"Advanced Technology: Bringing Today's Standards to the Industrial Laboratory"

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In order to save lives, doctors stay current with the latest medical developments and technology. In order to build the best houses, contractors keep abreast of the most current standards, methods, and equipment. And so it must be in engineering education. Faculty must be knowledgeable of the latest processes and equipment used in the engineering world. ABET recognizes this as seen in its program outcomes (Criterion 2: a-k).[1] To the best of our ability, we must teach current methodologies in our classroom along with basic concepts. This will not only better prepare our students for future employment, but will also heighten their interest and desire to learn.

The Mechanical Engineering Technology Department at Oklahoma State University is taking steps to meet this goal. In order to provide students with an education in the latest technologies available in their field, two laboratories are being created which closely simulate modern manufacturing environments. The labs meet current safety, technology, and quality standards, and will be used for multiple purposes such as classes, research, student-involved industrial projects, and educational tasks. This paper will discuss the steps taken to achieve our goals: aspiration, creation, utilization, and evaluation.

Aspiration

We desired to have a lab experience comparable to what work students would do in future jobs. We wanted students to develop pride in their skills and equipment, and expect quality results. To achieve these ends, we considered several factors. What are the current quality standards? What are the current safety standards? What capacity do we need to educate students appropriately?

In terms of quality, we needed to address every aspect of the lab: equipment, layout, procedures, maintenance, organization, and so forth. First, all equipment needs to work properly. Industries require this of their manufacturing machines, and gave this feedback to faculty as a necessary part of making a quality lab. Specifically, the equipment needs to reliably perform the same function to the same standard every time it is used. This requires that the equipment be in good working order, have appropriate tooling and other necessary supplies, and undergo routine preventative maintenance. There have to be standards and procedures that address these issues, or things go undone, leading to broken or poor quality machinery.

Furthermore, there need to be written procedures and detailed instruction for using the equipment. Lack of knowledge in operating equipment can cause damage to the equipment, and perhaps even the operator. No person--student, faculty, or staff--should be allowed to operate equipment without proper training. Training in equipment usage is a key factor in maintaining a quality laboratory.

Given our goal of being current, it seemed obvious that we should also follow industrial standards for quality that have developed in recent years, such as 5S[2], First Article Inspection (FAI)[3], and ISO[4]. The intent of 5S is to have only what you need available in the workplace, a designated place for everything, a standard way of doing things, and the discipline to maintain it. FAI is intended to provide objective evidence that all engineering design and specification requirements are properly understood, accounted for, verified, and documented. ISO 9001 standards specify requirements for a quality management system in which an organization needs to demonstrate its ability to consistently provide product that meets customer and applicable regulatory requirements. In a quality lab environment, students or workers must able to repeat a procedure accurately, as would be expected in a work setting. Unless the procedure is written out and followed, one is likely to get different results each time, which leads to poor quality. Moreover, unless plans are made for materials, there is likely to be a great deal of waste, which leads to poor economic practices for both university and industry. *Lesson #1: Quality of student work often reflects the professor's expectation.*

In regards to safety, students, faculty, and staff need to know how to keep themselves and their co-workers safe. The equipment, procedures, and chemicals found in an engineering environment are potentially dangerous. Faculty have a responsibility to ensure the safety of the students in their classes. Therefore, safety standards and procedures must be taught and closely followed at all times. All persons--students, faculty, staff--in a manufacturing lab environment should wear safety glasses, ear plugs, and proper dress. They must be trained in equipment safety precautions such as using guards and tools that promote safety. Training in accident prevention is also necessary. Furthermore, all persons in the lab should know how to respond to basic emergencies such as location of first aid kits and how to handle blood born pathogen situations. Material Safety Data Sheets (MSDS) for all chemicals should be current and available. Students should be trained in their location and content. Current government regulations should be consulted annually to ensure overall safety. These are the things that go into safe, quality manufacturing environments around the world, and so these are the things students need to know and experience, both for their preparation for work, and also for their safety in school and beyond. *Lesson #2: Students deserve to be safe, and should know how to take responsibility for safety.*

In order to address capacity, we looked at the numbers of students enrolled in the relevant courses, and also at the different types of manufacturing processes that students were likely to encounter when they went to work as engineers. We found that enrollment had almost doubled in the past few years, and that we did not have the space or equipment for them to receive quality training. It must be said here, to address questions that continually arise: we are not training machinists, we are training engineers. We strongly believe that for a student to become a good engineer, he needs to know about the processes common to his field, so he can approach problems with a practical knowledge base, backed up by theory and understanding. Given that, in order for the increased number of students to have adequate time on equipment, we needed more machines. We also needed more space for them to gather around the equipment in order to observe processes.

Furthermore, we desired to add more processes beyond basic milling and lathe work. Plastics are the current boom in manufacturing, so we wanted to add plastics processes to be current with the industrial world. We also desired to add metal fabrication and casting, so that students would have a wide base of knowledge. These desires for more processes and more equipment availability for students further fueled our aspiration to create a new lab. *Lesson #3: Students need some knowledge of all facets of their field in order to be good at their specialty.*

Creation

Given the goals discussed above, our current labs fell short in all three areas: quality, safety, and capacity. Therefore, as with most creative endeavors, a need was the basis for action. Faculty began to look for options. As is often the case, there was no money available to build new buildings or buy new equipment, so vision and creative partnerships became the key to progress.

The project was kicked off to a great start with the donation of several machines and other equipment from Seagate. When the Oklahoma City Seagate plant closed, faculty connections with the plant manager led to OSU being considered as a tax-friendly beneficiary of the equipment. Because Seagate also considered taking the equipment to its plant in Ireland, the process took several months, but eventually the equipment arrived at OSU. That led to the next problem--where to put it. *Lesson #4: Form relationships with industries in your field.*

Within the College of Engineering, Architecture, and Technology (and probably within most research oriented departments on most campuses), there were several buildings filled with antiquated equipment, out-dated project supplies, and "stuff we might need someday." After appropriate permission was granted, faculty sorted, threw away, restored, and sold the building contents. Then repair work, thorough cleaning, and painting were necessary to makes the facility professional and like new. The same was done for the donated equipment. Faculty did this work with little help, as there was not money to pay anyone else to do it. Finally, the like-new equipment was set up in the like-new facility. The building was incredibly different than it was six months prior. The facility was now professional, clean, and capable of high quality instruction, rather than being a forgotten dusty storage building. *Lesson #5: Be willing to work hard, even outside your box.*

However, another problem remained. The facility did not have appropriate electrical wiring to run the equipment. The problem seemed insurmountable, when bids came it at about $50,000 to do the work. But, good fortune stepped in again when a local hospital that was undergoing new construction donated its old electrical transformers, thereby covering about $10,000 of the needed electrical equipment. Close work with an electrical contractor and creative funding from a partner research organization within the university helped the project along farther, and money from two departments completed the needs. *Lesson #6: Don't be daunted by obstacles; continue to pursue every possible source of help.*

During these months of creativity and hard work, it seemed important to get feedback from industrial sources. After all, we could not develop an up-to-date, high quality lab without knowing the most current trends in manufacturing. Also, we wanted neighboring industries to know what we were doing for several other reasons. Perhaps some would get excited about the project and provide assistance. Perhaps some would be impressed with the level of education we were providing, and be more likely to hire our graduates. Perhaps some would be willing to utilize our capabilities by bringing projects for students. Perhaps others would be willing to join our Industrial Advisory Board. In order get the word out about the lab project, we hosted a barbeque lunch and open house, inviting many neighboring industries and the department's students. The event was well-attended, and we were able to share our vision and show-off our progress thus far. We received positive and helpful feedback, and the benefits of hosting this event continue to become evident. *Lesson #7: Share your vision, ask for input, and serve your students and community.*

Utilization

The vision for the utilization of the lab is quite ambitious. The hope is to use the lab for multiple functions: class work, research, student-based projects originating from industries, and training and project partnerships with industries and other various groups.

As discussed earlier, the wide variety of processes available will increase the usage of the lab. Examples of capabilities within the lab include:

- CAD/CAM (mastercam, edgecam, solidworks, autocad)
- plastics injection molding
- plastics extrusion
- plastics welding
- traditional machining
- CNC machining
- welding
- CNC plasma cutting
- CMM
- materials testing
- heat treatment
- metallurgical analysis
- safety assessment and consultation

Obviously, with these capabilities, faculty will be able to meet the needs of students enrolled in manufacturing related courses. The hope is also to accommodate students in other related disciplines gain the skills needed within these areas, and to help meet the needs of those engaged in research projects. However, as stated earlier, there has to be strict management of a lab to ensure continuous quality and safety, especially when so many different people are using it. In order to appropriately train all students and personnel in the use of the lab, safety and operational procedures will be available online through Audio Visual Interface (AVI) files. All persons using the lab will have to be certified in basic procedures and precautions by watching the files and passing appropriate testing. Lab classes will, of course, expand on these concepts and teach more in-depth safety and manufacturing concepts.

In addition to class and research use, faculty hope to bring in industrial projects for student work and experience. Companies, organizations, research groups, and university departments are invited to submit requests for projects. If projects are within appropriate time, equipment, cost, and feasibility guidelines, they can be assigned to faculty-approved students who are enrolled in

Special Projects courses, work-study, or those who merely want experience for their knowledge base and resume. Faculty can supervise the work and offer input. The end result will be a project completed at low cost for a group and positive real-world experience for the student. Here are some examples of possible projects:

1. *An inventor wants to know how to make his product. A student could work with him to draw and make a prototype of the product.*
2. *A small manufacturing company wants to see if buying new machine would be appropriate and cost effective. A student works with them to explore options, does cost analysis, and researches purchasing options.*
3. *A company needs a part made for research and development. A student takes their drawing, refines it for manufacturability, does a material selection analysis, and creates the part.*

The lab could also be used for industrial consultation and training. Faculty, students, and industrial organizations may host training in specific content areas within capabilities of the lab. For example, a company may desire to host a training or marketing seminar for industrial personnel at the lab. This could have several benefits to the university and lab: more relationships with industry, income from facility use, possible good deals on equipment or software, or seats at the training for interested students and faculty.

To do all these things, and maintain the quality and safe environment for which we aspire, it is necessary that the lab have appropriate management and oversight. An Industrial Advisory Board will provide input and help on relevant issues. A faculty director, and possibly an assistant director, knowledgeable of and vested in the quality and safety of the lab is also necessary. With these key elements in place, along with established quality and safety procedures, the lab will be fully capable of all these functions and more.

Lesson #8: Dream big, and use what you have to the greatest extent possible.

Evaluation

As with all quality improvement endeavors, it is important that one evaluate the effectiveness of the effort. While the lab has not yet been established long enough for formal evaluation, several measures are planned, and several benefits are expected. We hope to look at the lab through the quality and safety standards based on 5S, FAI, and ISO 9000, and strive to come closer to meeting those standards. Annual safety audits and annual utilization reviews will also be helpful in evaluating the performance of the lab. Finally, participating industries, organizations, and students will be asked to complete surveys regarding their lab experience. It is hoped that these measures will provide information on which to base further improvement and better utilization.

Multiple benefits are expected, not only for students, but also for the community and university. For students, the experience and knowledge gained from working in a modern manufacturing laboratory will be very helpful. They will have the opportunity to participate in a variety of real-life projects and training, and possible part-time job opportunities in their field of study. The presence of industrial projects to be completed by select students will encourage competition for excellence and the opportunity for industrial networking. Students will have excellent experience for resume development and documentation of their skills. Finally, their degree becomes more marketable as industries come to expect well-trained graduates from the associated programs.

For the university and community, the lab will provide a wide variety of resources for training, assistance, research and other projects. The lab will likely help the university move into a more elite class of top engineering schools. University recruitment and retention is likely to increase as students become more excited about the opportunities and learning available to them. More benefits and means of improvement will be evident in the months and years to come as the lab develops to its potential.

Lesson #9: Always be willing to be better.

Conclusion

The Mechanical Engineering Technology Labs at Oklahoma State University were born of an aspiration to do better and a willingness to work hard for achievement. Students deserve a quality education in a modern working environment, and it is hoped that the lab experience will accomplish that goal. The quality, safety, and current technology available in the lab will surely benefit students, the university, and the community for years to come.

Bibliography

1. ABET Criteria for Accrediting Engineering Technology Programs, 2006-2007.
2. Hirano, Hiroyuki (1996). 5S of Operators: 5 Pillars of the Visual Workplace. Productivity Press.
3. Aerospace First Article Inspection Requirement, SAE AS9102.
4. ISO standards, from www.iso.org.

Biographical Information

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