WORKFLOW BARRIERS IN SERVICE LABORATORIES

OVERVIEW

In the world of service organizations, laboratories differ very little from retailers, accountants, lawyers, healthcare providers, schools, and other service professions. At any time these types of organizations are vulnerable to delays in service caused by problems related to staff shortages, inadequate material resources, poor workflow designs, and seasonal business shifts. Consider the experience of visiting a doctor's office. Most patients arrive at the time of their scheduled appointments only to sit and wait for twenty, thirty, or forty minutes before an examination room becomes available. After that, the patient might sit another twenty minutes or so waiting to see the doctor. The causes of this level of poor service are many and varied, but the most obvious is that the healthcare provider is experiencing service bottlenecks for one reason or another. Similar workflow bottlenecks also occur in service laboratories, such as environmental, chemical, clinical, metrological, forensic, petrochemical, and specialty labs. These types of labs typically have an established client base and receive a predictable amount of samples each month, with occasional fluctuations occurring during seasonal shifts or large projects. In service laboratories, however, instead of patients accumulating, samples accumulate and this can lead to an increase in job demands beyond the capability of most technicians if the situation is ignored. This sustained work overload has a negative impact on the quality and quantity of work produced by some technicians, who experience anxiety and stress, resulting in inefficiency, substandard performance, and decreased productivity.

Stress and anxiety can occur for any number of reasons on the job. However, the effects of stress and anxiety are nearly universal. Under optimum conditions, a person who is energized and productive might feel a "good" type of stress, which causes the brain to secrete catecholamines, adrenaline, and noradrenaline (Sterrett, 2000). At the right levels, these hormones help us perform well. Under negative conditions, stress creates memory traces in the brain, and when repeated over time, these memory traces can evolve into "superhighways" for negative thoughts (Sterrett, 2000). Under severely negative conditions or during times of boredom, frustration, and anxiety, the brain secretes cortisol, which diminishes logical thinking and increases the possibility of mistakes (Sterrett, 2000). Not only are these extreme physiological responses harmful to a person, they also affect attitude, job performance, quality of work, employee retention, and ultimately the bottom line. A recent survey by the National Institute of Occupational Health and Safety concluded that 40% of workers consider their jobs "very" or "extremely" stressful, and 26% of workers report feelings of being burned out "often" or "very often" (Herman, 2005). This escalation of stress in the workplace is also contributing to higher healthcare costs, more workers' compensation claims, and increases in disability payments. Some employers report spending up to 50% more on healthcare for employees who endure high stress levels (Herman, 2005).

Service laboratory personnel are not immune to the effects of daily stress due to the nature of their work. Many service laboratory jobs have high sample volumes and repetitive tasks. For example, an environmental lab technician might sit in front of a gas chromatograph every day testing sample extracts for a group of compounds, or a medical lab technician may process numerous blood or tissue samples on any given day. These daily routines can be both stressful because of the sample workload and boring because of the repetition. When a technician already has a heavy sample load, a workflow bottleneck only exacerbates the situation. This work overload, combined with other environmental and psychological factors, can create job stress and anxiety. A vicious cycle then takes hold, as depicted in Figure 1.

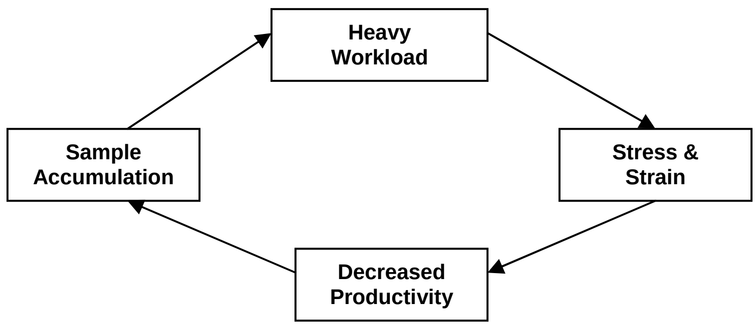

Figure 1: Work Overload Cycle

Fortunately, this type of negative situation is avoidable by applying several types of HFE countermeasures: ensuring adequate personnel resources, hiring the right people, training workers, managing processes, optimizing the laboratory design, applying visual order techniques, regulating the laboratory climate, furnishing the environment with quality materials, maintaining equipment, and upgrading equipment whenever possible. The key lies in attacking the sources of stress and strain to break the cycle.

CAUSES OF WORK OVERLOAD

When analyzing the potential problems that lead to work overload, we must first break down the job demands of a typical service laboratory technician in terms of the following: task type, quantity, and schedule; task environment; and task conditions, including work relationships (Kroemer, 2001). The types of tasks performed by a technician, such as sample preparation, might range from monotonous and repetitive, to complicated and time-consuming. Task quantities are most likely voluminous, and task schedules are driven by customer demands and sample requirements. The task environment, or the physical work area, varies depending on what types of analyses are performed. In general, however, a service laboratory has analytical equipment, fume hoods, sample preparation areas, desks, lab work benches, and all of the standard trappings of a full-service lab. The task conditions are highly dependent on the management structure and the social relationships among the workers. Along with these task-oriented job demands, a technician's individual capabilities, attitude, resiliency, and external sources of stress all affect the dynamics of job performance

(Kroemer, 2001). If job demands do not match an individual's capacity, the potential for overload arises, leading to higher levels of strain and ineffectiveness.

Personnel and Process Management Issues

One of the most important aspects in the operation of a service laboratory is having enough of the right type of people to complete work in a timely manner. Some laboratories hire marginally skilled workers or don't hire enough people in order to cut financial corners. Hiring unqualified workers and maintaining intentional staff shortages increase the probability that samples will not be analyzed in a timely manner, causing a number of interconnected problems: sample backups, customer service delays, analytical errors, reporting errors, and job-related stress. Additionally, technical problems might not be solved in a timely manner, causing further work bottlenecks and delays in customer service. Some laboratories might hire highly qualified workers in sufficient quantities, but many still fall short of promoting further training and education in areas such as problem-solving, process simplification, waste reduction, and other issues that affect productivity (Evans & Lindsay, 2005). Failing to keep close tabs on the production capabilities and professional growth of laboratory personnel can easily contribute to inconsistencies in workflow and the potential for job stress.

Another mistake in the building and growing of a service laboratory is the absence of a rigorous process and data management structure. Some laboratories, just by the very nature of their service, might be required to have documented processes and data management tools in order to obtain accreditations or certifications. Non-accredited laboratories, however, may fail to identify, document, control, and improve critical processes. A number of labs make the mistake of focusing only on their testing processes, or value-creation processes, and they neglect to streamline support processes, such as data management or order entry (Evans & Lindsay, 2005). A lab without some form of Laboratory Information Management System (LIMS) that can automate customer and analytical information is at a greater risk for operational errors, customer service delays, and workflow bottlenecks. Another critical error is in the formal communication process. Some labs handle project management, customer service, and intra-laboratory communications using informal processes. In this situation, technicians might not receive pertinent information about special customer requirements in a timely way, which can lead to irreversible analytical errors. Technical and analytical activities may become uncoordinated and inconsistent, leading to an unstable workflow. Training activities lose effectiveness and bad habits become ingrained in workers. Without adequate process and data management, workflow hindrances generate both internal and external customer dissatisfaction. So, it becomes obvious that from sample receipt to final submittal of the analytical report, ineffective data and process management systems can create serious barriers to productivity.

Defects in the Task Environment

In many cases laboratories just "happen." The launch of a new service laboratory sometimes begins without careful consideration for design requirements. A suitable space is chosen, equipment and materials are procured, and technicians are hired and trained. Initial plans might neglect problems associated with workflow and especially future growth. That being the case, the design of a laboratory has the potential to impede the movements of laboratory personnel, which decreases their efficiency and productivity. The possible design problems vary, ranging from bad layout and small work stations to inflexibility and little room for growth, all of which contribute to inefficiency and reduced productivity. A bad layout simply means that tools, equipment, materials, and samples are not accessible to each other. Small work stations can quickly become overcrowded with equipment and supplies, making it difficult for a technician to find materials and stay organized. Inadequate storage space means that materials, files, notebooks don't have permanent "homes." Stacks of papers, testing supplies, samples, and equipment cram together in disarray, overloading a technician's visual field and preventing a smooth workflow. Inflexible designs and little room for growth inhibit change, either in terms of increases in volume or addition of new equipment. Such flaws in design, size, and arrangement contribute to workflow barriers and unproductiveness.

Disorderly Storage. Another problem related to spatial design is the location and maintenance of general storage areas within a laboratory. Some reagents have special storage requirements. For instance, flammables require special storage cabinets, acids require segregation from bases, and some temperature-sensitive reagents require refrigeration. Quite often, these types of storage areas are placed in remote corners of a laboratory to keep them out of the way. The problem with this arrangement is that reagents and other testing supplies that are stored in isolated locations prevent quick and easy access. Poorly located materials hamper a technician's productivity and efficiency. Furthermore, failure to maintain material inventories causes either supply shortages or overstocks. Chemical storage areas may not be inventoried and cleaned frequently enough, causing a buildup of expired materials. Not only does this build-up impair laboratory functions, it also unnecessarily exposes workers to potential harm. Unstable chemicals might leak, separate, or become otherwise altered after the expiration date, making them more difficult to sort through or dispose of. Furthermore, the accidental use of expired materials might compromise the quality of analytical results. Inaccurate analytical results lead to retesting and additional workload burdens on technicians.

In addition to material storage issues, ineffective storage of customer samples can also impair workflow. Lack of a systematic sample storage procedure generates disorganization and a haphazard approach to workflow, not to mention the potential to lose samples. Sample storage areas become overcrowded when completed samples are not removed in a timely manner and they blend in with incomplete samples. Samples ready for disposal might pile up, further adding to the confusion. The simple task of locating a sample can turn into a thirty-minute rummage through a sea of misplaced samples. Technicians end up wasting time searching for samples, which slows down productivity and adds to their frustration and stress.

Physical Climate Concerns: Temperature, Lighting, Noise. The physical climate also has an affect on productivity and job performance. Depending on the types of analyses performed in a given laboratory, a technician may work in a wide range of temperature conditions. Some laboratory instruments require cool temperatures to function properly, causing discomfort for some workers. More specifically, skin temperatures below 20° C reduce manual dexterity, which could have a detrimental affect on tasks such as pipetting or using a micrometer (Kroemer, 2001). Other types of equipment, such as ovens and hot plates, emit heat, which alters the temperature of the work area, possibly leading to reductions in mental alertness, productivity, and coordination if the worker does not have enough time to acclimate (Kroemer, 2001). Another relevant aspect of the laboratory climate is ventilation, which may or may not be sufficient enough to remove harmful pollutants that adversely affect workers. One particular area of weakness is the fume hood. Fume hoods require at least semi-annual inspections to check for flow rate. Without proper inspections and preventative maintenance, a flow hood will not properly evacuate chemical fumes and other airborne pollutants that can cause health problems and lost productivity in lab technicians.

Lighting may be inadequate, which weakens concentration, decreases productivity, and increases the risk of occupational injuries (ilo.org). In many labs, standard fluorescent overhead lighting provides adequate illumination. Some tasks, however, require supplemental light sources depending on the visual requirements and length of time of the task. For instance, measuring small items with a micrometer for extended periods of time might require some form of task lighting to reduce eye strain. Without supplemental lighting in this type of situation, a technician will not perform at optimum levels and will be exposed to adverse health affects like headaches, nausea, and neck pain (ilo.org). Additionally, laboratory furniture and cabinet surfaces have the potential to produce unwanted glare, which may interfere with a technician's ability to read gauges, instrument panels, markings on glassware, and other visual indicators.

Excessive noise from fixtures and equipment like fume hoods, vacuums, compressors, stirring apparatuses, fans, centrifuges, computers, timers, and other items may also be disruptive. Too much noise over a period of time can interfere with a technician's observational skills and thus diminish the performance of a task (Kroemer, 2001). Abrupt, unexpected noises, like the sudden sound of a buzzer, can interrupt a technician's concentration and interfere with successful task completion (Kroemer, 2001). Individuals respond differently to these types of sounds, but the universal psychological effects of noise include anxiety, inattention, vulnerability, and other responses that break down work performance (Kroemer, 2001). Quite simply, interferences from noise can translate into productivity and workflow barriers.

Physical Surroundings: Furnishings, Instruments, & Tools. Desks, chairs, lab benches, and other furniture might be outdated and uncomfortable, further adding to increased stress levels and impaired functioning of lab technicians. The arrangement of work areas and the furnishings might not be ergonomically sound, creating a number of risk factors for fatigue or even cumulative trauma disorders (CTDs). Technicians will be at risk if their physical environments force them to do any of the following for extended periods of time or in repetition: tilt neck forward or backward, bend wrist up or down, extend arms, lean, experience insufficient leg clearance, reach, assume static postures, exert excessive force, and endure contact pressures (llnl.gov). Not only will these risk factors affect worker health, they will also decrease productivity due to fatigue, which is another contributor to work backlogs.

In addition to inadequate laboratory furniture, outdated instruments and other equipment can contribute to decreased productivity and stress. Older instruments have fewer capabilities, tend to break down more, and are more difficult to calibrate, maintain, and repair. Replacement parts might be harder to find, which increases down time and adds to work backups. Other types of outdated equipment might have problems like worn-out markings, stains, loose fittings, loose wires, structural weaknesses, accumulations of grime, and basic design flaws. The cost of doing business with outdated, worn-out instruments and equipment is probably higher than the replacement costs in terms of down time, productivity, and ultimately worker stress.

COUNTERMEASURES TO WORK OVERLOAD

The question that begs to be answered is what types of HFE countermeasures will help solve the dilemma of preventing the workflow bottlenecks in service laboratories that lead to worker stress, anxiety, and degraded performance? The quick and easy answer is to ensure that workload does not exceed the psychological and physical capabilities of the workers, but finding that balance requires an in-depth look at the underlying reasons for the bottlenecks. We can only solve the problem by first identifying systematic or environmental weaknesses in task conditions, then correcting and/or preventing those weaknesses before work overloads take a mental and physical toll on laboratory personnel.

People and Processes First

First, laboratories need to address the personnel component of task conditions by hiring qualified technicians who have the personality traits that make them suitable for laboratory work. Desirable qualifications vary, depending on the type of laboratory, but suitable technicians will generally have at least some college education and some experience in a scientific setting. Hiring managers need not only focus on education and work experience to fill laboratory positions. They must also seek candidates with specific personality traits that fit well within their specific laboratory. Lab managers need to understand their organizational needs and know which types of traits are absolutely necessary in a technician versus those that are absolutely unacceptable (Barker, 2003). To start with, scientific employees share some common characteristics that make them suitable for different types of laboratory jobs. In general, scientists are achievement-oriented, prone to restlessness, selective about job tasks, inclined to seek job autonomy, eager for new challenges, and more productive when given a variety of duties (Davis, 1977). Even with these generalized common characteristics, not every technician will adapt to a fast-paced service laboratory. By recognizing that scientists share some common traits, yet have different degrees of adaptability, hiring managers take the initial steps towards creating job satisfaction for their employees and avoiding the stress and anxiety associated with job dissatisfaction.

Once a laboratory has qualified staff members, managers need to be vigilant in maintaining staff levels to avoid detrimental shortages, which have a significant affect on the balance between workload and available resources. Managers must also provide on-going training and education in order to add to organizational capabilities (Evans, Lindsay 2005). Furthermore, cross-training and worker rotation schedules will not only increase personnel resources but will also relieve boredom and monotony. A first-rate laboratory does not stagnate and will change over time, especially with regard to personnel. As workload increases or becomes more sophisticated, the laboratory will need more technicians, some more skilled than others. A determination of man-hour requirements can help create an idea of how many workers are needed at different skill levels. Spreading out the workload reduces task quantities among workers and controls task schedules. Managers must also stay on the alert for signs of burnout, which include exhaustion, anger at decision-makers, cynicism, negativity, suspiciousness, headaches, feelings of being overwhelmed, and sensitivity to inconsequential issues (Neils, 2005). A shrewd laboratory manager will work to prevent burnout by maintaining adequate staff levels, yet will provide solid solutions to handle burnout if it is detected.

Effective data and process management can help mitigate workflow problems by streamlining and automating work functions (Gillespie, 1994). The key to finding the problems is by documenting work processes. Flowcharts, for example, are excellent tools for mapping out work processes and determining whether or not the processes have extraneous steps. A customer-focused lab defines, documents, and manages value-creation and support processes (Evans & Linsay, 2005). The primary value-creation process in a service laboratory is sample analysis, and this process should receive special attention. The sample analysis process should have tight controls to ensure data accuracy, efficiency, and timely customer service. Examples of analytical process measurements might include quantifying the number of retested samples, the number of non-conformances, periodic check samples, average turnaround time, and instrument down time. By measuring these types of elements, management can better implement formal controls. A superior service lab also works on streamlining support processes, particularly the sample receipt and log-in process, which is highly prone to errors. Processes should be in place for requirements involving sample chain-of-custodies, special customer requirements, damaged samples, mislabeled samples, incomplete sample information, turnaround times, new customers, communication of changes, and any other extraordinary circumstances. Additionally, a modern lab will have some form of LIMS that can automate customer and analytical information in order to avoid errors, customer service delays, and workflow bottlenecks. With the latest LIMS software and documented processes, a service laboratory has the potential to speed up workflow by nearly 30% (Gillespie, 1994). Such improvements can only lead to decreases in productivity barriers and worker stress.

Task Environment

Beyond personnel requirements, a good laboratory incorporates a number of design requirements that facilitate workflow and provide a healthy work environment for employees. Laboratories are no longer stereotyped as dark, isolated, cavernous rooms filled with bubbling concoctions and wild-eyed scientists. Instead, new, modern laboratories feature worker-friendly designs that have open spaces, windows, natural lighting, and flexible work stations (Fiske, 2000). For instance, Penn state's new Biomedical Research Building is not only visually aesthetic inside and out, but it is also designed to encourage team interaction, to allow room for expansion, and to increase the efficiency of usable space by 13% more than the old building (Fiske, 2000). These types of advances stimulate workers and increase productivity simply by providing an environment that removes productivity barriers, which in turn relieves stress and creates a happier work force.

The most obvious way to combat other design problems, such as a bad layout, small work stations, and inflexibility, is through careful planning in the design stage of building a laboratory. Modern service laboratories incorporate a number of design features that facilitate productivity, collaboration, and flexibility: open spaces, natural lighting, semi-permanent walls, high-quality building materials, multifunctional work spaces, appealing laboratory furniture, whiteboards, and other specialty amenities (Romig, 2005). In further analyzing the design of work spaces, modern laboratories are designed to increase multi-functionalism, which is the solution to having maximum efficiency (Romig, 2005). In the real world, however, service laboratories are more or less pieced together without much thought for growth or change. With that in mind, the next best option is to reorganize the layout and work stations based on the organization's philosophical and practical framework (Barker, 2003). Employees need to get involved in improving work areas, since they know best what types of arrangements will allow them to practice efficient work habits.

Storage & Organization: Lab 5S. One approach to improving work areas in a service laboratory is the application of the Japanese concept of 5S, or visual order. Visual order is typically used in factories, but any type of business can benefit from implementing visual order because it reduces non-value-added motion (Galsworth, 1997). A visually ordered service laboratory will be clean, safe, and uncluttered. Work stations will only contain the most essential tools and materials, nothing more, nothing less. Chemicals, reagents, testing supplies, notebooks, and other equipment will be properly labeled with names, safety information, expiration dates, calibration dates, and location information. Non-essential supplies, chemical or non-chemical, will be properly organized and stored in labeled drawers, cabinets, freezers, and refrigerators that are out of the immediate work area, yet easily accessible when needed. A healthy lab will also have a chemical hygiene plan that addresses maintenance and disposal of chemical stocks. Customer samples will be properly stored in labeled storage facilities according to receipt date, turn-around time, and/or sample matrix. Work in progress (WIP) will be segregated from finished work, and procedures will be in place for sample disposal. A visual service laboratory will also use color-coding, not only for the identification of hazardous and non-hazardous substances, but also for helping workers easily identify storage areas, work items, internal borders, functional areas, waste disposal, and WIP (Galsworth, 1997). The implementation of visual order reduces unnecessary motion, which generates a smoother workflow, greater productivity, and fewer opportunities for bottlenecks.

Refining the Work Climate: Temperature, Lighting & Noise. Temperature controls are another area of improvement that can add to worker comfort and increase productivity. Any good laboratory should have temperature controls to regulate the macroclimate of the entire facility, but unique work zones may require separate controls, usually to keep instruments cool. In this situation, it is best to minimize the time technicians spend in cooler rooms by moving certain tasks, like data reporting, to more comfortable sections of the lab. Frequent breaks will also help alleviate the affects of working in cooler temperatures. On the opposite end of the temperature spectrum, heat-emitting equipment, such as hotplates and ovens, should be kept off when not in use to avoid overheating a technician's microclimate. Whenever possible, heat-emitting equipment should also be situated away from heavily-used work areas to avoid uncomfortable task conditions and, more importantly, burns. These temperature-control practices support the comfort of workers who can then focus on their jobs and maintain productivity.

Lighting problems in a laboratory may not require expensive solutions. Lab workers can provide valuable feedback about areas that need improvement, particularly if the workers suffer from eye-strain. Some specific ways to improve general or task-specific lighting might include one or more of the following:

- Full use of natural light where practical
- Blinds, curtains, or louvers on windows for control of daylight
- Use of light-colored paints on walls and ceilings
- Mixture of direct and reflected light to help reduce glare
- Use of backlighting to help distinguish objects from backgrounds
- Simple backgrounds at work stations (i.e., limit number of charts, posters)
- Maintenance schedule for cleaning light fixtures and replacing bulbs

These countermeasures are low-cost and they promote a healthier work environment by reducing fatigue, increasing productivity, and relieving workload demands (ilo.org).

Along with temperature and lighting controls, noise abatement in a service laboratory poses a considerable challenge because the lab is usually bustling with the activity of workers and noisy equipment. In spite of this, noise controls are possible. The first line of defense against noise in the lab is to avoid generating it by maintaining equipment and/or upgrading to "quieter" models whenever possible (Kroemer, 2001). Dirty vacuum pumps and old timers are good candidates for preventative maintenance or replacement. The second line of defense is to dampen the source of the noise by insulating, distancing, or enclosing the offending source (Kroemer, 2001). For instance, the noise from an air compressor could be dampened by moving the compressor outdoors or enclosing it in an insulated cabinet. The third line of defense is to reduce time spent in noisy areas by allowing frequent breaks or by scheduling tasks in other rooms (Kroemer, 2001). The last line of defense is the use of hearing protection devices (HPDs), such as earplugs or earmuffs (Kroemer, 2001). Protecting laboratory workers against the fatiguing affects of noise will help them concentrate better and be more productive, which positively impacts workflow.

Physical Surroundings: Furnishings, Instruments & Tools. Laboratory furnishings, instruments, and tools have a significant impact on the physical and psychological states of lab technicians. Worn out, outdated, or ill-fitting lab furnishings are not only uncomfortable but also unappealing. Just like everyone else, lab technicians want to work with and around high-quality, ergonomically sound lab furnishings. Beneficial countermeasures against discomfort, fatigue, and possible CTD's include anti-fatigue mats, foot rests, adjustable ergo-task chairs, removable drawers, and laboratory workbenches of different heights for precision, light, or heavy work (niehs.nih.gov). Shelving units should be positioned to reduce overhead lifting, excessive reaching, and asymmetric lifting, and laboratory hoods should provide enough room for work materials to be within easy reach (niehs.nih.gov). These types of countermeasures diminish the risk factors for work-related injuries while increasing efficiency and productivity.

Modern, well-maintained instruments and tools contribute to productivity as well. Modern instruments are more automated, multifunctional in many cases, often smaller, and more user-friendly than older instruments. The main benefits of moving towards automation include accelerating service, eliminating human errors, and handling large numbers of samples (trueforce.com). Apart from improving through automation, keeping instruments and tools well-maintained means fewer equipment failures. This reduces incidents of down time and lost productivity, further eliminating potential sources of bottlenecks. Quality-oriented laboratories will have procedures in place for preventative and corrective maintenance, and they maintain service contracts with their instrument suppliers to avoid costly down time and workflow barriers.

CONCLUSION

No matter how well a service laboratory is run, they all have the potential for workflow bottlenecks. What matters is how those bottlenecks are handled. Ignored, they only get worse, resulting in stressed-out workers, absenteeism, decreased productivity, and high employee turnover. Looked after, they free up, and workflow becomes streamlined, allowing technicians to perform at optimum levels. The successful, quality-oriented, customer-focused labs will have preventative measures in place to handle unexpected obstructions to workflow: large projects, seasonal variances, personnel changes, and growth. Unfortunately for the other labs, there are no pre-packaged solutions for the workflow bottlenecks that cause job stress and degraded performance in lab technicians. Since all service laboratories are unique, they must have a tailored approach to breaking the work overload cycle. Managers and technicians must work together to investigate processes and find the sources of productivity barriers, or suffer the consequences of constantly working to catch up. Just like the human heart cannot sustain its customers (brain, lungs, liver, etc.) when it has arterial blockages, the service laboratory cannot support its customers when it has sample blockages.

REFERENCES

Barker, K. (July, 2003). At the Helm: Avoiding Management Mistakes. *Science Magazine*. Retrieved November 9, 2005 from http://sciencecareers.sciencemag.org/layout/set/print/career_development

Davis, K. (1977). Human Behavior at Work. New York: McGraw-Hill.

Evans, J. & Lindsay, W. (2005). *The Management and Control of Quality.* Ohio: Thomson/South-Western.

Fiske, D. (August, 2000). New Approaches to Laboratory Design. *Architecture Week*, page D1.1. Retrieved October 22, 2005 from http://www.architectureweek.com/2000/0802/design_1-1.html

Galsworth, G. (1997). *Visual Systems.* New York: AMACOM.

Gillespie, H. Documented Processes Improve Data Management. Retrieved October 22, 2005 from http://209.15.62.20/library/limszine/sca_ldm/ldm1094.html

Herman, R. Stress on the Job: Is It Driving Up Your Turnover Rates? Retrieved October 20, 2005 from http://www.employee.org/article_stress_on_job.html

Kroemer, K., Kroemer, H., Kroemer-Elbert, K. (2001). *Ergonomics: How to Design for Ease and Efficiency*, 2nd Edition. New Jersey: Prentice-Hall.

Neils, H. Symptoms of Burnout. Retrieved November 9, 2005 from http://www.assessment.com/mappmembers/avoidingburnout.asp

Romig, J. (2005). How to Promote Interaction Without Sacrificing Efficiency, *R&D Magazine*. Retrieved October 22, 2005 from http://www.labdesignnews.com/Laboratory Design/HB05_Chap5_1.asp

Sterrett, E. (2000). *The Manager's Pocket Guide to Emotional Intelligence*. Massachusetts: HRD Press.

Authorless Internet Sources

http://www.llnl.gov/ergo/lab_risk.html

http://www.niehs.nih.gov/odhsb/ergoguid/home.htm

http://www.ilo.org/public/english/protection/safework/hazard/ergono/lighting.pdf

http://trueforce.com/Lab_Automation/laboratory_automation.htm