Evaluation of systems for real-time inspection of cast parts

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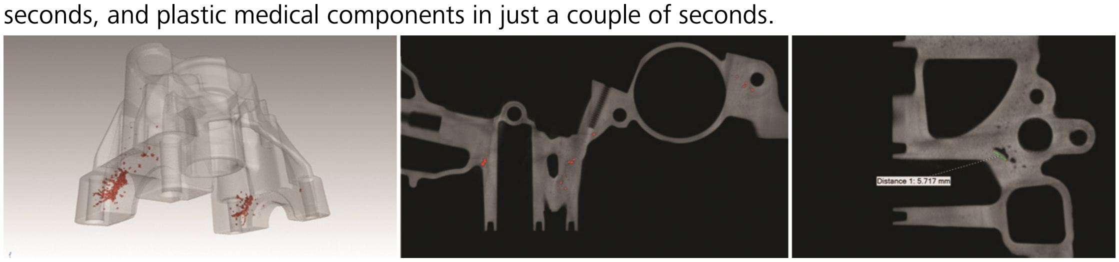
Casting is a process of pouring a liquid, typically metal or plastic, into a mold to produce a solid part. That's the theory. But, in fact, "solid" parts often contain voids or inclusions, which may or may not impact the performance of the finished part. Porosity can be *bad*, meaning that the resulting part will not perform as required due to reduced strength or open pores left after final machining. It can be *acceptable*, meaning either that the void will be removed by secondary processes such as machining or that it is internal and of a size and shape that will not affect performance. **The challenge is differentiating bad porosity from acceptable porosity or desired porosity, and diverting bad parts before either spending additional production time on them or sending a sub-standard part to market.**

The Ideal Inspection Process

If a void is on the outside of the part, it can be easily identified and evaluated visually. Dealing with internal voids is the challenge, and the technologies for identifying them involve either 2D x-ray or 3D computed tomography (3D CT). The ideal inspection process is one that can:

1. inspect 100 percent of your cast parts and do so quickly enough to keep the production process moving
2. be repeatable, reproducible, and accurate enough to reject all unacceptable parts without falsely rejecting those with non-problematic voids
3. achieve the above goals without requiring frequent recalibration or mastering
4. provide a 3D representation of the scanned results to enable meaningful analysis
5. be capable of analyzing the part and classifying it as good or bad

Today's increasingly complex parts require 3D CT in order to meet these goals. However, until now the first goal has been a problem even for 3D systems. The good news is that the best 3D CT systems can now fully examine a part as complex as an automotive engine cylinder head in as little as 90 seconds, a piston in just 30 seconds, and plastic medical components in just a couple of seconds.



Cast part measured in 10 seconds with advanced 3D CT technology. Shows pores in red and actual measurement of pore size.

Accurate Measurement without Recalibration

The only way to really produce fast, repeatable, accurate measurement results is to use a system that *physically* ensures accurate measurements of parts or pores without the need for compensation. The best way to determine the capability of a system is by direct observation while evaluating systems, preferably under the most challenging conditions a system will face in actual use. Measure parts of significantly different sizes, and repeat the process measuring smaller, larger, and again smaller parts. Observe the required setup and evaluate the repeatability and the accuracy of resulting measurements by comparing them to results obtained with known systems such as a CMM.

Effects of rotary platforms and temperature on accuracy
Another potential source of error is the rotary platform that turns the part during testing. This is a component that *has* to move during testing, but the steadiness and predictability of that movement depends on the bearing technology on which the platform turns.

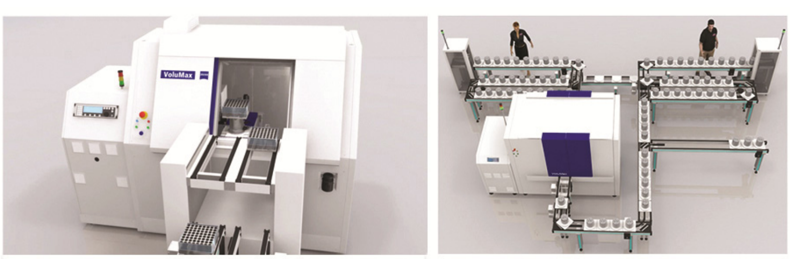
Temperature variation can also impact accuracy. A change of even a few degrees can significantly throw off results as components of the CT system expand or contract. And while systems can be recalibrated periodically to account for temperature change, that recalibration takes the system out of operation and reduces throughput. Systems designed to minimize or eliminate the impact of temperature change cost more, but they are much more cost effective in operation and produce reliable, repeatable results.

The Importance of Software
While system software cannot adequately compensate for decreased physical accuracy of a system, it *can* evaluate results and assist in the sometimes-complicated determination of part quality. The ideal standard by which a part should be measured is its original CAD design. This can be a critical feature of any CT system, but it only works if the comparison is based on accurate data from the CT system.

Evaluating Systems Based on Requirements
Obviously, not all applications require the highest degree of accuracy and throughput. For those that do, there are several steps in determining the performance of a system. The first is to define your needs in terms of:

- the size range of the parts you will evaluate
- the acceptable degree of porosity
- whether you need 100 percent testing of castings
- how fast your line operates
- how continuous your testing process must be
- cost of false rejections
- cost of slippage
- budget for test equipment
- cost of testing a single part including preparation time, calibration, and scan time
- operational costs including cost of false reject (overkill) or defective parts that pass inspection (escape).

Armed with that information, you can begin evaluating systems. Keep in mind that performance in a laboratory or other controlled setting is not necessarily what you will find on the production line. Use your own parts for testing. And unless you are willing to frequently recalibrate an inline system, require that your parts be measured without prior calibration. Monitor results of continuous testing to ensure repeatability and reproducibility. And make sure you know how wide of a range is being used to define acceptable parts and how that range is determined.



3D CT system caters to a wide variety of applications and is very flexible for inline and atline scenarios.

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