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Effective Implementation of Lean Practices in a Secondary Educational for the Purpose of More Effectively Preparing Students for a Career in a Manufacturing Setting

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Introduction

"72 percent of educators believed that graduates were ready for employment, only 45 percent of youth and 42 percent of employers agreed. This data reveals that today's post-secondary education fails to equip people to successfully exploit current and emerging economic opportunities." (Trend, 2015) Educational institutions must equip students for good high paying jobs and post secondary education and training. This means reaching beyond traditional academic settings and practices. It is projected that careers like welding will grow by about 10,000 jobs by 2024. (Department of Labor, 2016) Typical educational requirements for these positions is a high school diploma. (Department of Labor, 2016) Most high school student's resumes are pretty empty. This is typically due to the lack of work experience a teenager can obtain in just a few years, combined with the type of jobs they qualify for. So, how do we help prepare students for good, high paying manufacturing jobs with little to no experience? How do we give them experience they can use for the manufacturing sector while they are still in our classrooms? How can we do both of these while improving the classroom environment? All of these can be achieved by implementing lean manufacturing practices in the educational setting.

Many lean practices have a place, and should be implemented in educational settings. By implementing practices designed and used in lean manufacturing we can simultaneously expose students to strategies used in the real world, while improving the classroom environment by making it more efficient. Lean can be defined as the total removal of waste, to achieve competitive advantages. (Agarwal, 2015) By definition this will give our students an advantage while creating less waste. By creating less waste in our classroom environment we have an opportunity to see an economic advantage as well.

Journal Review

Many lean practices come from overseas. Kaizen was introduced by Masaaki Imai in the late 1980's. The process literally means Change Good. This practice entails several strategies utilizing continuous improvement. These practices include working as a team, making sure everyone is included in the solution, speaking with data, containing and correcting the root cause of problems, as well as looking at the situation directly. (Kaizen Institute, 2015)

Many lean programs and practices require the dedication of employees to be on the look out for areas in need of improvement, and to actively participate in the changes being made based on the organization's lean program. It requires employee commitment in searching for areas in need of improvement, as well as their commitment to carrying out the changes and adjustments needed to improve the process. (Brajer-Marczak, 2014) Keeping employees engaged in their work and allowing them to take owner ship in the improvement process is vital. This could be the most challenging part of the improvement process. The employees, or students are the ones to assure that the tasks are carried out and improvements are actually being made. 13% of employees are known as Engaged in their work. This shows a commitment that is linked to them finding joy in their job, and who actively participate in innovation and improvements in the products and the workplace. (Brajer-Marczak, 2014) For their education to be relevant and meaningful to them, they must be engaged and find joy in the work they are doing.

Grouping Technology

Some manufacturing practices can work really well in the education sector if they are modified slightly to fit. For example, group technology is manufacturing parts that are similar together. They can be the same size/shape, function or have the same manufacturing process.

Group technology puts these parts in the same area in manufacturing to create less tool change, and alterations to machines and processes. This practice can be used in forming product families because as engineers design machines and their components they can be thinking of this practice. They can also keep in mind previously produced parts and implement them into the design of a new product. This is implemented into the educational setting by simply replacing the part or process being completed with the students.

5S Methodology

Other methods are easily implemented into classrooms. The 5S methodology was designed to instigate and maintain ongoing workplace improvement (Nicholas, 2011). The 5s methodology is one of the best tools for involving all employees to participate in the improvement process and engage them in the improvement activities (FEIN, 2015). The 5S system is based on the Japanese words- Seiri (sort), Seiton (set in order), Seiso (shine), seiketsu (standardise), and Shitsuke (Sustain) (FEIN, 2015). Using this system can require more substantial training than some other techniques but it also involves all employees at all levels. The 5s Methodology is a set of guiding principals that lead organizations into continuously improving (Ablanedo-Rosas, 2010). It asks the employees, or students to take ownership in the decisions that are being made and be a key role in insuring the tasks required to continue implementing the improvements are completed on a daily basis. That same process can be used to improve the environment of a high school classroom as well. The methods have been utilized in the education sector and in classrooms alike before.

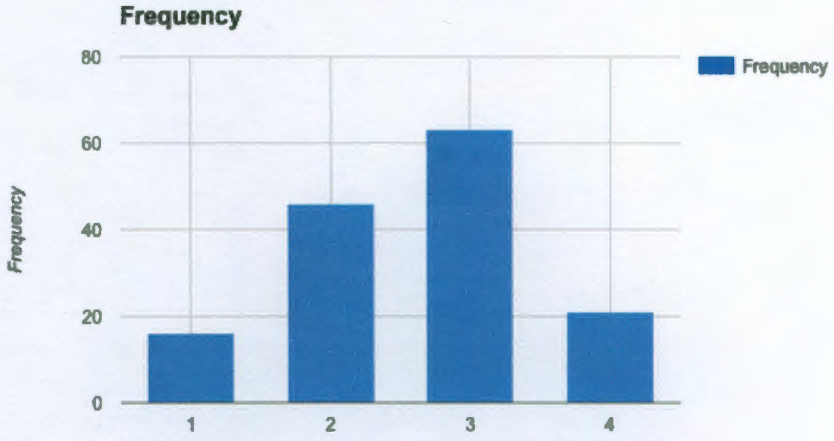
Implementing Grouping Technology

Currently we are implementing an educational grouping strategy called ability grouping. "Educators found that the obvious solution to addressing the inherent differences that existed among students was to individualize instruction, and teachers were able to do this by: assigning tasks to each student that were appropriate to his or her specific abilities and interests; using techniques and learning styles that were appropriate to each student's temperament; and moving each student ahead at his or her own pace" (Merritt, 2015). In this particular situation students are being grouped based on their ability, ranked on 4 levels of understanding for a particular task. The example given is asking students to demonstrate the essential standard "Views and dimensions on a orthographic drawing should be appropriately positioned on the paper." Students will be able to demonstrate their competency of views and dimensions on a part by "Creating an orthographic drawing file using Autodesk Inventor." Students will complete the project, and then score their own work using the 4-point rubric shown in figure below.

4	3	2	1
All required dimensions are located in the correct locations on each view. No rules are being broken and the correct views are located in the correct location.	Most dimensions (missing 3 or less) are located in the correct locations on each view. No rules are being broken and the correct views are located in the correct location.	Several dimensions missing (4 or more). No rules are being broken and the correct views are located in the correct location.	Some rules are being broken (dimensions on edge of paper, or duplicated dimensions) Not all views are correct or in the correct location.

Once students have completed the rubric the instructor collects them and then decides students into groups based on their score. A frequency table shown to the right was created to show the scores. This can help the teacher determine if the lesson will need re-taught to the entire class. Since the chart shows most students achieving a 3 or a 4, the grouping process can continue. Students who score a one will be given specialized instruction to help them gain a better

understanding of dimensions and views in an orthographic drawing. Groups scoring themselves a 2 and 3 will also receive specialized instruction in their small group which typically consists of 4-7 students. Students achieving a 4 could be given harder or more advanced tasks, or they could be utilized to assist in the re-training of students scoring at the lowest level. This method is essentially the same principal as grouping technology that can be used in manufacturing. The educator can group students in order to save on resources and time, while giving all students the opportunity to meet the standard discussed. As lean manufacturing creates less waste in materials and rework, the lean strategy of grouping can create less "rework" in reteaching by grouping students together who require similar assistance.



Implementing 5S

The cause for implementation of 5S in the Ottumwa High School Welding Technology Classroom was a desperate need for organization and accountability. The district's welding instructor retired, leaving some parts of the shop with broken pieces of equipment, some that had not been used in over 10 years, and a lack of organization and cleanliness. This arrangement can lead to a number of problems. Equipment break down is one problem caused by a lack of cleanliness. When the equip is showing signs of ware, or showing problems its hard to catch them a head of time if the workspace is a mess. For example, the classroom has a horizontal

bandsaw used to cut metal. Shown in Picture 1.1, the bandsaw is left with shavings, and cut off pieces of metal on the bed of the machine. The oiling system stopped working, it was not diagnosed early because of the mess, and as a result the band got too hot and broke. Picture 1.2 shows the machine after implementation of 5S.

Photo 1.1

Photo 1.2

Cases like this one were found all of the the shop area. Another benefit to implementing the 5S system is costs. While costs occur when machines are not maintained due to lack of cleanliness, large costs also occur when tools and parts are lost due to lack of organization. For example, while cleaning the bandsaw used in the example above, a screw driver and drill bit was found.

While these are not expensive tools, over time, at each work station missing tools will start to add up increasing costs of replacing tools and parts.

This process can sometimes take some time to fully implement, especially during the school day. Some organizations add safety as 6th step to the process, for this project safety will continue to be its own entity. It was discovered while implanting the process that the students begin to take pride in the organization and cleanliness of the workspaces. When they are a part of creating that space, they want to do more to maintain its organization. It was also discovered that with all students working together, multiple spaces can transition into the 5S system very quickly. While the entire shop has not been fully transformed, substantial improvement has been made and plans for continued improvement exist.

The first step taken was to educate the students on what the 5S process is. This was a brief introduction and used as the foundation of the reasoning to improve the workspaces in the shop. Students were educated on the benefits of creating a sorted, systematic, shined, standardized, and sustainable work area. When the students learned the benefits they had no hesitation to being implementation.

The second step was Seiri, or Sort. This began the process of removing tools and equipment, parts, and scraps that did not belong in the areas they were. Pictures 2.1 and 2.2

Photo 2.1

below show an example of removing parts that had been machined as well the shavings from a mill used in class. While its clear the machine would not have been operated with the parts laying on it. If it needed to be used it would have taken substantial cleaning to even begin. Photo 2.2 shows the machine ready for use after Seiri had taken place.

This process is still taking place. There are several very large pieces of equipment in the shop that are not being used and have not been used for several years. The process for removing those pieces of equipment is lengthy and takes a great deal of manpower and effort. More than likely this step will continue to take place into the summer months.

Once several work areas had been sorted, the class moved to Seittion. This step asks the students to find a home for every tool and part we have. In the photo below, 3.1 shows lines created to distinguish the place that the Oxy Acetylene torch, and two Miller MIG welders go. Its easy to see if something is missing by and empty box being on the floor. This is another process

PHOTO 3.1

that is still creating improvements. The students have begun to find new placements for tools in the tool boxes, lockers, shelves, and hooks found on the wall. We have also created boards that are color coded to go with a color coded lathe. The student have been asked create the new places for the equipment and tools. This allows them to have the buy into the process and also helps them learn where the tools and equipment will be located when they need to use it.

The major benefit to the Systematic arrangement step is going to be simply keeping track of the tools and equipment. It will be easy for the instructor to look into the tool cabinet and quickly scan the shop before the end of the period to ensure the tools are not missing. This will help assure we are not replacing tools each year due to them being lost, stolen or misplaced.

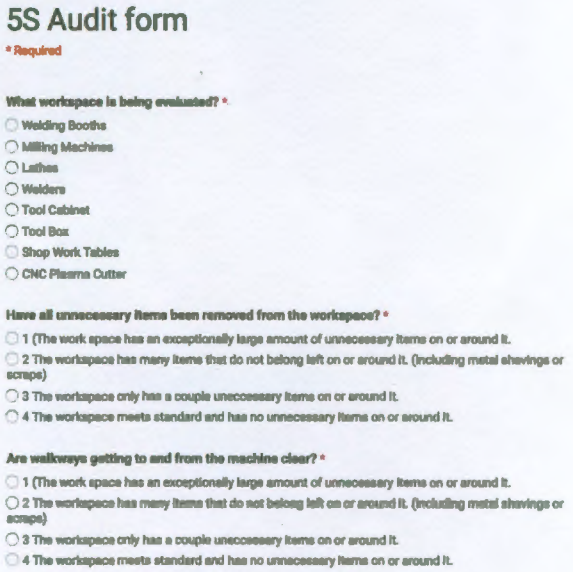
The next step in the 5S process is Seiso, or Shine. For this step the students have started to completely clean workspaces. For years cleaning in the shop had not been viewed as a priority.

There are years of welding dust, metal shavings and dirt on the floors, machines and workspaces. This is another step in the process that is going to take some time to fully implement. Each area will be swept through and cleaned to a higher standard. Painting is being done in some areas and planned for other areas. While welding booths are sometimes hard o make "shine", the students are giving it their best effort. The picture blow shows a welding booth that has clearly not been used for a while due to its lack of organization. You can also see where it had been spray painted with red spray paint. This is one area that was covered up with new paint to help make the booths shine. Now this welding station will be able to be utilized. It will be outfitted with a MIG and Stick welder so students can use it. The Shine step of the process has proven to be the hardest one to implement in this particular setting so far. Painting is something that typically requires approval and is done by an employee of the district or outside company. Requests for areas to be painted have be submitted but have not yet taken place. The students will continue to improve areas of work and paint areas and parts that are allowed by the district.

The Seiketsu step or, Standardize step of the process requires students to design a practice for each work area. They have decided that standards will be carried out by them when they are using each machine. The problem with this step is, there are 2 other instructors, and two other

sets of classes using the same shop later in the day. The 5S process will be fully implemented into those class when the same instructor is teaching them.

The final step implemented into the Welding Technology lab is Shitsuke, or Sustain. For this practice students will take responsibility of their workspace. They will do with out being told, ensuring that each workplace is cleared and organized when they finish using it, so it can be ready to be used later. This process also includes regular audits. These audits will take place by both the students and the instructor. Once a week audits will be made to collect data on the shop as a whole, and each workspace. These audits will be performed using google forms and an ipad. The form uses a 4 point system. Each question is answered giving a 1-4 rating on the workspace. Each workspace will be evaluated once a week, although they may not all be evaluated the same day. The data will be used to give feedback to the class on how well they are maintaining the cleanliness and organization of the shop. We will be able to use the data to decide if more time must be created for organizing and cleaning on a daily basis. It will also help identify problem areas that need the process improved, or students who need re-trained on the proper procedures for cleaning up a workspace. The picture above shows as screen shot of the form used.



5S Audit form

* Required

What workspace is being evaluated? *

- Welding Booths
- Milling Machines
- Lathes
- Welders
- Tool Cabinet
- Tool Box
- Shop Work Tables
- CNC Plasma Cutter

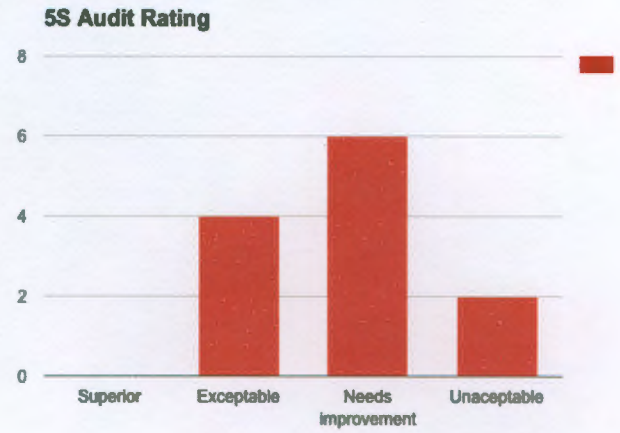
Have all unnecessary items been removed from the workspace? *

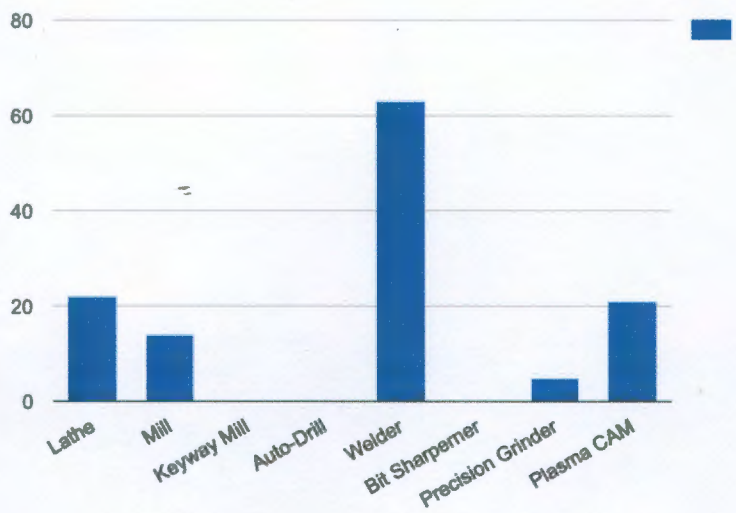
- 1 (The work space has an exceptionally large amount of unnecessary items on or around it.
- 2 The workspace has many items that do not belong left on or around it. (including metal shavings or scraps)
- 3 The workspace only has a couple unnecessary items on or around it.
- 4 The workspace meets standard and has no unnecessary items on or around it.

Are walkways getting to and from the machine clear? *

- 1 (The work space has an exceptionally large amount of unnecessary items on or around it.
- 2 The workspace has many items that do not belong left on or around it. (including metal shavings or scraps)
- 3 The workspace only has a couple unnecessary items on or around it.
- 4 The workspace meets standard and has no unnecessary items on or around it.

This system is still in the process of being fully implemented. In the areas that its already being used many benefits have been observed. The chart below shows the results of the 5S audits that have been conducted up to this point. The frequency is averaged of all the audits being conducted. The data is slightly flawed. Not all students are taught and take part in the 5S procedures. This is due to having more than one instructor using the same lab. This causes for some of the ratings to be lower than they should be. However, given this flaw, machines are running more properly, they are easier to use, and students have started to take ownership of the machines and work areas in the shop. By them taking ownership in the process it will help maintain it. As the school year goes on and more students are trained on the processes of each work area, the 5S practice in the Welding Lab will get stronger. By continuing to analyze the data from the 5S audits, as well as looking at maintenance records of equipment,





we will be able to determine when is an appropriate time to replace older or worn out equipment. We will also perform repairs in a more timely manner due to the weekly audits of the equipment. This will keep the most up to date equipment in the shop and provide students better experience to what they would be using in the work place.

Over the next year we have plans set in place to remove equipment that is broke beyond repair or no longer useful. The first step of the process is Sort. Part of the sorting process includes removing unnecessary items from the work space. To help determine what equipment was needed a survey was pulled of all the students in the class to determine what pieces of equipment are being used. Students were asked to estimate the number of times they have used each piece of equipment in a semester. The totals were averaged and placed on the chart. By eliminating equipment that is not necessary we can increase the funding to the shop and allow the purchase of equipment that can enhance the education of the students taking the courses. By looking at the data from the survey of students, and assessing the future goals and projects of the course, it was determined that 4 large pieces of equipment will be recycled. By selling the equipment funds can be generated to purchase equipment and supplies that will be used on a more regular basis.

Lean manufacturing practices have been implemented in America more frequently since the days of Henry Ford. (Lean Enterprise Institute, 2015) Some of these practices have leaked into the health care and Education sectors. These types of systems can help make more efficient educators, while introducing topics relevant and meaningful to students as they prepare for post secondary experiences. As stated before, "72 percent of educators believed that graduates were ready for employment, only 45 percent of youth and 42 percent of employers agreed. This data

reveals that today's post-secondary education fails to equip people to successfully exploit current and emerging economic opportunities." (Trend, 2015) Educators must be prepared to give students the best possible opportunity for success after graduation. By implementing strategies used in real work places all over the country, allowing them to practice and giving them something to bring to the table after graduation. These strategies can help make our teaching more efficient by grouping students together who have alike needs in order to allow for more individualized group instruction, providing them with the best possible opportunity to improve their knowledge on any topic. We can improve the classroom enviornment, keep equipment running and up to date, all while allowing students to have ownership in their projects as well as the facility its self.

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