The survey found that 93% of respondents like the type of work they do, while 71% feel they are valued at their organizations.

Throughout the West, 54% of the survey respondents believe their career goals are currently being advanced and that their organizations have numerous advancement opportunities for

them to strive for and acquire. Of interest, only 59% of respondents are regularly being acknowledged, recognized, or promoted by their companies.

Undoubtedly, employee value and job satisfaction are not major issues for most science professionals nationwide. However, recognition and advancement opportunities are significant issues for employees throughout the United States.

So, will more organizational leaders and managers begin to listen to their employees' requests and needs during the coming months and years? What are organizations doing today to retain their most talented employees tomorrow? Will they respond to their employees' needs by improving their current recognition, reward, and training programs?

Science professionals are motivated by the value they add to society each day. Now is the time for their employers to show them how valuable they really are.

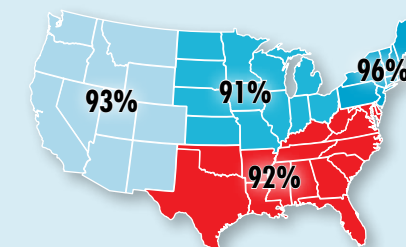
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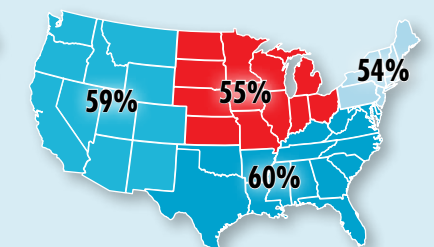
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Percentage of Respondents in Agreement

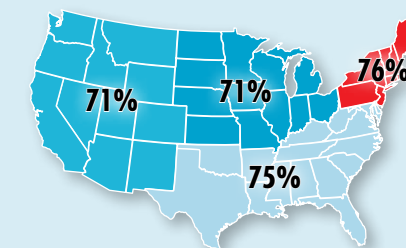
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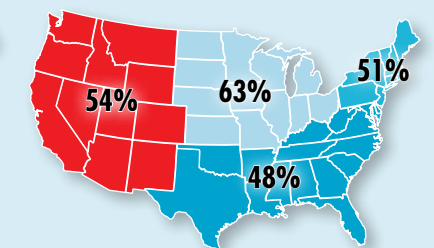
WORK RECOGNITION



EMPLOYEE VALUE



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PERFORMANCE APPRAISALS

SUCCESS LIES IN TAILORING THE APPRAISAL SYSTEM TO YOU AND YOUR STAFF by Ron Pickett

My reaction to performance appraisals is strong and emotional—I've been appraised many times and I've done many appraisals. Only occasionally has the process led to a strong, positive result. However, on several occasions, I have written performance appraisals that resulted in important decisions about people—decisions that led to promotions and, less frequently, decisions that resulted in a person being let go. (I've followed up on some of

This important topic has certainly not been exhausted. I encourage you to review the previous articles and think about the information you found useful. The 360-degree process is particularly valuable in situations where supervisors' observations are indirect or based on reports written by other employees. The "360" literature is also valuable for developing skill sets and position requirements. While this approach is an excellent way to get performance feedback from peers and subordinates, from my experience, the 360 process can become an administrative burden if it isn't tightly controlled. (Check out http://en.wikipedia.org/wiki/360-degree_feedback for more information.)

My goal in writing this article is to add to and expand on some of the previous articles and to focus on the application of appraisals in the workplace. There are three key issues related to performance appraisals (in fact, there really is nothing else that matters!):

1. How can you maintain and improve current performance?
2. How can you assess and improve the future potential of the person being appraised?
3. How can you document behavior that might be an indication of character defects?

Any profession that has a high entry barrier—extensive education, internship, training, etc.—has an inherent implied or explicit protection for those who make their careers in this industry. (This is not to imply that blatant character flaws should not lead to immediate dismissal; rather, appraisals are sometimes the first documentation of personality, character, and performance deficits.)

Organizational systems

If you are part of a large organization, you are likely bound by an existing system—a system that may or may not

provide you with a structure that permits or encourages you to accurately evaluate and report on the successes, needs, and future potential of members of your staff. These systems tend to be generic and stylized and generally fail to recognize the unique characteristics, challenges, and opportunities of your group. Still, you have to make your evaluations fit into the corporate structure and ensure that your staff is competitive for salary and promotion opportunities. Can you both fit into the organization's system and enable the system to be helpful in managing your group? Yes—and here are some ideas about how to do this.

First, if possible, arrange for a modification of the system as it applies to your group. This can be challenging and difficult, but some of your colleagues will have had success in getting such alternate systems in place.

Second, think in terms of two systems: the company requirements and the requirements of your department. Prepare two appraisals—a formal one to submit and an informal one to use for your staff development purposes.

Third, use a model that involves having monthly or more frequent discussions with your staff that will become the annual or semiannual formal evaluation.

Biases

You know about the biases that can influence objectivity—that's why double-blind protocols are vital to getting a true measure of the outcome of an experiment. However, you may not be as familiar with the impact that normal human biases can have on dealing with staff members.

Here's a review of the biases we bring into all management situations. This can be especially important in preparing performance appraisals. (Visit <http://www.scribd.com/doc/30548590/Cognitive-Biases-A-Visual-Study-Guide> for a listing of the cognitive biases we all bring to situations.)

Recency errors

"A good deed today is worth ten good deeds six months ago." I just made that up, and the proportion is probably way off, but the truth is that we tend to value recent wonderfulness, or devilment, much more highly, or lowly, than that we experienced some time ago. This

is a fact that you can use with your boss too! Here's a tip to overcome this bias: keep good notes for the entire appraisal period.

Similarity

We tend to evaluate people who are like us more highly than those who are different. It isn't necessary to delve deeply into the psychodynamics of this fact, but

a mirror will probably help to explain the rationale. The problem, of course, is that we undervalue, or devalue, people who are different from us.

As objective evaluators, this is something we really need to keep in mind. It doesn't mean that we are bad—just that we are human.

Tip: Give the people who are different from you in terms

"Arrange for a modification of the system as it applies to your group."

these latter scenarios and have been pleased to see that repetition of the behavior or performance issues continued, so my written comments were the first to document patterns of behavior and were instrumental in getting rid of the person.)

Lab Manager Magazine has published two articles on conducting performance appraisals in the past year: "Performance Reviews" by John K. Borchardt (July/August 2009) and "I Told You!" by Stephen Balzac, which covers 360-degree performance feedback (January 2010).



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of ethnicity, age, sex, or personality a special look to satisfy yourself that you are as free from bias as humanly possible. Ensure that your evaluation is based on what they do—not who they are. (Note: This was described in my article “Honing Your Interview Skills,” *Lab Manager Magazine*, October 2009.)

“The more objective and the more specific you can be in your evaluations, the better.”

Objectivity

The more objective and the more specific you can be in your evaluations, the better. Numbers are the most objective indicators of proficiency, but for most of the people whom you are evaluating, that approach really won't work often. But if you can design and prepare your evaluations as if they were based on numbers, you can remove at least some of the subjectivity from them. Tip: Use as many cold, hard facts as you can in the evaluations you prepare; the results may surprise even you.

Halo

The halo effect refers to our tendency to evaluate someone who is excellent in one area as excellent in all areas of evaluation. It may be that we feel constrained by the system from really properly rewarding our best performers. It may be that excellence in one area really does mean excellence across the board as far as the impact of their work is concerned. However, if you want to make the system work as it should, and if your system is supposed to be identifying potential for promotion, this error will subvert the intent and objectives of the system. Tip: If you want to reward someone who really deserves it, grade the person more highly than he or she deserves in some areas, but be fully aware of what you are doing!

Horns

This is the other side of the halo effect. I will admit to grading someone poorly across the board when the specific grades in some categories were a stretch. But it worked! I knew the system, how the system worked, and how to “work the system.” My technique was important and effective in identifying someone who needed to be fired who effectively had “tenure.” (This happened in a system where the protections were near-

ly as strong as those found in academia.) The individual whom I was appraising and his ACLU lawyer could have challenged each of the marks I gave the employee, but that would have opened up an opportunity to get more damning evidence into the record. They chose not to. Tip: If you choose to use this technique, which I'll call “sharpening the horns,” make sure you can stand the possible heat; can, in general, back up your positions; and, most important, are sure that your cause is just. Is awareness enough to overcome these human characteristics? No, but it is the vital first step.

Things you can do to have more effective performance appraisals

Set objectives together. Work with your staff to set individualized, measurable objectives. When you do this, you will have established the foundation for an easy and mutually agreeable appraisal, one that will be useful in supporting the growth and development of the person.

Review performance and coach frequently. Set a standard time frame for review and updating the objectives you set together. Keep these conversations clean and simple—“Just do it.”

Check your biases. Don't expect to eliminate your personal biases, as they impact your performance appraisals regardless of your best efforts to prevent them from doing so. Simply be aware that they exist, and that will help reduce the negative impact they have.

Keep your system clean and simple. Hold discussions that are objective, interactive, and specific. Focus on improvements and sources of help—things that can be fixed or changed. Don't let things that are outside the control of someone keep them from being successful. Your 5'2", 120-pound, 23-year-



old recent college graduate isn't going to succeed in the NBA—and that's not something he can correct!

Remember, performance appraisals should do three things: improve or maintain current performance; assess and improve future performance potential; and (infrequently!) identify character deficits.

“Work with your staff to set individualized, measurable objectives.”

Finally, it is unlikely that formal performance systems will disappear in our lifetimes, so learn to live within the system you work with and mold it to be helpful to you in the management and development of your staff. Done well and consistently, performance appraisals can be one of your most important tools in becoming an excellent coach. Accuracy, truthfulness, objectivity and courage are the keys to effective performance management through performance appraisals.

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DON'T JUST DO SOMETHING, S.I.T. THERE!

COUNTER-INTUITIVE APPROACH TO "GETTING BUSY" by John Storm

"Don't just sit there, do something!"

You've probably heard this phrase uttered (i.e. screamed) from frustrated lab managers to their employees. It is usually followed by a sincere, yet pathetically feeble, attempt to look busy while pretending that "doing something" will help. Yet, success ultimately depends on the "something" that we do, not a flurry of misguided activity.

With today's grim economic realities, most people and companies are running scared, frantically "doing something" without strategic, thoughtful, calculated evaluations of their plans and actions.

Certainly, I believe this IS the time for Massive Action for lab managers.

However, I'm advocating a counter-intuitive approach to your natural tendency to "get busy". Massive Action is great, but WHAT you do is more important than WHEN you do it.

My contrarian mantra is: Don't just DO something, S.I.T. there! S.I.T. is my 3-step plan for Massive Action:

1. Strategize

The first step involves digging down to the core issues and getting clarity about WHY and WHAT you want to do. The key is to become (or hire)

a "strategic questioner"— someone who knows how to craft provocative questions that get past your cliché-ridden, top-of-mind, cookie cutter answers. Great strategy comes from being clear about the results you seek, the trends and technologies that will affect them, and the resources needed to produce a successful outcome. Many companies are sticking their heads in the sand, hoping CHANGE will go away. It won't. In fact, it's coming FASTER than ever. Look how fast the banking, music, and real estate industries have changed. What's next? ... Your lab!

2. Innovate

Make a list of every area of your lab and the processes you can innovate (i.e. research, techniques, equipment, vendors, relationships, etc.). Set up a lab-wide "TeamStorming™" event to harvest stakeholder ideas. Ask your team to review the list and share ideas about:

1. Stupidest things we're doing and why?
2. How can we save time/money?
3. How can we make money?

Be prepared for their honest feedback. You're looking for both micro (incremental) and macro (revolutionary) ideas, some of which can be acted on immediately, and some of which will take more time. Think about

your idea evaluation process (who, how, criteria, budget, communication plan, etc.). Think about the pros/cons of anonymity, incentives for best ideas, transparency, etc. Categorize and combine the ideas, eliminate duplicates, and then select the top 1 to 3 ideas within each area. Then assemble cross-functional teams to flesh out each idea and develop a plan.

3. Take Action

In today's high velocity world, we can't wait forever to make the perfect decision. The days of 5-year strategic plans are long gone, replaced by a rapid evolutionary process. Once you are clear about your ultimate goals, you must take massive action, knowing you'll make mistakes along the way. The process of testing, risking, failing, evaluating, and continually improving is the new norm for strategic action. Just be sure you know WHY you are doing what you're doing and what the BENEFITS are for your stakeholders.

"Don't just do something, S.I.T. there!"

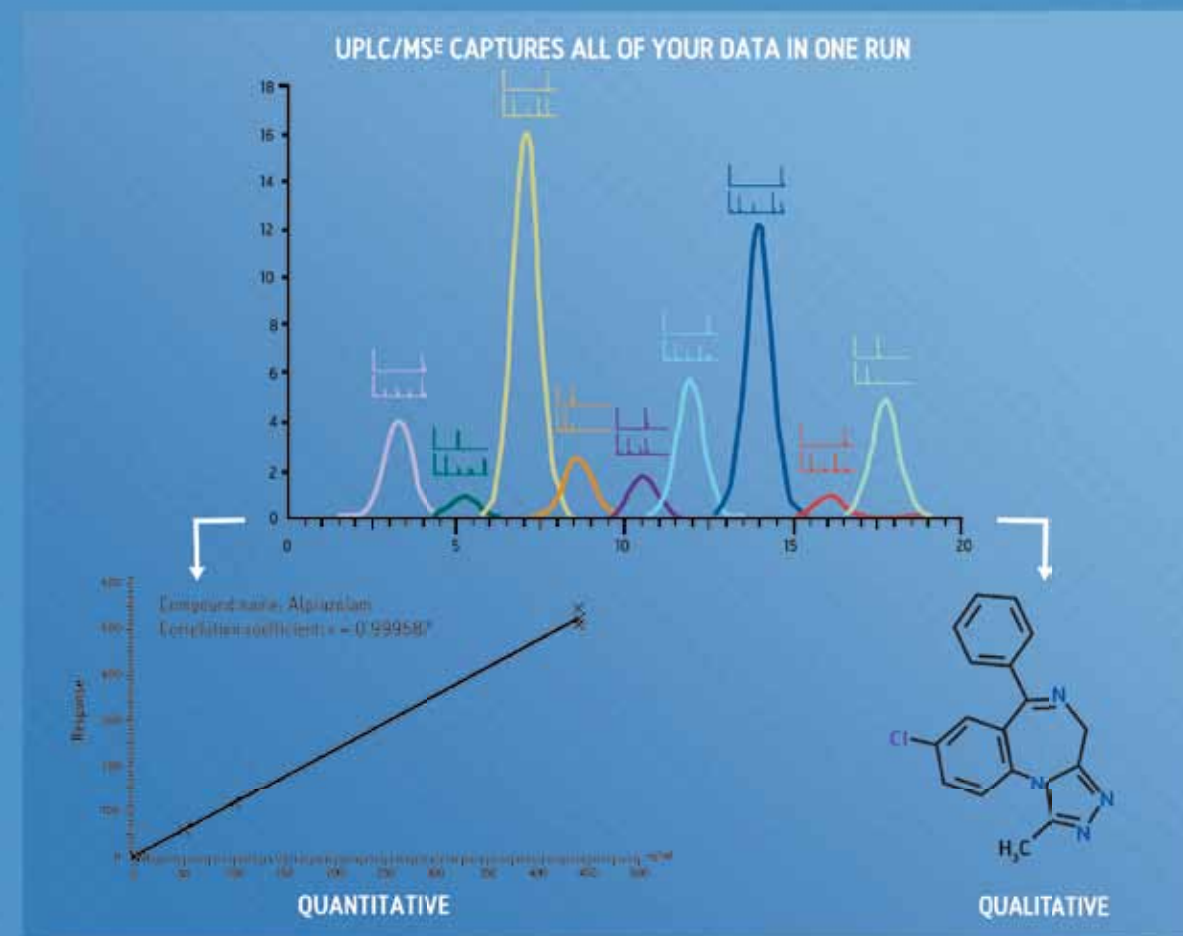
John Storm helps people get unstuck and is the Innovation Strategist for BrainStorm Network. For a free copy of his High Stakes Innovation magazine, send email to: Lab@BrainStormNetwork.com.

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SURVEY REVEALS EMPLOYEE SATISFACTION CRITERIA

For the fourth consecutive year, the annual *Lab Manager Magazine* - Kelly Scientific Resources® Salary & Employee Satisfaction Survey revealed valuable and interesting findings that can assist managers and their employees in improving efficiency and morale.

This year's survey revealed that employee satisfaction is slightly lower today than it was in 2009. According to the findings, 70 percent of respondents currently feel valued at their organizations, compared with 79 percent of last year's respondents. This drop in morale is likely due to the negative impact the recent economic recession has had on budgets, employee satisfaction and management stress levels.

Yet there is certainly a light at the end of the tunnel. Research and development, product implementation, and hiring are increasing in organizations across the country, likely due to government stimulus bills that have been passed in recent months.

Three criteria for job-satisfaction

A majority of science professionals looking to advance their careers are focused on three specific organizational or career criteria. First, they hope to perform meaningful work, within reputable organizations, that positively impacts society as a whole. Second, scientists desire an effective work-life balance, so that they are able to fully concentrate on their daily business objectives but also have time to relax with family and friends. Finally, researchers are looking

for opportunities to expand their skills in order to succeed in the future.

While salary is definitely an important factor in most scientists' career goals and decisions, a good many are also focused on the nature of the work they do and its value to society and human health.

A desire to positively impact society

Undoubtedly, the recent economic recession has had a detrimental impact on the lives of scientists all over the world. From pay reductions and layoffs to profit losses and budget shortages, both managers and employees have been negatively affected by the recession.

However, one aspect of scientists' lives has been unaffected by the economic downturn: the desire to be involved in meaningful research, perform analytical testing and clinical research, and produce and sell high-quality products that have a positive impact on society.

According to the survey, 82 percent of respondents want to work for organizations that serve society through their ongoing research projects and product implementations. This same group also believes that those organizations are highly respected for the products and services they provide to their customers.

Adequate work-life balance

Many research professionals are being asked to multitask on a daily basis. In addition to their own job responsibilities, they

are also performing the duties of former colleagues who may have been displaced during the recession. This is creating an even greater need for a proper balance between work and home.

Interestingly, according to the survey, 64 percent of respondents are currently pleased with their work-life balance, compared to 78 percent in 2009. These latest numbers will likely increase during the coming months as more and more organizations regain financial stability and begin to hire new contract and full-time employees.

Also, only 49 percent of survey respondents believe their organization's present staffing levels are adequate to provide high-quality products and services to customers, compared to 61 percent who felt that way last year. At the same time, 61 percent of the survey respondents are currently pleased with the amount of information, equipment and resources their organizations provide them—much lower than last year's results, as 78 percent formerly believed their organizations provided adequate resources.

An overwhelming majority of respondents (92 percent) stated that a proper balance between work and personal life is very important to them. In fact, work-life balance may be the deciding factor for those choosing whether to remain at their current organizations or look for new opportunities elsewhere. Although a majority of surveyed employees feel valued at

their organizations (70 percent), more employees might feel highly valued if they were given more flexibility. Quite simply, adequate work-life balance will likely help employees lower their stress levels so that they are better able to perform to the best of their abilities in the future.

Training programs

The survey also found that 49 percent of respondents believe their organizations provide ample and satisfactory training opportunities to new employees. Unfortunately, training programs do not appear to improve as employees acquire more work experience, as only 48 percent of respondents feel their organizations provide effective ongoing training.

It is also apparent that today's scientists generally want more training but are unsure of where it will actually come from. Currently, only 21 percent of respon-

dents are planning to go back to school to obtain their next degrees. In addition, 51 percent are preparing to attain additional on-the-job training on their own, without assistance from their employers.

Of interest, 94 percent of the respondents said they feel adequately trained for their current positions, but only 68 percent believe they are ready for the jobs they may acquire in the future. Why are these statistics so important? What type of impact can training opportunities possibly have on science professionals, both inside and outside the lab? In short, training programs may indeed impact the work-life balance of employees, which, as discussed earlier, tends to lead to either low or high employee morale.

According to the survey, only 34 percent of all respondents believe their organizations provide training programs to help them improve their current work-life

balance. By offering a variety of training programs within their organizations, employers will ensure improved on-the-job performance; a more adequate employee work-life balance; and, consequently, much higher levels of employee morale. Managers can continue to improve employee morale by providing opportunities to conduct meaningful research and to create innovative products. In addition, an adequate work-life balance, as well as a wide array of effective training programs, will ensure that employee morale will remain high in the future.

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STILL THE HOTTEST DEGREE NO ONE HAS EVER HEARD OF
by Richard Daub

It is commonly referred to as the “MBA for scientists.” A 2004 *USA Today* article said that the professional science master’s (PSM) degree promised “to be the hot degree no one seems to have heard of—yet.” At the time of that article, fewer than 400 students had earned a PSM and only 45 universities offered it.

Six years later, the Council of Graduate Schools indicates that 96 institutions now offer recognized PSM programs and that approximately 2,700 students have earned this degree, 530 of which are awarded annually. It has taken root at the university level as a program that gives students a rigorous scientific education while also preparing them for employment outside of the academic setting. Skills such as finance, budgeting, regulatory affairs, and communications are emphasized to enable the science student to adjust to the culture of the workplace.

being successful is a process. Somebody related to me a while back about how the MBA started with a certain number of students and then it grew as more people went out there with those degrees.”

“I think that there needs to be more awareness of the degree and the stature that it brings with it because it is an end degree and not just a step to a PhD program,” says Donna Wolk, an associate professor at the University of Arizona and a member of the PSM advisory board there. “It is a terminal degree in that, like an MBA, you should be able to take that degree all the way up to CEO [level] if that’s your goal. Most scientists are trained with little to no business management or employee communications, strategic planning, financial planning, but for them to advance in their careers from bench-level science, they need to understand budgets and interpersonal communication and planning.

Many of the lab managers in academia don’t have that background, so they’re thwarted in their efforts to advance.”

Carol Lynch, director of the PSM Initiative at the Council of Graduate Schools, says that with the exception of a few professional degrees such as the MBA, the Master of Public Admin-

istration or the Master of Public Health, little thought was put into the function of a general master’s degree beyond its being an intermediate step toward a PhD. This seemed especially true in the realm of science.

“It was something that, well, if you’re going to get a PhD, maybe you might want to do this first, or if your grade point wasn’t that good, take another two years to get a master’s and then you’ll look better,” she says. “When you talk to employers, many of them say that they want people with advanced training and a master’s is fine, but they also want these other skills that it takes to succeed in business. So the Sloan Foundation [which funded the original grants for the PSM initiative] picked up on this and felt that there was a real need for this intermediate-level degree.”

“A scientist with some formal business training may be a more valuable commodity than a PhD with no business training.”

Yet, despite some early media hype and nearly a decade of acclaim from academia, the PSM remains mired in obscurity. Not one of the seven employees of nonacademic laboratories interviewed for this article had even heard of the PSM; however, after being given a nutshell description of what it is, most agreed that it sounded like a good idea and that a scientist with some formal business training may be a more valuable commodity than a PhD with no business training.

So why is this degree still so little known?

“I think it’s just a progression,” says Susan Lawton, PSM planning coordinator at the University of Massachusetts. “It started about ten years ago, and just getting students who graduated from the program out there and

Despite its weak brand name, the PSM is designed to help develop skills that employers find valuable. Therefore, even an employer who has never heard of a PSM can easily recognize that PSM graduates have skills listed on their résumés that many science students typically don’t have.

This was the experience of Bill Becker, one of the earlier recipients of the degree, who enrolled in the PSM program at Oregon State University in 2004 and received his degree in

2006. Bill is presently an air monitoring technician at the State of Oregon Department of Environmental Quality Lab and also teaches part time at Mt. Hood Community College in Gresham, Oregon. He hadn’t heard of the PSM program either, but he was intrigued by the aspect of a non-thesis/internship-based master’s degree in science.

“I wanted to do a wider range of coursework than almost every master’s or doctoral student who I encountered,” he says. “They always say, ‘Oh, I wish I could take that, I wish I could take that.’ Well, I took all the courses in the botany department, and because I didn’t have the time constraints that a lot of the thesis students had, it turned out to be a good choice for me. I got to go a fair ways down a number of roads, whereas a person who is stuck in a thesis pretty much goes all the way down one road.”

Instead of being holed up in a laboratory working on a thesis, Bill worked as an intern for the U.S. Forest Service, an experience he credits as helping him land his teaching job.

“When I described my internship experience, that pretty much sold me as a potential teacher on their staff,” he says about his job interview at Mt. Hood CC. Additionally, the communications courses he took as part of the PSM program—classes he likely would not have taken in a traditional science-based master’s or doctoral program—helped him develop his teaching skills.

“I pretty much had been strictly a scientist up until this time,” he says. “We focused a lot on public speaking skills and abilities in that area. I hadn’t had a lot of experience in that realm before and it made me a lot more comfortable in a teaching situation. Basically, everything I’m doing now is as a result of the time I spent there either directly or indirectly.”

One concern that PSM administrators have, however, is that the program could be perceived as some sort of science/business hybrid that leaves students short on the science side.

“Like an MBA, you should be able to take [a PSM] degree all the way up to CEO [level] if that’s your goal.”

This perception is one possible reason that a science student unfamiliar with the program may shy away from it.

“We’re not compromising on the science,” Lawton says. “It’s a rigorous science education, but we also offer business fundamentals. We designed our programs based on input from industry, and they’re looking for students to have not only the core science training, but also other skills to help them step into the work environment and contribute.”

Communications is one of the vital components of the PSM “Plus Piece.” No matter the industry, job descriptions always seem to call for good communication skills, and skills such as these are not typically a natural strength of scientists. So, while it may not be as important for a bench-level lab technician to understand the finances of the company, communication skills will almost always prove useful in the workplace.

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“At some point in somebody’s career, they’re going to have to present what they’re working on to others,” Lawton says. “For example, if you’re working on something in research but you’re going to be presenting it to the financial people or the marketing people, you need to be able to communicate both written and orally. Our communications courses are set up to allow the students to be able to present the science to nonscientists and to interact with all the different functions within the organization.”

Lisa Race is the lab manager for Oilfield Environmental and Compliance (OEC) in Santa Maria, California. She had never heard of the PSM degree, but based on what OEC looks for in a job candidate, she says a PSM graduate may be a better fit than someone with a PhD.

“The doctoral degree focuses more on theories and research,” she says. “In our field, it’s not so much research as the practical application and knowledge of what the analyses mean as far as the sample and how the sample is going to be handled by the public.”

The most important thing OEC looks for in a prospective employee, she says, is how well the candidate does in what they call “the sit,” which takes place when the group sits with the interviewee for a discussion to try and gauge how well he or she will fit in.

“We have a pretty varied group here,” she says. “We have people who have degrees; we have people who don’t have degrees. It’s quite a multicultural laboratory, so it is someone who can fit into that and work well. It has to be someone who can really work well with a team.”

“The sit” is exactly the kind of thing that the PSM is designed to help graduates prepare for and an aspect of the program that is attractive to what is sometimes referred to as the “PSM personality.”

“They are much more open-minded and sort of forward thinking in many ways and have an understanding of the interdisciplinary aspects,” says Wolk. “I think there is sort of a management mind-set in these kids before they even get here, or else they wouldn’t choose the PSM, they would go straight science.”

“They’re not your typical science geeks,” says Lynch. “The students who are interested in these programs tend to be re-

ally outgoing and gregarious. They’re kids who like science, so if they identify as geeks, they do so proudly. They like working in teams, they like the cross-working between the science and the marketers, and they’re really interesting people.”

While expertise in one specific area may be attractive to a large corporation that can hire a large team of scientists who perform only specific tasks, smaller companies, particularly start-up biotech firms, may like the idea of a single employee who can perform a diverse set of tasks.

“PSM graduates are ideal for the smaller companies because they can do a lot of different things,” Lynch says. “They know the technology, so they can talk to the scientists who founded the company and are actually in the R&D product development area, but they also understand finance and marketing and how to take a product to market, and they also get out and talk to the salespeople and develop marketing strategies.”

Paul Todd is chief scientist at Techshot in Greenville, Indiana. Techshot is a firm that custom designs software for complex engineering projects and hires what it describes as “some of the finest, widest-ranging, most innovative minds in the country.” Dr. Todd was the only one of the seven employees of nonacademic laboratories interviewed for this article who flat out said that he would prefer to hire

“An employer ... can easily recognize that PSM graduates have skills listed on their résumés that many science students typically don’t have.”

the PhD over the PSM, but he acknowledged that such a choice comes with a price. He also conceded that other factors besides the degree type would be considered.

“If we could afford it, definitely the PhD,” he says. “This is because this individual has typically been through a thesis process and understands the significance of peer review of his or her work and is quite likely to have learned a certain level of dedication in the form of the work ethic that involves more than 40 hours a week to complete a thesis. That being said, we also have to balance individual issues like will this personality fit the company? Will the individual’s skills prove adequate to the tasks expected of the open position?”

This is where the PSM can make up some ground, even in the eyes of someone who has a doctorate and had never heard of the PSM degree. Besides having a willingness to accept a lower salary than a PhD would likely command, the PSM graduate would be trained in practical business skills, while the PhD probably would not. Even if the job is technical and/or purely scientific, the business skills may give the PSM perspective that may affect how he or she approaches the job.

“We like to have our workers understand that they have something at stake, because if a project is successful, the company thrives,” Dr. Todd says. “If the project is unsuccessful, that creates problems for the future of the company.”

This understanding that the job is not just about test results, but how these results impact the company and how the success of the company affects the lives of all the employees and their families, is probably the most abstract and least scientific concept that one needs to understand about having a job. This understanding is especially important in a weak economy. It is not a skill, nor is it some-

thing that can be effectively taught without having actually experienced it. Perhaps the true benefit of the PSM, the PhD or any other type of degree cannot be measured statistically but through whether or not it has the ability to allow the student to experience the process that leads to this understanding. If the PSM can do this, its value to the degree holder will surely overcome its obscurity.

“The students who are interested in these programs tend to be really outgoing and gregarious.”

Richard Daub is a freelance journalist based in New York City who writes for trade publications in a variety of different industries. He can be reached by phone at 917-657-6532 and by e-mail at rdaub82@gmail.com.

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UHPLC

**FAST, VERY HIGH-PRESSURE SYSTEMS
ENTERING THE MAINSTREAM**
by Angelo DePalma, Ph.D.

Although less than a decade old, UHPLC—ultra high-performance liquid chromatography—has become the de facto performance standard despite lagging far behind conventional HPLC in total systems sold. UHPLC refers to about a dozen rapid, very high-pressure (above 5,000 psi) LC systems employing stationary phase particle sizes of around two micrometers or smaller. Hence the equivalence of “sub-2-micron” and UHPLC.

The terms UHPLC and UPLC™ are often confused. UPLC, which stands for “ultra performance liquid chromatography,” is a trademark of Waters Corporation (Milford, MA), but the technology is generically known as UHPLC. So while every UPLC is UHPLC, the reverse is not true.

“Capital outlays for UHPLC—today, between 20 percent and 40 percent higher than for HPLC—remains a sticking point for potential adopters.”

Continuous improvement

UHPLC debuted in 2003 with Agilent’s 1200 series, which used 1.8-micron particle “rapid resolution high throughput” (RRHT) columns. The next year Waters introduced its Acquity UPLC system, which employed 1.7-micron bridged ethane-silicon hybrid particles. Today every major HPLC manufacturer manufactures a high-pressure system: Thermo Fisher (Accela), Jasco (Xtreme-LC), Shimadzu (UFLC-XR), Hitachi (LaChrom Ultra), Scientific Systems (Ultra HP), Dionex (RSLC), Knauer (Platin Blue), and PerkinElmer (Flexar). Each product introduction builds on the strengths of previous systems.

According to Bill Foley, director of LC Product Marketing at Waters, UHPLC has entered the mainstream. “UHPLC is pretty much the standard or benchmark today, particularly in quality control and for repetitive HPLC workflows.”

Customer input has led to numerous upgrades in detectors, autosamplers, column chemistry, and methods. Most mass spectrometers that Waters sells, for example, are sold with UPLC systems. Other detector modes today include optical detectors, photodiode array detectors (PDAs)

operating at extended wavelengths, and enhanced fluorescence detectors. These innovations result from the need for speed, throughput, and sensitivity required by ever-more-complex samples and low-abundance analytes.

Surface chemistries, which give columns their selectivity, are somewhat more limited for UHPLC compared with HPLC; but UHPLC is catching up, with numerous vendors offering a full range of column chemistries. Waters has recently introduced charged surface hybrid (CSH) chemistry, which applies a uniform positive or negative surface charge (in acidic and basic mobile phases, respectively,) in addition to a surface chemistry. The company also recently added size exclusion/gel permeation in sub-2-micron format, raising its UHPLC column chemistry offerings to eleven.

HPLC physics, particularly with respect to how particle size and flow affect resolution, apply to UHPLC, and predict that UHPLC will provide superior resolution, sensitivity, and speed. But obtaining these benefits

requires taking a holistic approach to LC system design, which must be matched to the chemistry, bandspread, and dispersion. For example, the size of flow cells and the length and internal diameter of the tubing is reduced, data acquisition rates for the detectors must be higher, and filter time constants must be optimized.

Cost versus performance

Capital outlays for UHPLC—today, between 20 percent and 40 percent higher than for HPLC—remains a sticking point for potential adopters. Yet one can make a reasonable case that sub-2-micron HPLC can save many labs money in the long run.

The most obvious way is through its higher throughput and productivity. “For some labs you can replace two, even three HPLCs with one UHPLC,” Foley says. Slower flow rates translate to significantly lower solvent consumption as well. LC-grade solvents are notoriously expensive, but labs pay twice for them: on acquisition and through waste generation. Disposal costs for some solvents are almost as high as the purchase price.

The flip side of replacing several instruments with one higher-throughput system is the “all your eggs in one basket” argument: Downtime and repairs can be disastrous when the only HPLC available stops working.

“Some customers see a dramatic payback,” notes Foley. Considering the productivity gains, savings in solvent and disposal, reduction in bench space and controlled environments, and ongoing operating costs, UPLC is priced “pretty reasonably.”

The payback argument becomes even more compelling when the value of high-quality data is factored in. Foley provides several examples where the difference between good data and bad data can cost millions of dollars: quality control for pharmaceutical batches, pesticide levels in foods, quantities of incriminating evidence at crime scenes. “Everyone in the analytical chemistry business is looking for an edge, an advantage,” Foley tells *Lab Manager Magazine*. “Clearly, UPLC allows them to see things in their samples they could not otherwise detect.”

The naysayers

UHPLC’s introduction caused something of a schism—that persists (although not as strongly) to this day—among HPLC experts.

UHPLC promised much faster throughput and the potential for higher resolution. But detractors noted that speed and resolution were often at odds in very high-pressure systems. The other major knock against UHPLC was that methods were not easily transferred from 3- or 5-micron particle systems to the newer sub-2-micron formats. Methods remain a sticking point for UHPLC, particularly in environmental, safety, pharmaceutical, and forensics industries where data integrity is paramount.

There were many other bones of contention as well, including cost, whether UHPLC was overkill given the capabilities of current 3-micron particle columns, and operational issues.

Foley admits that UHPLC may not be for everybody, as conventional HPLC systems still strongly dominate LC sales. “It might not make sense to revalidate or reconfigure legacy methods,” he says, particularly in highly regulated industries such as pharmaceuticals/biotech, or where data is routinely presented in a court of law.

Nevertheless, developing UHPLC methods or porting over HPLC methods to UHPLC is easier than ever. Most vendors now offer kits, consisting of a sub-2-micron and conventional column version of the same chemistry, to facilitate method transfer.

Methods development groups, which make dozens or hundreds of injections for one project, love UHPLC because the shorter run times, coupled with automation, allow them to conduct experiments that are more thorough in less time than with conventional HPLC.

Where research labs are inclined to adopt UHPLC, standard analytical labs have been reluctant to jump on the sub-2-micron bandwagon in large numbers. UHPLC is found in only about 10 percent of QA labs, according to Wilhad Reuter of PerkinElmer. “UHPLC demands more from the operator—more vigilance and savvy. It’s very effective, but there’s a learning curve.”

UHPLC solvents must be carefully filtered using a 0.2-micron membrane, and those who take shortcuts with their solvents sooner or later pay for it, Reuter says. Samples are filtered as well. Users should avoid opening purge valves and system leaks that at UHPLC pressures can cause serious damage to the instrument.

While no one argues that UHPLC runs are much shorter, some are dissatisfied with equilibration time for column chemis-

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tries and pressures, particularly when using gradients. To reduce waiting time, pumps are being designed without pulse dampers or with lower-volume dampers. Pulse dampers are components that smooth out pump pulses to create a uniform flow.

Against the backdrop of UHPLC's alleged shortcomings and notable achievements, one should remember that traditional column packings, particularly 5- and 3-micron particles, still dominate the HPLC market, with a share of at least 80 percent. Even 10-micron particle columns are still serving legacy methods.

Tom Jupille, an HPLC trainer and consultant with LC Resources (Walnut Creek, CA), likens 5-micron particles to a Toyota Camry, and sub-2-micron particles to a Ferrari Testarossa. "The Ferrari is faster and sexier, but it's also phenomenally expensive, requires a much more skilled driver, and spends more time in the shop."

He argues that most users would do better to optimize their standard-particle HPLC systems than to invest in UHPLC. The reasons he gives are a higher standard of operator training, cost, and the established base of equipment and methods.



◀ *The resolution and sensitivity of UPLC combined with mass spectrometry gives chemists more information about their samples than ever before.*

Jupille admits the technological brilliance of UHPLC and that some users will definitely benefit. Yet he believes that sub-2-micron is little more than another stop in the continuing evolution of HPLC. Jupille also has nothing but praise for the leaders in UHPLC systems, calling Waters' UPLC "brilliant... their original Acquity system blindsided the competition." But with the introduction of the Agilent 1290, he says, that

company finally managed to surpass Waters' specs on pressure and flow. "Not enough to make a Waters shop switch, but it should prevent Agilent shops from defecting."

Agilent's 1290 Infinity was the first LC system, according to the company, capable of running standard HPLC as well as UHPLC columns. Agilent's advertising campaign for the 1290 recognizes the lingering controversy



▲ *Operating an Agilent 1290 UHPLC.*

surrounding very high-pressure LC: The 1290, according to the company, "ends the debate."

Early on one could argue that UHPLC was overpriced, says Helmut Schulenberg-Schell, Ph.D., Agilent's worldwide LC marketing manager, based on cost and a narrow application range. "But with the introduction of the 1290, there is no longer a reason not to try UHPLC since the investment hurdle is eliminated."

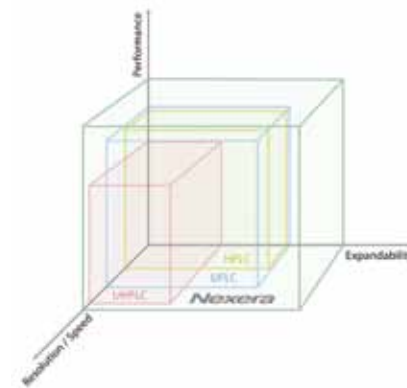
More recently, in June, 2010, Dionex (Sunnyvale, CA) announced that henceforth all its LC systems, including its entry-level units, will be capable of both HPLC and UHPLC. All that is required to switch between modes is changing the column swap. "Users can run legacy five-micron particle methods just as easily as sub-2-micron methods," explains Phil DeLand, market development manager for pharmaceuticals.

Dionex is retaining its original line and model designations for the new "UHPLC+" instruments, as well as physical presentation and – most importantly – the original pricing. This essential eliminates "capital costs" as a barrier to UHPLC acquisition.

Dionex has also upgraded oven temperatures, to 110° C, to reduce mobile phase viscosity and improve flow rates. And, through its acquisition of ESA Biosciences last year, it can provide UHPLC-capable charged aerosol and electrochemical detectors in addition to conventional detection modes.

Early UHPLC spent a lot of effort promoting the technique, but chromatographers perceived the UHPLC-HPLC choice as an either-or decision, says Phil DeLand of Dionex. "But there's no fundamental reason it has to be that way. Nothing prevents making every module UHPLC- and HPLC-capable."

Shimadzu (Columbia, MD) was one of the last major manufacturers to introduce a UHPLC instrument. For years the company's position seemed to be that a lot of life remained in supra-2-micron systems.



◀ *3D visualization of Shimadzu's Nexera UHPLC application range.*

For example, by employing columns with 2.2-micron particle sizes operating at 10,000 psi, Shimadzu's XR systems provide the performance of sub-2-micron UHPLC without the pressure-related drawbacks, says Simon Robinson, HPLC product manager at Shimadzu.

Robinson recently clarified his company's positions, past and present. The HPLC instrument business can only go as far as current column technology will take it, he explained. Shimadzu was not initially impressed with the available choices of sub-2-micron particle columns. "But that has changed. Today the market is much more customer-driven," and it's clear that at least a subgroup of users prefer the higher-pressure systems. "The [column] situation is still not ideal, but it has opened up quite a bit."

Although it is not universally adopted and its drawbacks are often exaggerated, UHPLC is recognized by all as chromatography's crowning achievement. Is a UHPLC system in the stars for your next LC purchase? That depends on your lab's workflow and the relative value you place on performance and cost or familiarity.

"You've got to enter this market cautiously," reminds Robinson.

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

FAST ALTERNATIVES AT MODEST PRESSURES

Several column technologies promise something approximating sub-2-micron performance but without the extreme pressures or need to purchase new systems. One such technique is core shell technology from Phenomenex (Torrance, CA). Agilent ("superficially porous") and Supelco (Fused Core™) have similar products.

Core shell technology uses silica particles consisting of a solid inner core, with chemistries bonded atop a porous outer shell. Standard silica particles are porous throughout, in a configuration that David Schock, marketing manager at Phenomenex, calls "a spherical sponge." With conventional media, the mobile phase and solutes diffuse throughout the entire particle. In core shell, solutes remain mostly on the particle surface, experiencing anywhere from 20 percent to 50 percent less stationary phase during their travels down the column and, therefore, faster elution.

According to vendors, core shell extends the capabilities of conventional HPLC equipment by providing separations as good as those achieved on sub-2-micron columns, but without the high backpressures and need to purchase new equipment. Core shell's only drawback is relatively low capacity, meaning it is not suitable for preparative LC.

Another "fast" method employs monolithic columns, which are essentially a single rod of porous silicon or polymer encased in a metal or plastic jacket. Monoliths are intriguing for the numerous selectivity possibilities and rapid elution. Numerous vendors now supply them, including Phenomenex (Onyx), Bia Separations (CIM Disk, CIM Tube), Agilent (Bio-Monolith), Merck Chemicals (Chromolith), and Dionex (ProSwift).

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MIND MAPPING

A TOOL FOR ORGANIZING IDEAS AND TASKS, PROBLEM SOLVING, AND DECISION MAKING by John K. Borchardt, Ph.D.

Mind mapping is a powerful technique for quickly generating, capturing, and organizing ideas, tasks, and projects. It has also been called task mapping and idea mapping. Mind mapping uses a diagram that depicts ideas, tasks, or other items linked to and arranged around a central key word or idea (Figure 1). Mind maps can incorporate visual cues such as colors and arrows, which activate more regions in the human brain, resulting in better memory than linear, text-heavy outlines and notes.¹ For example, color can be used to highlight project milestone deadlines. Mind maps are used as an aid in organizing ideas and tasks, problem solving, and decision making. Besides using them in my consulting work on lab projects, I also use mind maps to organize large writing projects.

Using mind mapping

Lab managers can use mind mapping to design R&D projects to develop new products or process innovations and track progress of the work. Although the central box of Figure 1 is a brief description of the project name, the central box can also be used for the project charter: a statement of the scope and goals of the project. Additional “satellite” boxes not shown in Figure 1 can document assumptions and definitions of success.

Mind maps can also serve to indicate progress on various phases of the project. Should you need to reduce project costs or accelerate progress, mind maps can help you do so. Consider Figure 1, a simplified mind map of a product development project. If you need to reduce costs or accelerate progress, you might reduce the number of candidate methods of synthesizing a new product

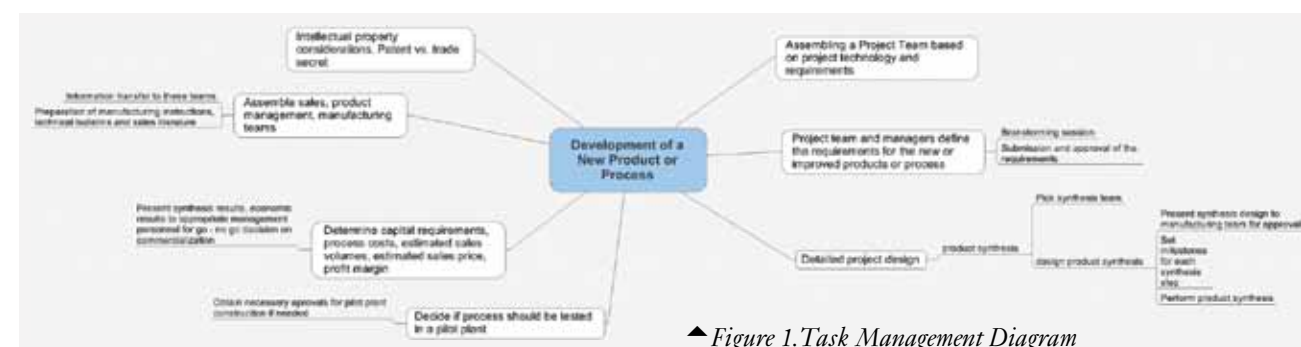
(the lower right of the mind map). Mind maps facilitate discussing changes in an R&D project with other project stakeholders: pilot plant and manufacturing plant managers, business managers, and others. The mind map facilitates team members’ and project stakeholders’ understanding of how a change in one phase of the project will impact other project activities.

Mind mapping can also be used to manage information. This can be internal information such as catalyst properties or external information such as competitors’ activities. When using project management software, hyperlinks can be used to connect to detailed technical information, project reports, minutes of meetings, memoranda, and other information.

Mind mapping can be used by instrument makers to define processes to troubleshoot and diagnose faulty lab equipment and to repair it. Plant managers can use it to anticipate and proactively respond to critical operational issues. People working in technical service can use mind maps to anticipate and proactively respond to commonly encountered customer service problems.

Lab managers and business managers can use mind maps to predict customer purchasing behavior, determine weaknesses of product/service offerings, and identify new innovations that meet customer needs.

Mind mapping can be used to monitor the external environment and translate issues into action. One can use mind maps to identify the competition, their technology, and the relative advantages and disadvantages of their technology and marketing strategies. One can also study technology and economic trends relevant to a project,



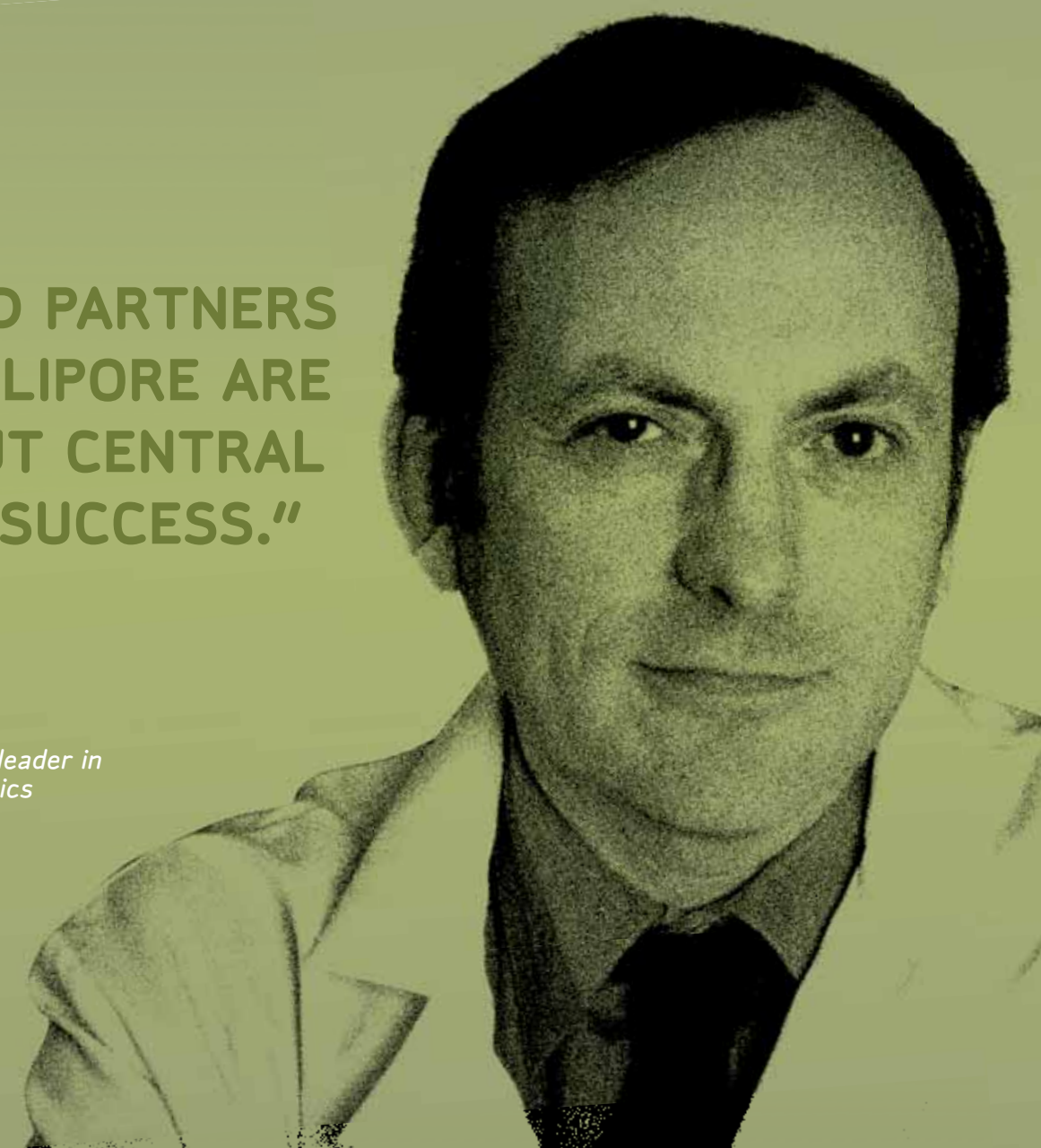
▲ Figure 1. Task Management Diagram

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the laboratory, or the organization as a whole. Mind maps can be used to consider political and regulatory issues, technology innovations, and social and cultural changes.

One can include links to computer files, information, and information sources in mind maps. For example, note the item "Intellectual Property" in Figure 1. This item can include a list of relevant patents that could be cited as prior art should you decide to file a patent application. You can include the URL addresses of such patents, which are located on the U.S. Patent and Trademark Office website. This category can also include inventors and their contributions, the status of patent applications in preparation, and external disclosures of information to customers or as conference presentations.

Some mind-mapping software packages include a notes section for each item in Figure 1. One can record more extensive and detailed information, such as discussed above in the notes section, to avoid making the mind map as shown in Figure 1 cluttered with detail and thus hard to understand.

Software

The development of mind-mapping software has greatly reduced the difficulty of preparing mind maps while increasing their flexibility. Several commercial software packages have been designed for developing mind maps (Table 1). Although I paid \$380 for Mindjet 6.0 at the behest of a corporate client, there are several other mind-mapping software programs available that are free, including FreeMind² and XMIND, which runs on the Mac. FreeMind can be downloaded from Reference 1. User reviews indicate the software is quite good, and readers can experiment with it at no cost.² There are also additional computer programs available for purchase, such as Buzan iMindMap.

Table 1. Mind Mapping Software

Software Name	Internet URL Address of Information
FreeMind	http://freemind.sourceforge.net/wiki/index.php/Main_Page
MindManagera	http://en.wikipedia.org/wiki/MindManager
Buzan's iMindMap	http://en.wikipedia.org/wiki/XMIND
Compendium	http://compendium.open.ac.uk/institute/about.htm
SciPlore Mind Mapping	http://en.wikipedia.org/wiki/SciPlore_MindMapping
MindGeniusa	http://en.wikipedia.org/wiki/MindGenius
Creately	http://en.wikipedia.org/wiki/Creately
MindMapper	http://en.wikipedia.org/wiki/MindGenius
Mindviewa	http://en.wikipedia.org/wiki/MindView
XMIND	http://en.wikipedia.org/wiki/XMIND

Commercially available software uses automated techniques to create mind maps. Creating a visually appealing, useful mind map has nothing to do with your ability to draw.

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One can also go a low-tech route to build mind maps. Mind mapping has been around for about thirty years, more than a decade before mind-mapping software became commercially available. One low-tech approach to developing mind maps is to use a whiteboard and Post-It® Notes on which the general organizational topics are written.³ If one uses Post-It Notes to capture ideas generated in a brainstorming session, these could be used as the basis to generate a mind map.

Mind maps generated using software are easier to modify during the course of the work than hardcopy mind maps generated using a low-tech approach. Another advantage of using mind-mapping software is that one can incorporate much more information legibly into a mind map. Legibility can be maintained by focusing on a particular portion of the mind map of current interest and then enlarging it. Also, projecting the image on the computer screen onto a wall screen, thus enlarging it, enhances legibility. The ability to project an enlarged image of the mind map onto a wall screen facilitates discussion of the project by a project team or for management presentations.

"The ability to project an enlarged image of the mind map onto a wall screen facilitates discussion of the project."

Explaining mind mapping to staff members

Using either software or the Post-It Note approach, topics can be repositioned on a mind map to provide the best structure of tasks for a project. Using an LCD projector, one can project a mind map onto a wall screen so a team can organize a project and revise the mind map as the project proceeds. The same is true with a Post-It notes/whiteboard approach, although the team will have to work close to the whiteboard.

Psychological scientist James Harter of Gallup, Inc. concludes from his survey research that one way managers can increase employee job satisfaction is to "clarify expectations for employees by helping employees see the ultimate outcomes the organization is working to achieve and how they play a role in achieving those outcomes." Mind maps are one way to do this. Managers can use mind maps to explain to team members where they fit in the organization of a complex project or a department. Mind maps can provide team members with an understanding of how their work fits into and contributes to project goals and activities. When new team members join a project, lab managers can use mind maps to quickly explain a project and introduce the new team member to his or her role in the project. Because team members can clearly see how they contribute, they are more likely to buy into the project and be committed to its success.

Mind mapping will be new to most of your staff. Rather than just recommending or giving them a book on the subject, it is probably more

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effective to teach a workshop that includes a demonstration of building a mind map. The process of building a mind map that is projected onto a wall screen can be quite effective in demonstrating mind mapping and helping staff members understand the process. Doing so for a recently completed project may be more effective than demonstrating the process while developing a mind map for a new project because some of your staff members already will be familiar with the project in question. Although preparing such a workshop involves a substantial amount of work, it will also greatly enhance your own mastery of the mind-mapping process.

Lab managers could conduct such a training session with their team leaders who, in turn, demonstrate it to their team members. The objective isn't necessarily to teach every staff member the concepts and use of the software in detail. Rather, it's to familiarize them with the basics and how mind mapping can be used. It can be the managers and team leaders who actually use the software to build mind maps during team meetings. As team members contribute their thoughts and see the mind map take shape on the screen, they are included in the process, thus feeling empowered.

Mind mapping and meetings

Mind mapping can be used to organize and run meetings. The meeting agenda can be presented as a mind map projected onto a wall screen. A member of the group reasonably skilled in using the software can be designated the scribe and can record important points, actions, ideas, and deadlines on the mind map. Everyone at the meeting can literally see the results of the meeting taking shape before their eyes.

Before breaking up, the meeting attendees can review the results of the meeting and be sure that appropriate action items are assigned to specific individuals and that deadlines are set.

Mind mapping also can be used in conjunction with brainstorming sessions. One can use a mind map to record ideas as they are generated. Then, when one shifts to organizing the ideas, one can work with the mind map projected from a computer onto a wall screen. One can use the mind map to group similar ideas, designate individuals or teams to evaluate the ideas, and record deadlines on the mind map. The individuals or teams can use the mind map to develop their thoughts and later present them to the entire team or to the manager. Alternatively, one can use flip charts or a whiteboard.

Project documentation

Mind mapping can be used to organize the process of project documentation and track progress. It can be used in writing reports, plant operating procedures, emergency response procedures, and other complex documents by providing a structure for these documents. Some software permits mind map notes sections to be copied and pasted into word processing programs such as Microsoft Word.

Authors are beginning to use mind mapping. For example, I am using mind mapping to structure the book I am writing, *Accelerating Innovation through Effective Laboratory Management*. Mind mapping is more two-dimensional than the linear flow of a traditional outline. It helps one to see how discussions and concepts presented in different places in one's text are related and helps writers expand on earlier discussions while eliminating unnecessary duplication. One of my consulting clients requires a mind map of a report to be included in the report introduction.

Final comments

There are several books on mind mapping provided in the reference list below.^{1 and 3-5} The partial list of mind-mapping software in Table 1 provides a number of software options to choose from. Although the visual nature of mind mapping may initially make one uncomfortable, mind mapping doesn't have to be a difficult subject.

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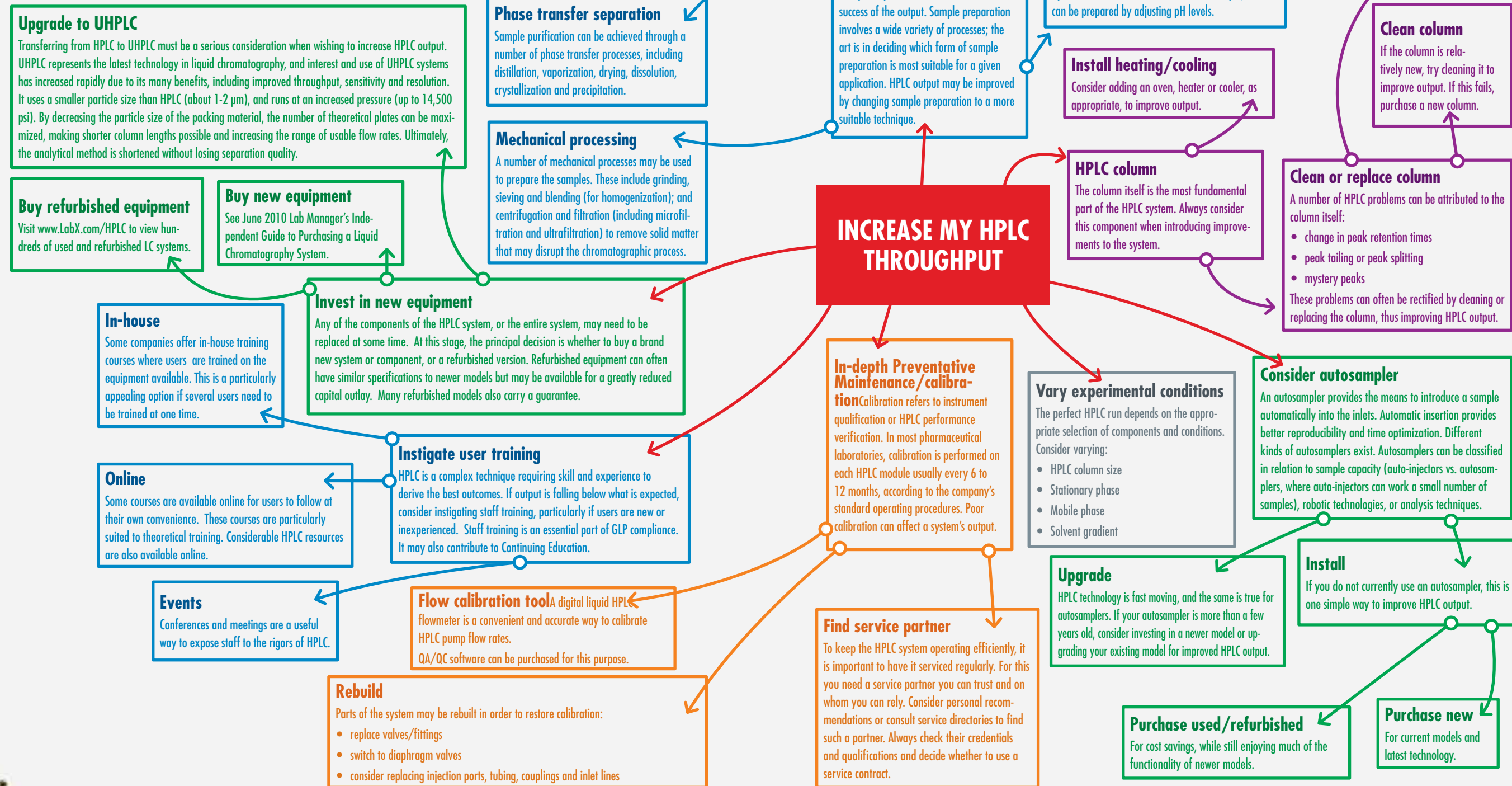
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MIND MAP FOR INCREASING HPLC ANALYSIS

By John Buie

IDENTIFYING AREAS WHERE IMPROVEMENTS TO HPLC OUTPUT CAN BE MOST READILY ACHIEVED

HPLC is one of the most common analytical methods, ubiquitous in laboratories worldwide. The sheer number of HPLC analyses that are conducted in laboratories every day makes it imperative that the process runs as efficiently and effectively as possible. A small waste of time or solvent on a single run adds up to significant losses over time. However, like many familiar processes, HPLC is often performed routinely without proper thought about optimizing output. The following MIND MAP provides some mental prompts that should be considered when running a specific HPLC process, or when conducting HPLC analysis in general. Often, the simple adjustment of a standard parameter can lead to huge gains in efficiency and performance.



MODULAR LABS GOING MAINSTREAM

SYSTEMS WELL SUITED TO THE GROWING MULTIDISCIPLINARY NATURE OF CURRENT RESEARCH EFFORTS **by Bernard Tuli**

At some point in his or her career, every lab manager has had to—or will have to—grapple with one or more of the following issues. How can we conduct multidisciplinary laboratory activities under one roof? What is the most efficient and cost-effective way to add new laboratory space? How can we refresh, modify, or replace fixed lab facilities?

Flexible modular laboratory buildings have evolved as innovative answers to these often-daunting questions. Modular buildings can be packed and shipped to different locations on demand, they can be erected or rearranged within hours, or they can remain in one location as highly flexible additional laboratory space.

Over the years, modular laboratory units have been much in demand from government departments that have responsibility for overall environmental surveillance, including air- and water-quality testing and rapid response during natural disasters, disease outbreaks, and terrorist attacks, especially those that may lead to the release of toxins and pathogens. Now that same interest is moving to corporate and university labs.

On top of their inherent traits of mobility and flexibility, modular units offer a number of clever inclusions that have made them more ergonomic and operator-friendly than traditional laboratories. Some of the available innovations are wheel-mounted workbenches; ductless fume hoods that are not attached to large, fixed air handling systems; point-of-use ultrapure water systems; localized (versus centralized) vacuum systems; and labor-saving devices that are conveniently hitched onto walls and ceilings.

“Modular units offer a number of clever inclusions that have made them more ergonomic and operator-friendly than traditional laboratories.”

To be sure, these attractive characteristics have not gone unnoticed, and now modular labs are increasingly evident in more traditional settings. “Many companies and universities are building and renovating lab space, and confronting the fact that the rapid advances in science and technology demand that lab space be flexible

enough to adapt to changing scientific priorities and technology tools,” says Peter Coffey, vice president of marketing with Vacuubrand, which manufactures and sells high-performance laboratory vacuum products.

He notes that a number of cities have developed research parks to serve as incubators for technology start-ups. The hope is to replicate the success of Boston’s Route 128, California’s Silicon Valley, or North Carolina’s Research Triangle, from which more than a few fledglings grew into global players. Coffey says, “New research parks generally have a rotating array of tenants, each with unique

needs. These tenants need utilities that are separate from one another, because their needs are different, because they need to avoid cross-contamination, and because the building manager needs to keep billing separate. There is also a strong movement to design labs for flexibility or modularity, to avoid obsolescence and the costs of renovation, and to adapt to changes in mission.”

That is certainly the case with laboratory water systems. Wayne Darsa, director of the North American Health Sciences division of Siemens Water Technologies, says that his company builds “modular systems for large medical areas, small areas or clusters of labs, and

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individual lab spaces. We can provide water solutions for everything.”

Siemens Water Technologies does not have a separate division for modular labs. Darsa, who works with both modular and traditional labs, defines modular water systems as “smaller central or point-of-use systems going into one or a series of laboratories.” He says that, depending on the specific circumstances, there are important installation and operational costs and management differences between modular and traditional labs. In

tional systems. On the other hand, there is no comparison to the flexibility advantage that modular systems have.”

He notes that modular systems are not necessarily more environmentally friendly. Traditional water systems have more efficient drainage, because they use variable-speed pumps to control energy and reduce output. Large modular systems save energy and water through the use of reverse osmosis, where recovery rates are high. In smaller modular systems, the recovery rates are low and a higher percentage of the water is sent to drain. “When you multiply that by hundreds of units, the water loss could be substantial,” Darsa says.

When deciding on a water-supply system for a modular unit, lab managers should weigh a number of issues, including the volume of water and the number of end points that will be required, according to Darsa. Some labs may need ultrapure water and validation, but they may also have humidifiers that need different quality rates and flow levels, as is often the case in biopharmaceutical labs. “There is always a need to weigh the pros and cons of modular versus traditional systems,” says Darsa.

Siemens offers water technologies for all kinds of laboratories. Its largest modular system, the Centra reverse-osmosis and deionization system, can be placed in a closet or central area and can feed five to 10 points of use. Considered inexpensive to operate and maintain, the Centra system can, depending on the code requirements for the distribution tubing or piping, accommodate any type of



▲ A common configuration for a small central vacuum pumping system: two pumps and a control panel mounted on a ballast tank in the basement.

traditional settings, one water system feeds into many areas, whereas in modular labs, multiple systems supply individual departments, according to Darsa.

“The advantage is that if one modular system goes down, the lab or group of labs that it was feeding can go to another floor or lab to obtain water. When a traditional system goes down, or has to be sanitized, water is inaccessible for a few hours to a few days,” he says. Darsa adds that modular systems are designed to meet specific water needs—for example, genetics labs need to keep bacterial levels low and need to sanitize water more frequently.

Darsa believes that modular water systems offer many advantages, but also that there could be drawbacks. “I have seen modular systems that are much more expensive, both in installation and operational costs, than tradi-



◀ With local vacuum pumping systems, the pump fits under a fume hood, with manual or electronic vacuum controls mounted on the fume hood panels.

material—such as stainless steel or polyurethane. This system is often seen in biotech, food-processing, pharmaceutical, quality-control, and research labs, where they are regulated in much the same way as in traditional labs.

Today, Siemens has the largest market share in overall water purification. Another major water-systems supplier, Millipore, is the largest in the laboratory market. Darsa says that modular labs have become more prevalent in

the last four to five years. “The market is not necessarily broken down as modular versus traditional, but modular is seen as the growth laboratory market.” Darsa believes that, over the next several years, modular systems “will continue to grow and take away from central systems.” He bases this prediction on the views of architects and engineers who are active in this area.

Vacuubrand’s Coffey says, “It used to be that science would be done in silos. You would put all the biologists in one place and the chemists in another. The common objective now is to build multidisciplinary buildings.” This he sees as one of the driving forces behind the growth of modular laboratories.



▲ A point-of-use modular water system. Tap feed RO/EDI system provides Type II quality water, but will achieve 10 Megohms consistently.

Turning to his company’s specialty, Coffey says that central vacuums have been the traditional approach. “Historically, there was no modular alternative—only one pump per application at a time. Already, the trend in Europe is that local (modular) systems have displaced the central approach, largely because the local approach offers higher-quality vacuum. Modular vacuum systems are new enough in North America that growth rates are high, because penetration is low. In Europe, where there has been greater acceptance, market penetration occurred in the last decade, and there was fabulous growth over the last 15 years. Growth

in Europe is slowing now, since local systems have become the standard approach,” says Coffey.

He notes that, typically, a central vacuum is installed throughout a building for filtration purposes. If high-performance vacuum were required, however—to manipulate evaporative boiling points, for example—another pump would be installed next to the central vacuum port.

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▲ Custom overhead service carriers, mobile cabinets, and fixed steel casework. Project: Carnegie Mellon University, Pittsburgh, PA.

This would provide two different ranges of vacuum.

"If you don't have to install a central vacuum system throughout a building, and can put the vacuum only where it is needed, and the vacuum system you install has the ability to do what all the dedicated pumps would

do, you effectively eliminate much of the need for the dedicated pumps and the central vacuum system—in effect, eliminating a duplicate investment. The idea is to do it in a modular way and put the vacuum where it is needed," says Coffey.

"A lot of people have begun to question the need for the central vacuum system—and many have stopped using them. Because central vacuums draw waste vapors into in-wall piping, institutions are choosing to leave them out of many new buildings," he says.

Coffey predicts increasing acceptance of the modular approach over the next few years. "The critical mass of awareness that happened in Europe will happen in the U.S. as both architects and scientists become more familiar with modular systems," he says.

This view is shared by Chip Diefendorf, Director of Business Development at Mott Manufacturing, which makes and sells furniture for both modular and traditional labs. He says that modular lab furniture has been an area of focus at Mott Manufacturing for the past 15 years. "A



▲ Mobile cabinets (Sigma Carts™). Project: The MaRS Center, Toronto Medical Discovery Tower, Toronto, Ontario, Canada.

variety of tables and work stations that are integrated with overhead service carriers have taken quite a jump in the last five years," he says.

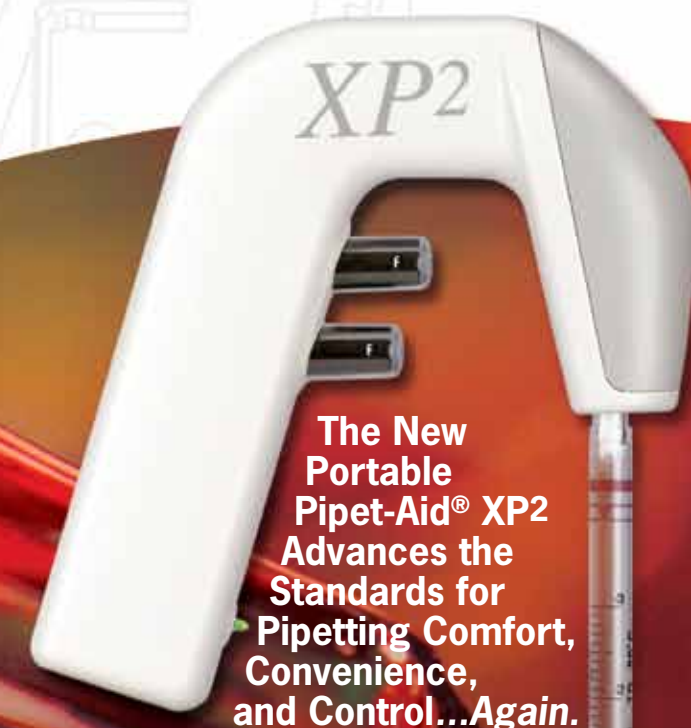
"Typically, there is a blend of these two systems. Modular systems allow the lab to be quickly and easily modified to meet changing requirements, such as adjusting a new piece of equipment to a person with a disability. It allows a lab to serve different purposes. Modularity gives you the ability to reconfigure and change."

Diefendorf says that flexible modular furniture solutions generally have a higher initial cost, and the difference depends on the solutions in question. "Typically, you are going to pay a premium for flexibility. However, there will be cost savings through the reduced need for renovations, with the opportunity for quicker lab reconfiguration," he says.

Laboratory furniture is a crowded market segment, with several large manufacturers throughout the U.S., the Middle East, and Asia, says Diefendorf. "Plug-and-play furniture systems and pedestal cabinets are growing the fastest, and the largest markets outside of North America are the Middle East and Asia. Higher education and the government sector are the most active market for this furniture," he says.

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

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TEMPERATURE RANGE, UNIFORMITY, AND CONTROL TOP FEATURE LIST

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

Ovens are found in almost every industrial, research, and development laboratory. Applications include drying lab ware and keeping it ready for use; sterilization; conducting above-ambient, constant-temperature experiments; drying reagents and desiccants; annealing and curing materials; component and materials testing; and many others.

“Nobody gets excited about lab ovens, but [they] are definitely essential lab components.”

“Nobody gets excited about lab ovens,” comments Frank Brombley, general manager at Jeio Tech (Seoul, South Korea), “but ovens are definitely essential lab components.”

What to look for

The most important characteristics of lab ovens are temperature range, temperature uniformity, size, ergonomics, energy consumption, and price.

Temperature range, the most important oven property, refers to the highest reliable operating temperature above ambient. Common ranges are 250°C, 300°C, 400°C, etc., up to 1000°C.

Temperature uniformity is arguably the most important oven property after temperature range. “Uniformity and accuracy have always been the key specifications for heating and cooling instruments,” says Mr. Brombley.

Until relatively recently, lab oven manufacturers adhered to an ASTM standard for temperature uniformity

that was based on the temperature at nine locations within the oven chamber. This standard served the industry well for many years, but its shortcomings became obvious as experimentation and processing requirements increasingly demanded highly uniform temperatures throughout the oven.

“You want the temperature at every point inside the oven to be the same as the number on the unit’s temperature display,” Brombley tells *Lab Manager Magazine*.

Top oven manufacturers, including Binder, ESCO, Memmert, Jeio Tech, and Thermo Fisher, have adopted a more rigorous temperature-uniformity standard,

DIN 12880, for some of their products. Instituted in 2007 by a German standards agency, DIN 12880 uses 27 measurement points to provide significantly improved temperature uniformity.

The DIN 12880 standard is as much a corporate-cultural statement as an absolute requirement. Brombley believes that the use of DIN 12880 conveys that manufacturers are making extra efforts to guarantee the quality of their products.

Measurement points are just one aspect of uniformity, however. To achieve the goals of DIN 12880, ovens must circulate air constantly and uniformly. Binder ovens, for example, use mechanical convection and proportional-integral-derivative control. “Mechanical convection provides greater consistency and more rapid recovery after oven doors are opened,” says Uwe Ross, president, BINDER Inc. (Great River, NY).

Oven size is a major consideration for laboratories that are short of space or concerned about energy consumption. Those considering the purchase of new or used units following the older, ASTM standard should know that temperature control is somewhat more difficult in larger ovens.



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the capabilities of standard pipettes while minimizing strains associated with standard mechanical pipettes, [thereby] improving ergonomics.”

Calibration

Calibration is perhaps the most important service-related activity for pipettes. Calibration ensures that the pipette is delivering precise volumes after thousands of cycles. Regulated industries calibrate their instruments several times a year: all labs using pipettes should consider taking advantage of calibration services every six to twelve months.

Some pipettes may be calibrated by the user, but most calibrations are carried out at the original manufacturer’s facility or, as in the case of BrandTech products, through a third-party service provider. Some service companies perform calibration at the customer’s site.

Calibration is conducted by dispensing volumes of water and weighing them on an analytical balance. Calibration usually takes place off-site at

the calibrator’s facility, under conditions of strict environmental control and using standardized methods and materials. For example, Eppendorf employs a weighing vessel and a trap to reduce evaporation from small samples. The company’s calibration room is maintained at 50 percent relative humidity and a constant temperature. Water used during testing is degassed and distilled; technicians test three different volumes for variable-volume pipettes; and all volumes are measured at least ten times.

“Calibration is perhaps the most important service-related activity for pipettes.”

A typical calibration costs between \$20 and \$100 per pipette. Off-site calibration has a turnaround time of two days, while on-site calibration can be done the same day.

Like most routine maintenance, calibration may be viewed as more of an inconvenience than a necessity. “Some

users are less concerned about the quality of calibration than about getting a sticker on their pipette that says it’s been calibrated,” says Petrilli, “but most recognize the value of a pipette that is calibrated properly. Certainly anyone in a regulated environment knows the importance of calibration.”

Dickstein adds, “A pipette needs to be thought of as a precision instrument. That’s why being certain it is performing as intended by the manufacturer is so critical. Calibration ensures these standards are met.”

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

SURVEY SAYS: PIPETTES



SURVEY SAYS: YOU NEED A PIPETTE... NOW WHAT?

As part of our online Lab Products Survey series, *Lab Manager Magazine* has compiled the responses of 464 lab professionals regarding their pipettes, their purchasing habits and what is important to them in their decision-making process.

The goal of pipetting is to ensure maximum accuracy and repeatability when transferring fluids. A high-quality pipette in the hand of an untrained operator is an unreliable instrument. Beyond user skill and consistency, ergonomic design, product durability and performance, and calibration requirements are the most important features to consider when purchasing a pipette.

The worldwide pipette market is expected to grow by 48.27 thousand units by 2012. This growth is driven by novel designs, a rise in PCR diagnostic tests and the involvement of ultra-micro volumes in laboratories. Despite being an everyday laboratory commodity, pipettes have a history and anticipated future of responding to the demands of the scientific marketplace with groundbreaking innovations. With ergonomics, precision and safety becoming the buzzwords in the pipette market, electronic models are poised to overshadow gains in the mechanical pipette market.

Considering how electronic pipette technology has advanced, in order to lessen the strain on users’ wrists and hands, 83 percent of respondents are using manual, single-channel pipettes in their labs. It is important to take frequent breaks, in order to lessen the risk of repetitive strain injuries.

For more information on pipettes, please visit www.labmanager.com/pipettes

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Number of pipettes being used in labs.

None	2%
1	2%
2	3%
3	4%
4	3%
5 or more	86%

Types of pipettes being used.

Manual: Single-channel	83%
Manual: Multi-channel	46%
Manual: Fixed volume	32%
Electronic: Single-channel	23%
Electronic: Multi-channel	20%
Electronic: Fixed volume	7%
Repeater	34%
Other	4%

The primary purpose for these pipettes.

Research	44%
Quality Control	20%
Clinical and Diagnostic	19%
Production / Processing	9%
Other	7%

Satisfaction with pipettes being used.

Very Satisfied	56%
Satisfied	37%
Not Satisfied	7%

General comments on why a user is not satisfied:

Not ergonomic (hard on wrist and thumb), break/leak easily and hard to repair, tips fall off, ejector gets sticky and rusty, frequency of calibration required and accuracy issues. For digital pipettes, program not flexible enough.

Related pipette components in labs.

Buret	23%
Controller	10%
Racks	50%
Bottle top dispenser	31%
Other	3%

Annual pipette consumable purchasing budget for items such as tips.

Less than \$2,000	51%
\$2,000 - \$5,000	31%
\$5,000 - \$10,000	11%
\$10,000+	7%

Purchasing plans for a new pipette.

Starting the review process	8%
Plan to purchase in the next 1 to 6 months	19%
Plan to purchase in 6 to 12 months	10%
Plan to purchase in 12 + months	6%
No current purchasing plans	44%
Don't know	10%

Reasons for purchasing a new pipette.

Addition to existing systems; increase capacity	53%
Replacement of current pipette	51%
First time purchase of a pipette	3%
Setting up a new lab	12%
Other	3%

Budget range for a pipette purchase.

Less than \$250	25%
\$250 - \$500	41%
\$500 - \$750	22%
\$750 - \$1,500	23%
\$1,500+	12%

Factors/features that influence the decision-making process when buying a pipette.

Accurate calibration data	94%
Performance of product	90%
Durability of product	89%
Availability of tips and accessories	88%
Ease of use; ergonomic operation	85%
Low maintenance; easy to clean	85%
Low operating costs	74%
Total cost of ownership	60%
Past experience with product	58%
Warranties	58%
Service and support	57%
Ergonomic features	56%

Respondents’ fields of work.

Biochemistry and biology	27%
Hospital/Medical center	13%
Microbiology	9%
Pharmaceutical industry	9%
Chemical	8%
Environment	8%
Quality control	4%
Food and beverages	3%
Forensic labs	1%
Fuels	1%
Metal industry	1%
Other	16%

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COMMODITY LAB APPLIANCES, BUT STRONG ON INNOVATION

by Angelo DePalma, Ph.D.

It would be difficult to imagine a chemistry laboratory without at least one fume hood. Despite their ubiquity and the notion that they are not “sexy” lab products, a great deal of innovation has occurred in fume hoods during the last decade.

Fume hoods are connected to a building’s heating, ventilating, and air conditioning (HVAC) system, which removes air through the hood’s front panel. Vented air ultimately comes from the lab’s working area. It is expensive to heat and cool work-space air, says Jon Zboralski, director of air-flow products at Thermo Fisher Scientific (Two Rivers, WI). Wasting air by forcibly removing it is the most significant ongoing cost of fume hood operation—greater, eventually, than the cost of acquiring and installing a hood, and much greater than the fume hood’s operating costs.

Luke Savage, a sales engineer at Lab-conco (Kansas City, MO), describes conventional fume hood designs as “huge energy hogs.”

About ten years ago, the industry introduced the first low-flow fume hoods, which operated at lower face

velocities than did traditional hoods. The standard used to be about 100 cfm; low-flow systems vent toxic gases just as well at 60 cfm, a 40 percent energy savings. Typical lab air entails costs of about \$5/cfm/yr, so a typical old-style hood costs about \$5,000–\$6,000 per year to operate.

Low-flow systems are designed to operate at 60 cfm at all sash positions. “You get great savings, even with the sash fully raised, but even better savings with the sash closed,” Savage says.

Yet low flow is by no means universally acknowledged as an improvement. According to Alvin Heath, director of business development at ESCO Technologies (Hatboro, PA), low-flow (which he calls “high-containment, low-flow”) hoods “challenge the traditional concept that higher inflow equates with better containment. Convincing end users to work with these hoods is an uphill task,” even when gas-containment tests prove low flow’s mettle.

Resistance is particularly high in highly competitive, low-margin analytical labs with an installed base of old-style hoods. “And some folks still wonder whether low flow is a good thing to

do. It’s been quite a battle between the facilities people and the environmental health experts,” Zboralski tells *Lab Manager Magazine*.

Ergonomics, “smart” sashes, and air recycling

Fume hood manufacturers have incorporated other interesting innovations as well. Today’s hoods have an expanded viewing area and an improved counterbalance system that assists in raising and lowering the glass window. Thermo Fisher, for example, has adopted advanced chain-and-socket mechanisms to make the counterbalance more reliable. “A good cable and pulley used to last for about 100,000 cycles,” Zboralski says. “Today the chain-and-sprocket systems are still going strong after 250,000 cycles. All the major players have adopted this system.”

Fume hood vendors have also finally addressed ergonomics, an important consideration, since many organic chemists practically “live” inside their hoods. Hood entrances are now slanted back, rather than outward, which



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makes them easier to work in for long periods. Sash designs have also improved, and some units now feature horizontal sliding panels.

Another interesting development is the “intelligent sash,” which closes when a motion sensor detects no movement in front of the hood for a specified time period, for example, when the operator walks away. This feature alone can reduce energy consumption by 70 percent, according to Savage.

Hood baffle designs have also undergone significant improvements, says Heath. “Baffles are cleverly angled, and nowadays even perforated, to allow for best airflow navigation to the exit point; that is, to reduce airflow residence time in the hood as much as possible.” Today’s baffles are also easily removed for cleaning, which prolongs the service lifetime of the hood.

Digital airflow monitors, which are reasonably priced, provide real-time diagnostics of the hood’s extraction performance and can alert building maintenance when problems arise.

Perhaps the most striking recent de-

velopment has been the introduction of ductless fume hoods. Instead of venting to the environment, ductless hoods use filtration systems that recycle conditioned air.

Early variations of the recycling idea worked fine, but the charcoal filters were less than optimal for some important fumes, and users were slow to replace the filters. “There was a lot of resistance to these devices,” Zboralski says.

Then Erlab (Rowley, MA), a Thermo Fisher partner, designed a charcoal material that removes and retains a much broader base of reagents. The new designs are unlikely to replace all vented fume hoods any time soon, but they can easily serve about 10 percent of installations today, according to Zboralski. “And as time goes by that number will grow,” he adds.

Purchase considerations

Users should be aware of problems that may crop up during specification and installation of fume hoods. Most new fume hood purchases are for new

laboratories, according to Heath. Traditionally, laboratory furniture suppliers provide the fume hoods as well. Although a few manufacture hoods that are standards-compliant, Heath says, “many still construct fume hoods as though they were simple boxes. Fume hood prices are often bundled with furniture prices, and that makes it difficult for the end user to make informed decisions.”

Heath provides the following wish list for potential fume hood buyers:

- Local installation and support for ducting, controller, and exhaust blower
- Appropriate safety certifications
- Construction materials for specific application, for example, polymer inner liners for corrosive acids, ceramic work tops for high temperatures
- Local references for the supplier/installer
- Aesthetics and cost

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

SURVEY SAYS: FUME HOODS



SURVEY SAYS: YOU NEED A FUME HOOD... NOW WHAT?

As part of our online Lab Products Survey series, *Lab Manager Magazine* has compiled the responses of 274 lab professionals regarding the operation and maintenance of their fume hoods and, if they are thinking of purchasing a new fume hood, what they consider in their decision-making process.

The purpose of a fume hood is to contain contaminants and prevent their escape into the laboratory. This is accomplished by drawing contaminants within the hood’s work area away from the user, so that inhalation and contact are minimized.

Purchasing the correct fume hood for your laboratory is a very important, long-term decision and your choice in lab ventilation systems will affect future lab planning, flexibility and safety.

There are four main questions you should ask before proceeding with a fume hood purchase:

1. What level of protection will the lab worker require?
2. What is the face velocity needed for the experiment?
3. What materials are going to be used under the hood?
4. How much space is available in the lab for the fume hood?

For more information on fume hoods, please visit www.labmanager.com/fume-hoods

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Number of fume hoods being used in labs.

None	9%
1	21%
2	16%
3	9%
4	6%
5 or more	39%

Types of fume hoods being used.

Conventional ducted fume hood	43%
Benchtop ductless fume hood	15%
Canopy ducted fume hood	13%
Variable air volume ducted fume hood	12%
Down flow workstation	7%
Portable ductless fume hood	7%
Other	3%

The primary purpose for these fume hoods.

Research	43%
Quality Control	18%
Production/Processing	16%
Clinical and Diagnostic	8%
Other	15%

Satisfaction with fume hoods being used.

Very Satisfied	49%
Satisfied	44%
Not Satisfied	7%

General comments on why a user is not satisfied:

Most of the respondents who were not satisfied had older fume hoods. As a result, the noise levels are high and the blowers are not evacuating the fumes and odors as well as they once did.

Related fume hood components used in the lab.

Airflow monitor	20%
Work surface	18%
Digital monitor	15%
Blowers	14%
Base storage cabinet	13%
Fume extractor arms	10%
Transport support cart	5%
Other	6%

Annual fume hood consumable purchasing budget for items such as filters.

Less than \$3,000	73%
\$3,000 to \$10,000	22%
\$10,000 - \$20,000	2%
\$20,000 to \$50,000	2%
\$50,000+	1%

Purchasing plans for a new fume hood.

Starting the review process	9%
Plan to purchase in the next 1 to 6 months	12%
Plan to purchase in 6 to 12 months	10%
Plan to purchase in 12 + months	5%
No current purchasing plans	57%
Don't know	8%

Reasons for purchasing a new fume hood.

Addition to existing systems; increase capacity	34%
Setting up a new lab	32%
Replacement of a current fume hood	25%
First time purchase of a fume hood	4%
Other	5%

Budget range for new fume hood purchase.

Less than \$5,000	37%
\$5,000 to \$10,000	27%
\$10,000 to \$15,000	14%
\$15,000 to \$20,000	3%
\$20,000 to \$30,000	5%
\$30,000+	14%

Factors/features that influence the decision-making process when buying a fume hood.

Durability of product	99%
Performance of product	99%
Safety and health features	99%
Low maintenance; easy to clean	98%
Ease of use; ergonomic operation	93%
Value for price paid	93%
Low operating costs	91%
Warranties	90%
Availability of supplies and accessories	88%
Service and support	82%
Total cost of ownership	81%
Vendor reputation	74%
Past experience with product	51%
Currently using vendor's product	45%

Respondents' fields of work.

Biochemistry and biology	14%
Chemical	14%
Environment	12%
Pharmaceutical industry	12%
Food and beverages	7%
Hospital/Medical center	7%
Quality control	6%
Microbiology	5%
Metal industry	4%
Forensic labs	3%
Fuels	2%
Plastics	2%
Other	12%

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BOOST PRECISION, REPRODUCIBILITY FOR CRITICAL LC METHODS

by Angelo DePalma, Ph.D.

Chromatographers who learned their craft twenty years ago may not have been familiar with autosamplers then, but today nearly every high performance liquid chromatography (HPLC) instrument includes an autosampler as standard equipment.

"Autosamplers existed in the early days of HPLC but many scientists preferred manual injection," notes Simon Robinson, HPLC product manager at Shimadzu Scientific Instruments (Columbia, MD). Back when sample was plentiful, manual injection was a convenient way to flush the injection loop between runs, an operation most easily accomplished (at the time) by hand.

"Today 95 percent or more of HPLC systems from major manufacturers ship with autosamplers."

But the main reason most lab workers preferred manual injection was that early autosamplers were not very reliable. Robinson recalls horror stories where analysts set up a tray of twenty labile samples or so, then returned the next day to find the instrument stuck

on sample number two and all the remaining samples "wrecked."

Today 95 percent or more of HPLC systems from major manufacturers ship with autosamplers, a testament to the improved reliability and reproducibility of autosampler hardware and controls. "There's been so much engineering focused on improving these instruments that it's safe to say autosamplers are 100 percent reliable."

Automation reduces errors

By automatically drawing from and injecting a predetermined set of samples, autosamplers spare lab analysts from uninteresting, repetitive work. Most autosamplers handle multiple sample containers, including microtiter plates, by default.

Even more time and drudgery can be saved when autosamplers are coupled with robotic sample preparation. But autosamplers' major contributions to HPLC are reproducibility, repeat-

ability, precision, and accuracy in delivering precise injection volumes. "An autosampler can do a much better job than any human working with a manual injector, particularly with small-volume injections," Robinson says.

Sample scarcity is one of the hallmarks of modern analytical science. Whether one works with biological samples, in forensics, pharmaceuticals, or food science, HPLC is called on to do more with less—to detect trace constituents or contaminants, more often than not within tiny samples. HPLC artifacts are common with manual injection, and many of these anomalies may be traced back to sampling and injection errors.

Autosamplers have eliminated these persistent sources of error, allowing analysts to target other possible sources of chromatographic anomalies. Now, analysts need only set up a tray of samples and make sure the correct sample is in the right vial. One would, therefore, be hard-pressed to find anyone involved in serious research, development, or analytic support using manual injection.

"For these reasons autosamplers make sense even for low-volume situations," says Helmut Schulenberg-Schell, Ph.D., worldwide LC marketing manager for

Agilent Technologies (Waldbronn, Germany), as well as for walk-up instruments shared by users and groups.

But are autosamplers for everyone?

So who would not routinely use an autosampler? According to Robinson, academic labs still rely heavily on manual sampling and injection because their primary objective, aside from data quality, is cost-effectiveness.

Another area where autosamplers are often impractical, observes Schulenberg-Schell, is in preparative HPLC. Prep work tends to be specialized, one-off, non-routine, and does not require the sensitivity or accuracy of analytical HPLC.

Autosamplers provide a level of automation, throughput, and productivity that is multiplicative. Using an autosampler, one chromatographer can operate multiple HPLC systems simultaneously, injecting many hundreds of samples after spending just a

few minutes with the control software. This frees workers to perform other tasks like making mobile phases or analyzing data.

A systems approach to speed

Speed, throughput, and reduced sample volumes are critical for most analytical laboratories, and autosamplers

"Most autosamplers handle multiple sample containers, including microtiter plates, by default."

play prominently among the various "fast" techniques adopted toward achieving those goals. Autosamplers have become critical enablers—like columns, pumps, and detectors—of these trends, and in doing their part they have required substantial re-en-

gineering for both stand-alone performance and integration. As such, autosamplers have been a primary target of engineering efforts to shorten cycle times vs. simply run times. After all, an HPLC or UPLC system does not add much in the way of throughput or speed in reducing analysis time if the slowest link in the cycle still requires several minutes to re-equilibrate.

The wider adoption of UHPLC underscores the "need for speed" and the role of autosamplers within that scheme. "Now, suddenly," says Schulenberg-Schell, "you can run ten times as many samples on an HPLC instrument, and the question of automation in sampling, injection, sample prep, and sample tracking becomes more urgent."

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ENABLERS OF THE BRAVE NEW WORLD OF RNA INTERFERENCE

by Angelo DePalma, Ph.D.

RNA interference (RNAi) uses short strands of synthetic ribonucleic acid (RNA) to silence or “knock down” (19 to about 25 nucleotides) interfering RNAs (siRNAs) and short hairpin RNA (shRNA). Approximately 75

relatively facile, and the reagents are easy to work with.

For example, Integrated DNA Technologies (Coralville, IA) keeps about a dozen cationic lipid transfection agents on hand, some of which it sells. Mark Behlke, M.D., Ph.D., chief scientific officer at Integrated DNA, also uses electroporation and peptide reagents, such as Transductin™, which was invented at the University of California, San Diego.

Not all transfections are equal

shRNA reagents are introduced in plasmid format, which means the target cells can incorporate the silencing agent into their genome and pass it on to offspring. “shRNA is absolutely needed when the phenotype takes longer than about two weeks to develop,” says Steven Suchyta of Sigma Aldrich (St. Louis, MO).

shRNA may also be introduced into cells via a virus transfection agent. Sigma Aldrich and other companies offer lentivirus transfection reagents that provide long-term, stable knockdown in almost any mammalian cell.

“The advantage of siRNA is that it is relatively facile, and the reagents are easy to work with.”

genes implicated in certain phenotypes—most commonly (but not limited to) diseases. The “interference” occurs when interfering strands bind to complementary, naturally occurring RNA according to standard base-pairing rules. Unlike antisense technology, which operates on DNA, RNAi works by silencing RNA, which is the immediate precursor of proteins implicated in the phenotype of interest.

Reagent types

RNAi occurs in nature in most animals through a group of molecules known as microRNAs. RNAi reagents seek to duplicate this process.

Reagents consist principally of the interfering RNA construct and a transfection agent for introducing the RNA into cells. The most commonly used interfering RNAs are the short

percent of the RNAi reagent market uses siRNA, according to Chris Cuning, Ph.D., senior manager of market development at Invitrogen (Carlsbad, CA). Both reagent types bind to complementary sequences on genes.

But there are differences. siRNA produces transient transfection through the action of a lipid reagent, which encapsulates the siRNA within a liposome or soap bubble, disrupts the cell membrane, and chaperones the gene into the cell. Transient transfection means the siRNA signal is not carried from one generation to the next. Thus, even if siRNA is introduced at very high transfection efficiency, the silencing gene is eventually extinguished because daughter cells do not carry it. Moreover, only certain cells, such as “immortalized” cancer cell lines, accept siRNA transfection. The advantage of siRNA is that it is

Vendors also offer peptide-based reagents

Viral transfection is “difficult and labor intensive,” says Invitrogen’s Chris Cuning. “It’s harder to predict what sequences will actually work with them.” shRNA-based interference works about half the time, whereas siRNA is about 90 percent predictable.

In the early days of RNAi work, research groups were much more likely to synthesize their own RNA constructs than they are now. Since RNA synthesis is a tedious process, biologists usually farm out this work to reagent manufacturers. Reagent companies use complex, proprietary algorithms to predict sequences that will work. “The considerations are extremely deep,” says Mr. Cuning, “including toxicology and effect on known, natural microRNAs.”

Reagent companies sell RNAi reagents as “virtual kits” consisting of the shRNA or siRNA sequences and an appropriate transfection reagent. Vendors usually guarantee that a certain per-

centage of multiple knockdown constructs they sell for a particular target RNA will succeed. Users can monitor the progress of their knockdown by performing a before-and-after Western blot to determine if the protein coded by the putative knockdown gene is still being produced.

Length is a critical attribute of siRNA and shRNA reagents. In nature, interfering RNA species are usually between 20 and 25 nucleotides in length. Longer constructs could theoretically work better since they cover a greater fraction of the target gene, but 20 to 25 nucleotide lengths are ideal for entry into RISC complexes. Furthermore, larger genes tend to be recognized by cells as viruses, which induces an undesirable interferon response.

More important than PCR?

RNAi may eventually have greater impact on biology than polymerase chain reaction (PCR). But Behlke warns that RNAi is “far more complex” than PCR. “Gene knockdowns

require a lot more optimization and work since they occur in living cells.”

The main obstacle is introducing the interfering RNA sequence into the cell, into the location of the target gene, and then getting it to bind to and inactivate the target. Success with one sequence, transfection agent, and cell does not guarantee success when one variable changes.

Delivering interfering RNA into whole organisms (vs. cells) presents even greater challenges, but the potential rewards are also high. Whole-organism or whole-tissue knockdowns would provide new opportunities in drug testing and, eventually, for human therapy.

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EVOLUTION OF THE pH METER BY JOHN BUIE

The pH meter is an essential piece of equipment in most laboratories, vital for many analytical and synthetic processes. Typical pH meters consist of a glass electrode connected to an electronic meter. The electrode produces a small voltage, which is converted to and displayed in pH units by the meter.

In **1906**, Max Cremer discovered that an electrical potential develops when two liquids of different pH levels come into contact at opposite sides of a thin glass membrane.

In **1909**, Fritz Haber and Zygmunt Klemensiewicz used the principle described by Cremer in 1906 to create the first glass electrode that measured hydrogen activity. However, technical difficulties, including the large internal resistance of glass electrodes, prevented the large-scale potentiometric measurements of pH. Because of these difficulties, use of a very sensitive, but expensive, galvanoscope was necessary to obtain reliable results. Today, glass electrodes are the most commonly used measuring electrodes.



A Beckman Model G Acidimeter from 1936, later renamed the Model G pH meter. Courtesy of Beckman Coulter, Inc.

In **1934**, Arnold Beckman proposed that the current obtained through Haber and Klemensiewicz's electrode be amplified, allowing it to be measured using a cheap milliamperometer. He devised a simple, high-gain amplifier using two vacuum tubes for this purpose. This advance represents the development of the first pH meter, known at the time as an "acid-o-meter".

In **1936**, the first commercial pH meters were introduced in the U.S. by Dr. Arnold Orville Beckman, the founder of the Beckman Instruments Company (now Beckman Coulter). The Beckman model was known as the Model G acidimeter and later renamed the Model G pH meter. This device was revolutionary because it was the first to combine the whole apparatus (amplifier, electrochemical cell, electrode, calibration dials, batteries and measuring gauge) into one unit. During its first year, Model G sales reached 444 units. The model continued to be sold until the mid-1950s, with an estimated 126,000 sold during its lifetime.

In **1937**, the Danish company, Radiometer, introduced its first commercially available pH meter, model PHM1. This model was an improvement on the original Beckman design, which had been found to give pH measurements that were somewhat dependent on the depth of electrode immersion.

In **1945**, Dr. Arthur Kuntze founded the family business, Dr. A. Kuntze, specializing in analytical instrumentation and pH meters in particular. This company is still owned by the family in its third generation.

In **1947**, the first laboratory combination electrode was introduced by Cannon. Improvements in sensor technology led to refinements in glass formulations that reduced alkalinity error and improved selectivity.



Mettler Toledo's SevenMulti conductivity meter.

Also in **2003**, Mettler Toledo introduced the only fully modular pH meter on the market: the SevenMulti. This pH meter offered impressive flexibility, allowing the customer to choose any combination of modules to create a tailored multichannel instrument. The instrument also allowed the customer to buy and add extra extension units at a later date, providing greater flexibility.

In **1999**, WTW introduced several new instruments within their inoLab line that featured three function levels. These instruments set new standards for the analytical measurement of pH, oxygen, conductivity and temperature as well as for ion-selective electrodes (ISE) and multi-parameter measurements.

In **2000**, Hanna Instruments became the first company to offer simultaneous testing for pH and EC in a single instrument. In this year, the company also released the world's first multi-parameter (pH/conductivity/temperature) pocket tester.

In **2003**, Hanna Instruments introduced the world's first pH meter with a calibration-check feature.

In **2004**, the first pre-amplified probe multi-parameter instrument was launched by NEOTEK PONSEL.



The Docu-pH meter with DocuClip technology.

2005 The Docu-pH from Sartorius Mechatronics featured DocuClip® for sensor identification. DocuClip® technology was the first to provide complete documentation to ISO/GLP/GMP and 21 CFR Part 11 FDA standards on electronic records.



A DocuClip attachment.

In **2006**, Hannah Instruments launched the world's first pre-amplified probe multi-parameter portable meter.



Schott Instruments' ProLab 3000 laboratory measuring device, which measures pH, ISE and conductivity.

1910

In **1948**, the first handheld pH meter was launched by NEOTEK PONSEL.

In **1966**, the first pH preamplifier was developed and patented by P. Carderio.

In the **1970s**, the first portable digital pH meter was designed and manufactured by Jenco Electronics in Taiwan. This meter was sold under the Cole-Parmer brand.

In **1978**, the porous Teflon reference junction was patented by Gary Bukamier. This replaced the earlier commonly used ceramic and wood junctions, and remains the junction of choice today.

In **1980**, the first single-probe portable conductivity meter was developed by Hanna Instruments.

In **1982**, Hanna Instruments launched the world's first pH-controlled chemical dosing pump.

In **1984**, the world's first microprocessor-based handheld pH meter was released by Hanna Instruments.

In **1985**, Hanna Instruments became the first company to introduce a pH electrode with a built-in temperature sensor (HI1217S). This was sold worldwide, and became ubiquitous throughout the market.

In **1986**, Hanna Instruments became the first manufacturer to offer an electronic, pocket-sized pH tester. Also in this year, Hanna introduced pH electronic paper (pHep®), providing for the first time a simple, accurate and affordable method of pH testing.

In **1988**, Hanna Instruments launched the world's first pre-amplified pH electrode.

1930

In **1990**, the first waterproof portable pH meters for use in harsh environments (HI9025) were launched by Hanna Instruments.



The portable, waterproof HI 9025 pH/ORP meter from Hanna Instruments.

In **1991**, Hanna Instruments launched the first replaceable electrode pH pocket tester.

In **1992**, NEOTEK PONSEL released the world's first pH meter with Plastogel technology.

Also in **1992**, the world's first portable pH meter with plain-paper printing was released by Hanna Instruments.

1950

In **1993**, WTW became the first manufacturer of pH meters to be certified to ISO 9001.

In **1994**, Denver Instruments introduced the Basic pH Meter, the first meter to feature calibration check, automatic buffer recognition and an automatic electrode efficiency test.

In **1996**, Denver Instruments released the Advanced AP series of portable meters. These were the first to offer a waterproof IP67 rating with "no glass" Field-Effects Transistor (FET) electrode capabilities.

In **1997**, Hanna Instruments became the first company to offer a pH tester with double-junction electrode.

In **1998**, Denver Instruments' 200 Series Advanced Research Meters were the first to read pH/ion/conductivity readings simultaneously.

In **1999**, Hanna Instruments launched the world's first pH/temperature tester with dual level LCD.

1970

In **2007**, SCHOTT Instruments introduced the first pH meters with integrated PC capability—the ProLab 3000 and ProLab 4000—offering Windows-comparable menu structure and mouse handling.

In **2008**, Denver Instruments released the Meridian pH Meter with GLP clip technology, to meet ISO/GLP/GMP and 21 CFR Part 11 FDA standards on electronic records.



The 827 pH Lab pH meter from Metrohm.

In **2009**, Metrohm US launched the Metrohm 827 pH Lab, a versatile, GLP-compliant pH measurement system. This instrument offered the new Primatrade™ combination electrode with an integrated temperature probe, a measuring resolution of pH 0.001, automatic buffer recognition and temperature compensation.

Also in **2009**, Metrohm launched the 867 pH Module, equipped with both conventional and intelligent measurement inputs for pH, potential, ion and temperature measurements. An integrated electrode test was able to quickly check the electrode and deliver troubleshooting information.

1990

Also in **2009**, Hach Lange launched the pH ultra, which offered rapid measurement for all sample types, even difficult samples such as low-ionic strength (pure) water.

Again in **2009**, NEOTEK PONSEL manufactured the world's first pH/T digital sensor with pH cartridge.

Finally, in **2009**, SCHOTT launched the IoLine electrode with an iodine/iodide reference system in place of the traditional Ag/AgCl reference system for the most demanding laboratory measurements. The patented 3-chamber system with iodine reservoir in the reference electrode offered an increased working life, while the lower temperature dependence of the iodine/iodide reference potential allowed greater accuracy of measurements at changing temperatures or at a temperature that differs from the calibration temperature.

THE FUTURE FOR PH METERS

Like many laboratory instruments, pH meters have evolved beyond all recognition over the last several decades. However, experts predict a gradual evolution rather than a revolution in the design of pH meters during the coming years. It seems likely that the product hardware will continue its trend towards miniaturization, while software will undoubtedly become easier to develop and use. Although its form and function may change little in the immediate future, it seems certain that the pH meter will continue to enjoy its status as one of the most ubiquitous pieces of laboratory equipment.

SPECIALIZED INSTRUMENTATION AND METHODOLOGICAL EXPERTISE REQUIRED

by Gerry Broski

▲ Thermo Fisher Scientific's FSRC instrument lab.

▲ The FSRC sample preparation area.

The potential for food contamination, economically motivated adulteration, and other related food safety issues is leading to an increased awareness of the important role that food testing laboratories play in ensuring the safety and quality of our food supply. The requirements

safe from chemical contamination.

Food testing laboratories have traditionally been separated into three categories: in-house, contract testing, and public laboratories. However, in response to emerging food scares, a new and unique dedicated food safety laboratory has been set up

(FSRC) is a dedicated food safety lab that constantly monitors for contamination crises through expert sources, developing testing methods and providing protocols to guide analysts in the public and private sectors. The FSRC is not a contract testing lab and does not accept samples on a random basis. The lab is a resource and support mechanism in times of crisis.

This article will provide an overview of the types of food testing laboratories in existence today and the influencing factors behind a company's selection of a food testing facility. The article will also use the example of the FSRC to reinforce the need for reliable food testing facilities to respond to potential threats.

Food safety laboratories

There are many criteria for companies producing or distributing food products to consider when selecting a source for food safety testing. These criteria are often shaped by the situation of the company making the selection. For example, a small company that needs only limited testing may make its selection on the basis of cost per sample and the type of testing required. Therefore, some small businesses may benefit financially from securing the services of a contract laboratory rather than investing in setting up internal testing facilities. Regardless of a company's size,

additional benefits of outsourcing food testing include improved quality and accuracy of testing, faster turnaround time, wider range

certified to national or international standards of compliance.

For all laboratories, analyzing and testing for potential food contaminants requires specialized instrumentation and methodological expertise to perform analyses and produce rapid results. The need for the quality and consistency of laboratory equipment and techniques also contributes to a company's decision process. Contract laboratories perform testing on one or more components of projects for external clients. The ownership of the project remains with the client and the work done by the contract lab typically represents just one

"Quickly obtaining test results is essential because of the perishable nature of food."

for sophisticated instruments and well-trained, experienced analysts in food safety laboratories are essential factors in making certain that food is

by Thermo Fisher Scientific; its goal is to respond quickly to food contamination emergencies such as those endangered by the Gulf oil spill. The Food Safety Response Center

"Laboratories in the public sector are typically the front line in a crisis or major health issue."

of analytical services provided, greater expertise, and the increased confidence of using a lab that is

portion of the overall project. However, by combining highly skilled, professional staff with state-of-the-art laboratory facilities, contract laboratories are able to provide companies in the food industry with highly accurate and reliable, rapid testing services.

Within the food industry, quickly obtaining test results is essential because of the perishable nature of food and the batch processing of many food products. Contract labs also offer unbiased results, as they typically have no stake in the findings or a financial interest in the samples being tested. As contract laboratories undertake a wide range of analyses using various techniques, they offer a high level of expertise, whether identifying unknown samples or conducting routine food testing. This means that companies employing their services benefit from reliable and speedy testing as well as access to advice from the labs in situations in which in-house experience is lacking.

Government and research laboratories

Laboratories in the public sector are the vanguard of public health on a very broad scale. Because of their outreach, they are typically the front line in a crisis or major health issue. Besides short-term reaction, they also conduct many long-term tests and studies in such areas as diet, obesity, nutrition, and food fraud. Many thought leaders are found in universities and colleges and are focused on a specific area of food safety. From a macro view, the balance of public and private research and capacity for response to a crisis has served the public interest. Going one step further, Thermo Fisher Scientific has created a lab that can react quickly, using existing structures and creating new testing methods that are needed in times of crisis.

Food Safety Response Center

Developed in response to an increasing frequency of food crises, Thermo Fisher Scientific's FSRC is designed to respond rapidly to chemical contamination crises such as the one created by the recent Gulf of Mexico oil spill. The FSRC is staffed with a team of experienced food chemists who have diverse backgrounds in areas of contamination as well as expertise in analytical method development, allowing them to be actively responsive when such crises occur. Strategically

located in Dreieich, Germany, the Center is also close to Europe's leading food safety research institutions and houses state-of-the-art analytical instruments to enable rapid method development to detect chemical contamination in food. As a result, the FSRC is able to respond quickly to food threats, typically cutting the delivery time of analytical methods from between six and eight weeks to around three.

"The FSRC is able to [cut] the delivery time of analytical methods from between six and eight weeks to around three."

The FSRC's method development capability aids government regulatory bodies, research institutes, independent test labs, and private companies. Supporting global food safety as an investment in developing food safety protocols, the FSRC is raising awareness and gaining expertise in order to benefit the industry. The FSRC contains two laboratories—a sample preparation area and an instrument lab—to speed workflows and reduce the sample interference that often occurs when transferring samples from different testing laboratories.

It is also imperative for analysts working in food testing laboratories to have full knowledge of the food industry and keep up to date with regards to potential threats. The 2008 deliberate adulteration of milk with melamine helped the food industry realize that researchers were mainly undertaking targeted screening. Laboratories need to be set up to undertake both targeted and non targeted analyses in order to identify all potential contaminants in food samples. The melamine crisis highlighted that food companies need access to methods and instrumentation that allow for the identification of very small molecules, even in the presence of interference, and reinforced the need for analysts to keep ahead of potential food safety threats.



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Conclusion

As food safety issues continue to make news, food hygiene and the role of testing laboratories will become even more essential. When choosing a testing laboratory, it is important for companies to recognize that there is no one solution to meet all requirements. Companies should choose a laboratory based on individual requirements and financial capabilities, as well as by taking into consideration the potential investment in expert training of personnel with a broad range of skills including analytical expertise, and the way in which the labs approach their maintenance of equipment, standardization and adoption of analytical methods, verification of results, quality control measurement procedures, and certifications.

“Laboratories need to be set up to undertake both targeted and non targeted analyses.”

As the majority of food scares cannot be anticipated before they occur, it is essential that methods are developed quickly when threats occur. In the wake of recent food safety scares, it has become clear that existing infrastructures can be slow to respond. It is therefore essential that labs equip scientists with strategies for tackling contamination where it occurs in the food chain, providing greater knowledge about food-borne diseases and actions to take in future crises. It is also necessary to recognize that surveillance of food should be given high priority in the development of food safety equipment and protocols, thereby ensuring that laboratories are equipped to anticipate emerging risks.

Gerry Broski, food safety marketing director, Thermo Fisher Scientific, can be contacted at gerry.broski@thermofisher.com or 763-783-2600.

For the latest information about Thermo Fisher Scientific solutions and its wide range of applications for food safety, please call 800-532-4752, e-mail analyze@thermofisher.com, or visit www.thermoscientific.com/foodsafety.



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« EXPERT: Dr. Serena Silver

ASK THE EXPERT

HOW TO CHOOSE THE RIGHT RNAi REAGENTS

by Tanuja Koppal, Ph.D.

Dr. Serena Silver, Group Leader for RNA interference (RNAi) Screening Projects at the Broad Institute talks to Tanuja Koppal, Ph.D., contributing editor at Lab Manager Magazine, about the choices that need to be made when selecting reagents and optimizing assay protocols for RNAi-based screens. She points to useful resources that can help people set up their RNAi screens and gives some details on how and why she made her choices regarding RNAi reagents, assay design and screening formats.

Q. With RNAi screens, how do you choose between using small interfering RNA (siRNA) versus small hairpin RNA (shRNA)?

A. It depends on scientific and practical considerations with regards to your screening assay, and your institutional resources. The RNAi Platform at the Broad Institute is also the home of the RNAi Consortium (TRC), which has designed and produced an extensive lentiviral shRNA library, so we have focused almost exclusively on shRNA screens. The beauty of the lentiviral system is the ability to infect diverse cell types, including the traditionally hard-to-get-into cells, like primary neurons, and we are able to determine conditions which allow excellent transduction for almost all cell types. Lentiviral delivery also allows one to do pooled screens and long-term assays that can go on for weeks and months and require continuous delivery of integrated shRNA reagents. It is also a renewable resource in that more lentivirus can be made to express the shRNA for follow-up experiments. There are distinct advantages of using siRNAs, including the many commercial sources and fewer biosafety issues, and they are well suited for assays

that will be performed soon after delivery. In arrayed screening, a format with many siRNAs per well can help cut the costs compared to screening shRNAs in distinct wells, but gives up the independent measurements and information about off-target effects gained by independent shRNA tests.

Q. How do you go about picking the right screening assay and format?

A. We like to separate the optimization of the RNAi delivery from optimization of assay readout. They are intimately linked and can become a “which comes first, the chicken or the egg?” type problem, but a good phenotypic assay must generate reproducible results and relate to the biology of interest. Optimizing RNAi delivery involves developing a good transduction protocol, selecting the right conditions for feeding, infecting and selecting

imaging assays can be performed in 384-well plates. Once both transduction and readout are optimal, it is important to go through the entire protocol with small pilot to assess the effects of RNAi delivery on the assay readout. Essentially, my advice is not to skip on the assay development. The more time you spend on getting the assay right and asking the questions you want answered, the more rewarding the follow-up will be.

Q. Can you give some recommendations on how to go about setting up the right positive and negative controls?

A. Having good positive and negative controls in assay development and screening are important. We like to use a panel of negative controls because of the off-target effects seen in RNAi. Rather than scrambled hairpins, we have shRNAs targeting

“My advice is not to skimp on the assay development. The more time you spend on getting the assay right and asking the questions you want answered, the more rewarding the follow-up will be.”

cells. Optimizing the assay involves performing it reliably in a multi-well format by eliminating edge effects, reducing background and determining appropriate concentrations for all reagents. This then brings us to the assay format. Some assays, such as ELISAs, often need to be in 96 well plates where enough cell lysate is generated to measure the phenotype, while others such as high content

genes that are normally not present in the cells, such as lacZ, GFP, RFP, and luciferase. We use the most innocuous set of 10 to 50 of those shRNAs to test during assay development. During shRNA arrayed screening, on a 384-well plate we have at least 20 negative controls and about 5 to 10 negatives on a 96-well plate, while our pooled shRNA libraries contain 80 to 120 negative control clones.

Dr. Serena Silver is the RNAi Screening Projects Group Leader for the RNAi Platform at the Broad Institute of Massachusetts Institute of Technology (MIT) and Harvard University. The RNAi Platform is also the home of the RNAi Consortium (TRC), a public-private consortium based at the Broad Institute, developing RNAi reagents and technologies for functional analysis. The first phase of TRC's efforts involved the creation of an RNAi library consisting of 160,000 short hairpin RNA (shRNA) constructs targeting 15,000 human and mouse genes. The second phase, launched in 2007, focuses on functional validation and making improvements to the library design, with over 150,000 additional shRNAs. Dr. Silver received her Ph.D. in biology from MIT, using the retinal determination network to study crosstalk among signaling pathways. While a postdoctoral fellow in Dr. Norbert Perrimon's lab at Harvard Medical School, she was introduced to laboratory automation and the large datasets that result from RNAi screening at the Drosophila RNAi Screening Center and continued to study gene networks, examining the role of micro RNAs (miRNAs) in signal-transduction pathways. Presently the Group Leader for Screening in the RNAi Platform at the Broad Institute, she collaborates with dozens of labs on RNAi screening projects, using the lentiviral shRNA library in arrayed and pooled formats.

Positive controls are more dependent on the individual screen, and we often create a custom plate with shRNAs targeting known or candidate genes, which are tested during assay development to identify positive controls for screening, and we also use cell lethal hairpins as generic positive controls. We create the screening library with negative controls on every plate, and leave empty wells at the bottom corner to add in custom positive controls.

Q. What would you do differently with your assays if you were to do it today?

A. Initially, even though we used the same number of negative controls over the screening set, we did not have them included on every single assay plate. Also the shRNAs for the same gene were right next to each other on the plate, which led to the concern that any plate location effects would bias the analysis for that gene. We have now learned from our mistakes and have randomized the clones across the plate, and have negative controls on every plate.

Q. Do you rely heavily on automation for your screens?

A. The arrayed screens are fairly automated where we use liquid handlers to add virus, and to add and remove cell media or assay reagents. One major focus during assay development is defining the appropriate protocol on the robotics so that the cells are not disturbed by the media changes. However, it's important to validate your equipment, in terms of precision and accuracy of

dispense steps, or they will introduce errors in your screen. With the correct protocol, automation is quite useful and can reduce variability and allow for larger screens. Pooled shRNA screens do not require automation, and may be the most straightforward type of screens for labs that are not looking to invest in automation. In those assays, we infect millions of cells with thousands of different hairpins at the same time, and then deconvolute them using a custom microarray or by deep sequencing.

Q. What are some of the commonly encountered problems with RNAi screens?

A. Contamination can be a big problem. We have more than 100 scientists using our labs and we have established strict protocols for de-contaminating. We perform lot tests on almost everything we make and use in the lab—viral titers, for example, and reagents for transfection and cell culture. We perform PCR-based microplasma testing for all the cell lines and cells that come in. To make sure that the lot tests are cost effective, we use those opportunities to generate more control viruses to replenish our stores for assay development. Once the reagents pass the lot test by titrating, we can mitigate the costs of lot testing by using that virus in the next set of screens.

Q. How can you leverage your relationships with vendors?

A. We have worked with vendors to test and evaluate different reagents. Being a large customer we have been able to

negotiate prices on reagents and consumables. We managed to get pre bar-coded plates from our vendor and these barcodes are unique for our Institute. This is proving to be very helpful in tracking plates and has solved some issues with sterilizing plates following our own barcoding.

Q. How do you keep up with and evaluate the new cells and reagents that are continually being introduced in the marketplace?

A. I think it's important to create a network of like-minded people. Being a part of the RNAi Consortium, going to conferences and talking to other screening groups have all been very helpful. We also get ideas from our collaborators, and the more creative the screen, the more we get to push the envelope in terms of new protocols, new assays, and new types of screens. There are also good online resources for setting up both siRNA and shRNA screens. The TRC website has protocols for lentiviral delivery, including a list of cell lines that have been infected. For lipid-based delivery the ICCB-Longwood screening facility website offers a good comprehensive summary of what is out there. Many vendor websites are also useful resources for reagents and protocols. Starting with conditions that have previously worked in a particular cell type can certainly provide a step up in determining the assay conditions.

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LOOKY HERE

PROPER EYE PROTECTION FOR THE LAB

by Vince McLeod

Of all the hazards faced in research laboratories, the one ubiquitous danger is hazard to the eyes. Here is a typical scenario from down under:

A research worker was performing a routine procedure in the laboratory. The technique involved heating a glass Pasteur pipette, stretching it out and then quickly breaking off the tip to obtain a sharp end. Some fragments of glass hit the worker and became lodged in his eye, causing some scratching of the cornea and resulting in a corneal ulcer. The worker was not wearing eye protection at the time of the incident. Several other people in the area who performed the same operation also did not wear safety spectacles or work behind safety screens.¹

We know that most research laboratory professionals are familiar with basic eye protection, but did you know that about 2,000 eye injuries occur on the job EVERY DAY, resulting in lost time away from work?^{2,3} And here is a shocker: three out of five eye injuries are due to employees not wearing any eye protection at all. There is no excuse for this. Do either you or your workers realize that even “minor” eye injuries can cause long-term vision problems and suffering? That corneal scratch mentioned above, for example, can lead to corneal erosion and a lifetime of recurring pain.

Research laboratories have their own unique eye hazards, and eye protection should be worn all the time, even by visitors. It is also not a question of when eye protection is needed, but the correct type of safety eyewear; many of the 2,000 injuries per day that require medical attention are caused by wearing the wrong type of eyewear. So—what type of eye protection is appro-

priate for your laboratory? Let's see if I can help answer that question.

Step one – Perform hazard analyses

Industrial hygienists are trained to deal with occupational hazards in a basic three-step process: Recognition, Evaluation and Control. We are strong believers in prevention, and this means either removing the hazard if possible or controlling it with engineering methods. Personal protective equipment, such as eye protection in this case, should be a first step toward putting a safety barrier between the hazard and the worker.

After identifying the potential eye hazards in your lab, see if you can reduce the hazards by either substituting chemicals, changing the procedure or installing engineering solutions. Engineering controls include shielding or guards to prevent particles and splashes being dispersed, and fume hoods or local exhaust ventilation to contain dust, particles and vapors.

Step two – What type of eye protection is best?

No matter the type or style of eye protection, workers should always wear equipment that meets American National Standards Institute (ANSI) standard Z87.1-2010.⁴ Safety eyewear that meets Z87 is tested and must pass stringent requirements for basic mass impact (a 1-inch steel ball dropped from 50 inches), high mass impact (a 500-gram pointed projectile dropped from 50 inches), high velocity impact (a quarter-inch BB shot at 150-300 feet per second), distortion, light transmittance, and

“It is also not a question of when eye protection is needed, but the correct type of safety eyewear.”



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lens thickness (not for impact rated protectors), among others. Safety eyewear that passes all the tests will carry the Z87+ mark in addition to marks for the lens type and application usage. After this, the next rule is the old cliché—the right tool for the job. The type of eye protection must match the hazard, and there are definitely more appropriate types for certain hazards.

Polycarbonate lens safety glasses are the most prevalent type of eye protection. Polycarbonate is a type of plastic that offers extreme resistance to impact because of its unique properties of strength and flexibility. Used in “bulletproof” windows, in addition to safety glasses and many other applications, polycarbonate provides excellent protection from flying debris and UV light while being lightweight. However, because its impact resistance comes from being flexible, the material is prone to becoming easily scratched. Therefore, look for safety glasses with hard-coated polycarbonate lenses.

Safety glasses come in every shape and style imagin-

able. Well-designed products are lightweight, comfortable and economical; also important is a good fit. Things to look for are soft rubber nosepieces and adjustable, rubber-tipped temples that hold well without excessive pressure. Soft, sticky rubber in these areas provides a good grip even when the wearer is sweating.

“The type of eye protection must match the hazard.”



Style may be even more important than comfort and fit, at least in some cases. Although style does not rank high as a safety feature or score points with management or your purchasing agent, style is what motivates many workers to wear their safety glasses. In our experience, facilities that offer the newer, stylish wraparound safety glasses find compliance problems reduced significantly as workers actually want to wear the glasses. Another advantage of the wraparound safety glasses is that they also provide good protection from airborne debris and meet the OSHA personal protective equipment eye and face protection standards for side protection in the presence of flying objects.⁵

Note: Specialty safety glasses

An undeniable demographic trend is the aging of our nation's workforce. One result of this is that many workers are people over the age of 40 who need reading glasses. Manufacturers of safety eyewear have taken notice of this trend, and quite a few now offer safety reading glasses with polycarbonate lenses that give workers the ability to see close up as well as the ability to read print and manuals. These safety bifocals are available for much less than prescription safety glasses. In fact, bifocal safety glasses have become a large market and offerings now include contemporary stylish designs—even the newest wraparounds—in a range of bifocal powers or diopters.

Sometimes the need to work either outdoors or under intense light is unavoidable. Safety sunglasses are the answer when these situations arise. Good quality safety sunglasses will have natural color balance gray lenses and provide protection from UV light as well as infrared and blue light. UV protection is even more important now, as ultraviolet levels have increased recently due to changes in the atmosphere. UV also increases at higher altitudes, so take your location into consideration, too.

When working near water, glass or metal buildings, or other highly polished, shiny surfaces, reflected light could become an eye hazard. In this case, polarized safety glasses are needed. Polarized lenses selectively eliminate the reflected light off surfaces by only allowing certain wavelengths to pass through, thus considerably reducing glare.

Lasers and radiation impart dangerous risks to the eyes. The hazards present depend on the wavelength and power of the light source, the duration of the exposure and which structure of the eye absorbs the light. Reflections off surfaces are a serious potential hazard. A competent technical person should carefully select appropriate safety glasses for the wavelengths encountered.

Step three – Keep a lookout for eye hazards

One of our most precious senses is vision. Our eyes are very susceptible to injuries that can lead to either long-term problems or a permanent disability. Given the economical cost, performance and myriad styles of today's safety eyewear, there is no excuse for not wearing proper eye protection. Ensure that your employees are keeping a lookout for eye hazards.

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Vince McLeod is an American Board of Industrial Hygiene-certified industrial hygienist and the senior industrial hygienist in the University of Florida's Environmental Health and Safety Division. He has 22 years of occupational health and safety experience at the University of Florida, and specializes in conducting exposure assessments and health-hazard evaluations for the university's 2,200-plus research laboratories.

SAFETY TIP

PROVIDE INCENTIVES FOR SAFETY PERFORMANCE

By James A. Kaufman

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

For students, grades and praise are good incentives. For staff members it becomes more difficult. Academic institutions do not usually give merit raises. Even so, if you perform staff evaluations, make safety one of the written criteria. Let staff members with good safety performance records get recognized, appreciated, and generally treated in a way that others would want to emulate.

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

See if you can get the dean, department head, or president to host a party or barbeque if the school or company can achieve an accident-free record over a prescribed length of time. Post the goal and keep visible track of your progress. “Our goal is an accident free [name of the month or quarter] - etc.”

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



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BUYING A PRE-OWNED SEM

THINGS TO CONSIDER WHEN PURCHASING USED ANALYTICAL EQUIPMENT **by Gary Brake**

Since the commercialization of the scanning electron microscope in the mid-1960s, research, development and quality control in the areas of medical and physical sciences have flourished. The scanning electron microscope, or SEM, has allowed researchers to observe things unseen by either the eye or light microscope, and is a key piece of instrumentation in virtually all modern laboratories. Today, the cost of an upper echelon field emission scanning electron microscope, with accessories, is approaching \$1 million. This can be out of range for most laboratories. Even a new, traditional type of scanning electron microscope can be too cost prohibitive for a start-up, small company, or department within a major corporation or university. Always in the back of any manager's mind is the cost of ownership this piece of equipment will entail. In cases such as this, a pre-owned scanning electron microscope becomes a cost-effective possibility.

"The resolution a scanning electron microscope can provide at low-accelerating voltages is the major determinant of its selling price."

SEM selection

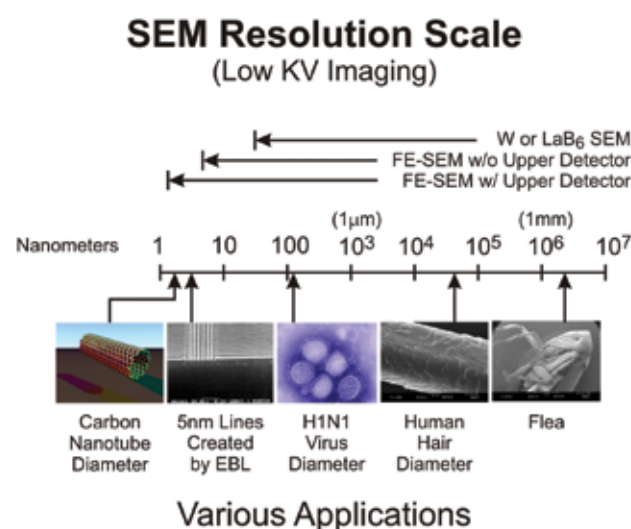
Before moving to purchase any SEM, new or used, the first couple of questions that must be answered are:

1. Is it a requirement that the samples be viewed in their natural state?
2. What is the minimum resolution needed to observe a particular feature of interest on the sample?
3. How large a sample needs to be imaged?

Besides asking about your timing and budget, one of the first topics that any SEM technical sales engineer will ask about is your application. By knowing your particular application, the engineer should be able to intel-

ligently refine your search to focus on a particular type of SEM. The choices essentially come down to emitter type and detectors used to collect the electrons as they are reflected back off the sample.

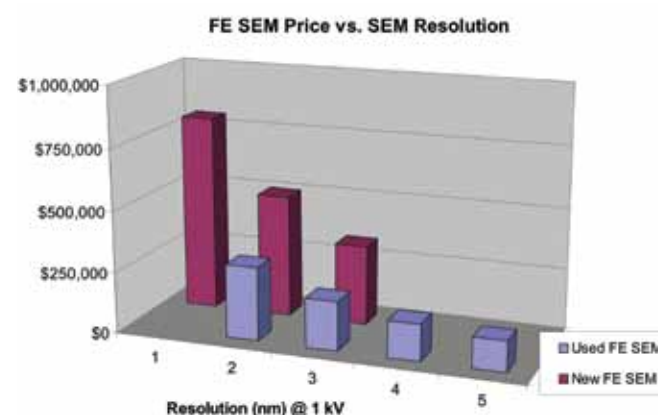
There are three basic types of emitters, or sources used for electron emission: field emission (FE), tungsten (W), and lanthanum hexaboride (LaB₆). The three methods of detecting these electrons are a standard Everhart-Thornley (E-T) detector, an upper detector, or a backscattered electron (BSE) detector. Today, for high-end nanotechnology applications, such as viewing individual carbon nanotubes or advanced semiconductor devices, field emission SEMs with an upper detector are required, as shown in Figure 1. For traditional applications, a standard FE-SEM will suffice.



▲ Figure 1. SEM resolution charted against various applications

In addition, while tungsten or LaB₆ SEMs may appear in Figure 1 to approach the resolution of the FE-SEMs, they need to view the sample at higher accelerating voltages, which means that samples must be coated with a thin metallic layer. Since FE-SEMs can image at very low accelerating voltages, the need to coat samples

with a metallic layer is substantially reduced. To address the issue of having to coat samples for observation with a tungsten or LaB₆ SEM, the use of a BSE detector, combined with control of vacuum pressure, allows these SEMs, known as variable pressure (VP) SEMs, to view samples in their natural state. However, it is at the expense of lower resolution. To address the additional resolution requirements, VP FE-SEMs have recently become available.



▲ Figure 2. FE-SEM price vs. resolution

Generally speaking, various applications have different resolution requirements, and this reality prompts the need to consider SEM type. The resolution a scanning electron microscope can provide at low-accelerating voltages is the major determinant of its selling price.

SEM pricing

Purchase prices for scanning electron microscopes are primarily dictated by resolution. Other factors that determine the price are automation, chamber size, and optional SEM accessories, such as an elemental dispersive spectroscopy (EDS) system.

Figure 2 depicts how the price of FE-SEMs is related to resolution. As seen, the closer the SEM gets to 1 nanometer in resolution, the higher the price. Also, the price difference between new and used SEMs can approach 50 percent or more, depending on the circumstances. Such circumstances may include the seller's urgency to move the SEM as quickly as possible and the age of the SEM. Typically though, if one is involved in a quick sale purchase, chances of running a representative sample or seeing the machine in a working state of operation is low. So the buyer must beware.

It should also be noted in Figure 2 that at the 3-nano-

meter resolution mark, SEM manufacturers introduced the upper detector, which has been the driving force for increased resolution right down to the 1-nanometer regime. Without an upper detector, a FE-SEM's standard detector would not be able to resolve features below 4 nanometers. An upper detector is a factor in system pricing as the 1 nanometer mark is approached.

A recent SEM purchase

Earlier this year, the Nanometer Structure Consortium at Lund University in Sweden purchased a pre-owned Zeiss/LEO 1560 FE-SEM (shown in Figure 3). Before Lund University inspected the tool in the United States, samples were sent in advance and images were returned for initial review. After that, the local Zeiss customer service organization in the U.S. was contracted to perform an agreed-upon checklist procedure to note anything that might be problematic. The Zeiss service report (with comments) was sent to Lund University, and



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upon review of the report, Anders Kvennefors, a research engineer representing Lund University, made the trip to the U.S. to personally inspect the system before the final purchase.

According to Kvennefors, "Going through this procedure was our way of ensuring the system was going to meet our expectations and that we would not encounter any surprises upon its arrival." In addition, Kvennefors notes, "SEMtech Solutions provided our nanotechnology facility with a nice, reconditioned SEM. It was a smooth transaction [with regards to all phases of the transaction: demonstration, shipping logistics, and installation]. The field emission resolution of this tool advanced our capabilities at a fraction of the cost of new equipment."

Adding to this point, Mark Reynolds, CEO of SEMtech Solutions, explains: "The sale of this system is a win-win-win for all parties involved. Lund University wins by purchasing an excellent SEM at a great price, SEMtech Solutions wins by having sold such a quality system, and Zeiss' customer service



▲ Pre-owned Zeiss/Leo FE-SEM at Lund University

team in Sweden wins by gaining a new customer. It was a true partnership and collaborative effort by all three parties."

Tips on buying a used SEM

Purchasing a used scanning electron microscope is a large investment that cannot be taken lightly, especially by a start-up or small company where cash flow can make or break a business. There are several factors to be wary of when looking for used equipment. First and foremost, consider the applications at hand. Have good knowledge of your required resolution and maximum sample size. Second, the SEM should be inspected personally to make certain it will perform well for your applications. Just because a machine is new or appears new does not mean it will work better. In addition, make sure that spare parts are available from either the original equipment manufacturer (OEM) or seller. Finally, inquire about potential upgrades that may be required for your applications in the future, such as EDS or BSE detectors, infrared chamber scopes, etc.

Furthermore, when buying a used SEM, cost of ownership should be factored in, to assess variables such as maintenance, associated running costs, and consumables. In addition, leasing, as opposed to an outright purchase, should be considered as well. The overall benefit of using a cost-of-ownership model is that it involves recognizing the lifetime costs of acquiring an asset, rather than simply focusing on the initial purchase price. Five years' worth of reasonable equipment maintenance should be included as the basis for a cost-of-ownership model.

Things to consider

1. Know who you are buying from

- Is the business or seller you are dealing with well known, and do they maintain a good reputation?
- Can the seller demonstrate the SEM with your particular samples?
- Does the seller possess industry knowledge and have good references in terms of both sales and service capability?
- Can the seller or OEM provide a warranty?
- Can the seller or OEM provide parts?
- Is the seller willing to consider leasing the equipment to you?
- Can the seller train your staff on-site after the SEM has been installed?
- What are the payment terms?

2. Inspection of equipment

- Inspect the equipment before purchasing it. If you are outside the country and cannot personally inspect the SEM, find a reputable local technician in the area to inspect the machine for you. This can be fairly inexpensive and very beneficial. In most cases, a technician can find issues that you may miss.
- What additional options are available that you have future interest in?
- Can the seller or OEM provide these options before system inspection or on your site, and at what price?
- What type of documentation is provided with the equipment?

3. Shipping and installation

- Although you may be paying for these services, ask the seller to assist in coordinating the trucking and rigging of your SEM, if necessary. In the long run, it can save

you time, money, and headaches.

- Make sure that all equipment is insured for loss during the transportation/rigging process.
- Is there building work required in advance to support the installation of the SEM? Does your preferred location have:
- Adequate room size to accommodate the SEM and its accessories
- A quiet room that is low in acoustical emission
- A room with minimal floor vibrations
- EMI at a level that will not affect the imaging
- Facility issues, such as N₂ gas for venting, water for cooling when necessary, compressed dry air, electrical hookups, etc.

Making a choice

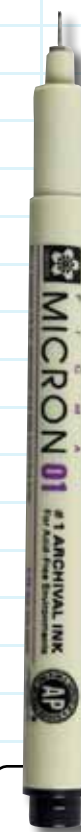
No matter what avenue you choose to explore when adding pre-owned equipment to your laboratory, the benefits remain the same: the machine you want is ready for shipment, the delivery time is short, the equipment is reliable, and the cost is significantly less than the price of brand-new equipment. Taking the time to investigate which system is right for you will go a long way toward ensuring that your purchase stands the test of time in your laboratory.

Gary Brake is the marketing manager for SEMtech Solutions. SEMtech Solutions, headquartered in North Billerica, Massachusetts, is the leading provider of pre-owned scanning electron microscopes. For more information, visit www.semtech-solutions.com or contact Gary directly at gbrake@semtechsolutions.com.



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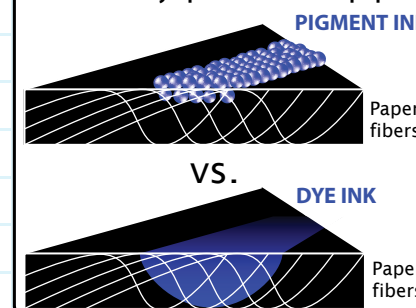
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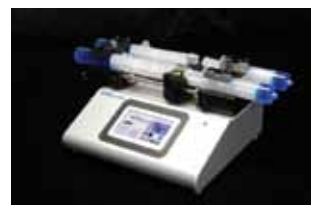
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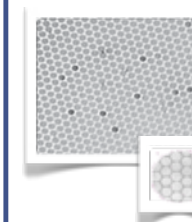


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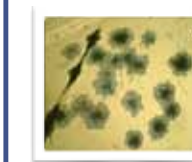


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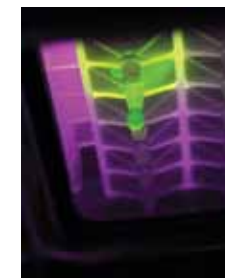
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SPOTLIGHT: SIMPLE BENCHTOP TITRATION

FLEXIBLE DATA EXPORT FROM TITRATORS

Metrohm's new 900 Touch Control device starts titrimetric analyses through the use of a touch screen. Smaller than a netbook, and powerful as a PC, the device measures 19 cm by 18 cm, and provides direct access to LIMS and network printers. An Ethernet interface also allows users to access the corporate intranet.



The brilliant color touch screen doesn't need direct skin contact to function—it can be operated by a user wearing gloves. Up to 14 methods can be linked to "favorite" icons on the touch screen, and each user has direct access to his or her favorites with a single touch of an icon.

George Porter, Product Manager, Titration, at Metrohm, says the device allows for flexibility in the lab. "It allows more flexible data export from titrators," he said. "And it's a space saver, since it takes up a lot less space than a computer."

The 900 Touch Control is compatible with all Titrando titrators and USB sample processors and meets FDA 21 CFR, Part 11 compliance. It also features an autostart function so that coulometric Karl-Fischer titrations are started automatically once a sample is added.

For more information, visit www.metrohm.com or call 1-800-727-6768 (from USA).

ABSORBANCE MICROPLATE READER

INSTANTLY CAPTURE FULL SPECTRA FOR LOW VOLUMES, MICROPLATES AND CUVETTES

The SPECTROstar Nano absorbance microplate reader from BMG LABTECH uses a proprietary spectrometer that can capture a full UV-Visible spectrum (220 to 1,000 nm) in less than one second per well, and measures sample volumes down to 2 µL.



An integrated cuvette port, which measures all standard microplate formats up to 1,536 wells, lets users analyze individual samples without the need to pre-program wavelengths.

Some of the most common absorbance assays, including ELISAs, DNA, RNA, Protein (Bradford, BCA, Lowry), cell growth, and beta-galactosidase can be read at the touch of a button due to predefined protocols.

SPECTROstar Nano's built-in cuvette port, assigned for individual samples, can be used for kinetic studies and quick experiments. It also allows for single push-button operation for basic commands, as well as specific assay protocol set up.

EJ Dell, Business and Applications Development Scientist, BMG LABTECH, says the device's durability makes it an essential instrument for any lab. "Being a solid-state detector with no moving parts, the spectrometer is highly durable," he said. "It never needs to be retuned or recalibrated, thereby ensuring perfect measurements each time."

Additional features include multimode shaking, incubation, kinetic readings, well scanning, automated path length correction and a gas vent.

For more information, visit www.bmglabtech.com.

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LIMS

Matrix Gemini version 5.2.7

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Reducing Operator Time for Rotary Evaporators

Problem: Rotor-vacuum evaporators are commonly used by synthetic and purification chemists to dry solutions prior to redissolution in another solvent or prior to long-term storage of the finished product. Since the volume of the starting solution is always greater than that of the final dried compound, the practice of moving to a 20 mL scintillation vial for the final evaporation step is common. Rotorvap manufacturers have facilitated compound transfer from round bottom flasks to scintillation vials by providing special adapters to maintain a vacuum-tight seal between the relatively small vial format and the large vacuum taper of the rotorvap. Drying the last 10mL in a scintillation vial requires care and experience to prevent sample loss or contamination from bumping and foaming. This compound finishing step is critical to the process and can require the same amount of rotorvap time to complete as the first 490 mL, while requiring much more analyst time.

Solution: Modular SFC's Centrifan PE can be used instead of a rotorvap to efficiently dry the last 10 mL of product solution in a 20 mL scintillation vial with confidence and unattended operation. The Centrifan PE is a portable, easy-to-use centrifugal evaporation system that provides safe, rapid drying of purified fractions and lab scale reaction mixtures. After transferring the 10 mL aliquot from the round-bottom to the scintillation vial, the user simply places the sample in the rotor of the Centrifan PE, closes the lid to start the rotor, and sets the temperature. The solution in the scintillation vial dries securely without further monitoring and frees the laboratory worker for other tasks. In addition, the Centrifan PE offloads the time-consuming finishing tasks from the rotorvap, potentially increasing overall evaporation productivity.

The Centrifan PE generates its own gas flow to accelerate sample evaporation by recirculating the volume of gas captured inside its

enclosure. Centrifugal force keeps samples secure in their containers and ensures maximum purity and yield. The technique eliminates the need for a vacuum pump or a large supply of blow-down gas, significantly reducing complexity and maintenance compared to rotary evaporators, vacuum centrifuges and blow-down equipment. Because it operates without vacuum, the system eliminates the potential for cross-contamination and sample loss caused by solvent bumping and foaming. The enclosure can be purged with inert gas for oxygen-free evaporation.

With a small 8 x 12 inch footprint and only 18 inches high, the self-contained Centrifan PE requires

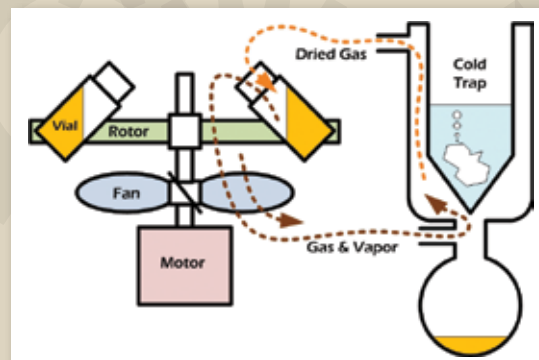
little bench space and doesn't need to be placed under a fume hood; an elephant trunk is usually sufficient for instances when the Centrifan PE cover is open during loading and unloading. The portable system can also be operated on a lab cart, providing further convenience and savings of bench space. The versatile Centrifan PE provides rotor options for six 20 mL scintillation vials, eight 1.6 mL Eppendorf tubes, and smaller test tubes.

For more information, visit www.modularsfc.com/centrifan_pe.html



▲ Centrifan PE streamlines final dry-down into Scin vials and Eppi tubes.

◀ Centrifan PE produces blow-down flow by an internal fan; no external vacuum pump or gas supply.



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Pasteurization in a Laboratory Glassware Washer

Problem: Pasteurization is a thermal treatment applied to foods to destroy pathogens and prevent spoilage. In the food and beverage industry, tunnel washers are often used to pasteurize beverage bottles in a production line. Within R&D flavors laboratories, new flavors and additives are tested for heat stability prior to being used in new formulations and production. Typically, pasteurization here is performed with a benchtop pasteurization system in a stove-top immersion bath. Bottles are immersed in boiling water and held at temperature for a given amount of time. The immersion process, while inexpensive, is neither accurate nor controlled, and the benchtop equipment can be expensive and complicated to install and operate.

Solution: A laboratory glassware washer simulates tunnel washer conditions—i.e. the bottles are sprayed with water at a certain temperature. With the G 7836 from Miele, temperatures can be raised step-by-step, then held for a specific time interval and reduced. This temperature ramping can be customized for a particular liquid and flavor. For example, the program can be written with a number of steps, with each step raising the temperature by 10 degrees (variable) then holding a temperature designated by the researcher. At first, the temperature/hold can be estimated for each step until the pasteurization temperature is reached—then it needs to be determined exactly.

Miele has been customizing programs for this function for more than two decades. For a global spice manufacturer looking to test the heat stability of spices, Lisa Choplo, Miele application specialist, created a program that held the temperature at 63 degrees for 12 minutes. For a global food ingredients developer, she created a program that allowed water temperatures to be held at 82°C for two minutes. Temperatures and holding times can be customized, allowing researchers to optimize for flavor. For example, if the material is heat-sensitive, the water temperature



can be held at a lower level for a longer period of time. Once the temperature is held, it must then be ramped down to cool the bottles. Using the programming function of the G 7836, the incoming tap water can be mixed from the hot and cold taps so the system can circulate ambient temperature water for a few minutes. This eliminates bottle breakage due to direct cold spray, which would shock the bottles.

Sample program:

Step One: Fill with hot water and heat to 82°C. Circulate for three minutes at 82°C. Drain (this is the main step of

pasteurization, where beverage temperature is held for a specific amount of time).

Step Two: Fill with two parts hot water and one part cold water. Circulate for 20 seconds and drain (this begins the cool down step, which is gradual at first to avoid thermal shock to bottles).

Step Three: Fill with equal parts hot and cold water. Circulate for 20 seconds and drain (adjustable for more cool down).

Step Four: Fill with two parts cold water and one part hot water. Circulate for 10 seconds and drain (repeat).

Step Five: Fill with cold water. Circulate for 30 seconds and drain (bottles should be totally cool at the end of this step—timing may need to be adjusted appropriately).

For more information, visit www.miele.com.

◀ Miele's G 7836 laboratory glassware washer.

Technology Brief ILLUSTRATING BENEFITS OTHER THAN INCREASED SENSITIVITY FOR MYCOTOXIN ANALYSIS USING XEVO TQ-S

GOAL

To show that Waters® Xevo™ TQ-S reduces ion suppression and makes peak integration easier at sub-legislation concentrations for mycotoxin analysis.

BACKGROUND

Mycotoxins are a class of chemical compounds produced by fungi growing on food. These chemicals are subject to legislation around the world as they are a concern to human health. They are known to cause problems associated with the digestive system and liver. Using the most sensitive mass spectrometers, such as Xevo TQ-S for analysis of these compounds makes compliance with legislative limits easier, but there are other benefits to be attained as well.

THE SOLUTION

The increased sensitivity achieved by Xevo TQ-S improves peak shapes at sub-legislation concentration, levels already achieved by Xevo TQ MS. The relative intensities of any imperfections in peak shape created by poor chromatography are reduced because the peak is larger. The start and finish of the peaks are more clearly defined, so processing software such as TargetLynx™ can achieve baseline to baseline integration more routinely. This is shown in Figure 1; the injection is spiked barley matrix at a pre-extraction concentration of 0.1 µg/kg. This concentration is 20 times below EU legislation levels for aflatoxin B1. The Xevo TQ chromatography has been manually changed but the Xevo TQ-S chromatography was automatically integrated. The increased sensitivity at low levels helps to reduce the number of manual integrations in a sample batch. This in turn reduces operator variability and the results from processed data sets become more consistent.

A further advantage of Xevo TQ-S is that the response for the secondary (confirmation) ion is large in size. This is also shown in Figure 1. The consistency of integration, even at low concentrations, helps to stabilize any fluctuations in the ion ratio produced by the two MRM transitions. This increased peak area gives a more accurate ion ratio at lower concentrations, and thus increases user confidence by clarifying the identity of the compound analyzed.

Extracted animal feed samples were also injected; animal feed is considered to be a complex matrix that can cause significant problems with regards to ion suppression. The results of 10 µL, 5 µL, and 2.5 µL injections are shown in Table 1. The ion suppression was calculated in the normal way of comparing the response of a solvent standard to that of an equivalent concentration in matrix.

The ability to inject a smaller amount on column can help reduce the effects of ion suppression because a smaller amount of matrix is also injected onto the column. The increased sensitivity of Xevo TQ-S makes detection at lower injection volumes possible. The reduction in ion suppression is clear at a 2.5 µL injection volume, with the majority of results between 70% and 120% (shown in light blue).

SUMMARY

Improved peak shapes have been achieved due to the increase in sensitivity provided by Xevo TQ-S.

Data processing becomes quicker as baseline to baseline integrations are more common, reducing the time that analysts require when reviewing and editing processed data.

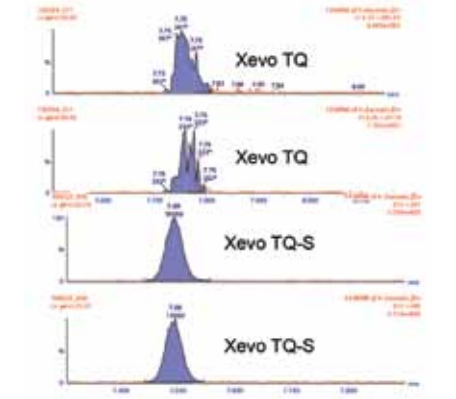
Ion suppression is lowered with smaller injection volumes, but this can only be achieved with the sensitivity increases obtained by Xevo TQ-S.

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Ion suppression is lowered with smaller injection volumes, but this can only be achieved with the sensitivity increases obtained with Xevo TQ-S.



▲ Figure 1. The same barley sample analyzed with Xevo TQ and Xevo TQ-S at a concentration of 0.1 µg/kg, 20 times lower than EU legislation levels. The mycotoxin shown is Aflatoxin B1.

	10 µL injection	5 µL injection	2.5 µL injection
Nilvalenol	88%	89%	86%
DON	81%	83%	88%
3-ac-DON	75%	78%	84%
Aflatoxin G2	64%	71%	112%
Aflatoxin G1	60%	68%	103%
Aflatoxin B2	52%	57%	89%
Aflatoxin B1	47%	50%	77%
Fumonisin B1	92%	93%	89%
HT2 toxin	44%	41%	62%
Beta zea	67%	71%	80%
Alpha zea	76%	81%	93%
T2 toxin	44%	49%	66%
T2-CT3	76%	86%	104%
Zearalene	20%	24%	37%
Ochratoxin A	76%	80%	82%
Cytochalasin E	108%	102%	90%
Key	70% to 120%	50% to 69%	0% to 49%

▲ Table 1. Ion suppression data using different injection volumes.

Efficient Oligonucleotide Analysis and Design

Problem: Oligonucleotides are short sequences of nucleic acid that are often used as primers and probes for amplifying DNA in polymerase chain reactions (PCR), measuring gene expression levels in qPCR, or for detecting DNA or RNA in applications such as DNA microarrays, Southern blots, allele-specific oligonucleotide analysis, and fluorescent *in situ* hybridization (FISH). In order to effectively anneal to their target sequence, each manufactured oligo must be complementary to the target sequence without a tendency to form undesirable secondary structures. These secondary structures include hairpin formations and self-dimers, which render the probe unable to bind to the target sequence. In addition, properties such as GC content and melting temperature must also be closely monitored in order to optimize the efficiency of the application. Ensuring that all these parameters are considered can be a lengthy process and can occupy a significant quantity of laboratory time. These assessment and optimization measures need to be considered, but can hinder the streamlining of high-throughput protocols.

Solution: In order to address the need for a quick and easy-to-use method of oligo optimization, Integrated DNA Technologies (IDT) offers the SciTools suite of free, online oligo analysis and design tools. The SciTools suite provides a central resource where users can input any sequence and determine its properties. It is comprised of the OligoAnalyzer 3.1, a number of application-specific, pre-design and design tools, as well as a dilution calculator, resuspension calculator and mFold, which determines the folding properties of the oligo.

As the mainstay of the SciTools, the OligoAnalyzer enables quick and easy analysis of any oligo sequence through use of complex algorithms to assess various properties. In order to initiate the analysis, users simply enter their sequence, which can include standard and mixed bases, as well as DNA, RNA, methylated, locked, and phosphorothioated bases into the box provided. Once the sequence is entered, users can initiate a variety of different calculations.

By clicking on the 'analyze' icon, the OligoAnalyzer automatically calculates the physical properties of the sequence. These include length, GC content, melting temperature range, molecular weight, the extinction coefficient and the optical density (O.D), which are all displayed on-screen for quick and easy review. The sequence can subsequently be altered and re-analyzed, as required.

Clicking on the 'hairpin' icon directly links to the SciTools mFold function, which measures the folding properties of the sequence to determine the likelihood of a hairpin structure forming. Hairpin structures can prove highly problematic in a number of applications by hindering the ability of the oligo to anneal to its target sequence. The formation of self-dimers can have a similar effect. For example, a PCR primer that forms a self-dimer will decrease the concentration of free

primer available for binding, thereby reducing both the efficiency and accuracy of the reaction. The potential to form primer-dimers can result in false positive data due to non-specific annealing. The probability for each type of non-specific binding is easily detectable by a simple click in the OligoAnalyzer.

As an additional level of functionality, clicking on the NCBI Blast icon initiates a comparison of the oligo sequence in the NCBI database and will calculate the statistical significance of the matches.



▲ *The SciTools OligoAnalyzer has a simple, user-friendly interface.*

For further information and to explore the complete suite of SciTools, including the PrimeTime pre-design, RNAi design, and anti-sense design, visit www.idtdna.com.



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A Biological Safety Cabinet Exhaust Canopy

Problem: Exhausting type A2 biological safety cabinets (BSCs) to a building exhaust system is safely accomplished by using what is commonly called a canopy exhaust connection (CEC) on the top of the cabinet. The openings on these connections are typically big enough to maintain correct airflow through the cabinet in the event of building exhaust system fluctuations. However, the openings remain fully open in the conventional canopies even when the exhaust system is functioning normally. This results in a continual draw of room air through the openings that mixes with the BSC exhaust and enters the building's exhaust system. Exhausting more room air results in losing more conditioned air and running the building exhaust system at a higher flow level, which results in substantially higher energy costs.

Solution: The Baker Company's FlexAIR® canopy exhaust connection saves energy and improves overall safety performance. Importantly, the new exhaust canopy meets NSF standards even when the building's exhaust system fails and an alarm alerts the user to the system failure.

With environmental resources becoming more and more limited, reducing energy costs is a paramount concern of every laboratory. An analysis published by the U.S. Environmental Protection Agency concluded that laboratories consume five to 10 times more energy per square foot than typical office buildings.¹ The addition of the new FlexAIR canopy can reduce energy consumption in laboratory environments and improve a biological safety cabinet's operating characteristics.

The Baker Company's FlexAIR canopy exhaust connection (CEC) requires 15% less airflow than designs presently available. Even more significant, productivity levels remain high and safety for both the product and personnel will continue to exceed NSF standards even when the building's exhaust system fails.



▲ Cabinet functioning with FlexAIR canopy during normal operation mode.

By incorporating FlexAIR into the design of a laboratory, it can replace the need for a general room exhaust as it allows air changes set for the space, even when the BSC is off.

The Baker Company's new biological safety cabinet line, the SterilGARD e3, operates at a higher efficiency level while maintaining optimum performance. Adding a FlexAIR

(CEC) to these cabinets further reduces energy consumption while still providing maximum containment through a total exhaust connection.

The new FlexAIR canopy is designed with a single opening covered by an air damper and designed to reduce the overall volume of air required during normal operation of the cabinet. FlexAIR also accommodates lower air changes during unoccupied times and night setback modes.

If the building exhaust system attempts to pull in more air than is supplied by the cabinet, two-sided intake dampers will open to allow room air in through the intake ports, thus enabling the cabinet to maintain A2 intake airflow conditions at its front access opening.

For more information, visit www.bakerco.com

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2. The Baker Company, white paper: "Energy Efficient Biological Safety Cabinet Reduces Energy Costs while Ensuring Safety," 2008.

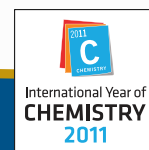
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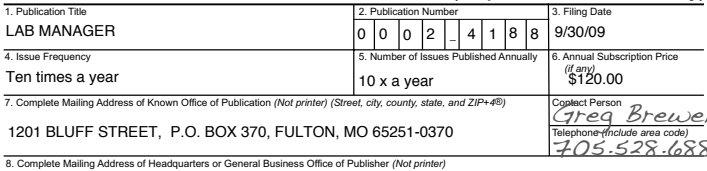
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PARTING POINTS

Takeaways from this month's issue:

CAREER BUILDING

Attitude is an important factor in determining one's success. University of Pennsylvania psychologist Martin Seligman concluded that people with positive attitudes are healthier, go further in their careers and earn more money. Here are some attitudes lab managers need in order to be successful:

- Find reasons to enjoy your job; this improves your disposition and increases your energy level
- Promote yourself and your accomplishments (without sounding boastful)
- Take charge and make good things happen, instead of waiting for them to happen

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EMPLOYEE SATISFACTION SURVEY

This year's survey results show that the headcount in labs has shrunk, and respondents feel less trust toward leadership at their organizations. However, the majority of them enjoy what they do and share a sense of purpose and a commitment to their work. Here are some of the numbers:

- This year, 59% of respondents said they have confidence in leadership, compared to last year's 70%
- Those making less than \$25,000/year climbed from last year's 6% to 11%, suggesting new hires at the bottom of the pay scale
- Only 49% of respondents feel their organizations provide adequate initial training (compared to last year's 70%)



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MIND MAPPING

Mind mapping is a technique for generating, capturing and organizing ideas, tasks, and projects. It uses a diagram that depicts ideas, tasks, or other items linked to and arranged around a central key word or idea. Some ways this technique can benefit lab managers:

- Design R&D projects to develop new products and track progress of the work
- Manage information, such as catalyst properties or competitors' activities
- Define processes to troubleshoot and diagnose faulty lab equipment and repair it
- Predict customer behavior and identify new innovations that meet customer needs
- laccus nestius, to magnam faccum et



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THE PSM

The professional science master's (PSM) degree has been referred to as a program that gives students a rigorous scientific education while preparing them for work outside the academic setting. Though obscure, the PSM provides students with additional skills a Ph.D. might not have. Get to know the PSM:

- A PSM might be trained in practical business skills, whereas a PhD is trained only in one area of research
- PSMs get core science training as well as other skills to help them contribute in the workforce
- A PSM might be a good candidate for a smaller company because he/she can do a lot of different things



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BUYING A PRE-OWNED SEM

The scanning electron microscope (SEM), a key piece of instrumentation in many modern laboratories, can carry a price tag of up to \$1 million, putting it out of reach for most labs. A pre-owned SEM is a cost-effective option. Some tips on buying a pre-owned SEM:

- Consider your applications and the required resolution and maximum sample size
- Personally inspect the SEM to ensure it will perform well for your applications
- Make sure that spare parts are available from either the OEM or the seller
- Inquire about potential upgrades you may require in the future

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