Profits through Education

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Focus on process not results-If you improve the process you will get results

The goal of any foundry is to make process changes that reduce costs and yield a higher profit on every casting sold. Management's responsibility is to make the right decisions based on sound data from the shop floor. Usable data comes from properly trained employees who understand the process, the machines and the company's goals. Understanding the process and applying the correct controls to the process comes from proper education.

This paper will cover some educational experiences from foundry members who have applied what they have learned to reduce costs. This application of knowledge when applied to process control has increased profits for their companies. I will also review what the ICI is doing to help train your employees.

Education comes in a lot of shapes and sizes. I tried to come up with a nice simple definition and there just isn't one, there are many. We all learn differently and we probably all have examples of some of those very expensive ones. Sure those of us who have put our children through college all know too well the cost of higher education. But I can tell you from experience that my college education was cheap compared to what I have spent learning how to manage my business.

I have learned from our customers that some of the simplest changes to process control make the biggest impact on profitability for their company. I will be sharing some of these examples with you today. I am focusing on wax rooms because that is my area of expertise, but all of these lessons can be applied to every area of the foundry.

First I would like to start with an example of what I call a "Typical Failure."
MPI put a very sophisticated piece of wax injection equipment into a company but its ROI, return on investment, has not been fully realized. The machine worked per design but the implementation failed. The machine was able to meet the production goals required by the customer. However, after a year in the foundry, it was no longer meeting those goals. It was being used as if it were a 30 year old wax injector. Here is what happened:

1. Management knew where they wanted to go with the project and they set the wheels in motion.
2. Management's goal was to reduce cycle time by introducing paste wax injection into a large wax room that had been injecting liquid wax for its entire existence.
3. The customer's engineers and MPI engineers worked together to achieve their goal of reducing cycle time using paste injection.
4. MPI built the machine with paste capability and it worked great. The customer performed trials at MPI injecting the customer's wax at paste temperatures into their dies. The average cycle time reduction was 75% for the parts injected.
5. The machine was installed at the customer's facility.

6. The operators were properly trained on the machine's operation for paste injection.
7. Our customer achieved their production goals.
8. One year later MPI visited the customer and the wax room was using the paste machine as a liquid injector. All the cycle time gains were lost.

What happened? It could have been many things-
Management changed and the project goals were lost through the transition; first shift knew how to run the machine as paste and why, but the information never got transferred to second and third shifts; the wax room supervisor changed; new management didn't ask for feedback from the shop floor and didn't learn that the cycle times had been reduced on this particular machine; employees went back to what they were comfortable with since there were no systems in place for the transfer of information.

I believe that most managers have had similar experiences. How many times have you wanted your staff to implement an idea and they just didn't do it. Or, more frustrating yet, you thought they did it, but when you went back and checked, things were still going on the same as before. Unless you put into place a training program with documentation and a method of keeping the goals fresh in the eyes of the employees the program will not stick. Your employees need to be educated and they need to be a part of the decision making process so that they understand the 'why' for the change. This is how to create long lasting changes.

Here are a few success stories.

Pine Tree Casting

This is an example of formal education and consulting

Pine Tree Casting has implemented lean procedures throughout their foundry. In the wax room they went lean to reduce their WIP, Work in Process. Previously the wax room consisted of two separate departments: the injection department and the assembly department. Patterns were loaded into trays and the trays were loaded onto carts. Once the carts were full they were transferred to the assembly department. This approach created a large amount of pattern inventory that also used a large amount of floor space.

Today, through a lean initiative, they use wax cells that consist of injection and assembly matched to the assembly person's throughput capability. One of their cells consists of the following arrangement.

- One fully automatic wax injection machine running small, high volume parts managed by the pattern assembly person. The wax patterns fall into a pattern catch tank that is full of water and are presented to the assembly person at the end of the conveyor.
- One semi automatic machine operated by a second person making medium volume parts. The patterns are loaded into a tray and are transferred to the pattern assembly person.
- A second semi automatic machine run by another person making low volume complicated parts which are also loaded into a tray and transferred to the assembly person.

This cell worked well until the patterns coming out of the automatic machines pattern catch tank became too soft for pattern assembly requiring additional cooling time. This created additional WIP. The problem was solved by adding a refrigerated water cooling loop to the pattern catch tank. By simply adding temperature control to the pattern catch tank and making the catch tank part of the wax room's process the work cell is able to meet the designed throughput.

- This Injection/Assembly Cell has reduced WIP, Work in Process, by 80% over the previous method.
- Not only has the WIP been reduced but the amount of time and effort transporting patterns has been reduced.

Wisconsin Precision Casting

Example of Internal Training

Wisconsin Precision has attacked their business slow down head on and they are doing it for the long term. One of the many areas of improvement is the transfer of knowledge from one employee to another. In the past Wisconsin Precision would have their most experienced person in a department do the training. Over time as new employees did the training things would get missed, very similar to the game "Telephone." To prevent this from happening they are now creating a video for each job. Once the video is correct the training for each employee will be the same. In addition to the training video they are now creating tests so that they can be certain that the employee has learned what is needed to perform their job correctly. In some cases they have the training video reviewed at the machine every time the job is run to insure its success

Recently MPI did formal wax room training at Wisconsin Precision and the training was video taped, edited and is now part of their formal training program. They use this for all new wax room employees. This approach is a good example of training the trainer.

The benefits for Wisconsin Precision are:

- Reduced the training time for an employee.
- Ensured that every employee is being trained correctly, and each one has the same knowledge.
- Reduced the amount of errors created by the employee during the training program.
- Improved the productivity of the employee.

The system for training the employee is now being controlled, which transfers into improvement of the entire production process.

Johnson Matthey Ltd.

Example of Life experience and Consulting

Johnson Matthey has had many years of experience using paste wax for pattern production. They realized that they would be able to get the same kind of productivity gains if they applied the paste injection technology to their runner production. With a limited budget MPI worked with them to convert their old Jahnke C-frame injection machine from liquid to paste injection. The results are a hybrid injection machine.

The results included:

- The machine conversion to paste wax improved sprue production ……..80%
- The machines capacity nearly doubled
- Improved the pattern quality and stability of the runner

	Liquid Injection	Paste Injection
Sprues per hour on average	10	18
Sprue requirement per day	100	100
Sprue Production per 240 day year	24,000	24,000
Annual production hours	2,400	1,333
Sprue Cost per year	$134,400	$74,667
Annual Savings	**$59,733**	
Annual Simple Payback	0.87	
In Months	**10**	

Because the runner quality was improved the down stream foundry operations are improved resulting in reduced casting scrap.

Unnamed Commercial foundry

Example of consulting services

Sometimes it takes an outsider to facilitate (educate) improvements in your foundry. Consultants can be called upon to evaluate your current operations offering a different perspective. Often times it may not be clear to you what can be changed because you are too close to the situation.

In the wax area a typical wax room evaluation consists of:

- Foundry tour to get a view of the entire foundry operations.
- Wax room walk-thru
- Evaluation of the equipment – determine the current process capabilities
- Speaking to the operators – many times the answers come from within. Operators know the equipment and problems they experience on a daily basis.
- Observe the wax room operations – watching actual production
- Speaking to management – understand the company's objectives.
- Report results

This is an example of a commercial foundry that was interested in automation and improving pattern quality in the wax room. An evaluation was performed with a focus on the current operations in the wax room. Their wax room consists of 3 fully automatic wax injectors and 4 semi-automatic wax injectors.

Evaluate the equipment – Speak to the operators – Observe the wax room operations

Automatic Injectors:

Machines were not functioning as they were designed, to run fully automatically.

1. Every 5 cycles the machines were being stopped for manual mold lubrication; the automatic mold lubrication system had been turned off and was not operational.
2. The clamping units were running at the slowest speed.
3. One machine had a temperature control problem which created an occasional non-fill, incomplete wax pattern.
4. Items 1-3 resulted in the machines through-put being less than the semi-automatic machine.

Semi-automatic Wax Injectors:

All of the machines were not able to produce repeatable wax patterns without purging wax between injections.

1. All machines had temperature control problems.
2. One machine had paste capability but wasn't using it.
3. Several machines had non-insulated sections of wax plumbing and exposed wax fittings.
4. Operators were forced to inject at high temperatures to overcome the variation in the equipment.
5. The wax runner injection machine had limited process control. Three to four times a day the machine injects a non-fill pattern.
6. Operators were adjusting the injection time, temperature, flow or pressure to overcome the variations in the process.

Wax dies:

Wax dies on the semi-automatic machines produced patterns with flash and were often distorted.

1. These dies have manually operated slides that have been worn by operator handling.
2. There is no pattern ejection therefore operators are distorting the patterns when removing them from the wax die.

Wax dies used on the fully-automatic machines operated nicely but took a long time to setup in the machine.

1. Wax dies being used on the automatic wax injectors do not produce pattern flash.
2. Current changeover times are 30 minutes. There are no standards for wax die designs.

Report Results

After reviewing the initial findings with the customer a plan of actions needs to be created.

- The information gathered has to be prioritized.
  - Which task will bring the most immediate return?
  - Are there simple tasks that can be taken care of with little effort?

These are some of the tasks being considered:

1. Updating the die lubrication system to allow the automatic injection machines to run automatically coupled with reducing the cycle time by optimizing the process control increases the throughput of these machines by 30%.

   Average time required to manually lubricate the wax die ..... 45 seconds
   Time required to automatically lubricate the wax die ..... 5 seconds
   Current injection cycle time ..... 84 seconds
   Optimized cycle time ..... 61 seconds
   Estimated machine cycle time savings ..... **27 %**

2. Repair semi-automatic paste injection machine and test pattern quality. Paste wax will inject more stable patterns that will be less likely to distort after injection.

   Average cycle time reduction when changing from liquid injection to paste injection ..... 50 %

3. Perform maintenance on existing liquid injection machines.
   a. Evaluate the current process control capabilities of each machine
   b. Improve pattern quality by focusing on temperature problems
   c. Create systems to improve process control.
   d. Estimated productivity increase for machines operating at optimal performance 6 %

4. Update wax dies
   a. Add automatic pattern ejection to all future wax dies
      - Reduce operator handling of the wax patterns.
      - Reduce changeover times
   b. Potential productivity savings by eliminating pattern fixtures: ..... 6 %
      - This does not include eliminating the cost of the fixture
   c. Potential savings casting rework reduction ..... 3 %

5. General recommendations.
    a. Formal Process training for operators and process engineers. Instruct operators to make good process decisions.
        - It doesn't require more production time to make quality wax patterns, it takes good process decisions.
    b. Recommend putting systems in place that takes the process control away from the operators and places it in the hands of management.

Conclusion

I think it's clear that there will always be room for improvement in every aspect of the foundry. The way improvements are made will vary from foundry to foundry. A common thread throughout all foundries is education; education of the employees, the managers and the executives. Education never stops, how we educate people hopefully will improve.

The ICI has been running the Investment Casting Institute's annual Certification Course at Pittsburg State University for 9 years. This course covers subjects from casting design and development right through every step of the investment casting process to heat treating and casting finishing. This comprehensive course enables attendees to see where their piece fits into the whole picture. For instance a wax room employee can see why a poor wax pattern results in increased waste through out the process while an employee in dipping can see some of the difficulties in creating a quality wax pattern. This year will be our 10^{th} anniversary.

In 2010 the ICI will introduce our second ICI course covering in-depth Process Control for Investment Casting. In the Process Control courses we will cover the entire foundry process which will be broken down into four basic areas, People, Wax, Shell, and Foundry. The key process control variables of each section will be highlighted and we will teach how these variables affect the process and what can be done to control them.

The ICI looks forward to working with you teaching you and your people the basics of Process Control with practical take home examples. You will be able to implement positive process changes to your foundry resulting in more control in your process and gains to your bottom line.