Right-first-time at Newby Hilltop Foundry with the MAVIS solidification simulation software

The MAVIS solidification simulation software, developed within the Department of Materials Engineering at the University of Wales Swansea was first introduced as a rapid simulator for the prediction of macro-shrinkage defects in castings in January 1992. Developments since that time have seen the inclusion of a full numerical finite difference simulator which can provide the foundryman with more detailed information including solidification times, die temperatures, Niyama coefficients and dendrite arm spacings. This information combined with the macro-shrinkage predictions from the rapid simulator can help methods engineers and die designers to improve casting quality, improve yields, reduce scrap rates and reduce tooling development costs. This article published in 'The Foundryman' describes a typical right-first-time method at Newby Hilltop Foundry achieved with the MAVIS system.

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Case study

Newby Hilltop Foundry purchased the MAVIS software in January 1995 as a methoding design tool for the production of grey, SG and Ni-resist iron castings. A 2,480kg casting in BS 3468 grade S2B Ni resist iron for the nuclear power industry was simulated on the MAVIS system in an attempt to avoid various costly production and development problems which had afflicted a similar type of casting some years earlier. The casting and all methoding designs were modelled using the integral solid modeller supplied with the MAVIS solidification simulation software.

An initial simulation of the cast part without a method revealed four main areas in the casting where macro-shrinkage defects were likely to occur. These were concentrated in the outer ring, inner top ring, intermediate top ring and the base of the central bore.

A method was designed based on the trial simulation results and a further analysis carried out (fig. 1) The shrinkage defects were effectively removed from the outer ring by using 8 feeders with very small traces of porosity located at the junctions with the web sections of the casting. However the four non insulated feeders located above the inner ring had not eliminated the shrinkage problem, in addition shrinkage was also revealed in the central bore, inner boss and intermediate ring areas.

It was proposed to insulate all of the feeders used and place two additional feeders above the intermediate ring to remove the shrinkage in that region. Four insulated feeders were also placed beneath the top ring to feed the central bore and the chills in this area were extended to drive solidification towards the feeders. Analysis of the simulation results (fig.2) showed a significant reduction in the shrinkage porosity located in the base of the central bore and the inner ring, however shrinkage porosity was clearly evident in the intermediate ring and outer bosses. In order to remove the shrinkage from these outer bosses a continuous circular chill was located directly above them. Feed metal to the inner and intermediate rings was improved by insulating the feeder necks adjacent to the casting. Computer simulation of this method revealed a clear casting in all areas with one exception, the intermediate ring (fig. 3).Several further attempts were made to remove the shrinkage in this area with chills and feeders however a sound casting could not be achieved. At this stage it was decided that the shrinkage could not be removed by feeders and chills and that the fundamental problem was the design of the cast component which did not facilitate directional solidification. A variety of component modifications were proposed in an attempt to remove the porosity in the intermediate ring area completely. Simulations of these design modifications were carried out in order to assess which design would give the largest im-

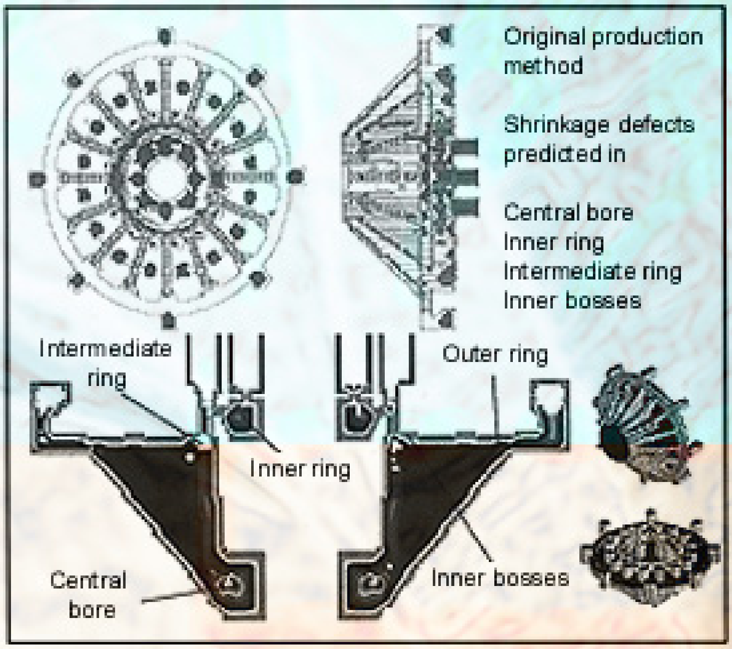

Fig. 1

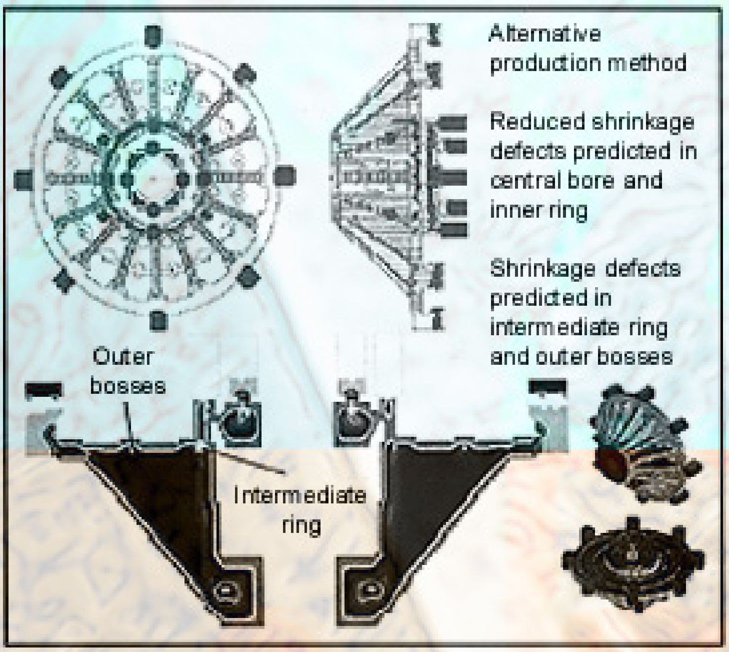

Fig. 2

provement in casting quality. Additional simulations were then used to refine the modifications and produce a sound casting.

The computer simulations demonstrated that the shrinkage could be removed by filling in the thin section between the inner ring and the main body of the casting (see fig. 4). A presentation based on the simulation results was made to the customer who granted a design concession for the part. High integrity castings were produced in furane moulds and sampled 'right-first-time'.

Casting weight 2,480kg
Poured weight 3,800kg
Yield- 65%
Simulation time (per method) - 1Hour

Modelling time for initial model - 4.5 hours
Modelling time for additional methods and designs - 4.5 hours

Summary

Computer simulation had enabled large very high integrity castings to be produced 'right-

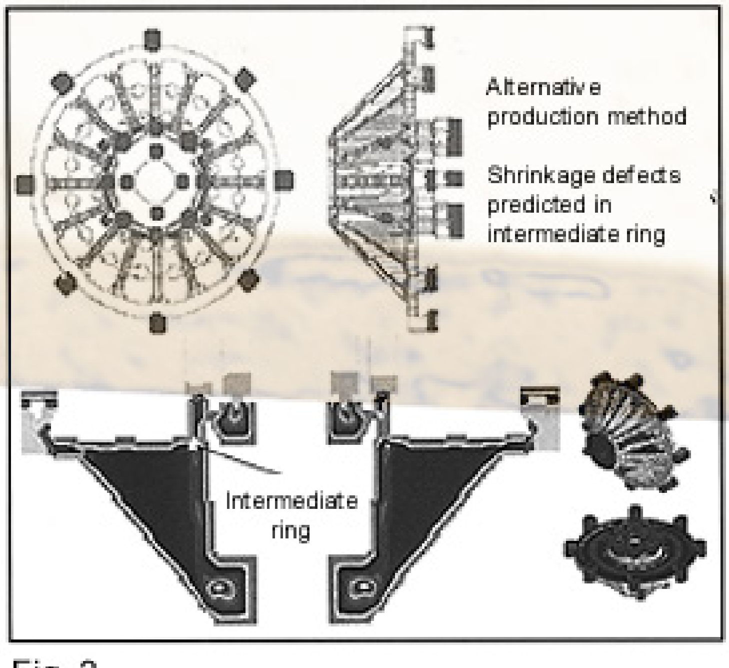

Fig. 3

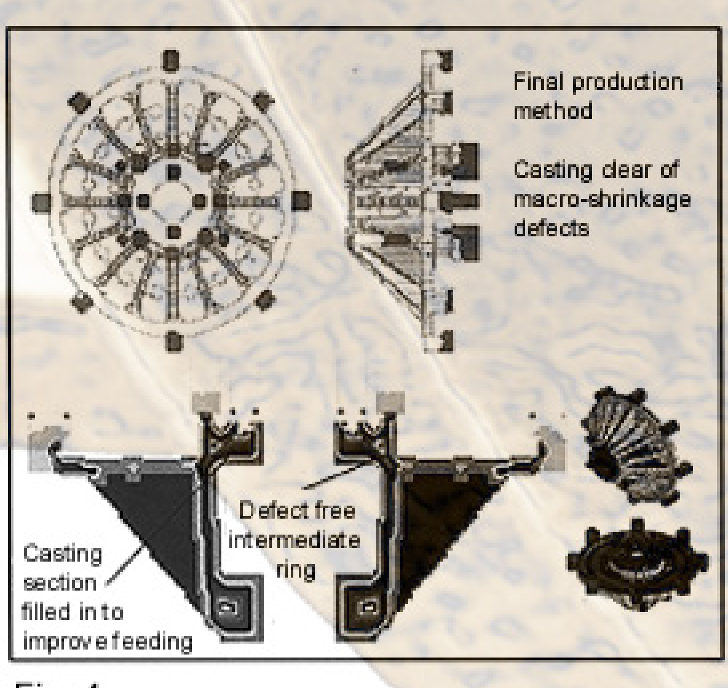

Fig. 4

first-time' avoiding very costly development in the foundry. Ten methods were simulated on the computer to produce an efficient method within a few days. The equivalent development time in the foundry would have been two to three months with the production of several castings with significant defects.

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