Technical Paper

"Automation"

The Why and How

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"Automation"
The Why and How

Good Morning. Most of you know that MPI is a supplier of Wax Room Equipment. Although my paper "Automation" the Why and How, will focus on the wax room, the results will show up in your castings. The results… more castings shipped and castings with tighter tolerances!

Why should you automate? The simple answer is because automation can make your company MONEY. Automation works!

How does automation work?

By reducing process variation!

If you apply automation in the wax room you will…

- Reduce Pattern to Pattern Variation
- Reduce Assembly to Assembly Variation
- And Eliminate Poor Wax Welds

Therefore you will ship more quality castings with tighter tolerances.

The reason that I can say this with such confidence is because we have automation customers in aerospace, medical, automotive, and commercial that we have supplied automation solutions to and they are so happy with the results that they are not willing to share the competitive advantage they have achieved. I have to say that as much as I would love to have them here today telling you what they have accomplished, I totally understand their position. They have achieved the level of automation they have today with a lot of hard work. Each and every time we work with a new customer, implementation has been a challenge, and the challenge has been for both our customers and ourselves.

I think this is true because our customers do not clearly understand how to implement automation, what it really takes to make automation successful.

How do you automate the wax room?

Implementing automation is a process. But it is also a real opportunity to correct variations in your process and make them robust. It requires support from upper management and it needs a carefully laid out plan to make it happen correctly.

There is a natural resistance for foundries to take the necessary steps that insure successful automation. It is common for foundries to want to automate their manual process, but this generally is not the best approach.

I think Bill Gates put it nicely:

The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency.

So if you automate a bad process you will get bad automation!

Here is an example of how a failed automation project eventually led down the road to successful automation.

We have a very good customer today who, before they became our customer, made the decision to automate their existing wax assembly process. They made the decision to automate without changes to their process, because it appeared to be a simpler and less costly approach to what MPI had offered. MPI had proposed an automated assembly approach that required changing the wax runner design, that Sacred Cow, or Fixed Process. The design change of the runner was required in order to guarantee a robust automated solution of their wax assembly. Their existing process simply did not meet the requirements for automation, and it did not matter if the actual wax assembly process used MPI's patented welding process or the sticky wax gluing process.

Here are some basic requirements, if not followed, can make automated assembly fail.

- The pattern gate needs to be smaller than the runner so the wax welds are drip free.
- If the pattern has two gates and they are not on the same, or a parallel plane, one weld will drip.

Because we showed our customer what can't be done upfront, MPI lost this order for automated assembly.

We did however win them over as a customer through automated injection. We won our customers trust by stepping them through a process that guaranteed success.

- We brought our customer to MPI to do wax injection trials.
- We showed them their wax being injected into their die running on our machine.
- We showed them faster cycle times and better quality patterns.

With sound results from the demonstration we worked together to clearly define the scope of the automation project. Through clear communication with our customer we were able to define a path to a successful automation approach. Automation which our customer calls "sensible automation," not overly complicated machines but machines which are user friendly and easy for the operator to setup, understand and adjust.

Once the automated injection cell was built we performed an FAT, Factory Acceptance Test, with the customer at MPI. The results of the FAT allowed the customer to make final changes to the cell prior to shipping. This resulted in an extremely quick startup and commissioning once the automated cell was in the customer's factory, allowing the machine to go into production in a few days.

The measured output today of the automated injection cell doubles the manual process. But more importantly it also significantly reduces the metal scrap.

We are now engineering a fully automated assembly cell for this customer following the same step by step approach taken with the injection cell.

Where do you start?

When considering wax room automation you need to take a holistic approach. That is to say you need to consider your entire foundry. You need to analyze every step of the process starting at the end, part cut off and finishing, and work your way up to the wax room. Include an analysis of each step of your entire foundry process. Include key personnel from each department and understand the problems they are encountering every day.

It is our experience that when this analysis is completed thoroughly, root cause of much of a foundry's scrap and rework is actually found in the wax room with wax pattern and/or wax assembly defects. Many of these defects can be reduced through appropriate application of automation in the wax room. In order to achieve this you need to optimize the pattern assembly so that you have included the following:

- Design the assembly to have the highest pattern to runner density to achieve the highest metal pour to part ratio. **Note:** Remember that automation of the pattern assembly process allows for a pattern density that is tighter than what your operators can do manually, take advantage of this opportunity.
- The design needs to accommodate automated shelling.
- Create a layout that can have the parts cut off efficiently using automation. **Note:** Automated pattern assembly creates a common method for holding the runner which can also be used for casting cutoff.
- The assembly design needs to have the optimum metal flow characteristics.
- Design the assembly for optimum metallurgical properties.

Automation requires a new discipline, "Standardization." As I stated earlier, automation is a real opportunity to correct variations in your process. Take advantage of this opportunity and make your process robust. You need to take a future oriented vantage point. Do not let the past, or what you are presently doing today, contaminate your vision for the future. You need to see clearly where you want to be in the future, and work out how you are going to get there. Change can be painful but the gains are rewarding.

You need to work closely with your automation integrator from the start of the project so all the possible gains are achieved. You need to know what you want to automate.

1. The injection of wax patterns
2. The injection of wax runners

3. The assembly of wax patterns to your runners
4. The movement of materials and components from one department to the other
5. All the above

If the answer is “All of the above” you do not need to do it all at once. Automation if done correctly can be done in stages. But it is most efficient if you start by including your ultimate automation goal.

Wax Injection Automation

Now let’s talk about the automation of wax injection. **Note:** This applies to both wax patterns and wax runners. A wax runner is a critical wax pattern and needs to be treated like one.

1. Customer needs to define what is critical on the patterns, e.g.:
   a. Where the pattern can be gripped without doing damage
   b. The amount of witness that is allowed on the pattern after the injection runner is removed
   c. Are there secondary operations required, if so what are they:
      i. Trimming the injection runner
      ii. X-ray
      iii. Pinning cores
      iv. Inspection
2. An automated injection cell must include automated wax injection tools (dies/molds) with the following features:
   a. High quality automated tools with no flash on the pattern
   b. Tools need to have standardized mounting with accurate location features
   c. Automated core pulls
   d. Automated pattern ejection. The wax pattern needs to stay on the die half with the pattern ejectors every time. **Note**: a sticking wax pattern cannot be automated.
   e. Water cooling passages in the tool. Automation requires accurate die temperature.
   f. This applies to runner injection as well
3. An automated injection cell needs to have the following operations clearly defined:
   a. Tool clean off: Blow off any residue wax and die lubrication

b. Tool lubrication: The correct amount of mold release with the correct frequency. A programmable robotic movement is ideal for this operation.
c. Pattern removal: The pattern and injection runner comes out of the tool as a unit; the injection runner cannot break off.
d. Injection runner removal
    i. Cut off with a defined witness on the pattern
    ii. Deposit the injection runner into a receptacle
e. Pattern setter, does your pattern need to be cooled in a supporting fixture to prevent warpage? If so:
    i. All setters need to have common mounting and location features
    ii. If the setter clamps the pattern it will need to be automated
f. Pattern transport out of the cell needs to be defined
    i. What is the next operation and where?
    ii. How is it transported to the next operation?
        1. Tray
        2. Conveyor
        3. Tray on a Conveyor

4. Wax Pattern Specifications: You will need to provide solid model files and pictures of the wax patterns including the gate. The pattern gate is a critical dimension of the pattern and must be clearly defined for automation.
5. Wax Runner Specifications: You will need to provide solid models of the wax runners including any special requirements or tolerances of the runner. Include any steel inserts, pouring cups, and any special requirements or secondary operations.
6. Wax Properties:
    a. Wax Manufacturer's Part #
    b. Viscosity Curve

Automated Pattern Assembly

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, hold the wax runners, and tooling for welding of the pattern to the runner. In order to reduce the tooling cost for

automation, the more part numbers that can fit onto a single runner and the more similarity between the patterns will allow for the minimum amount of end of arm tooling. The end of arm tooling cost can be reduced with a family of parts because of commonality.

The range of products or wax patterns needs to be grouped into "families." Each family will have a defined commonality between them. For example they may be grouped by:

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

The Preliminary design process requires:

- Photos of the assembly
- Internal pattern assembly documentation

The final design will require:

- Solid model file of the complete assembly including:
  - Steel insert
  - Pouring cup
  - Any secondary venting or other unique features or requirements, i.e. minimum spacing requirements for specific alloys

Often times we get a negative reaction to an automation proposal such as:

- We have 2000 dies; we cannot afford to automate them all.
- We have 50 runner designs; we cannot afford to change them all.

The answer is you are correct! You cannot afford to automate them all, and probably you should never automate most of them. But you need to start thinking about automation, and you need to start.

As I stated earlier, implementing automation is a process. If you start the automation process you will see gains even before you turn on your first robot. It is amazing what standardization will do to improve your through-put.

Conclusion

Automation is a real opportunity to correct variations in your process and make them robust. Automation is also a clear means to reach many of the critical goals you set for your business. With the correct mindset and preparation, automating your wax room will have a significant impact to your bottom line. Once you have made the commitment you will begin to see new possibilities every time you quote, and every time you receive new orders, automation will become easier to implement. You need to tool up new jobs anyway, why not, using automation?