Process Improvement for Laboratories

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Process improvement is a concept commonly used to describe or justify unsolicited changes to the way we do our work. You could probably ask anyone in your workspace if they are familiar with process improvement and receive a nod and possibly an eye roll. Even though process improvement is a common phrase, it is not always common practice. Your lab could be missing out by not incorporating process improvement. This paper presents process improvement concepts specific to the metrology laboratory environment and discussed the benefit of implementing process improvements.

The Requirement

Laboratories are familiar with ISO/IEC 17025: 2017, General requirements for the competence of testing and calibration laboratories, which includes requirements to accomplish process improvement. They are as follows:

5.6.a: *The laboratory shall have personnel who, irrespective of other responsibilities, have the authority and resources needed to carry out their duties, including implementation, maintenance and improvement of the management system.*

8.6: *The laboratory shall identify and select opportunities for improvement and implement any necessary actions. Opportunities for improvement can be identified through the review of the operational procedures, the use of the policies, overall objectives, audit results, corrective actions, management review, suggestions from personnel, risk assessment, analysis of data, and proficiency testing results.*

8.9.2: *The inputs to the management review shall be recorded and shall include information related to the following: effectiveness of any implemented improvements.*

Continual monitoring, improving and implementing updated processes are required elements of a laboratory's quality system. The ISO standard requires the organization to consider not only how the floor operations work, but also the entire management process. This includes soliciting customer feedback and implementing changes to address the customers' needs. This paper provides some ideas for labs to consider implementing to meet this requirement.

Management

Management sets the pace for production, influences morale and controls the processes implemented. Management decisions directly affect the production in the lab. For this

reason, it is paramount to have buy-in at the management level for continual process monitoring and improvement.

If you work in management, you probably do not have enough time in your workday to get to everything needing your attention. As soon as you come in the door, people are waiting at your desk, needing you to address some urgent requirement. Your e-mail inbox is flooded with questions, actions and concerns from customers, staff, and employees. Having the luxury of sitting in a conference room, strategizing about how to optimize business processes seems like an impossibility. Spending time thinking about how to prevent problems that have not yet occurred does not address the immediate issues that need to be resolved. While strategic planning is important, it is not urgent, so it not prioritized.

Future planning is important. Continual process monitoring and improvement is essential for the health of any business. The following time saving suggestions for managers are presented for consideration, to free up some time in the schedule to think about how to proactively improve processes and increase productivity, efficiency and quality.

E-mail as a Constraint

Checking e-mail is the easiest way to derail a well-planned day. It is very common to start the workday by checking e-mail, because it requires very little prep time. In addition, when there is a break in the schedule during the day, reading e-mails is an easy way to fill the time. It is typical to have pop up notifications of incoming messages, so that even while personnel are meeting face-to-face with coworkers, they are distracted by incoming messages. Priorities can be shifted multiple times a day based on incoming messages.

In the book *Getting Things Done,* author David Allen provides a few simple tips. He recommends setting aside a specific time of day to review e-mails. While scrolling through the e-mails, if an action takes more than two minutes to complete, set it aside. It will be placed into a prioritization scheme discussed in the following section. If an action takes less than two minutes to complete, finish the action required in the e-mail, such as providing a response, answering a question, or delegating an action. Mute the e-mail notifications for the rest of the day. Turn off the pop-up notifications, as well as the icon changing on your inbox when incoming mail arrives. This will allow you to focus on the tasks you previously prioritized, vice intermittent incoming interruptions.

ABC Prioritization

Brian Tracy's book *Eat that Frog* starts out by stating: "You are overwhelmed with too much to do and too little time. You will never be able to do everything you have to do. You will never be caught up. You will always be behind on your tasks and responsibilities. The

need to be selective on your most important task will have more of an impact on your success than any skill you develop." This book was written over twenty years ago and it still holds true today. Brian Tracy provides a prioritization system that can be implemented by management to effectively allow for control of an individual's own time instead of being held hostage by the agenda of others. He calls the top priorities "eating the frog". His concept is if you are required to do something as unsavory as eating a frog in a day, you should accomplish it first and get it over with.

- **A: Top Priority Tasks That You Must Do**: Tasks designated with an "A" are the "frogs" that must be "eaten", or attacked first. These tasks can only be accomplished by the specific individual. These are also what a specific person, or management, is directly paid to do. Be mindful that sometimes a task may seem only accomplishable by one individual, yet it might be possible for someone else to do it. In fact, they might be able to do it even better.
- **B: Tasks You "Should" Do**: "B" tasks are important but not urgent, and, similar to A, can only be accomplished by a specific individual. These do not dominate the current day priorities but will need to be accomplished. This is where some of the e-mails that take longer than two minutes to address should fall into. These may eventually become "A" tasks at some point. The key take away is this, however- Do not accomplish a "B" task when there are still "A" tasks in the queue.
- **C: Tasks with No Consequence If They Are Not Accomplished**: These are tasks with nice-to-have results but they will not make a positive impact on the current requirement or throughput goal. There are several e-mails that also fall into this category.
- **D: Tasks That Can Be Delegated**: As mentioned under task "A", some things may seem like only one individual can accomplish them, but they may be able to be delegated to someone who would be better suited for the task. For example, there may be a database that requires review, and it has significant formatting that is still required. Although management may be very proficient in that platform, it may make more sense for an associate, who is an expert, to modify it and then submit to management for a final review. The associate may actually be the better person assigned for full responsibility of that database.
- **E: Tasks that can be eliminated:** These are tasks that arrive at management's desk that may no longer be relevant or timely. Consider putting tasks in this category to help streamline your day.

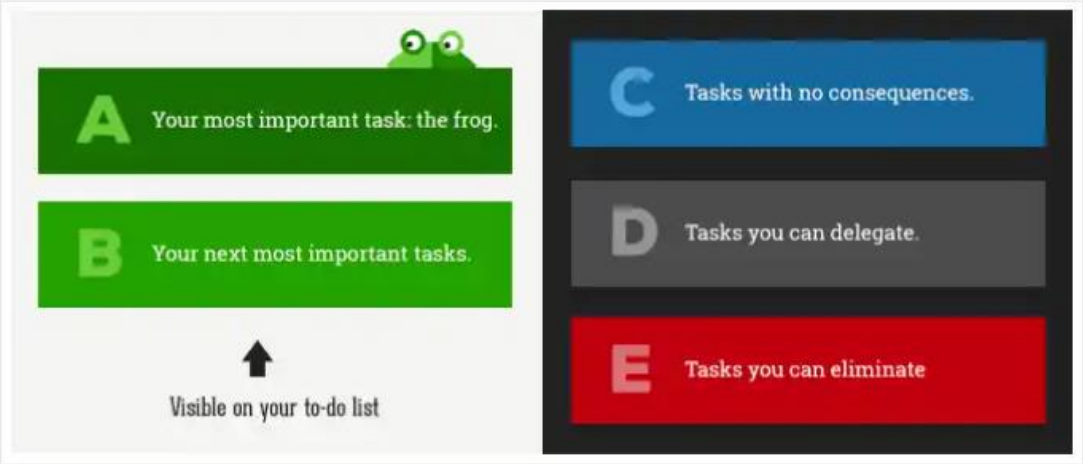

Figure 1. Eat that Frog Prioritization

These are a few tips that can help supervisors manage their day. By managing tasking and workflow, the manager can have time to focus on the needs of their employees and ensure the end goal of throughput is accomplished. Time with employees can also be assessed and streamlined as well.

Meetings

There is a meme commonly shared that is relevant to the common workplace. "I survived another meeting that should have been an e-mail". Almost everyone can relate to attending a meeting that did not seem worth the time given and the cost of having everyone sitting in the room together. Meetings can be productive, effective and worthwhile, but only if some consideration is given to them in advance.

In the *Pendaran Method* developed by Hossein Nivi and Carol Michaelides, meetings are a critical component that require modification for effective use. In this method, there are three critical roles within the meeting.

- **The Facilitator:** The facilitator keeps the meeting on track. They go in with a specific agenda and ensure the topic does not stray. If people have additional concerns that do not relate to the direct topic of the meeting, the facilitator ensures they are documented by the scribe for a later time. The facilitator is not necessarily the manager, but will ensure the manager is able to convey his information and that the members present are engaged and have any issues clarified as applicable.
- **The Scribe:** The scribe documents all notes for the meeting. They may also establish key information on a displayed board prior to the meeting occurring and ensure all applicable documentation is readily available.
- **The Timekeeper:** The timekeeper ensures the meeting is only accomplished for the prescribed time. The timekeeper may countdown to ensure the facilitator keeps the meeting on track to end on time.

If a laboratory is small, it may seem a challenge to establish these key roles, but they can be easily understood and implemented. If standardized into laboratory meetings, the participants can enter the meeting with clear expectations and readily accomplish whatever issue needs to be discussed.

If a meeting recurs weekly, such as a production meeting, or the managerial review, management can ensure the meeting is standardized. For example, instead of just setting a weekly time to meet with a loose agenda, the manager can request each person to present on their topic and tell them in advance what they are expecting to hear. For example, in the loose agenda production meeting, the manager may ask the production controller random questions, such as how much work has come in, and have there been any priorities that arrived in the past week. In the standardized, focused production meeting, the production controller is already aware of what the manager would like to know and comes prepared to present on all topics that are expected. The production controller shares the information without being prompted by inquiries from the manager. This engages everyone attending the meeting as they have deliverables to present. It is also an easy way to phase out attendees who do not need to participate on a recurring basis.

Employee Mindset

Management can control a lot within the workplace. From the work processes, production, meetings, morale, and customer satisfaction, it all falls within the scope of managerial responsibilities. It can seem burdensome, especially if one feels the responsibility to make it all happen. So, again, when does the manager have time to sit down and look at all the processes and determine if something should be changed? The answer is simple, they cannot and should not. Instead, they should seek and receive insight from the members that are essential to the daily processes.

If management develops a culture of ownership within the lab, then it can be easy to implement the concept of process improvement. If members of the laboratory team believe that they are an important contributor to the team, and know that management will take their feedback seriously, then they will offer it more freely. It is vital to establish the mindset of ownership at all levels. Here are some basic concepts that can be applied to help change from a stagnant culture to an ever-changing one.

The 2 Second Lean Concept

The *2 Second Lean* concept was written and developed by Paul Akers. He takes the complicated process of Lean Six Sigma/ Continual Process Improvement and simplifies it into this basic concept: “What changes can you make today that will cut your process down by two seconds?” For example, if one has to walk over to sign a document each day that is set in a corner of the office, consider moving it closer, or near a main access point that would reduce the process by two seconds. Here are some examples of other quick two-second changes:

- Storing highly used files on a shared drive in an easy to find location. Ensuring all team members have a link to that file on their desktop. This ensures people won't keep asking/looking "where are those files at again?"
- Using painters tape and markers at an artifact storage location so that boxes that are staged can be marked with a temporary indicator. This prevents opening and re-opening of boxes to see what is in them.
- Using the signature options in outlook to develop pre-populated responses for emails that go out frequently, such as shipping requests, funding requests, and monthly notifications.

This works at a micro and macro level. If one can implement these small changes within one's own environment it can really cut out waste in the day. The next level is to get everyone considering the following the question on a daily basis: "Where do I see waste and where can I reduce it?" If two-second improvements are made at all levels on a daily or weekly basis, the results are compounded significantly.

Empower Employees to Make Changes

A lot occurs in a lab that is not seen. There are many things written in an SOP, many processes that are standardized and strictly followed. Many of these processes may not work very well. There is a common saying that "Today's problems are yesterday's solutions". The technician on the bench may have in-depth knowledge of burdensome processes, or those that are not value-added, but does not feel that his/her opinion matters. A production controller may be new to the laboratory and have excellent ideas on how to streamline a process, but because he/she is new, the employee is too timid to share his/her thoughts. However, if management has made it well known that ideas and feedback are accepted and expected, it will allow for more personnel to open up. If feedback is frequently sought by management and the suggested changes are implemented, it will encourage more employees to share their insight. This is a culture change is not easy, but once it is understood, it will allow for a snowball of process improvements to occur.

Try Out Bad Solutions and Re-do Them

It can be tempting to give up on process improvement when a change was made in the past, and it had negative results. Instead of abandoning the idea of process improvement, what should be done is to reconsider the change that occurred, to establish a feedback loop to see if it was a good change or a poor one, and address the change if it simply didn't work. It may take several attempts at a new idea to get it right. If team members are encouraged to suggest changes and provide feedback if an implemented change really isn't working, then problems can quickly and openly be corrected. Going back to "Today's problems are yesterday's solutions", the best way to avoid this is to keep going back and considering if the change was the right one. If it wasn't, there should be no stigma for attempting and failing.

Regarding weekly production meetings, this topic of *2 Second Lean* could be an item that is presented. Two-second leans accomplished in the lab, as well as rectifying changes that don't seem to be working out well can have a significant impact on productivity. If management has set up the meeting in a way that these metrics are expected, they may be delivered more freely and quickly.

One last consideration for the 2 *Second Lean* process as described by Paul Akers is to document it, via photos or videos, before and after. If the changes are captured and can be visually seen, it will encourage the team members of the lab to keep searching for waste within the lab's processes and remove it.

Outside Opinions

One last consideration for management is to seek the advice of outsiders. During Steven Johnson's TED talk *Where Ideas Come From,* he discusses how the development of coffee houses really initiated a creative culture. One of the thoughts as to why coffee houses are such an innovative environment is that within them exists focused (caffeinated vice intoxicated) people that come from various backgrounds and have their own perspectives to share for idea creation. This concept can work within the laboratory environment. It may be ideal to invite an outsider with no knowledge of the metrology laboratory process into the lab. They would have no idea why things are done the way that they are, and they wouldn't be afraid to ask the "dumb" questions about certain processes. In fact, they may bring in insight that was never considered. If they are from an accounting background, they may have ideas to improve a funding process. If they have a creative background they may see how the work environment could be revamped for increased flow of product. This can be an enjoyable way to safely get constructive feedback on how a laboratory is performing and get a fresh look at if the process currently implemented really makes logical sense.

As part of the management team there can be various items to consider and implement. If management can streamline and protect their own time, while enabling the laboratory team to take ownership as well, the end goal of throughput can significantly be increased.

Process in the Lab

With continual process improvement comes many standardized tools. The following section presents these tools and how they can be specifically applied to a metrology laboratory environment.

Spaghetti Charting the Lab

A spaghetti chart is a method for visually seeing how much *Muda,* or waste, exists in the layout of the lab. This can be done by putting a map on the wall of the space, and having a participant use a measuring wheel and follow specific members of the lab around as they

work their typical processes in a day. The distance and route is then placed on the layout board. This method makes it incredibly easy to see what waste is occurring in the daily process of the lab.

Considerations for cleaning up a spaghetti chart:

- What job is each member accomplishing at that time? Is this the right person to be accomplishing it considering his/her pay and priorities?
- Does the repository of equipment, tools and assets make sense for the layout? Should the storing and staging of equipment be modified to increase the flow of work?

Once the spaghetti chart is developed and new ideas and processes implemented, it can be beneficial to redraw the spaghetti chart to visually document the improved process. As mentioned previously, if a new attempt at a layout does not work as effectively as planned, the laboratory should be mindful and willing to shift in a new direction or even revert back if needed.

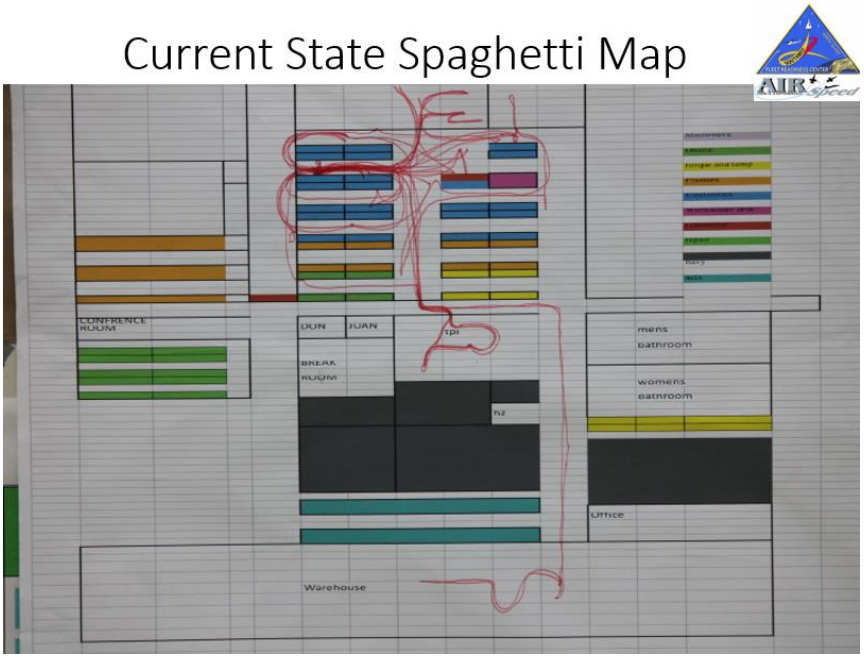

Figure 2. Example of a Current State Spaghetti Map

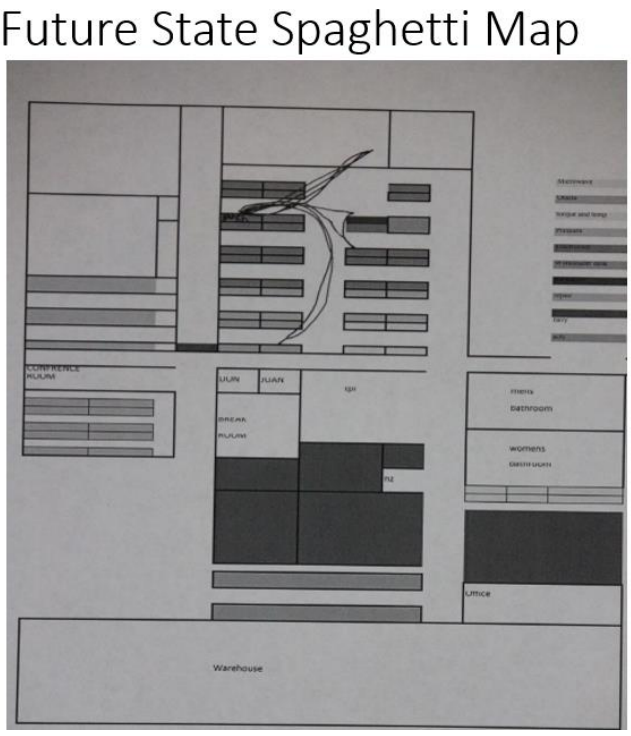

Figure 3. Example of a Future State Spaghetti Map

5S

5S stands for the following: Sort, Straighten, Shine, Standardize, Sustain. These concepts can be implemented within a laboratory space.

- **Sort**- Ask employees to remove everything from their designated workspaces. They will have to touch each asset and determine if it should go back in the space. This works better than inventorying as you remove items because participants will be less likely to put an item back that has already been removed vice removing an item. Some metrology considerations are for dirty/old connectors/adapters, FOD (foreign object debris), less frequently used equipment and ancillary devices, and any documentation/equipment that may result in an audit finding. It is common for technicians to keep all types of connectors and items "just in case"; however, this may be cluttering the workspace. Employees should determine whether the equipment should kept in close quarters, kept in a separate location or removed.
- **Straighten**- This is a complement to sorting. Straightening is tailored to the individual's preferences and needs for their niche workload. If the space is designated for unique equipment only, it should be organized and set up that way, free from obstructions and distractions unrelated to the workload. An example is a microwave station. Standards that are not typically used for microwave should be removed, while commonly used tools, such as gage connector kits and torque wrenches should have a designated spot at the test station.

- **Shine**- This relates to general housekeeping. A metrology application is to consider the location of assets on the bench in regards to contamination of filters, or overheating of the equipment (for example, do not place a 3458A DMM under heavy/hot equipment).
- **Standardize**- If technicians move from workbench to workbench, they should have a standardized location for readily required tools so that the process is easily implemented and followed. For example, required tools for each test stand should be labeled and placed consistently at each test bench (as applicable/ergonomic). If tools are frequently used with various requirements, such as thread plugs, clearly organized bins can be helpful. This is where two-second lean can be frequently implemented.
- **Sustain**- for a 5S process to be effective, it has to be sustainable. If items shift back into disarray, the standardization should be reassessed. A good 5S should make it easy for a user to place items back in designated spots, with clear visual indications.

Figure 4. Examples of before 5S

Figure 5. Examples of after 5S

Some other considerations in regards to 5S for laboratories is to assess by a lab intra-comparison program. Can technicians from one bench to move to another and accomplish the same measurements? If not, what is causing the variation?

Value Added vs Non-Value Added

Typically, when performing a Lean/CPI *Kaizen*, or Rapid Improvement Event (RIE), all the steps in the process will be written on sticky notes and hung on a wall. This includes every step performed, every transition to another person, and time sitting in each queue. A component of this process is to evaluate each step as follows:

- **Value added (VA):** A value added process directly contributes to the end item produced or service performed. Overhead processes, sorting and cataloguing processes, even some documentation process are not eligible for this category. Strictly speaking, typical value-added items that the lab's customers will pay for are calibration labels and the data associated with them.
- **Non-value added (NVA):** These are the items that the customer does not want to pay for. They do not care that the item is input in the lab's data system. They do not care that it is tracked from spot to spot. They do not care that it is going through a quality check (it should have been done right the first time). Almost all steps in the processes tend to have this category assigned.
- **NVA but business requirement:** This is where the auditing and other governing documents are added. At this time some NVA labels would be converted to a business requirement label as needed. Anything required by ISO 17025 would fall in this category. Any company or command requirements would fall in this category as well.

After a process is determined to be value added vice non-value added, about 15% of the processes in a typical system are non-value added. While some employees (especially veteran employees) may feel strongly that a step is an absolute requirement, going through VA vice NVA analysis can clarify which steps to remove from the laboratory's process and positively impact throughput. If there is still hesitation about removing a step in the process, the lab can have a trial period of removing the process and determine if it is ideal to remove it permanently or reinstate it. Again, this is a great opportunity to reach out to team members in the lab for revamping each process.

In-Service Checks

An application of process improvement directly related to the lab is the utilization of in-service checks. It is called by various names, but the goal of an in-service check is to increase confidence in a laboratory asset and to reduce impact analysis or recalls when standards are found to be out of tolerance. For example, thread wires in the Navy have a 36 month interval. There are only a few thread wires in the entire set that are used frequently. It may be beneficial for a lab to consider doing an in-service check on those specific wires at a more frequent periodicity to ensure they are not showing signs of wear. The same should be considered for PRT probes. While in-service checks can be beneficial, there should be a balance of the right amount of checks on the right amount of assets. If too many in-service checks are accomplished it could be considered waste and decrease throughput.

Personnel

A common issue in metrology labs that should be reviewed and addressed is the lack of cross training in measurement areas. Too often there is only one subject matter expert available in each section. This can critically hamper the lab if anything happens, positive or negative, to that person. If they are promoted, if they depart on parental leave, or if they move on to another job, it results in downtime and loss of capability. While cross training can reduce throughput temporarily, risk assessment in regards to personnel capability should constantly be considered and addressed. This also relates to processes in place throughout the lab. If only one person is authorized to review and sign off on items, a process bottleneck is created if that individual is unavailable. Sick days, vacations and other personal commitments will always occur. Losing a few days because only one person is available to resolve or approve a process can result in lengthy delays overall. This issue is compounded when there are multiple gatekeepers in the overall process. Not only does the lab need to consider having personnel cross trained, but they should also consider having one or two alternate approvers in processes when gatekeepers are not available.

Training is also another commonly overlooked issue when it comes to laboratory personnel. Metrology is such a niche community that it is not common to find training outside of the industry, and many personnel have to learn on the job. On the job training is a great tool to utilize, but there is also risk associated with this style of training. The trainer could pass along bad habits, or not be adequately familiar with the measurement area. In addition, methods and techniques are changing more frequently than before in each measurement field as technology develops, so older methods may not be as efficient as newer methods. For these reasons, ongoing training should be required in the lab. Training is becoming more readily available as new providers are developing content specifically for metrology. Attending industry conferences are also great opportunities for technicians to grow and educate themselves on upcoming changes to the industry. Management should consider which personnel would be the best to attend different training opportunities available to maximize the benefit for the lab and the individual. Sharing knowledge and lessons learned from each person's training is also a good consideration for lab practice.

Trust

One item that is not typically considered in a lab's process is the level of trust given to an employee. For example, it has been shown that removing a time-clock-punching system can actually increase the amount of time worked by personnel. As Captain D. Michael Abrashoff described in *It's Your Ship*, when a time-clock system was in place, people tended to stand around the kiosk at the end of shift to escape quickly; however, when the time-clock system as removed, the majority of people tended to stay later and work longer until their task or job was completed.

Another example from the book was the removal of a tool room. When a tool room was established, a person was hired to manage the tool room, and long queues were occurring to check out and drop off tools daily. The time spent checking out tools took away from

time at the bench. When the cost of the personnel to manage the room and the time spent away from production was considered, it was significantly more than the management paid to replace lost tools annually. The tool room was removed and personnel were entrusted with the tools they needed (This also goes back to the spaghetti chart. Imagine the waste each day going back and forth to the bench).

Small considerations such of these build trust between management and employees and increase throughput.

Workspace

Another item for laboratories to consider is a closer look at the workspace layout. This complements the 5S previously mentioned, but with additional considerations.

Cables, Adapters and Tools

Each bench should have the exact and right amount of tools required for that specific measurement area. Having a single repository for cables, adapters and tools is commonly observed in most labs. As previously mentioned, if the lab draws out a spaghetti chart of this configuration, they will see waste. Ideally, technicians should have the right ancillary tools at each bench. One best practice as observed at one laboratory is the color coding of tools to each specific bench. The benches each had similar jobs to perform and therefore similar tooling. Each bench had a color assigned and each tool was wrapped with that color tape to indicate it belonged to that bench. In addition to the color assignment, the tools had magnets adhered to them and hung readily available on the bench for use. An ideal bench has all the appropriate tools within an arm's length, and all the unnecessary tools removed from the space.

Business Case Analysis for Calibration Standards

One last consideration for each lab is to assess the need for standards used. The laboratory may have procured several standard assets over the years, which is typically the primary financial contribution considered for each item. There are several other financial costs/burdens from assets to consider.

- Cost of calibration: Whenever it is time for an asset to be serviced, use of the asset should be reviewed to see if it is worth servicing again. This is especially important if the asset needs to be sent out of the lab for service vice being accomplished locally.
- Cost of space: If an asset is being kept in the lab the cost of the storage of the asset should also be considered. If there are multiple assets with minimal usage, the space could potentially be better utilized for other equipment or processes.

Conclusion

There are several ways that laboratories can ensure that they achieve their goal of high quality throughput. Implementing small changes across the organization, from time management to small process improvements by each technician, the laboratory could see positive process change in all areas. Some of these changes are easy to implement while some may take significant effort. Sometimes new processes may need to be revamped or removed completely. When a laboratory is willing to attempt ongoing process improvement, and it becomes standard culture within the lab, there is a positive impact overall.

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