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Investment Casting Institute Technical Conference & Expo

Milwaukee Oct.22-25

KNOWING YOUR INVESTMENT CASTING PROCESS

Presenter: Mr. Bruce Phipps (President) MPI Inc.

Good morning.

I am going to start by making an assumption, and the assumption is, that since you are here today you have a real interest in maintaining your foundries competitive edge. I would also guess that there isn't a foundry here that has never lost work to a competitor on price or quality? Is there anyone here who is fortunate enough not to have lost work to a competitor?

Losing business on price or quality will continue until your customers know that using your castings will allow them to produce their products for less money than those supplied by your competition. This is a common thread in any business. Unless you adjust to the market your business will not survive. Many of the foundries present here today have done a fantastic job competing in the world market. You are supplying castings with added value by performing secondary operations such as machining, painting, and assembly. To remain competitive you continually ask yourself; what else I can do to stay ahead? Where else in my process can my company make improvements that will result in gains to my bottom line?

Today I want to talk to you about how you can increase your profitability with your existing process.

First let me tell you a little bit about MPI and how we developed what I will present.
MPI has been a part of the investment casting industry for 34 years, we have focused entirely on wax preparation and wax injection equipment. This long-term commitment to a narrow niche of the investment casting process has enabled us to become the acknowledged expert in the wax room.

Six years ago, we began developing the MPI Automated Pattern Assembly System, APAS. As of today we have installed six operating systems in four major sectors of the industry: fire arms; aerospace; golf

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and commercial. Our customers purchased the systems mainly based on labor savings but have been pleasantly surprised by additional savings they did not anticipate. They are finding that they are increasing the number of castings shipped without increasing the number of assemblies going into the shell room. The unanticipated down stream savings are contributing to a better bottom line. The reason for the downstream savings is that every assembly is being produced as a single perfect casting. That's right; every assembly is being produced as a single perfect casting. Think about it. An entire assembly that is a perfect casting, not just perfect castings on a runner. Each assembly is identical to the next. Because there are no variations in the wax assembly there are fewer variations in the downstream foundry process. Each and every time the Automated Pattern Assembly System is installed, it results in casting yields that far exceed the company's prior results. What our APAS customers have recognized and proven, is that consistency at the front end creates higher casting yields and therefore a better bottom line.

Working together, our customers and MPI have learned a lot about the impact of each element in the assembly process. The experience has been quite rewarding. Automating the pattern assembly process has forced us to carefully evaluate the impact of each element of the assembly. The quality of the wax pattern, the quality of the wax runner and the quality of their weld have an impact on the final result. Automating the assembly process has shown that the TOTAL is greater than the sum of the parts. Quality Wax Patterns + Quality Runners + Quality Welds = Perfect Assemblies. And a Perfect Assembly equals MORE and BETTER CASTINGS. And a BETTER BOTTOM LINE.

We all known that a quality wax pattern is required to make a quality casting but it is hard to quantify the definition of pattern quality. You all make judgments each and every day as to what your foundry process can and cannot produce. You know which features you can cast in and which features must be machined. You all know what your process is capable of producing and you quote accordingly.

Now ask yourself:

What if I could cast a part to a tighter finished tolerance?

What if I could eliminate some of the secondary operations?

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The fact is you can cast to a tighter tolerance and you can eliminate secondary operations and in order to remain competitive in the world market you must.

This is not an option!

As I said the experience in automating pattern assembly has been rewarding. But it was also a lot of fun, and extremely beneficial to our customers. To gain the maximum benefits of automating the pattern assembly process requires patterns of consistent quality. To produce patterns of consistent quality, regardless of what injector is used, led MPI to develop the technology to control the process of producing wax patterns from any wax injector.

Note that I said any wax injector. Now let's get into some specifics. How many of you have wax injection machines with "personalities"? You have a die that will run well on a particular machine (Machine A), and produce quality patterns. Then because of production bottlenecks you are forced to run the die on a different machine (Machine B), but now you are unable to replicate the same quality patterns on machine B. This can happen even when both machines are from the same manufacture.

So what is causing this inconsistency of patterns from the same die on different machines? There are a number of variables but today the time constraint will not allow me to go deep into the details. If you really want to know go back to the ICI Bibliography and look at all my previous papers that I have given over the last 25 years. The Bibliography shows I have spent my professional career testing and documenting the causes of pattern defects.

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NOW I CAN SHOW YOU HOW TO VIRTUALLY ELIMINATE DEFECTIVE PATTERNS

SIMPLY AND COST EFFECTIVELY: THROUGH PROCESS CONTROL OF YOUR WAX INJECTORS.

Here are some simple checks that you can do that will tell you if your wax equipment is out of control:

1. Do you see your operators purging wax out of the nozzle or throwing patterns away as they purge the machine prior to an injection? Often times after breaks, lunch, or long injection cycles operators purge wax out of the nozzle to remove any temperature variations before they start production. If you see this being done it is a clear indication that the machine has a temperature variation. If the temperature variations were removed from the machine the normal pattern-to-pattern dimensional variation found in production would be reduced, resulting in tighter casting-to-casting tolerances which equals less scrap, better parts and AN IMPROVED BOTTOM LINE

2. Do you see different temperature settings on each of the machines temperature zones? If you do then the operator believes that there is a temperature variation in the wax injector and the operator is compensating for the difference. The fact is that the operator is generally right, there is a temperature variation. The problem is the operator can only guess at where the variation is and how much to offset the machine. In short the machine is out of control. Often times the operator is contributing to the problem rather than compensating for the problem.

3. When you install a new wax injector does your operator adjust the temperature zones to match the settings on the old equipment? If so your operator has jumped to the conclusion that the new machine needs to run at the same injection parameters. Right off the bat the new machine is out of control.

These examples demonstrate a fundamental problem in the wax room.

[[First, your operator is controlling the injection process, rather than the injection process controlling the operator.

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Second, there is often no check to see that your process is in control or out of control. You are not verifying that the wax going into the die is achieving the settings on the machine.

In order to have consistent patterns for consistent tight tolerance castings and bring process control into the injection department we developed a "Process Vision" graphing system. This system will measure and compare actual wax temperature in the nozzle; wax flow and wax pressure ON ANY MACHINE against a set of stored values known to have produced "GOOD" patterns. Thus any injector capable of running the part can be set up to match the stored values and produce the part. The process control is accomplished through the stored values, or base line, which are GRAPHICALLY REPRESENTED on a touch screen. Data from a set up run is captured REAL TIME and compared to the BASE LINE GRAPHS. All your set up person has to do is make simple adjustments to match the BLUE GRAPH (real time) to the RED GRAPH (base line).

Our 20/20 "Process Vision" graphing system is packaged as a portable unit that measures the actual nozzle wax temperature, wax flow and wax pressure during a machine's injection cycle and records it graphically on the built in net workable Windows based operating system. The 20/20 accomplishes this using quick-disconnects to hydraulically connect to a machine's injection cylinder and putting a thermocouple into the wax stream in the injection nozzle. The injection cycle is recorded as a graph of the actual wax temperature, flow and pressure. This gives you the capability of recording the injection parameters from a machine that's making a good pattern and transferring those parameters to a second machine. The second machine can now duplicate the injection parameters of the first machine by adjusting the second machines controls to match the injection graphs of the first. It's that simple; just align the graphs of the second machine to match the graphs of the first machine. Once the graphs match, both machines will inject at the same actual injection parameters regardless of the difference in machine settings. Both machines can now inject the same quality wax pattern. This can also be done effectively from one manufacturer's machine to another manufacturer's machine so long as both machines have the performance capability to run the die.

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The patented technology developed in the Process Vision graphing system is so beneficial we have made it available on every New MPI wax injection system in our "Smart Line" of pattern producing equipment. That's right; on all injectors even on our manually adjusted equipment you can visually see and compare the wax pressure curve. This is an invaluable aid to the set up technician and shows the operator the injection pressure and fill times during each injection cycle. It's an industry first that a machine with basic manually adjusted control valves has the capability of giving the operator valuable information on the injection process for each and every injection.

Imagine being able to make a flow or pressure change and visually see the effect on the fill time of the pattern. Even on a machine with manual controls.

Being a Windows-based system, it's now possible to network your wax room equipment with your in house information system. You are able to store and transfer your job order and process card from the office into the wax room. The injection process can be displayed on the touch screen. If it's a new job the process parameters can be stored and retrieved by an alpha numeric job number.

The injectors control system gives you the capability of monitoring your injector's process by graphically viewing the complete injection cycle and all the operating parameters used to make the wax pattern. The operator is informed where in the injection cycle the process is, and what if anything has changed. What makes this a real process control system is its ability to run a die the same way it was run previously even on a different machine. Every time a job is setup it can be compared against a stored injection graph of operating parameters. This will verify that the process has not deviated from its original operating parameters. Your process control limits can also be set for each job. If an operator sets up a job outside of the preset control limits or the process drifts out of the control limits, the machine will alarm and stop. It's now up to a setup person or supervisor person to determine what has caused the problem and how to go forward. Access to the injection controls is set by levels of authority. Level one for the operator, level 2 for the supervisor, level 3 for the setup person and so on up to full access by a qualified person in the

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maintenance or engineering department. The access levels will be set by each individual foundry matching their particular access requirements.

From the maintenance stand point, all of the PLC inputs and outputs are displayed and labeled on the touch screen. This allows the technician to pinpoint an interruption in the machine cycle and quickly diagnose the cause of the interruption. Preventative maintenance can now be preformed based on the machine letting the service departments know when it is ready for a PM based on the cycles run and operating conditions of the equipment.

I have told you about how we have integrated the vision graphing technology into our Smart Line of injectors. But let's not forget the reason for Process Vision.

It was developed to bring process control to your existing wax injectors. Process Vision graphing allows you to run a die on any injector capable of running the die regardless of the injector's personality.

When your process is in control all your wax patterns are the same.

What does that mean to you?

It means confidence that sound castings can be made with each and every wax pattern produced.

It means more castings with tighter tolerances can be shipped with less wax patterns injected.

It means your foundry is more competitive and has a better bottom line.

It's really that simply.

Thank You