"Automation" The Why and How

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Why Automate?

Reduce labor costs?

Why Automate?

But, there is another key area to consider:



Why Automate?

But, there is another key area to consider: Reducing Process Variability

The Problem is Variability

Why Automate?

Automation = Repeatability!

- Pattern to Pattern Repeatability
- Assembly to Assembly Repeatability
 - Casting to Casting Repeatability

Customer Results

INCREASED DECREASED INCREASED YIELDS SCRAP PROFITS



Not so easy

Requires a Holistic Approach

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Requires a Holistic Approach Include Key Personal from all Departments Many Defects are not Readily Apparent Design your assembly for the highest yields

Optimize the pattern assembly to include:



Optimize the pattern assembly to include:

• A design for highest metal pour ratio



Optimize the pattern assembly to include:

- A design for highest metal pour ratio
- Design for optimum metal flow



Optimize the pattern assembly to include:

- A design for highest metal pour ratio
- Design for optimum metal flow
- Design for optimum metallurgical properties

Optimize the pattern assembly to include:

• Design for part cut off



Optimize the pattern assembly to include:

- Design for part cut off
- Design for de-wax



Optimize the pattern assembly to include:

- Design for part cut off
- Design for de-wax
- Design for Shelling

Now concentrate on the wax room:

- Automation requires Standardization
- Use a future oriented vantage point
- Get out of the past
- Change is painful but rewarding

Where do you start?

Understanding your motivation

- Work closely with your Integrator
- Have a well defined plan
- Reduce the amount of variables



Where do you start? Understanding your motivation

You need to clearly define the following:

What do you want to automate?

- The injection of wax patterns
- The injection of wax runners
- The assembly of wax patterns to your runners
- Transportation of the various components
- All the above

Where do you start?

Understanding your motivation

Why do you want to automate?

- Reduce labor
- Reduce pattern to pattern variability
- Reduce pattern warpage
- Reduce pattern drop off in the shelling operation
- Reduce metal inclusions due to inconsistent welds

Specifications for Automation

- Wax Pattern Specifications:
 - Provide solid model files wax patterns
 - The pattern gate is a critical part of the pattern
- Wax Runner Specifications:
 - You will need to provide solid models of the wax runners
 - Include any steel inserts, pouring cups, and any special requirements or secondary operations
- Wax Properties:
 - Wax Manufacturer's Part #
 - Viscosity Curve



Note: Wax Patterns and Wax Runners are **both** critical patterns Customer needs to define what is critical on the patterns e.g.:

- Where the pattern can be gripped without doing damage
- The amount of witness that is allowed on the pattern Are there secondary operations required if so what are they:
 - $\circ \textbf{X-ray}$
 - \circ Pinning cores
 - \circ Inspection
 - Pattern Cleaning and Trimming

Automated wax injection tools (dies/molds):

- High quality automated tools with no flash on the pattern.
- Standardized mounting with accurate location
- Automated Core Pulls
- Automated pattern ejection
- Water cooling passages
- This applies to runner injection as well



Need a clearly defined operation:

- Tool clean off
- Tool lubrication
- Pattern removal
- Injection runner removal
 - $\circ~$ Defined witness on pattern
 - $\circ~$ Where to deposit the runner



- Pattern setter:
 - $\,\circ\,$ All setters need to have common mounting
 - $\,\circ\,$ The setter needs to be automated
- Pattern transport out of the cell needs to be defined
 - \circ What is the next operation and where?
 - \circ How is it transported to the next operation?
 - Tray
 - Conveyor
 - Tray on a Conveyor

Automated Injection, 6 Axis Robot



Automated Injection, 6 Axis Robot



Customer Results

- Double the number of patterns injected per day
- Pattern yields increased 10 to 20%
 - Reduced pattern distortion
 - Reduced pattern defects
 - Uniform pattern trimming, minimal variation
- Higher casting yields

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When automating pattern assembly select a family of parts that will fit a single runner design. The automated pattern assembly process requires:

- Tooling to hold the wax patterns
- Tooling to hold the wax runners
- Tooling to weld the pattern to the runner

The end of arm tooling cost can be reduced with a family of parts because of commonality.

Each family will have a defined commonality and grouped by:

- Patterns of a similar size
- Patterns of a similar shape
- Patterns with a common gate
- Patterns mounted on the same runner
- Spacing of the patterns on the runner
- The angle of pattern to the runner bar
- The type of mechanism that is used to hold the patterns during the assembly process, e.g. grippers or vacuum

The design process requires :

- Photos of the assembly
- Internal pattern assembly documentation
- Solid model files of the complete assembly including:
 - Steel insert
 - Pouring cup
 - Any secondary or unique features



Combining advanced technologies with Smart Process Control

Outsourced Automated Pattern and Assembly



Outsourced Automated Pattern and Assembly

Unexpected benefit:

"What was the one finger rule now is the one finger nail rule." Mel Kman

President Avalon Precision Casting



Outsourced Automated Pattern and Assembly 1st Coat



Outsourced Automated Pattern and Assembly 2nd Coat





Outsourced Automated Pattern and Assembly 3rd Coat





Outsourced Automated Pattern and Assembly 4th Coat





Outsourced Automated Pattern and Assembly 5th Coat



Outsourced Automated Pattern and Assembly 5th Coat with Seal Coat



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Automated Pattern Assembly of Single Crystal Turbine Blades











Automated Assembly of DS and Single Crystal Turbine Blades

Results:

- Extremely uniform, repeatable and stronger assemblies
- A more uniform shell coverage due to accurate spacing
- Improved thermal gradient and metallurgical properties
- Decreased cycle times with reduced labor
- Higher casting yields



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Summary

- Automation is a clear means to reach many of the critical goals you set for your business.
- Automating your wax room will have a significant positive impact to your bottom line.
- Once you have made the commitment to automation you will begin to see more automation possibilities and they will be easier to implement so...

Why not automate?

Questions?