Scoring Castings

Looking objectively at the quality of the parts

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Business background

Corporacion POK is a job shop foundry and machine shop with over 120 years in the market, located in Guadalajara, Mexico. The company has approximately 330 employees in 4 major areas: Sand casting foundry, investment casting foundry, conventional machine shop and CNC machine shop. The foundry produces approximately 250 tons per month of castings ranging in weight from a few ounces to 12,000 pounds, net-weight. POK produces several alloys such as high-strength steel, stainless steel, low alloy steel, carbon steel, ductile iron, cast iron, bronze and other specialty alloys such as Monel and Inconel. The melting equipment in the foundry consists of six induction furnaces ranging in capacity from 300 pounds to 7,000 pounds and 1 vacuum induction furnace with vacuum pouring capabilities up to 300 pounds. Most of the castings produced are finish-machined in-house by our conventional and CNC machine shops.

Why score castings?

We score castings to look objectively at the quality of parts. This knowledge allows us to make the right decision about cause and effect. Scoring also allows you to compare the results of changes in your process.

Foundries have a tendency to say, “These castings look better than they did last year” or “these are the worst castings I have ever seen”. This subjective evaluation does not lead to solution.

There needs to be a way to compare objectively the castings made before and after a change, in order to make a decision about the appropriateness of a change. In fact, scoring castings will allow us to establish objective data that may be used as the basis of a DOE type evaluation.

You can evaluate a large population of castings and draw conclusions such as:

- Cavity 1 versus cavity 2
- Defects related to design and foundry engineering.
- Defects related to process parameters

Mapping and overlay of defect maps gives vital information about the location of defects, which can relate to cause. The ultimate outcome would be to determine the major variable that causes the bulk of our repair and scrap costs.

Finding the ultimate goal…

There are two types of quality problems in foundries:

Episodic problems: These problems pop up and the foundry team usually knows the cause, and makes the proper correction. For example, a hot tear may be caused by a core that does not collapse. Adding a lightener that makes the core break down, eliminates the defect.

Endemic problems: The other type of quality problem is endemic. Those defects that are not easily eliminated, yet cause a large percentage of scrap and repair costs. No one seems to solve these problems, after many unsuccessful trials. Every department blames the other because they truly do not know the solution to this type of problem. Hint: When this happens, this is a good time to stop the blame game and get people interested in solving the problem. The person who sets out to solve these problems should include all those who have input. This is a real boost to the attitude toward correction.

In most cases, some castings are good, some contain varying amounts of the defect and some are scrap. All of these conditions have information valuable to the solution of the problem. The variable of importance is sometimes in the "off" condition and sometimes in the "on" condition. The trick is to find that variable and begin to control it.

The variables you choose to test should match the type, frequency and location of the defects you are trying to correct. This takes some study and thought. Do not test a variable that does not match what you are seeing. For example, do not test the first shift versus the second shift when both produce the same level of the defect.

What is changing when the castings range from good to bad? The solution depends on determining the one (or maybe two) major variables that cause the bulk of the problem. Knowing this major variable becomes the focus of control. Variables that have no impact on the problem are not controlled.

Choosing your scoring method

When deciding upon your scoring method, your goal should be to find a method that is repeatable, and accurately relates to the level of a given defect. Before looking at the scoring methods, here are some guidelines:

- The scoring method you successfully determined for one type of defect might not be the best scoring method while trying to review a different type defect.
- Make sure you know the exact identification of the defect. For example, porosity may include many defects; be sure you are looking at one defect at a time. Sand, re-ox and gas can all cause a defect that is similar in appearance.
- Score different defects independently of others. The castings may have more than one defect, so score for each defect separately. (Related experience – a test done to find major variable causing core scabs, revealed the major variable causing cold laps, since pouring speed was one of the variables being tested for scabs).
- Use plant inspectors. Your scoring <u>WILL</u> be biased (since you think you know the cause and want to pre-determine the outcome).
- Be very explicit defining the task.
- Check the inspectors for repeatability.
- Do not use different inspectors to score castings on the same test.

1. Count: Count the defects (Do not relate to specifications, e.g. SP55). This is not an issue of acceptable versus rejectable castings. For cracks, count the number of cracks on one particular casting. You can count the actual number of inclusions, and this can be the score. Example, re-ox on a cope surface versus the pouring order from a pouring ladle.

2. **Measure:**
    a. **Length:** Measure the length of linear defects and add the total length of them (cracks, veins, cold laps, etc.).
    b. **Surface area:** Measure the area covered by a defect and let that be the score. This works for defects like scab, penetration, burnt in etc.

3. **Combine:** Utilize a combination of count and measure to establish an additional dimension of score.

Length of cracks	Count of cracks	Added length of cracks
0 – 0.125"	15	1.351"
0.125" – 0.375"	5	1.253"
0.375" – 0.750"	2	0.762"
Total	**22**	**3.366"**

4. **Rank**: Sometimes, you cannot get the full interpretation of the defect based solely on a count, a length or a combination of both. Under those circumstances, rank your castings from worst to best. Assign numbers, e.g. 1-12

5. **Compare:** Set actual castings as standards. The standards are labeled ½, 1 ½, 2 ½, 3 ½ and 4 ½. ½ being the best casting standard and 4 ½ being the worst. These castings become standards that can be stored and used again for further testing or to try new ideas. They represent different levels of the same defect. For example, if you inspect a casting at random, you might say "it looks better than the 3 ½ standard, but worse than the 2 ½ standard", therefore, its score is 3.

Conclusion

Scoring castings by assigning quality level numbers will allow for proper evaluation of the defect condition.

Scoring should be used in lieu of personal subjective evaluations.

Scoring allows objective evaluation of castings before and after corrective actions are taken.

Most important, scoring becomes essential to the proper performing of designed experiments.

Using this method can lead to valuable solutions of short and long term quality issues.