MAGAZINE
Lab Manager®
Where Science and Management Meet™
October 2007 Volume 2 • Number 10

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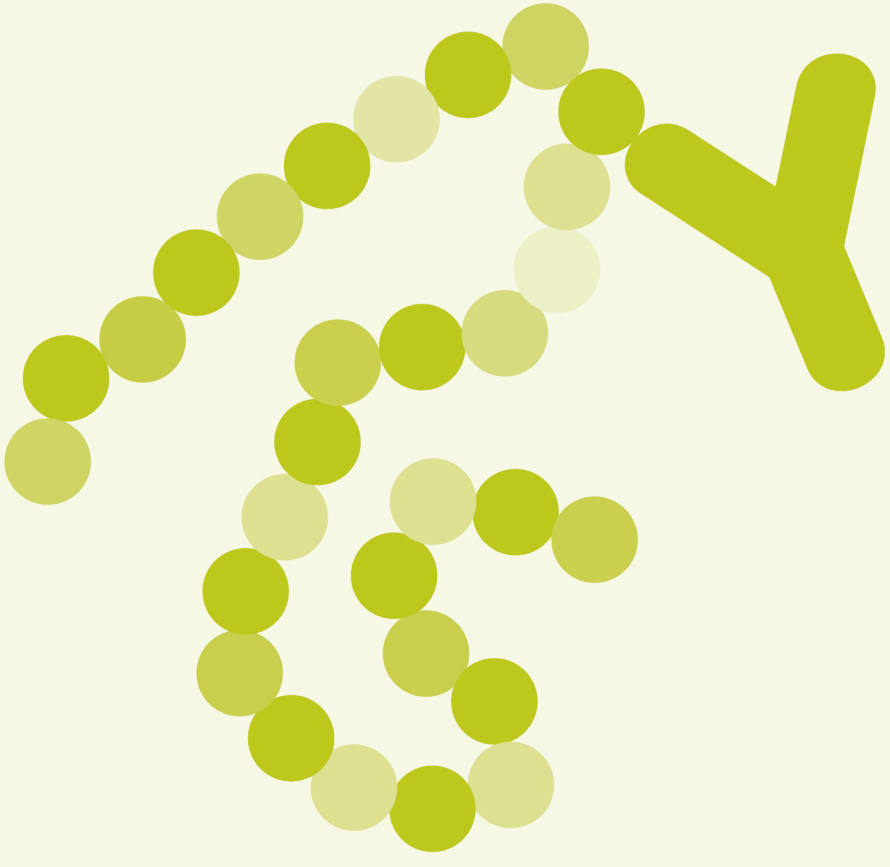

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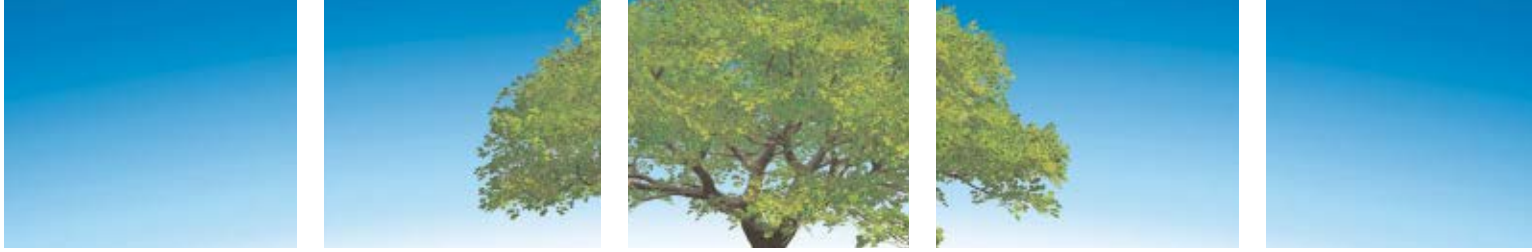

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Lab Manager® Magazine (ISSN: 1931-3810) is published monthly by Vicon Publishing, Inc., 4 Limbo Lane, Amherst, NH 03031. USPS 024-188 Periodical Postage Paid at Amherst, NH 03031 and at additional mailing office. A requester publication, *Lab Manager®* is distributed to qualified subscribers. Non-qualified subscription rates in the U.S. and Canada: $120 per year. All other countries: $180 per year, payable in U.S. funds. Back issues may be purchased at a cost of $15 each in the U.S. and $20 elsewhere. While every attempt is made to ensure the accuracy of the information contained herein, the publisher and its employees cannot accept responsibility for the correctness of information supplied, advertisements or opinions expressed. POSTMASTER: Send address changes to Lab Manager® Magazine, 4 Limbo Lane, Amherst, NH 03031.

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Lab Manager Magazine® is a printed publication of resources, products, and information for today's laboratory manager. Articles should address some aspect of laboratory management from the perspective of a professional who is both a scientist and a manager. Topics areas would include: managing budgets, personnel, technology, information, funding, training, safety, risk, expansion, building or renovation, among others related to the role of a lab manager.

The article review process should begin with a query by e-mail or phone followed by a brief abstract or outline. Please state your topic and objective, and indicate your perspective as well as your professional relationship to the topic. Content must be unbiased and cannot promote a particular product or company. Article length may range from 1500-2500 words. All manuscripts must be submitted electronically by email or disk.

To submit an article query contact:

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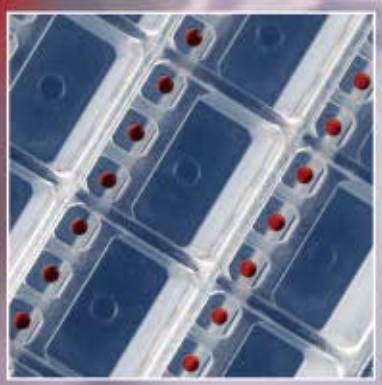

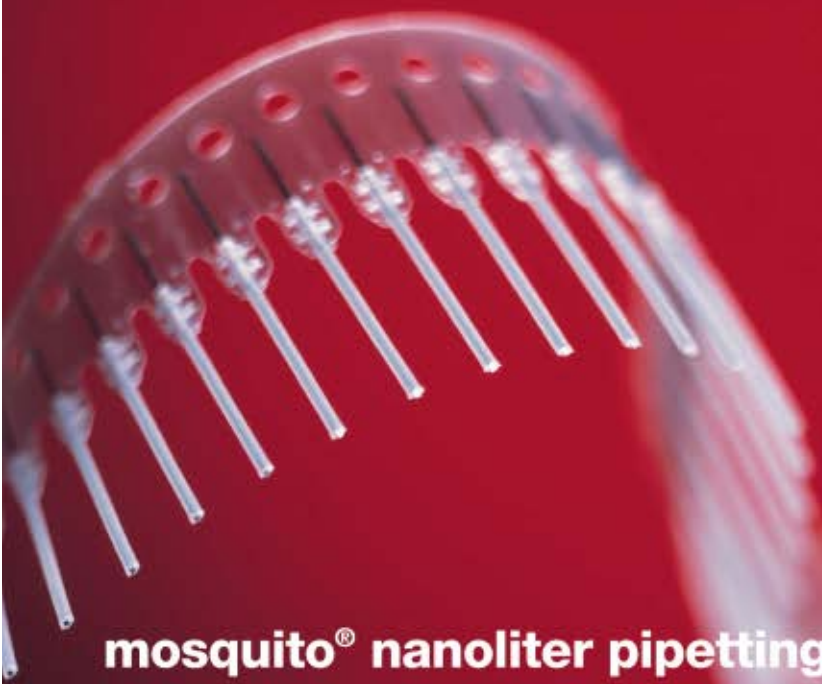

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"We are scientists first..."

CAROL HOMON TO GIVE THE KEYNOTE ADDRESS, "MANAGING INNOVATION SCIENCE AND TECHNOLOGY FOR BUSINESS SUCCESS," AT LAB MANAGER BOOT CAMP ON OCTOBER 25TH.

Lab Manager Magazine® is pleased to announce that Carol Homon will be giving the keynote address at Lab Manager Boot Camp this month. Carol's work has garnered awards and recognition throughout her career and her succinct comment about laboratory management, "we are scientists first," shows her strong sense of purpose along with dedication to her work.

Carol retired recently after 25 years with Boehringer Ingelheim Pharmaceuticals, Inc. She was the Director of Biomolecular Screening which included high throughput screening. Carol, one of the first scientists to see the potential of HTS, integrated the compound repository with the HTS process. Today, she is recognized worldwide as an expert in screening and has given many presentations and shortcourses at scientific meetings across North America and Europe. She has an extensive publication record including papers, abstracts and book chapters. At BI, Carol was twice recognized with a Vice President Award, a Team Spirit award, and received BI's most prestigious award, The International R&D Award in 2001.

Carol joined BI in 1982 as a biochemist, after eleven years at Wyeth Laboratories and steadily moved up the R&D ladder. Due to the vision of Carol and other "early adopters," HTS evolved, from testing a few thousand compounds to 100,000s in a day. Carol was a driving force to help establish and expand the Society for Biomolecular Screening (SBS) started in 1994. She served on its board of directors, two years as chair, and was awarded the SBS President's Award in 1998 and again in 2001. The second award was for her leadership in the development and approval of standards for the microplate by the American National Standards Institute.

Carol partnered with entrepreneurs at small and large corporations to identify novel product concepts for HTS improvement. "Allegro" was a new laboratory robotic concept which Carol implemented in 1998 after co-development with Zymark Corporation (now Caliper). The concept won the R&D Magazine Award for the Top 100 Innovative Technologies in 1999. That year, Carol won the ISLAR (International Society for Laboratory Automation and Robotics) Award for Outstanding Achievements in Automation and Robotics. This achievement was followed by a cover story in Drug Discovery and Development (2000), which in turn, was selected in 2004 as one of the seven best technology stories of the magazine's five year history. Carol was a finalist in 2006 for Connecticut Technology Council's Women of Innovation Awards.

In her retirement, Carol is pursuing her scientific interests by collaborating with a major company on a new biophotonics technology.

You can hear Carol along with other experts in science and management fields at Lab Manager Boot Camp on October 25th in Waltham, Massachusetts. For those not able to attend the event, all the sessions will be available live via video webcast. More information can be found at www.labmanagerbootcamp.com.

Don't miss the opportunity to hear Carol's address. I know I'll be taking a front row seat.

Patrice Galvin

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Development of an Equipment Monitoring System

A CASE STUDY DETAILS HOW ONE ORGANIZATION IMPLEMENTED AN EQUIPMENT MONITORING SYSTEM TO PROVIDE A SAFETY NET FOR THEIR RESEARCH.

Within a research environment, it is common for materials to be unique and quite literally priceless. Moreover, many of these need to be maintained in temperature-controlled environments.

It is an unfortunate fact that any controlled environment will fail at some point in time. The question is how organizations should prepare for this and manage the risk of loss. In this article, I will be referring primarily to ultra-low temperature (ULT) freezers as an example of critical equipment with valuable contents, and how we developed an equipment monitoring system to assist in our management of this risk of loss.

The development of an equipment monitoring system should be treated like any other risk assessment. It is only sensible that organizations monitor how they are insuring against loss through failure of critical equipment and how their policies reflect the replacement value of the contents versus the relatively insignificant cost of the piece of equipment itself.

Figure 1. Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
almost certain	M	H	E	E	E
likely	M	H	H	E	E
possible	L	M	H	E	E
unlikely	L	L	M	H	E
rare	L	L	M	H	H

L - low risk
M - medium risk
H - high risk
E - extreme risk

When a freezer fails, it may be holding one (or a combination) of the following:

- A laboratory's stock of commercially available, but often high-value reagents. In this case, the financial exposure and inconvenience of loss needs to be understood and managed.
- 15+ years of samples that cannot be replaced.

It is only sensible that organizations monitor how they are insuring against loss through failure of critical equipment and how their policies reflect the replacement value of the contents.

How do you adequately insure against a loss of such crucial samples? This latter scenario should alarm those within an organization who manage exposure — whether it be the "business loss" insurer or the researcher whose research (and livelihood) depends on the integrity of those samples. Both the insurer and the researcher will be looking for physical and operational systems that effectively eliminate the risk of exposure to such loss.

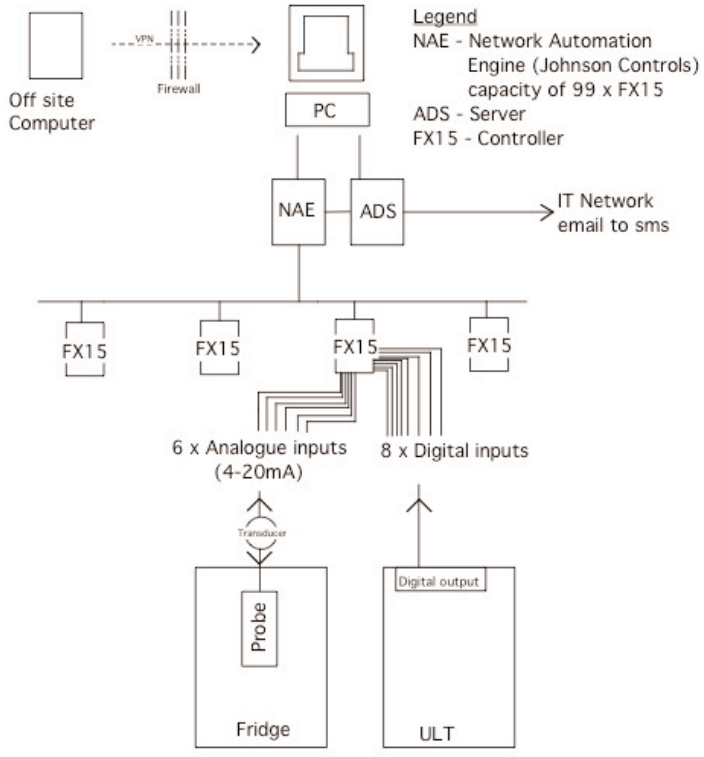
At our institute, the vast majority of ULT freezers contain unique biological specimens. Given that a freezer will fail at some point and that the consequence to our research will be major, reference to a risk matrix (Figure 1) indicated we were exposed to an extreme risk.

TECHNOLOGY

The simplest form of an equipment monitoring system should produce an alarm when the parameter being monitored moves outside a predetermined range. Our previous equipment monitoring system was based on industrial Programmable Logic Controllers (PLCs) with Supervisory Control and Data Acquisition (SCADA) monitoring. Although robust and

David Keenan

Figure 2: System Architecture



reliable when installed, the system was now obsolete (ten years old).

Additional features that we felt were desirable in any system we would implement were based on the limitations we had found with previous PLCs and SCADA systems. Key issues to be addressed included:

- Technology obsolescence (exposure if system failed) of a ten-year old system
- Poor technical support
- Non-intuitive user interface
- Un-informative alarm messages
- Reliance on proprietary PC-based software interfaces
- The desirability of 'Open Platform' technologies that allow equipment and services from a variety of suppliers to be connected cost effectively
- Remote access capabilities (preferably via a web interface).
- Alarm path flexibility
- Alarm messages with useful information
- Development of in-house expertise to expand and maintain the system

WHERE DO ALARMS GO?

The alarm function was of vital importance. When an alarm is triggered, we want the owner of the freezer to know and respond. If the owner is not interested or wishes to defer responsibility, then we must question the merits of the ULT freezers inclusion on the system. Our ambition was to have alarms that could be sent in both e-mail and sms forms and the flexibility to rapidly alter the pathway as required to ensure that the right people received the alarms depending on the time of day, week, or year. A severe limitation of our previous system was that the alarms were sent to a pager and the responsibility of acknowledging the alarms rested with that individual.

REVIEW

Armed with our wish list, we went to the marketplace and reviewed what was available. During this process, we reviewed off-the-shelf monitoring systems and investigated the potential of building our own customized system.

After a comprehensive review, we were able to discount ready-built systems as we felt they did not offer enough of what we wanted. We did, however, have favorable discussions with companies that could build, to our specifications, a system using equipment adapted to meet our needs.

A clear message to put across in this article is that it is far too restrictive to limit any technology review to only what is commercially available at the time. Our experience strongly advocates that a fundamental question to ask is the following: can we build something new and better?

BUDGETS

Project costs are built from the job complexity, available technology, and the expertise of the provider. A cost penalty is associated with tailoring a product versus off-the-shelf with a large component being the time required to develop graphics and the interface for the user. The hourly rate of a skilled engineer can be significant.

The project budget should be the result of a risk assessment, a review of key issues to be resolved, and what solutions are available. A case can then be made to fund the solution that is correct for that set of circumstances.

DEVELOPMENT

We opted to work with our Building Management System (BMS) maintenance contractor, Integration Control and Engineering (ICE), who proposed adapting BMS equipment to our needs.

There are many similarities with how a BMS works and what we wanted in our solution. A BMS is a system designed to take numerous inputs, manage that information, and pro-

vide a useful end product. We wanted to take numerous freezers, monitor them in real time, and when required, send out an alarm.

The ICE solution we went with is based on a Web — embedded, multi-protocol, controller connected to open architecture devices. The Web-embedded device meant that the system no longer relied on a PC loaded with proprietary software and operating systems for its functionality. In this case, the controller could be connected to the local intranet and viewed by a standard Web browser.

The installation of a multi-communication protocol device also ensured the long-term viability of the project. As the system grows, the ability to incorporate other equipment and gather information at a higher level will now be a possibility.

As with all IT-based products, we checked that it was technically suitable for our needs, could be supported long term, and could be networked. The development process was consultative (including interdepartmental communications) and met our desired outcomes.

Achieving clear communications between the client (us) and the ICE provider was challenging as each party was from a different background and skill set. We are not controls engineers and being able to document clearly our exact needs took some work. Equally, we were careful to ensure we had access to updates and progress reports so the contractor did not inadvertently go down the wrong path and waste time and effort.

Figure 2 displays the architecture of our system as it was designed and installed. To allow a Mac (common computer platform in our institute) user to remotely dial in to the system, we are using third-party software.

TIMELINE

Any organization thinking of going down the same path must allow for a significant investment in time if the end product is to be truly tailor-made. Our review process took two months to complete and the design/development/install process took an additional three months.

THE TAILOR-MADE SOLUTION

We developed and collaboratively produced a system that gave us:

- New technology with an emphasis on future needs
- The capability to expand the number of monitored items as the institute grows
- Increased accountability across departments to respond to alarms
- A simplified interface between system and operator
- A system with limited points of failure
- A system we could control and manage in-house

It was earlier noted that a goal of the project was to have increased coverage in where alarms were sent. In brief, we developed a system where alarms were sent to the "owners" of the devices during business hours via e-mail and to security after hours via sms.

FUTURE CHANGES

This article has focused on ULT freezers as the monitored device. However, the system was developed with a view to monitoring any controlled environment that could fail — these include:

- ULT freezers
- Freezers/Refrigerators
- CO_2 incubators
- Liquid nitrogen dewars

The system we developed allowed us to bring "in house" many of the skills required to manage and maintain our system where we were previously dependent on outside expertise.

CONCLUSION

Careful planning of the roll-out was critical to the success of the new system in that a single loss at this time might have seriously jeopardized its acceptance. To this end, we placed great emphasis on:

- Availability of skilled staff to quickly address system glitches
- Guiding staff through the changes in alarm notification procedures

As it was at the selection phase and still is, there are numerous other systems that can be adapted for similar needs. I am also sure that there will be continual development of off-the-shelf systems for this niche. For the reasons outlined above, I hope it is clear why we chose the path we did; we hope other laboratories can also use this experience to go outside of the commercial market place and think about building a custom solution.

Thanks to Dr. Jeff Freeman and Mr. Robert Lane for critical review and comments on this article.

***David Keenan** is Operations Manager for the Garvan Institute. Garvan Institute, 384 Victoria Street, Darlinghurst, Sydney 2010 NSW Australia; d.keenan@garvan.org.au; www.garvan.org.au.*

Greening Your Laboratory

LABORATORIES — MUCH LIKE THE LARGE PHARMACEUTICAL AND CHEMICAL COMPANIES THAT THEY OFTEN DO BUSINESS WITH — HAVE MANY OPPORTUNITIES TO BECOME MORE ENVIRONMENTALLY RESPONSIBLE.

Environmental sustainability — or "going green" — is a way to meet needs with less adverse impact on the world in which we live. Reusing materials, reducing the amount of energy and raw materials consumed, and recycling materials whenever possible not only makes good sense for the environment, but also returns value to production processes and lowers costs.

What can you as a lab manager do to help your own laboratory go green? You may have already discovered that recycling can reduce your costs and enhance the bottom line. Your customers may be asking you to provide evidence that you are operating in an environmentally sensitive manner so that they can rest assured knowing their supply chain is "green." Even your own employees may be concerned with environmental issues and want to become part of the solution, knowing that they are helping to reduce negative impacts on our world.

Here are some opportunities for you to consider:

RECYCLE/REUSE/REDUCE

Let's begin outside your lab. First, encourage and support recycling of materials in break rooms and other common areas. Segregate paper, aluminum, glass, and plastics in their own bins for recycling. Determine the best place to locate bins for collecting batteries and other workplace materials for recycling. In 2007, Sigma-Aldrich implemented several new recycling programs for resources consumed within our own facility offices. We have partnered with local recycling companies and organizations to establish a reliable and easy-to-manage recycling program.

Inside your lab, there may be opportunities to "green" the lab. Here are several options: (1) minimize the need to print and photocopy whenever possible. If a hard copy is necessary, make only one and send other copies electronically. (2) Consider a validated record keeping system for optical or electronic storage. (3) Look for resources that offer new ideas and alternatives using "green" chemistry (e.g., progressively using safer and environmentally friendly chemical alternatives as a substitute for more hazardous materials).

There are also opportunities to work with vendors to support recycling. We launched a well-received program to provide our bulk solvents customers with an easy process to return empty containers and cylinders. We also have a new polystyrene container recycling program. We pay all costs for the program, making it a unique opportunity to participate risk-free.

What can you as a lab manager do to help your own laboratory go green?

WASTE MINIMIZATION

If possible, redesign processes to generate less waste. Review procedures to determine where changes to reduce waste streams may be practical and safe. Do your procedures prescribe the rate at which water is to be left running when it is necessary? Are employees following procedures?

Purchase chemical supplies in amounts only as needed. Try to keep inventories as low as practical. Speak with your chemical suppliers to see if they can provide shorter turnaround times in order to allow you to minimize materials stored onsite.

Review procedures to identify opportunities to use less solvent, or an alternative solvent that is safer and more environmentally friendly. We were one of the first to supply 2-methyl tetrahydrofuran (2-MeTHF) and the only domestic distributor to supply cyclopentyl methyl ether (CPME). 2-MeTHF can be characterized as a true "green solvent" since it is manufactured from a by-product of agricultural waste, such as corncobs, bagasse, and sugar cane stalks. CPME is much more stable than both THF and 2-MeTHF when it comes to forming peroxides and does not have any of the safety risks or storage issues that occur when working with inhibitor-free THF.

Determine if it is possible to send packaging materials back to suppliers for re-use. With the Solvent Returnable Container program, customers can return all empty containers to Sigma-Aldrich to be refilled and reused. This eliminates the amount of glass and cardboard waste generated. The returnable containers maintain a positive nitrogen pressure that keeps solvents from being exposed to

Timothy Venverloh

the atmosphere. This extends the shelf life for high purity solvents, thus reducing the amount of solvent going to hazardous waste. Investigate local recycling opportunities for non-hazardous packaging materials.

ENERGY REDUCTION

Take inventory of how energy is used around your lab. Determine, by percentage if you can, to what extent energy is consumed for lighting and for equipment. Make the simplest changes first; use low energy-consuming, low mercury-containing light bulbs. Evaluate the impact of replacing water aspirators with vacuum pumps. Turn off lights at the end of the day, or for prolonged periods of non-use during the day. Turn off fume hoods when not in use.

ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS)

An EMS can be simple or sophisticated. It can serve as the record-keeping system and the waste-management system. A simple EMS may be a manual filing system that is properly managed and routinely updated. A sophisticated electronic EMS can organize and manage all information going through your laboratory. It can send reminders to those responsible for permit conditions, reveal resource use and waste disposal trends, and create compliance reports. An EMS can facilitate efficient management review and assign corrective actions and tracking to support continual process improvements. There are many EMS providers who create software for select industries. Many providers offer helpful demonstrations of their products.

ISO 14001 CERTIFICATION

Have your customers ever asked if your operations are ISO certified? If not, eventually they will. Your customers may want confirmation that your laboratory is being run in an environmentally sensitive manner. One way you can communicate this message is through ISO certification. Like EMS, ISO certification can be simple or complex, depending on your operations. The topics and programs discussed above, however, contain most of the elements of an ISO 14001 system, including Environmental Commitment and Policy, Planning, Implementation and Operation, Checking and Corrective Action, and Management Review.

SUMMARY

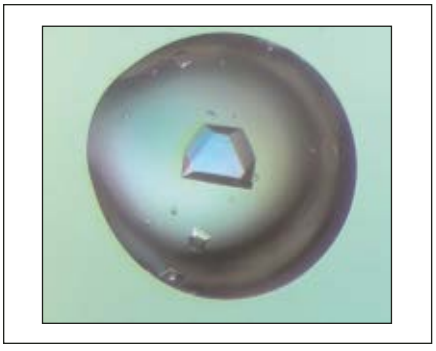
I have found that a committed group of passionate volunteers can make for a very creative and effective implementation committee. I have used committees to brainstorm, to investigate what others in the industry are doing, to prioritize ideas and needs, to assess the business aspects and costs of implementation, and to create awareness among other employees regarding sustainability efforts. A small committee of passionate employees can help solve problems quickly, and can be just plain fun to interact with. Depending upon the size of your laboratory operations, consider creating a "green" committee of your own, or merge with an existing (and effective) one, such as the safety committee, to create an Environmental, Safety and Health Steering Committee that can efficiently consider ideas, prioritize projects, and make business cases to management on the benefits of "green" activities. A stepwise approach, such as pursuing the opportunities discussed above, can help build confidence and momentum toward launching an effective green program in your laboratory.

Timothy Venverloh *is Director, Environmental Health & Safety Auditing and Sustainable Development for Sigma-Aldrich Corp.*

Protein Crystallography: Automating a Temperamental Science

HOW DOES THE LAB MANAGER BEST IMPLEMENT AUTOMATED TECHNOLOGIES TO OPTIMIZE EXPERIMENTAL WORKFLOW FOR IMPROVED COST- AND TIME-EFFICIENCY?

With the evolution of proteomics and the completion of the human genome project, protein crystallography has developed into a key area of pharmaceutical research. The sensitivity of this technique for identifying three-dimensional protein structures means it has proved invaluable for the process of rational drug design. As a result, the protein crystallography laboratory has been subject to growing pressures. As technological advances have allowed screening laboratories to increase throughput and maximize hit-to-lead success, it was rapidly realized that in order to prevent bottlenecks in the discovery pipeline, the protein crystallography lab must also keep pace. This has not been easy as individual proteins or protein families have specific requirements and crystallography methodologies and manual techniques are traditionally used for crystallization set-up and optimization. Nevertheless, in recent years technology providers have developed innovative technologies for the protein crystallography lab without compromising experimental flexibility and most of all, data quality. But what has this meant for the lab manager? What are the financial implications of such investment? How has the move to automated technologies been accepted by the scientists in what was once a very "hands-on" discipline?



AN INTEGRATED RESEARCH SET-UP

The role of many protein crystallography teams within pharma is predominantly to provide support to lead discovery programs. As such, they are very closely linked with many research areas and departments across the whole enterprise. The crystallography team is primarily involved with the crystallization and characterization of proteins. This includes activities such as screening, optimization of hits, crystal production, diffraction data collection, and structure determination. However, interactions with other teams, both upstream and downstream of the protein crystallography group, are essential for the successful contribution to any drug discovery program. These teams may include molecular biologists, protein engineers, and biophysicists to identify the targets and supply the proteins to be crystallized, in addition to computational and medicinal chemists, cell biologists, and biochemists, for downstream validation and further discovery efforts. This set-up often means that the crystallography team must not only be dynamic and flexible to meet changing demands but also have the combined expertise and crystallography know-how to deliver within a set time frame. Such enterprise-wide activities require seamless or near seamless interactions across departments and multiple sites worldwide, with regular meetings to address issues and re-evaluate objectives.

…the crystallography team must not only be dynamic and flexible…but also have the combined expertise and crystallography know-how to deliver within a set time frame.

ESTABLISHING PRIORITIES

Providing this level of support requires the protein crystallography lab manager to understand the needs of the various therapeutic areas and prioritize targets efficiently. Obviously, one of the associated pressures is effective time management. The timely delivery of crystal structures can greatly assist the decision making process as to what leads to follow and how. Additionally, the protein crystallography laboratory has to remain a viable source of data for the associated discovery efforts.

With the endless number of protein structures that are yet to be determined, it can be

Joby Jenkins

tempting for a crystallography team to place their own focus on specific protein groups or therapeutic areas. However, it is critical that pharma teams remain focused on targets specified by their collaborative departmental groups. Individual companies may also have a particular disease or therapeutic focus for which specific targets would be more relevant and have greater impact commercially. Such priorities mean additional pressure for protein crystallography groups as they may necessitate focusing on proteins that are more difficult to crystallize and require more time and effort to establish a successful and reliable crystallography method.

THE IMPORTANCE OF TEAMWORK

To meet these demands, one challenge for the pharma lab manager is to strategically distribute crystallography programs between team members taking into consideration the expertise and available time of members, and the equal distribution of high/low priority projects, so that the whole group has a balanced workload. Many teams will employ individuals specializing in crystal production, data collection, and structure determination and refinement. However, the most efficient teams will have the flexibility and the expertise to adapt as needs change or demand in one particular area increases. This often requires a certain level of integration which was not always achieved in traditional crystallography laboratories. Most crystallography groups are relatively small and throughput demands high. So the overall success of an operation will also depend on the effective communication and interaction with groups outside of the crystallization process, such as protein engineers, for a stable and continuous protein supply.

In recent years, many crystallography laboratories have faced these challenges on top of those associated with the process of protein crystallization itself. Getting a protein to crystallize is often a rare event, but then establishing whether this is a viable crystal for structure determination presents further difficulties. Departments are under pressure to increase project turnaround to meet demand and to top it off the crystallization process is expensive and utilizes valuable protein reagents that are often time-consuming and costly to produce. These pressures have stimulated many crystallographers to look at implementing new technologies to aid their research efforts and maintain their position as financially independent and viable business units.

TECHNOLOGICAL IMPACT

Technological advances have made new systems readily available to the market, and today there is a wide selection of equipment that can provide the protein crystallographer with the opportunity to improve throughput and increase experimental repeatability. However, the lab manager still faces many challenges. In order to successfully implement a new technology, they must feel confident that the equipment not

only suits the task at hand but is better and more reliable than the manual alternative and can be installed with minimal disruption to workflow. Thus, one of the main objectives is to identify a technology that has enough application flexibility to provide reasonable future-proofing and is fully supported by the vendor. This sounds simple, but in a scientific discipline where precise and difficult-to-automate manual processes dominate, it is no mean feat. Additionally, along the road to technology acceptance, scientists must acknowledge that with automation generally comes a different way of working, and that is not always a bad thing, although occasional compromises must be made.

Technology evaluations should form part of a major discussion between the lab manager and the crystallography research team, to allow assumptions about current processes to be questioned, evaluated, and tested against the new methods. Often, changing the mindset of the laboratory staff is one if the most difficult challenges the laboratory manager faces when implementing new instrumentation and thus it has only really been in the last few years that crystallography automation has been more readily accepted. Previously, most crystallization related work was done more or less manually.

Many laboratory discussions are based around comparisons between person and machine. For example, if a lab predominantly wants to increase the speed of a process, i.e., liquid transfer, it is arguable that a person can be faster than a machine for some operations. However there are other considerations: machines do not tire, their accuracy does not dwindle, they do not pose the health and safety or RSI risks commonly experienced with manual methods, and they repeat experimental steps identically. Conversely, they cannot make informed decisions, and this can limit flexibility. It is important that the lab manager evaluates both the process and potential compromises to establish a more efficient and reliable experimental set-up. Common aims for the protein crystallography lab are to increase sample throughput, minimize expensive protein and reagent consumption, and increase crystallization success with the production of more stable crystals for data collection and structure determination. The screening of protein crystallography conditions is one area where protein consumption is high and experimental procedures are manually intensive. For these reasons, automation can provide many benefits.

FINDING AN AUTOMATED SOLUTION

The automation of crystallization screening presents two main areas of focus: liquid handling for plate set-up and imagers to inspect and record the results of the screens. The general consensus is that the streamlining of both presents significant financial benefits to the protein crystallography laboratory. Consequently, there are two aspects of this process that require consideration by the lab manager and his team. One is obviously time and the need to increase throughput without compromising accuracy. The other is to miniaturize the volumes of valuable protein and reagent solution used to improve cost efficiency. This often means that several strategies can/must be applied. For many larger laboratories, it is common to outsource reagent preparation to save time and improve screening reproducibility with batch consistency. Another option is to source a suitable liquid handler that can accurately pipette small volumes across a range of viscosities.

The selection and implementation of such instrumentation can often be a process of trial and error, as not all liquid handlers can maintain pipetting consistency across different plate types and aspiration volumes can differ with changing viscosities. However, there are instruments that can overcome these issues. A pipetting volume range of 50–1200 nL is ideal for screening crystallization conditions as it allows the set up of many conditions using minimal amounts of protein.

Crystallography groups that have incorporated such instruments into their laboratory workflow have noted many benefits, including a faster and more accurate set-up of drops compared to manual methods used previously, a vast reduction in protein consumption and cost for setting up screening plates, (in some cases nearly 10 times less per condition), screening of more conditions in 96-well SBS-format, and increased reproducibility of all liquid transfer steps. Many experiments, such as hanging drop set-ups, can be implemented in an easier way: mosquito simply places droplets of reservoir condition and protein on the plate seal in a mirror image of the plate, which, when inverted over the plate for sealing, locates each droplet over the correct well.

Additionally, harvesting crystals for successful data collection, using smaller amounts of protein has had real advantages upstream with protein production and purification groups, as some proteins may be particularly difficult to obtain, purify, or remain stable enough for storage. Thus, automation has radically improved the crystallization process. In fact today, the protein crystallography laboratory will frequently automate all or most liquid handling steps, with a large volume dispenser for reagent handling and nanoliter pipettors (often staged at two different temperatures, one at 4 °C and one between 20–24 °C) for screening or optimization set-up.

FIT FOR PURPOSE

There are of course other aspects of the crystallization screening and optimization process that need to be considered, namely the crystallography techniques implemented. Some laboratories have found that through the implementation of liquid handlers — more specifically a nanoliter pipettor — they have been able to improve and modify some crystallization protocols. Although sitting drop is very popular, especially with automated set-ups, there is still a great demand for the hanging drop technique. This is either due to the nature of the protein being used, such as membrane proteins which are notoriously difficult to crystallize, or to the fact that some individuals prefer to screen with hanging drops as this technique is commonly used for the subsequent optimization steps — thus transfer is easier and often more successful. As one of the more time-consuming techniques, automation of this method was not always available, and if it was, it was not necessarily reliable.

For a manager of a crystallography laboratory, whether it be large or small, automated liquid handlers are at the top of the list of "tools to have." As far as automation goes they are not too expensive and, where labs have made the investment, they have benefited on a daily basis from increased experimental consistency. Liquid handlers also offer increased freedom for individuals to do the experiments they want or need to do. Additionally, some laboratories have opted to share both the investment and the use of such technology and can now successfully accommodate many users and optimized laboratory workflows.

In fact, the overall success of liquid handlers can also be measured by general acceptance. Previously, reluctant researchers who may have been less than confident with the idea of trusting a machine to do their work have been pleasantly surprised and adapted their workflow accordingly. This cautiousness is not uncommon and initially laboratory groups can shy away from automation. There is a misconception that automation means filling your laboratory with large integrated systems. Many crystallography facilities across the globe have proved that this is not the case and implemented liquid handlers as separate workstations. Although integration has its benefits in some laboratory set-ups, it can be too expensive and is often unnecessary for the crystallography laboratory. Many managers have found that separate workstations provide a greater flexibility, particularly for multiple user environments. Furthermore, an instrument can be easily removed from the operation for routine maintenance, with minimal disruption to operations. Of course, this is also where the relationship with the vendor, the quality of customer care and technical support, and the ease-of-use of the instrument come into their own.

ATTENTION TO THE FINER DETAILS

The lab manager is not only tasked with reviewing individual processes and how they can be best modified, but also looking at the bigger picture and how changes made to one system may affect another. One good example of this is the use of the microplate, a basic but essential consumable for the protein crystallography lab. Protein crystallography labs have strived to successfully incorporate image-capturing systems to accommodate the increased number of plates and crystallization screens generated. As a consequence they have also had to re-examine the microplates used. A shift from traditional hanging drops manually set-up on glass cover-slips to the use of automation to prepare sitting drops in plates covered with clear adhesive tape, is one such example that no doubt stimulated the adoption of the 96-well sitting drop SBS-format plate. To accompany the changes in crystallography methods and technological advances, consumable providers have recognized an increasing need to manufacture plates that are compatible with plate handling devices, liquid handlers, barcode readers, and imagers. Crystallographers now have the task of identifying the best one for their individual set-up.

LOOKING FORWARD

The protein crystallography lab manager has faced many changes in the last decade. By readily adapting and reorganizing the laboratory infrastructure, and by using the recent technological advances to their advantage, it has been possible to significantly improve the efficiency of the crystallization process to meet the increasing demands. This has been particularly relevant for screening set-ups, where not only has automated instrumentation for liquid handling and image capture been successfully incorporated, but crystallographers have also worked to semi-automate their X-ray data collection. The automation of sample mounting and centering, has helped accommodate the increasing number of crystals coming through for testing using X-ray diffraction. The concept of automation is now more readily accepted and, where implemented so far, for example to miniaturize set-ups, it has benefited many labs, improving project turnaround time and cost efficiency. However, there is always room for improvement. With improved delivery often comes increased demand and the laboratory is expected to continuously improve its output. The demands placed upon the crystallography laboratory will not cease in coming years but instead will change, putting strain on new areas of the crystallization process and producing new bottlenecks. But as automation for crystallography increases in flexibility and sophistication, we can expect to see continued improvements to crystallography set-ups and in turn, throughput and project turnaround. Whether it is through further miniaturization and the incorporation of 384-well formats, development of software for intelligent design and auto-scoring algorithms, fully automated crystal mounting for X-ray diffraction, or the use of in-house or table top synchrotons — only time will tell and the crystallography community waits with anticipation.

***Joby Jenkins** is a Product Manager for TTP LabTech.*

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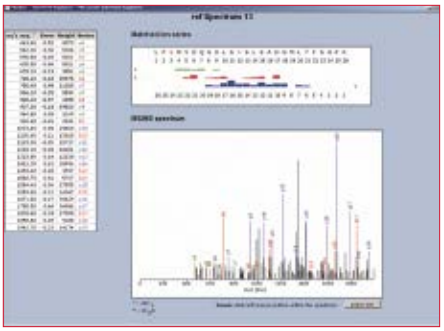

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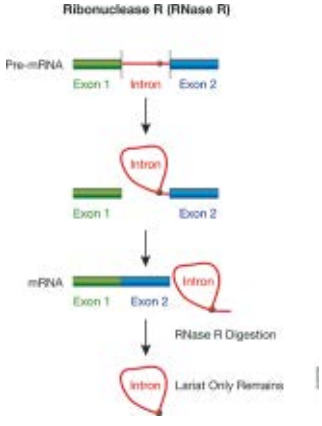

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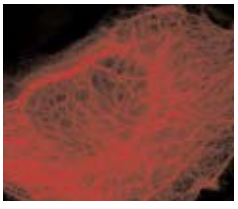

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- How to develop a cost-effective lab safety program
- Ten simple concepts that are critical program components
- How to create and maintain an excellent lab safety program

Dr. James Kaufman is the founder and President/CEO of The Laboratory Safety Institute – an international, non-profit center for safety in science and science education.

Dr. Kaufman is a former ten-year member of the American Chemical Society's (ACS) Council Committee on Chemical Safety and past-chairman of the ACS Division of Chemical Health and Safety. He authored the ACS Audio course on Laboratory Safety, "Safety is Elementary: the new standard for safety in the elementary science classroom", and "Laboratory Safety Guidelines"—distributed by Dow Chemical.

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Writing SOPs Using Flowcharting

So now do we get to start writing an SOP? Not exactly. Anyone can sit down and write steps in a procedure, but the person who outlines and gets the big picture will write an SOP that will really work.

FLOWCHARTING

They say that a picture is worth a thousand words. If that is true then a flowchart must be worth a thousand procedures. Flowcharting can be an invaluable tool for understanding the inner workings of a process or activity to be performed. So what is a flowchart you ask? Flowcharting is a method of graphically describing an existing process or a proposed process by using simple symbols, lines, and words to display pictorially the activities and sequence in a process. Flowcharts graphically represent the activities that make up a process much like a map represents an area of land.

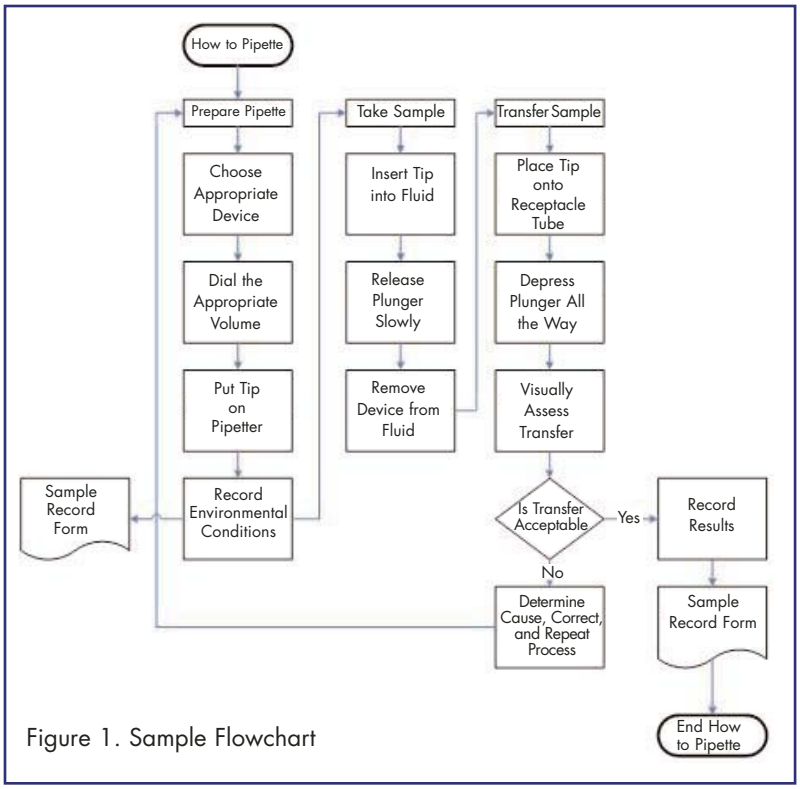

Figure 1. Sample Flowchart

ADVANTAGES AND DISADVANTAGES

Flowcharts are very useful when a process has many decisions or steps. Flowcharts can also take a complex process and break it into several simple steps. As a rule of thumb if you see more than three to five decision blocks in the flowchart consider breaking the SOP into separate documents. Flowcharts come in very handy when quick decisions or actions are needed and reading a textual style SOP is not an option. This is particularly true in emergency or critical situations such as in response to a spill or other lab emergencies.

One of the big disadvantages of flowcharts is they take time to create and maintain. Flowcharts are most helpful when defining a new process or procedure. As time goes on either the text or the flowchart become out of date. This of course opens the organization up to questions during audits and inspections. A common practice is once an SOP has matured (i.e. people are using it without any problems) consider removing either the flowchart or the text. Another disadvantage is that because they are pictorial representations of a process and you can only get so much information on an 8 ½" by 11" sheet of paper, flowcharts often contain minimal detail. And as we all know, the devil is in the details. Therefore, most flowcharts are supported by text which does contain the details.

Norm Moreau, PE

1.0	**How to Pipette**
1.1	***Prepare Pitpette***
1.1.1	**Choose appropriate device**
a.	Select pipette based on range...
b.	...
1.1.2	Dial the appropriate volume
a.	Turn dial until desired volume appears.
b.	...
1.2	***Take Sample***
1.2.1	**Insert tip into fluid**
CAUTION: Do not touch side of bottle with device.	
a.	Insert tip into fluid in bottle to depth expected to tip to fill.
b.	...
1.3	***Transfer Sample***
1.3.3	**Place tip onto receptacle tube**
a.	Place tip onto inside of receptacle tube touching side.
b.	...
2.0	***Recordkeeping***
2.1	**Complete sample Record Form**
2.1.1	**Using SOP 8.23, Sample Records**
a.	Complete sample record as described in SOP.

Figure 2. Sample Outline from Flowchart

FLOWCHART SYMBOLS

Although flowchart symbol standards exist (i.e. ISO, ANSI) people deviate form these standards to suit their own needs. In many cases, individual companies develop standards for their internal use. Below are the five most commonly recognized symbols used in flowcharting:

1. Rectangle for a process or activity,
2. Diamond for decisions,
3. Oval for starting or ending a process,
4. Line with arrow showing the direction of the flow, and
5. Small circle which act as a connector to other flowcharts or sheets.

Another common symbol used in SOPs is the document symbol that shows the need to use another SOP or the requirement to complete a form, or create a record. The simple flowchart in Figure 1 shows use of all the symbols except the small circle. If the"How to Pipette" process led to another process or more detail was shown the small circle (with the connector letter in it e.g., A, B, C…) might be needed.

Look closely at how the sample SOP is laid out. Did you see the outline of the SOP? By dividing the flowchart into three logical major headings: 1) Prepare Pipette, 2) Take Sample, and 3) Transfer Sample, the structure of the written portion of the SOP beginnings to take shape. Figure 2 shows what the "How to Pipette" SOP outline might look like.

Wouldn't you agree that this is a pretty easy method for drafting an SOP? There is a lot more that can be said about creating and using flowcharts. A couple of references are provided below but a web search on flowcharts will yield a wide range of material. Also to make the creating and maintaining of flowcharts easier, there are plenty of flowcharting tools available but that's a topic for another time.

Now we've worked through one method for drafting your SOP. Next time we'll look at a rather unique drafting method called mind mapping.

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Norm Moreau *is a consultant and trainer known for developing SOPs and implementing SOP programs that demonstrate GLP/GMP and nuclear QA compliance. His products and services are used to achieve ISO 9001 registration and ISO 17025 accreditation or by organizations that simply want to improve their operational efficiency and effectiveness. Since 2000, Norm has been offering the Writing SOPs that Work workshop at the National Meetings of the American Association for Laboratory Animal Science (AALAS). He welcomes comments, questions, even criticisms and can be reached at nmoreau@theseuspro.com.*

Glenn Ketcham, CIH and Vince McLeod, CIH

Want a Successful Lab Health and Safety Program?

With these 14 Essential Elements you are Sure to Succeed!

No, this isn't like the hype for one of those trendy diet programs that will magically shed pounds and inches from your waistline or one of those get-rich quick systems featured on late-night infomercials that will allow you to stay home by the pool, work only minutes a day, and triple your income. This is, however, a recipe for success for developing a solid, comprehensive approach to protect your employees from potential hazards in the lab. In past issues we have discussed some of these items as stand alone topics but looking back we realized that we haven't really provided a holistic picture of how a health and safety program should be structured. These 14 elements represent a consensus of opinions of health and safety professionals compiled by the National Safety Council (NSC).[1] This result represents a framework for modeling an effective health and safety program for any workplace or provides a basis for performing gap analysis of your current approach. These elements are compatible and, in fact, may exceed the required basic components of the Chemical Hygiene Plan (CHP) required by OSHA. Remember OSHA establishes minimum requirements; best practices often go beyond these.

Instead of trying to reinvent an already good approach, we will present the same program elements and same order as the NSC with added commentary and explanation. In practice, these are all interrelated and a single issue will generally overlap into many of the elements listed below. So let's get started:

1. **Hazard Recognition, Evaluation, and Control** — This element is key to any health and safety program and is the basis of standard operating procedures (SOPs) required by the CHP. When asked, most people on the street would say is this is what a safety program is all about. This involves proactive hazard recognition in terms of environment (the surroundings of the workers), the people actually doing the work, equipment/materials used in the work process, and processes/practices themselves. A formal "Job Hazard Analysis" assists with the process and is integral to many of the other elements listed below. Once experimental or process hazards have been identified and prioritized, they must be controlled. The generally accepted hierarchy of controls is elimination or substitution, engineering controls, personal protective equipment, and administrative controls.

2. **Workplace Design and Engineering** — We often see failures in regard to this aspect when we are called in to solve a problem. Designing "safety" into a laboratory facility is important. Some of this is already done by building code (e.g., electrical standards, fire suppression, and egress requirements) but other aspects must be consciously addressed, such as ergonomics; ventilation design for containment, comfort and noise levels; power/utility demands for the anticipated work and added reserve capacity; and flexibility should the nature or emphasis of the research change.

3. **Safety Performance Management** — This can be thought of as the measurable actions of people in relation to safety in their work. Performance measurement should reflect how workers, from senior scientists to support staff, are actually doing compared to regulatory requirements and the established lab requirements/culture. This should include a system for individual accountability in meeting those standards within their control.

4. **Regulatory Compliance Management** — Many lab operations must meet OSHA, EPA, FDA, and often, granting agency or accreditation specific standards. Non-compliance can have serious ramifications in terms of financial liability (penalties and fines), institutional reputation, and in some cases the ability to continue operations. It is very important to have a mechanism for staying informed and compliant with existing regulations and standards. It is also very important to keep abreast of new or evolving regulations that will impact your operations. A self-assessment or assessment conducted by an outside party is a good tool for determining level of compliance.

5. **Occupational Health** — The nature and scope of an occupational health program can vary widely from company to company. In laboratory settings, one might expect to find pre-employment health evaluations, periodic medical surveillance, and injury/exposure protocols. A system for management of medical records and coordination with the departments when work related health and safety issues arise is key.

6. **Information Collection** — Information is the lifeblood for proper decision making. Equally important to collection of information is its subsequent management. We have seen situations where long-standing problems existed. These problems were tolerated locally and were not corrected due, in part, to no established mechanism to feed that information to those empowered to make changes. Essentially management was kept in the dark. Much of the safety and health information collected must be managed properly to maintain regulatory compliance.

7. **Employee Involvement** — Employee involvement in a safety and health program generally benefits everyone. The bench scientists and laboratory supervisors may experience issues and recognize problems that might otherwise not make it to the radar screen of management. This also serves as an important bridge for understanding actions taken by the employer in terms of heath and safety.

8. **Motivation, Behavior, and Attitudes** — The goal of this element is to change behavior and attitude to promote a safer and healthier workplace. It places great value on visible management leadership and support for changing unsafe behaviors, attitudes, and work processes. Lab managers should lead by example. One additional key component is providing positive recognition for reinforcement of desired behaviors.

9. **Training and Orientation** — Training can assume a variety of forms from classroom-style to hands-on, from general concepts to task specific. Besides the need for safety training from a regulatory standpoint, it is critical that employees know what to do to perform their jobs correctly and safely.

10. **Organizational Communications** — Communication within the organization keeps employees informed of new and existing policies, procedures, lessons learned, and missions. Likewise, it provides avenues from the front line to upper management for consideration in the development and revision of those polices. The flow of information in both directions is critical for an effective health and safety program.

11. **Management and Control of External Exposures** — This might be considered incident or emergency planning. Plans need to be developed for emergencies. These might include severe weather, incidents stemming from contractor activities, building failures (e.g., water leaks, power failures, etc), or man-made issues such as protestors if the nature of the work contains aspects that are controversial.

12. **Environmental Management** — Environmental management is a broad and complex enough issue that it requires a program of its own. Often there is overlap of duties and as such, environmental management is grouped under the health and safety program umbrella. Issues from proper permitting to preventing potential environmental liability are considered in this element.

13. **Workplace Planning and Staffing** — In providing an effective safety and health program, effective human resource management is critical. It includes development of accurate job descriptions to take into consideration job duties (such as respirator use) that may trigger the need for pre-employment evaluations and medical surveillance. Limiting exposures by administrative controls or other safety considerations (e.g., tasks requiring two people) and development of safety rules would both be considered in this element.

14. **Assessments, Audits, and Evaluations** — These tools provide a measure for how an organization is doing in terms of health and safety. They are used to monitor compliance, behaviors, and provide a yardstick for discerning progress. A variety of tools are required to address these needs. These can be performed by in-house staff, committees, as part of a job task, or with outside consultants. The assessment

results serve as a springboard for improvement.

We have just skimmed the surface. With this discussion we hoped to provide you with a starting point for review of your own program, to identify any holes, and to provide a catalyst to move forward. This approach fits well with many of the process improvement models that organizations have adopted. This may not cause you to lose unwanted pounds, or make you rich without effort, but it will help those you work with return home each night in as good condition as they arrived at work that morning.

References:

1.14 Elements of a Successful Safety and Health Program, National Safety Council 1994

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The Safety Guys welcome your comments and questions. You can email them at thesafetyguys@labmanager.com.

Why a Thorough Background Check has Become a Recruiting Insurance Policy

On a pretty regular basis, business people can witness firsthand a high powered executive's fall from grace because of something they omitted, or more often, something they falsely claimed about their experience, background, and educational credentials.

In the rush to climb the career ladder, it seems that more than a few people prefer the quickest route, no matter what ethical issues they're forced to confront or, more common, those they choose simply to avoid.

Yet despite the myriad ways that resumé fraud can endanger even the most sterling of management careers, failing to conduct a rigorous background check on a new hire can put the hiring organization in serious jeopardy.

One executive recruiter figures that about 16 percent of executive resumés contain false academic claims and/or material omissions relating to their educational experience. But when you account for the fudging of claims of experience unrelated to academic degrees earned, it's easy to see why recruiters generally acknowledge that as many as one-third of management-level resumés contain errors, exaggerations, material omissions, and/or blatent falsehoods.

But given the alarming levels to which some job seekers attempt to mislead, it's especially important for hiring organizations to understand why it's critical they verify what they read on resumés, even at the executive level.

What's even more alarming — and more prevalent than the falsification of one's background and qualifications for a top job — is the number of hiring organizations who fail to conduct a rigorous background check on their new management recruits. Far too many organizations figure that checking a few references is enough.

But even the most thorough of reference checks won't uncover false claims that pre-date those references' own professional interactions with the individual executive. It's quite possible that a fabrication of one's education, certifications, and experience is what got them their first management job many years ago, leaving the trail cold unless it's reopened during the course of a diligent background check.

When it comes to the kind of executive-level hiring that's going to cost the organization into the high six figures to execute, it really comes down to caveat emptor.

It may be tempting to trust that a headhunter will uncover any potential recruiting entanglements during the courtship process; at the end of the day it's entirely up to the hiring organization to know exactly who it is that's being hired. Sure, misrepresentation will cost the unscrupulous executive, but it can also wreak havoc for a company's brand, workforce, and external relations teams.

A thorough background check is an important insurance policy for the recruiting process, and headhunters will tell you that your organization risks getting burned if a manager it hires has, at any time in his or her past, decided to assume the risks associated with conjuring their credentials.

What It Means For Your Career: The truth is that despite all that you've accomplished over the course of your career to this point, your reputation and future employment opportunities could be undone very quickly if you're not honest about your experience. Whatever you might gain in the short-term from exaggerating your professional experience or credentials or omitting something from your work experience may indeed come back to haunt you in the long-term. Give an honest, straightforward accounting of your experience and credentials and you'll never have to waste time reinventing yourself or looking over your shoulder.

Joseph Daniel McCool *is a writer, speaker and independent consultant on workforce management, recruiting best practices, and corporate management succession. He is the author of a forthcoming book about global executive recruitment and its impact on corporate performance, culture and profits and will be a featured presenter at Lab Manager's October 25 Boot Camp. He is also a senior contributing editor with ExecuNet, a leading executive business, recruiting and referral network, and his perspectives on recruiting best practices have been cited in BusinessWeek, The Economist, The Financial Times, The Wall Street Journal and other media around the world. Contact him at JoeMcCool@comcast.net.*

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Safety Meeting Success: Overcoming 7 Common Problems

CHATTERS AND COMPLAINERS IN THE AUDIENCE? HERE ARE A FEW TIPS FOR KEEPING SAFETY MEETINGS (AS WELL AS OTHER TYPES OF MEETINGS) ON TRACK.

There is probably no such thing as a bad safety meeting. Any time people get together to talk about how to work safely, something good has to come out of it. But some safety meetings are certainly better than others. Here's a brief guide to help you avoid common safety meeting problems.

1. THE LATECOMERS

Problem: Latecomers keep everyone waiting for the start of the meeting. Or they disrupt a meeting already underway.

Solution: Set a firm start time for your meeting. And enforce it. Start the meeting promptly at the designated time. Tell latecomers that you'll fill them in on what they missed after class.

2. THE DEPARTMENT OF REDUNDANCY DEPARTMENT

Problem: Each meeting is exactly like the one before it, and the one before that one, and so on and so on.

Solution: Repeating the material may be necessary for learning. But there's a fine line between repetition and echoing. You can make the same points but present them in a variety of ways. Spice things up a bit. Change your approach, change your lesson plan, change your activity, change your tone of voice. Even change your speaker by inviting a guest speaker from time to time.

3. THE SCENE STEALING GIMMICK

Problem: Trainers often use gimmicks such as skits, role-playing, and other dramatic devices to spice up their presentation. This is something that should be encouraged. But don't let the gimmick steal the scene.

Solution: Make sure that whatever gimmicks you use supplement but don't become the message. Keep the focus on communicating the safety information. If a visual aid or prop is stealing the attention, say "this isn't working" and take back control of the meeting.

4. THE GRIPE FEST

Problem: The safety meeting turns into a complaint session in which participants air their grievances about everything from lack of parking spaces to holiday staffing arrangements.

Solution: Although safety sessions should be interactive, they should remain strictly about safety. Don't let irrelevant concerns elbow out the safety message. There's a time and place to discuss other matters. But it's not at your safety meeting. So if somebody raises a non-safety matter, cut off the conversation and bring the discussion back to safety, where it belongs.

Catherine Jones

5. THE HECKLERS

Problem: There may be people in the room who crack jokes or make harassing comments during your presentation.

Solution: Dealing with hecklers isn't easy. Don't get defensive; just smile and keep going. If possible, try to spin the heckler's comments to make them relevant to the point you're trying to make. If the heckling persists, you can turn the tables on the heckler by assigning him or her to conduct the next meeting.

6. THE CHATTERS

Problem: It's not uncommon for individuals to conduct private conversations with each other during a safety presentation.

Solution: There are two ways to approach this problem. If you are moving about while giving your presentation, walk over to the chatters. Often, just by standing by them will be enough to quiet their conversation. Another technique is to draw the chatters in by asking them for their thoughts on the topic. You'll score more points if you can remain polite rather than snappish. But you do need to be firm and keep control over the meeting.

7. INAPPROPRIATE REMARKS

Problem: Sad to say, the world is full of bigots. Sooner or later, one of them might attend one of your meetings and make an ethnic, sexist, religious, racial, or otherwise inappropriate slur.

Solution: Put a stop to this kind of talk immediately. Don't do anything that even remotely suggests approval. For instance, don't smile at a sexist joke even if it draws a big laugh from the participants. There is absolutely no place for this behavior — in a safety meeting or anywhere else within your organization.

Catherine Jones *is the managing editor at Bongarde Media, SafetyXChange's parent company. Before joining Bongarde, she was a freelance writer and editor for consumer publications. Her writing interests include workplace health and wellness, off-the-job safety, and training techniques. She can be reached at catherinej@bongarde.com.*

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Personal Outsourcing for Productivity

Employers use outsourcing to increase productivity and thus profitability. You can do the same to increase your personal profits, productivity, job satisfaction, career advancement, and salary.

OVERCOMING RESOURCE LIMITATIONS

Both large and small firms can lack some of the resources you need. Outsourcing can compensate for this. Having analyses performed at a contract laboratory, government facility, or university can compensate for your employer's lack of specific expensive instrumentation. You could even outsource entire projects. For example, Battelle Memorial Institute has organized an international consortium whose members pay Battelle to periodically collect and analyze commercial household laundry detergents from North America, Europe, and Asia. These analyses enable manufacturers of detergent ingredients to keep up with changing formulation trends without investing the large amounts of time needed to perform the analyses themselves. Even if companies have the resources to do so, time-consuming analyses divert chemists and technicians from new product R&D and manufacturing process development.

Online databases and interlibrary loans can compensate for your corporate library's limitations. So can visiting nearby university libraries. Attending seminars at local universities can compensate for the absence of an outside speaker program at your firm.

Some universities have organized research consortia. Each firm's investment is thus modest. In return for helping fund basic and applied research, lab managers can gain learn about exciting new developments before they are published or presented at conferences. Most of these research consortia have periodic meetings to update the corporate sponsors on developments. In addition to learning about research developments, these meetings also offer opportunities for intellectually stimulating discussions with peers from other companies.

USING CONSULTANTS

Using consultants can overcome the limitations of your employer's technical staff. Being widely read and keeping up-to-date in your field can help you identify potential consultants when a technical problem arises at your firm. By closely watching scientific developments, lab managers can identify rising young "research stars" in various fields that could make excellent consultants for their employer. Whether or not these young academians consult for your firm, they can become valuable members of your professional network.

OUTSOURCE YOUR PROFESSIONAL DEVELOPMENT

Some employers may not be able to offer professional broadening opportunities that can lead to career advancement. You can outsource your professional development by finding these opportunities in professional society and civic association activities. These activities usually don't provide added income. However, they can do wonders for your self-image. The self-confidence associated with accomplishment can be carried back to your job.

Professional societies also offer networking opportunities that enable small company lab scientists to overcome the limitation of having only a limited number of intellectually stimulating coworkers. Professional societies and the contacts they provide can also help you locate consultants and other resources you need.

OUTSOURCING PERSONAL ACTIVITIES

You can also apply outsourcing to time-consuming personal activities. For example, like many lab managers and chemists, I have accumulated a large collection of business cards from researchers and managers, suppliers, customers, professional society contacts, and others. As I devoted more time and effort to writing, I accumulated the business cards of other writers, editors, book agents, and others. Keeping all this paper organized was a challenge. Software such as Act! and Goldmine to manage your contacts is available. The barrier for me was the time needed to transfer information from business cards to the software. However, once this is done, the collection of "business cards" is keyword searchable — must faster than searching through a Rolodex. In addition, as you have dealings with individuals, you can add information to their record.

After the computer program sat unused in my home office for four months, I finally outsourced the project of transferring my business card informa-

John K. Borchardt

tion to a computer. To do this, I hired my neighbor's teenage son. When I come back from a conference with a particularly large number of business cards, I have him add these to the contact database. Another option is a business card reader that can scan business cards and put the information into electronic address books or databases.

You can apply the same strategy to other collections of information such as research papers and reference management software such as Reference Manager.

BECOME AN ENTREPRENEUR

Outsourcing provides many chemists with opportunities to become entrepreneurs by providing services that companies no longer provide for themselves. Many members of the American Chemical Society Division of Small Chemical Businesses are scientists who started their own businesses. Some members of the ACS Division of Chemical Information are entrepreneurs providing literature search services to clients.

Personal outsourcing and the advantages you gain from it are limited only by your own creativity and energy. So get creative!

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

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