It is probably true to say that most of us who are familiar with the application of computer-based casting process simulation as an everyday activity still think of its primary role as that of helping with defect avoidance, particularly those defects related to poorly controlled mould filling and shrinkage phenomena. One aspect of using simulation systems to achieve these objectives which does not have the highest of profiles, and which is often a natural by-product of such efforts, is yield improvement.

During the 10 man-years or so of experience accumulated at Cti with the MAGMAsoft programs, better yields have been achieved with many of the re-designed methods that are the result of using casting simulation. It is not possible, of course, to determine a yield improvement if the casting is a new product and the method has been based on simulation from the start, but the experience of The Casting Design Centre at Cti is that typically 5% to 10% yield improvement can be achieved by using simulation to optimise existing methods.

There have been some spectacular examples where a mould filling analysis has highlighted an opportunity to site an extra casting in a moulding box as a means of primarily improving the filling characteristics with virtually no additional feed metal requirement. More usually, however, the yield is improved by virtue of demonstrating the ineffectiveness of an existing method/running system. Incremental changes to both the feeding and the running systems during an iterative casting simulation tend to provide single figure improvements in yield. These can still be very significant overall, whether the casting is to be an expensive one-off or a high volume item. The feedback from some users of simulation indicates that savings in yield alone have justified the purchase of the software, often in much shorter time-scale than one would have expected.

Two examples which illustrate yield improvement are a pump volute and a grooved clamp.

A pump volute in stainless steel
This casting was known to be difficult one to make, from experience with similar designs. The number and location of the feeder heads and running system used to make similar castings provided a relatively low yield, and usually required refinement before 'right-first-time' radiographic acceptance of the castings was achieved.

The MAGMAsoft simulation software installed at Cti was used to carry out investigations of six different methods of manufacture, involving two cast material specifications (one carbon steel, one stainless steel). The main process variables were pouring temperature and pouring time, but significant alterations were also made to the running system for introducing molten metal into the mould cavity. Also, the number, type and location of feeder heads used to supply metal to the casting during its solidification were varied.

Several areas of the casting were predicted to be prone to shrinkage cavity formation and some feeder heads found to serve little purpose with the original method proposed. Modifications to the method put forward by both The Casting Design Centre and the foundry predicted acceptable internal soundness.

As a result of the methods review, the proposed production method was altered. The castings were made and found to be in full conformance to the specification. A yield improvement of 9% was also achieved as a result of this work and a simultaneous improvement of metal rise rate within the mould cavity produced a much improved surface finish.

A 125 mm grooved clamp
The method being used to make this casting was being reviewed because of an unexpectedly high scrap rate which was eventually traced to a mould filling problem. The part was a medium-volume relative to high-volume but the potential savings by reducing the scrap level were very significant indeed. As a result of a fundamental re-think of the running system, it also became apparent that a 10% improvement in yield was possible. As in the previous example, the use of the MAGMAsoft simulation software was the key to establishing the detailed changes to the running system. The foundry subsequently reported a successful outcome and confirmed the yield improvement.

The final bonus in this instance related to a boost in morale amongst the workforce! They had for some time been concerned at the excessive scrap rate and at the company's difficulty in achieving a consistent improvement. Where subjective assertions as to the cause of this perennial problem had clearly failed, the application of physics-based process simulation had demonstrably succeeded.

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