
12TH
WORLD CONFERENCE ON
INVESTMENT CASTING

Casting Yields are Improved through Automation and Process Control in the Wax Room

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Their common objective was to reduce costs, improve quality, increase yields, and increase productivity, all while increasing profitability.

These foundries represent a cross section of our industry. Each had their own approach to implementation and each succeeded.

Casting Yields are Improved through Automation and Process Control in the Wax Room

Wisconsin Precision Casting Corporation

Casting Yields are Improved through Automation and Process Control in the Wax Room

Wisconsin Precision Casting Corporation

Dolphin Precision Investment Castings

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Wisconsin Precision Casting Corporation

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Pine Tree Castings

Wisconsin Precision Casting Corporation

Dolphin Precision Investment Castings

Pine Tree Castings

Invest Cast Inc.

First let me define Process Control and Automation.

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Process Control is a concept that states: If you control the variations in your process you will control the outcome of your process.

This is accomplished by:

- Knowing the variations in your process and how they affect your end product

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- Knowing the variations in your process and how they affect your end product
- Monitoring key parameters that effect individual operations

This is accomplished by:

- Knowing the variations in your process and how they affect your end product
- Monitoring key parameters that effect individual operations
- Having equipment capable of maintaining a consistent process

Automation is more than just mechanizing a manual process to reduce labor cost.

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Automation is the adaptation of changes to your existing processes so that you eliminate process variations and increase productivity by maximizing the use of automated equipment.

Casting Yields are Improved through Automation and Process Control in the Wax Room

Wisconsin Precision specializes in short run high value casting.

Casting Yields are Improved through Automation and Process Control in the Wax Room

Management made a strategic decision to redesign its operation to be more efficient handling low volume high value products. The goal was to be able to turn around small quantity orders quickly and efficiently with each department producing 100% yields.

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That's right 100% yields.

To achieve their goal they implemented Flow Manufacturing and a Process Control System.

The first department to implement Flow Manufacturing and Process Control was the wax room. The wax room was chosen because it was the first step in the process and its impact on the entire down stream operation is critical.

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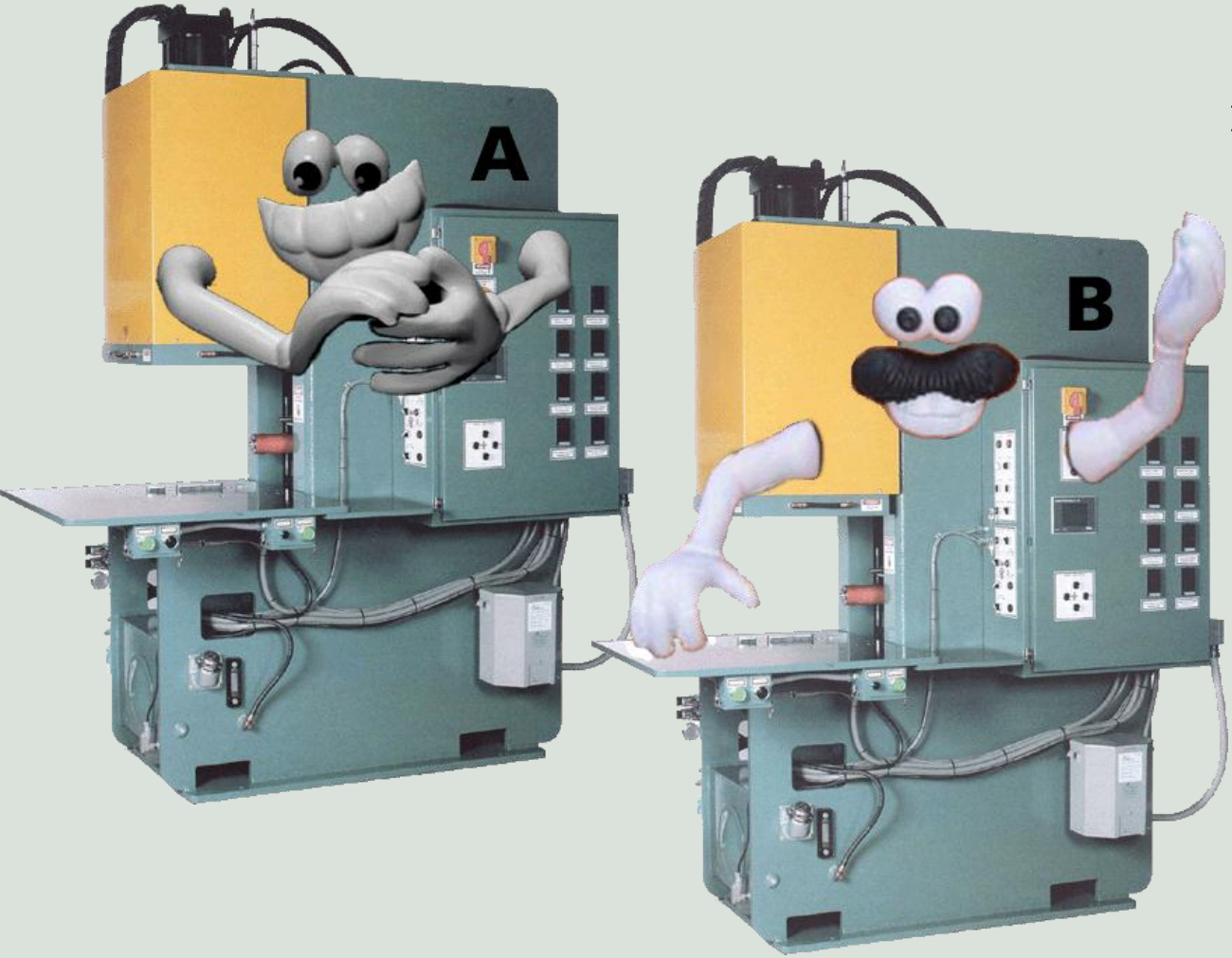

Each wax injector had it's own **personality**.

The injection parameters did not match from machine to machine.

The review of the wax room showed:

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- Procedures were based on memory
- Each wax injector was considered unique
- Setup cards were specific to every wax injector
- No measurements were taken or monitored
- There was no accountability

IMPLEMENTATION

To bring the wax room process under control:

- A new wax was selected that was suitable for different products from large bulky parts to thin walled parts.

IMPLEMENTATION

To bring the wax room process under control:

- Because wax temperature is the key process variable for making repeatable wax patterns

Wisconsin made a decision to run every wax injector at the same wax temperature for all products.

IMPLEMENTATION

To bring the wax room process under control:

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  - o Part change over problems were eliminated
  - o Promotes Flow Manufacturing

IMPLEMENTATION

To bring the wax room process under control:

- Supervisors can now visually monitor the process by observing if the wax temperatures on all wax injectors are set the same.

IMPLEMENTATION

To bring the wax room process under control:

- Operators receive continuous training and are given the information that allows them to do their job.

IMPLEMENTATION

To bring the wax room process under control:

- Each job has an order/process sheet that is followed and monitored throughout the foundry process

IMPLEMENTATION

To bring the wax room process under control:

- The wax supplier must provide test results for each wax shipment and a batch-to-batch historical trend to see if the wax properties are drifting.

IMPLEMENTATION

To bring the wax room process under control:

- Every wax pattern injected is counted and identified as either setup scrap or production scrap.

Operators are accountable for scrap, which is logged into Wisconsin's information system

IMPLEMENTATION

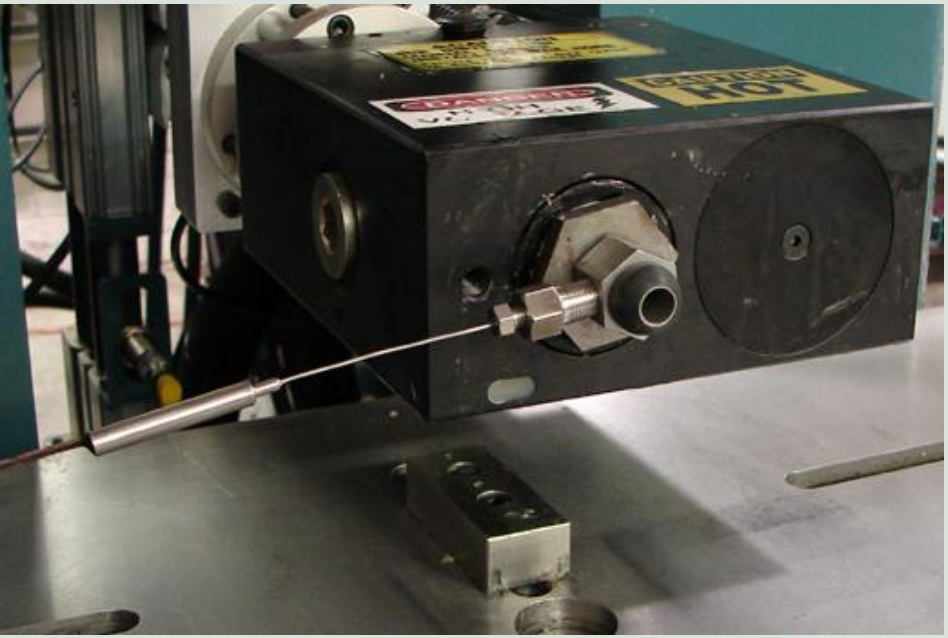
To bring the wax room process under control:

- Limits are set for wax flow and wax pressure. Changes can be made only by a technician or a supervisor.

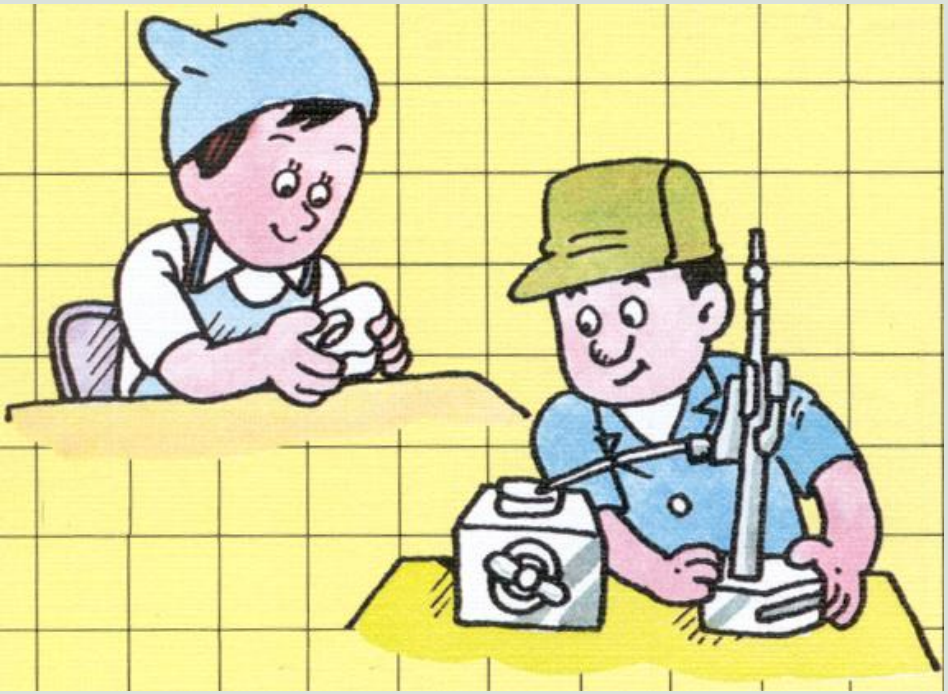
IMPLEMENTATION

To bring the wax room process under control:

- Once a week process review meetings are held to identify and eliminate process problems.



Wax temperature (actual wax temperature as it comes out of the nozzle, not from machine instrumentation) is measured two times per shift.



Wax patterns and castings are measured on a weekly basis to ensure that the process is not drifting.

INJECTOR TO INJECTOR PROCESS CONTORL

To maintain process control from one wax injector to another Wisconsin uses MPI'S 20-20 process vision graphing system

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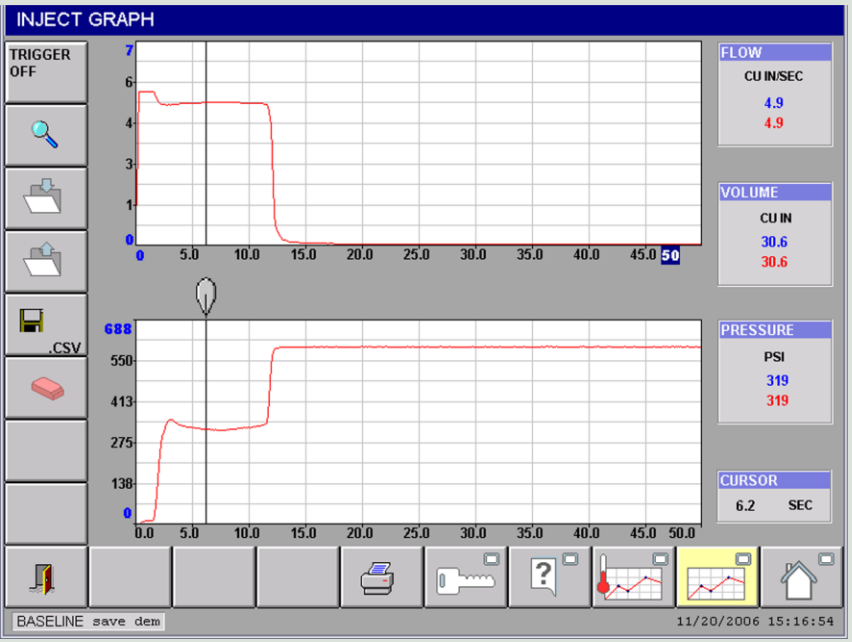

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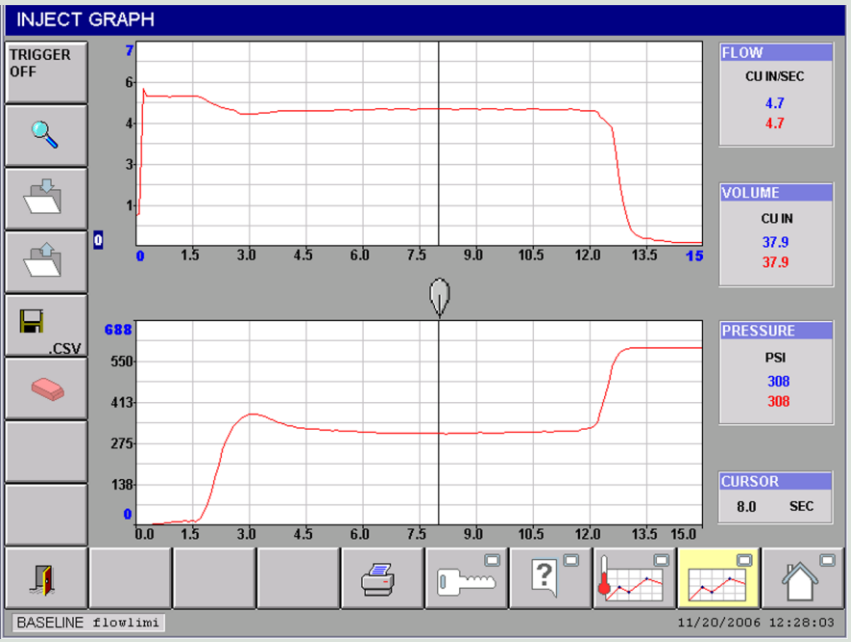

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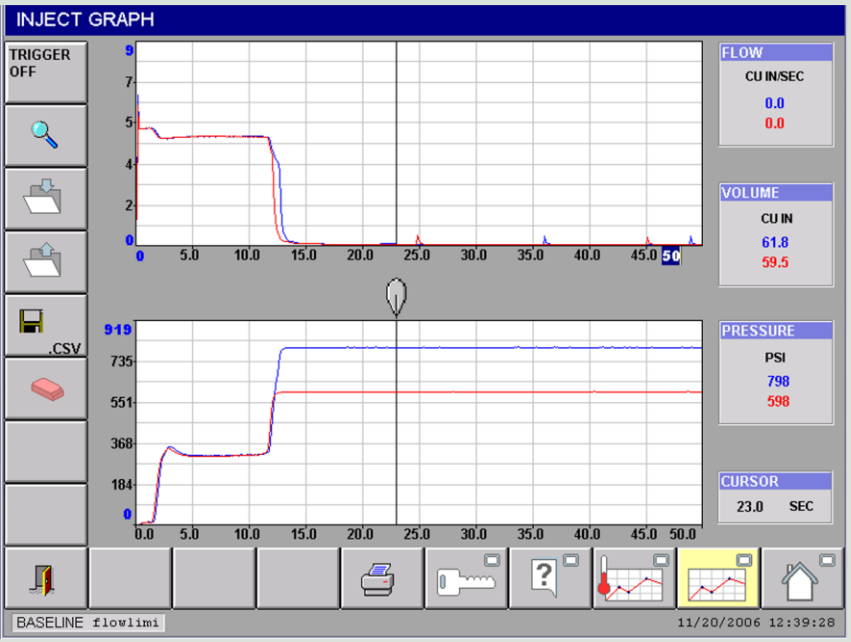
- Move a wax die to multiple injectors and achieve the same quality results



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- Monitor process control from machine to machine
- View the injection process to facilitate good process decisions
- Move a wax die to multiple injectors and achieve the same quality results
- Calibrate the wax injectors

Model 55-100-38

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- Provides process control feedback alarms

Model 55-100-38

When new equipment is purchased, process control features are an essential requirement.

- Views the injection process
- Provides process control feedback alarms
- Provides the operator with information and tools so they can perform their job

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- **Sales increased 72% without adding employees**

MANAGEMENT COMMENTS

Cliff Fischer stated:

- "You can buy all the sophisticated high tech equipment but if you do not change the attitude of your people and have them all working for the same goal it will not work"

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- "You can buy all the sophisticated high tech equipment but if you do not change the attitude of your people and have them all working for the same goal it will not work"
- Achieving good process control requires high expectations. Don't settle for less.

MANAGEMENT COMMENTS

• Implementing Process Control through Flow Manufacturing is the path that Wisconsin Precision is taking to achieve their goals of reaching 100% yields.

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By implementing Process Control and Automation.

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One of the challenges that Dolphin faced was the cyclic nature of their business. Each year the requirement for golf clubs goes from a low of 3,000 clubs per day to a high of 12,000 clubs per day.

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One of the challenges that Dolphin faced was the cyclic nature of their business. Each year the requirement for golf clubs goes from a low of 3,000 clubs per day to a high of 12,000 clubs per day.

Dolphins answer was to build a highly automated foundry that could turn capacity on and off to meet demand.

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Management quickly realized that their manual process of pattern assembly could not provide the accuracy and consistency to support cost effective automatic casting cutoff.

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- Increased the number of patterns per assembly
- Used one set of quick change tooling for their complete range of clubs
- Provided accuracy and consistency for automated cutoff

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- Automation of casting cutoff

THE RESULTS ACHIEVED BY DOLPHIN ARE IMPRESSIVE

- Paste injection cut the pattern cycle time in half

Model 20-10 APAS

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Model 20-10 APAS

THE RESULTS ACHIEVED BY DOLPHIN ARE IMPRESSIVE

- Paste injection cut the pattern cycle time in half
- One operator runs two (2) MPI APAS producing 18 assemblies per hour as compared to one manual assembler producing 4 assemblies per hour.
- That's a **78%** reduction in labor cost and a **350%** increase in productivity.

APAS runs 24 hours per day during peak demand. Rapid change over of products 8-10 times per day.

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Scrap from inclusions associated with assembly went down to almost zero.

Temporary personnel are now only used for unskilled tasks.

Quality and training issues caused by hiring and then laying off personnel were eliminated.

MANAGEMENT COMMENTS

Pete Poleon stated the following

•Dolphin is committed to Lean Manufacturing. The pull system of equal flow allows all departments to have the same flow with no inventory build.

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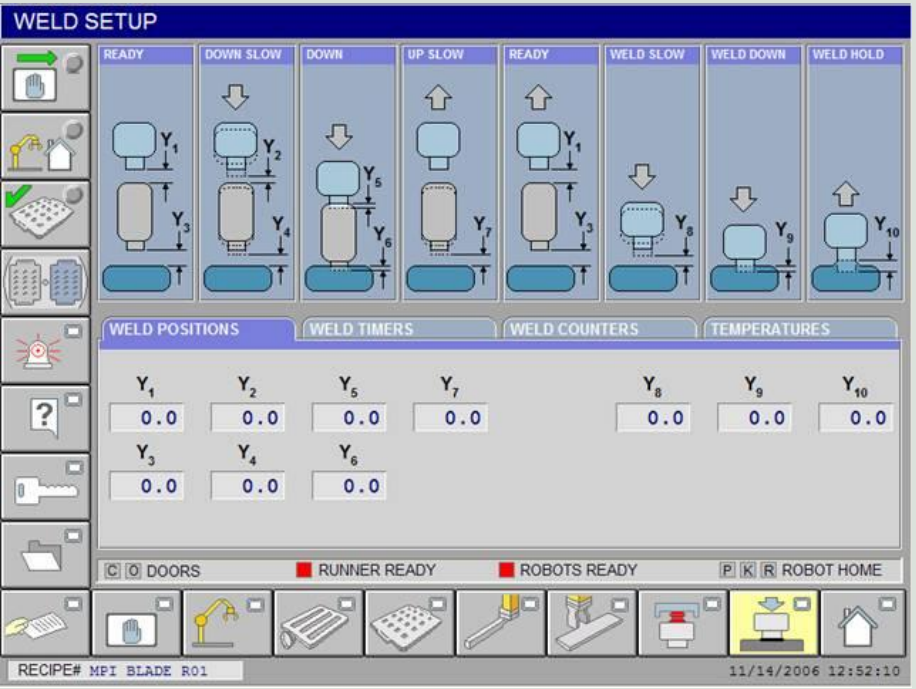

The APAS was a key element in allowing this to happen.

The APAS Human Machine Interface is user friendly, limits what the operator sees, and yet has a wealth of information in the background.

MANAGEMENT COMMENTS

Pete Poleon stated the following

The APAS learning curve is short and straightforward.

MANAGEMENT COMMENTS

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The Internet connection to MPI provides for very little machine down time.

For example when a thunderstorm shut down one of the machines MPI went on line to Dolphin and resolved the issue remotely.

MANAGEMENT COMMENTS

Pete Poleon stated the following

The equipment has handled 3 model changes of golf clubs and it is completely capable of adapting to whatever comes Dolphin's way in the future.


PINE
TREE
CASTINGS

Pine Tree Castings has been implementing lean manufacturing throughout their operation.

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This example shows us the productivity gains and reduced labor time achieved from implementing lean manufacturing into an Automated Wax Cell.

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This example shows us the productivity gains and reduced labor time achieved from implementing lean manufacturing into an Automated Wax Cell.

The comparison is between 3 operators doing three operations versus one operator running an entire wax cell.

The part used in the comparison is a scope ring for a rifle and the assembly consisted of 40 patterns.

One operator ran a semi-automatic wax injector for patterns, inspected the patterns, trimmed off the injection runner and placed the patterns in trays.

Time: 10 minutes and 55 seconds for 40 patterns.

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Time: 6 minutes and 27 seconds.

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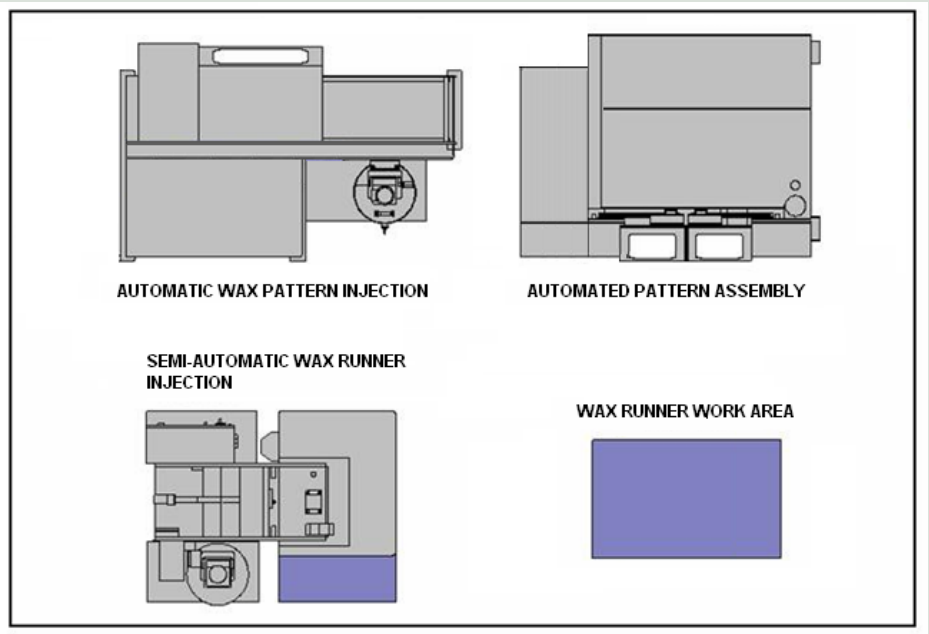
A third operator ran MPI's APAS which automatically welded the 40 patterns to the assembly.
Time: 6 minutes and 27 seconds.

The total labor time to make one assembly of 40 patterns was
18 minutes and 22 seconds.

When Pine Tree created the wax cell they replaced the semi automatic wax injector with a fully automatic wax injector.



AUTOMATED WAX CELL

The Automated Wax Cell allowed one operator to inject patterns and runners, trim, inspect and load the wax patterns directly into the APAS and remove the finished assemblies.

A fully automatic wax injector MPI 45-12 for injecting patterns.

An MPI 54-50 semiautomatic wax injector to inject runners.

An MPI 20-10 APAS to automatically assemble (weld) the patterns to the runner.

- Total labor time to produce an assembly was 6 min. and 27 sec.

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- Or to look at it another way an increase in operator productivity of **185**%

CONCLUSION

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- An automatic 45-12 injector produced more patterns
- The automated production of wax patterns and runners was matched to the automated cycle time of the APAS.
- The equipment used was capable of maintaining continuous production and consistent quality.

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- The pattern spacing on the runner is at a higher density, more patterns per runner
- The pattern placement is more accurate which gives a more uniform shell
- A more uniform shell equals a more consistent metal pour
- This all adds up to higher casting yields

MANAGEMENT COMMENTS

Adam Kuper also stated:

One part has recently been increased from a density of 56 pieces per assembly to a 112 piece assembly. The spacing between the patterns was decreased form .300" (7.5mm) to .120" (3mm). That's a 100% increase in yield per assembly and this yield flows down stream to increases in shelling and pouring.

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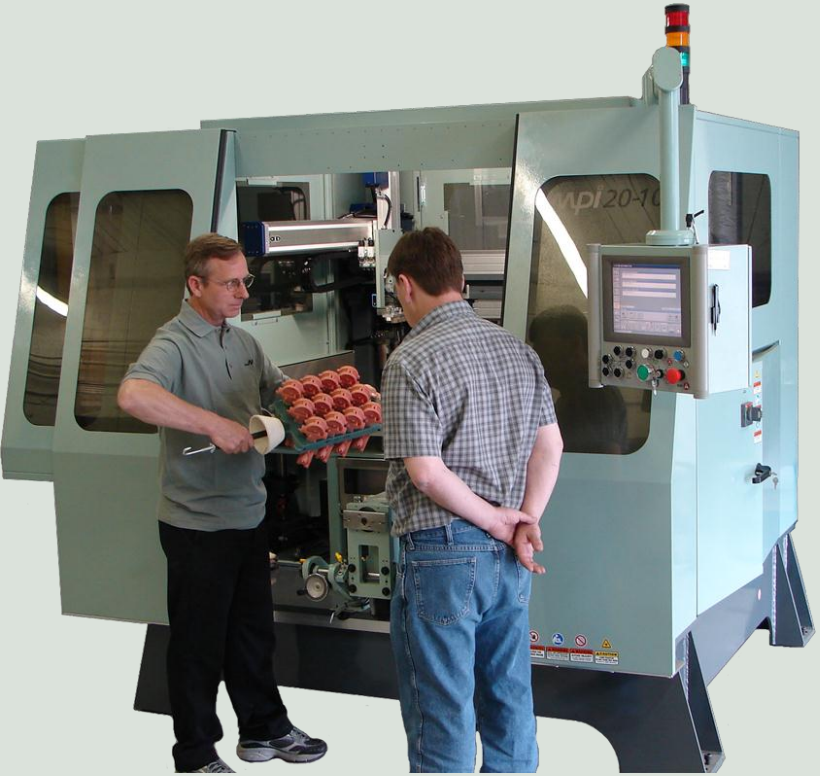
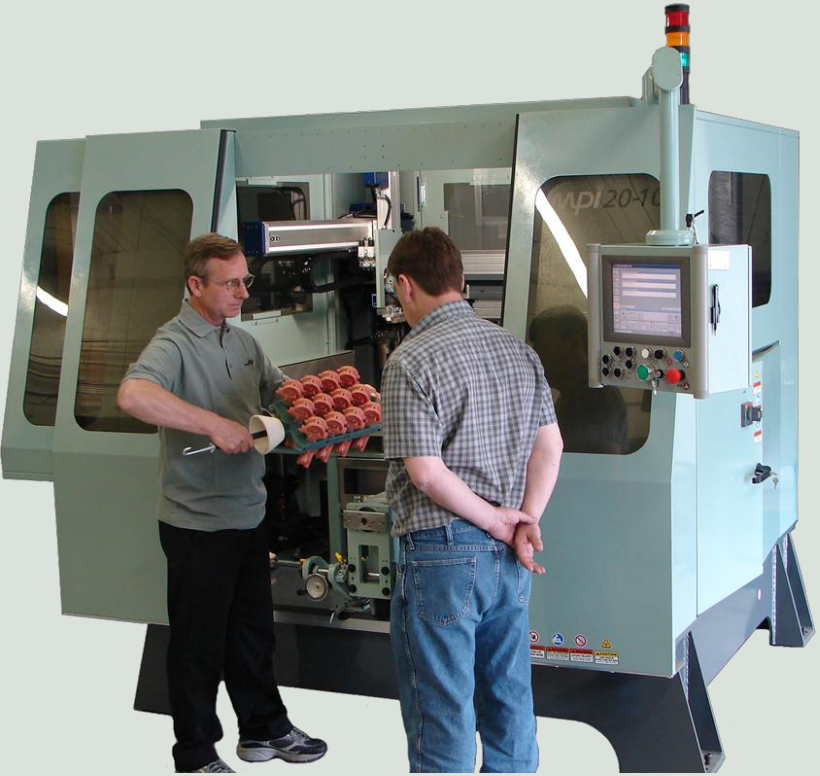
Invest Cast realized that they would be able to increase their productivity and casting yields if they could reduce pattern assembly time, improve the weld quality and increase the number of patterns per assembly.



Invest Cast made a strategic decision to adapt its process for automation using the MPI APAS.



Invest Cast made a strategic decision to adapt its process for automation using the MPI APAS.

Invest Cast was very open and took a fresh look at how an assembly could be made to achieve the maximum throughput for the entire foundry operation from the wax room through cutoff and finishing.

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• Working as a team Invest Cast and MPI designed “Foundry Friendly” wax assemblies. These are assemblies that are both operator and process friendly encompassing the entire foundry operation.

• In most cases this meant more patterns per assembly. But in some cases it actually resulted in fewer patterns per assembly in order to reap the benefits of an assembly that was more “Foundry Friendly”.

• In either case all the assemblies have pattern spacing too close for manual assembly.

WHAT DID AUTOMATION AND PROCESS CONTROL DO FOR INVEST CAST?

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Part Number 1:		
Manual assembly	175 patterns per hour	
APAS		300 patterns per hour
Percent increase	71%	

WHAT DID AUTOMATION AND PROCESS CONTROL DO FOR INVEST CAST?

Part Number 1:		
Manual assembly	175 patterns per hour	
APAS		300 patterns per hour
Percent increase	71%	
Part Number 2:		
Manual assembly	45 patterns per hour	
APAS		110 patterns per hour
Percent increase	144%	

Part number 3:

Manual assembly	230 patterns per hour
APAS	320 patterns per hour
Percent increase	39%

Part number 3:

Manual assembly	230 patterns per hour
APAS	320 patterns per hour
Percent increase	39%

Part number 4:

Manual assembly	220 patterns per hour
APAS	450 patterns per hour
Percent increase	105%

Part number 3:

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APAS	320 patterns per hour
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Part number 4:

Manual assembly	220 patterns per hour
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Percent increase	105%

Part number 5:

Manual assembly	170 patterns per hour
APAS	325 patterns per hour
Percent increase	91%

Part number 3:

Manual assembly	230 patterns per hour
APAS	320 patterns per hour
Percent increase	39%

Part number 4:

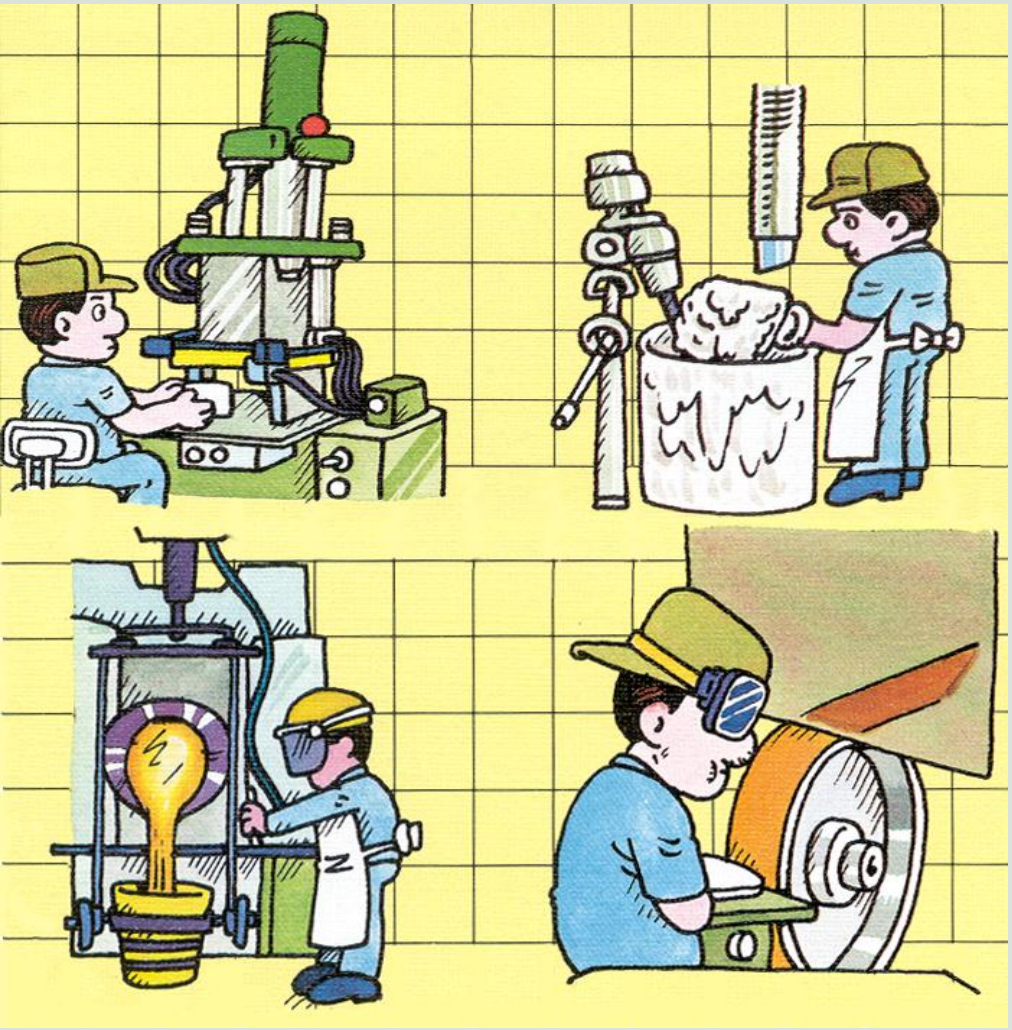
Manual assembly	220 patterns per hour
APAS	450 patterns per hour
Percent increase	105%

Part number 5:

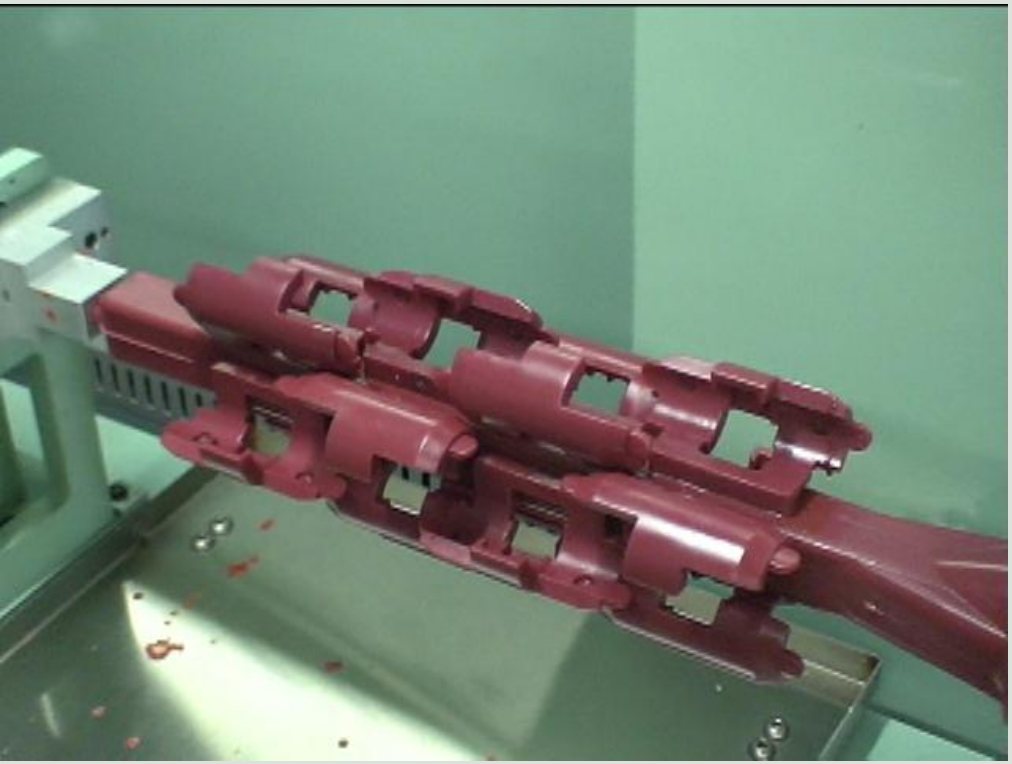
Manual assembly	170 patterns per hour
APAS	325 patterns per hour
Percent increase	91%

Part number 6:

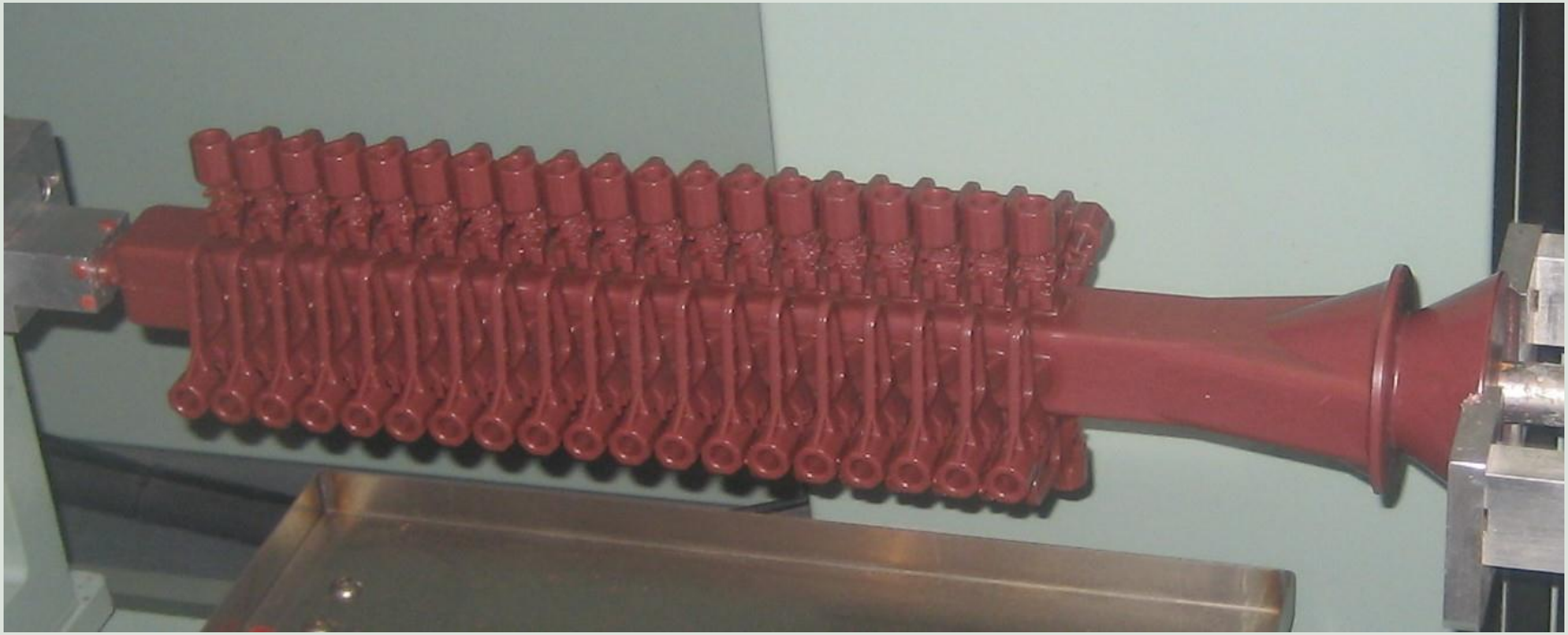
Manual assembly	210 patterns per hour
APAS	250 patterns per hour
Percent increase	19%



As I stated above, for a part to be "Foundry Friendly" it does not necessarily mean that it always has more parts per assembly.



Part number 2 for example went from 36 parts per assembly using the manual process to only 16 parts per assembly using APAS. Yet the number of patterns assembled per hour was increased by 144% and the assembly flowed through the foundry easier resulting in higher casting yields.



Part number 4 on the other hand was loosing money when assembled manually with 60 patterns per assembly. When converted to a “Foundry Friendly” assembly they were able to assemble 76 patterns per assembly, 104% more parts were assembled per hour and the castings are now running through the foundry with a positive profit margin.

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One thing I really likes about the APAS is that you can take a person off the street and within 15 minutes you can have them operating the machine making perfect assemblies. This is compared to 4 to 6 months to train an operator for manual assembly.

DOWN STREAM OPERATIONS

These four companies have shown clear examples of how they were able to make gains through the implementation of process control and automation. These gains did not stop in the wax room. The gains multiply as the assemblies move through the foundry.

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- A 20% increase in casting throughput

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- No additional metal was poured to make the runner, only the metal needed for the 8 additional castings
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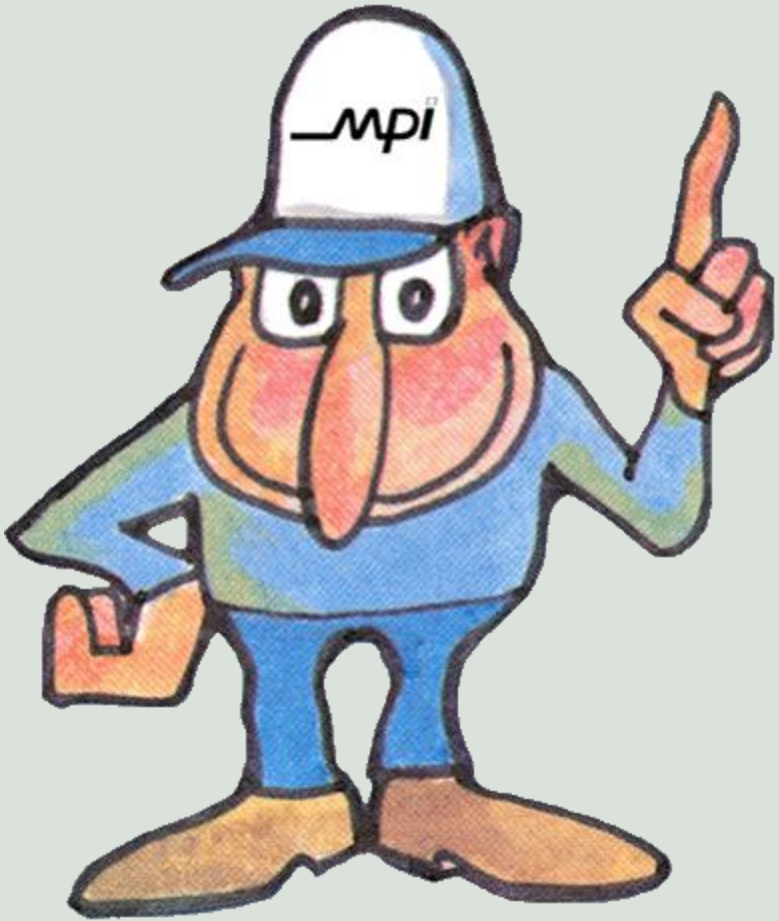
- No pattern damage from manual assembly

Automation and Process Control will produce more castings with less labor cost.



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CONCLUSIONS/TAKE HOME

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- Equipment must be capable of process control.
- Process Control and Automation will give foundries the tools they need to succeed in a an ever more competitive market.

I would like to thank the following people who made this paper possible:

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Bill Walker Jr. and Tyler Albert from Invest Cast Inc.

Thank You

WISCONSIN PRECISION CASTING CORPORATION

DOLPHIN PRECISION INVESTMENT CASTINGS

PINE TREE CASTINGS

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12TH WORLD CONFERENCE ON INVESTMENT CASTING