MAVIS at Pickersgill Kaye Ltd

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The area of solidification simulation technology may at first sight appear to be a very daunting prospect. How does the foundryman identify which software package will best suit his needs and be the most cost effective purchase for his company? One approach to answering this question is to compare simulation results from various packages for a component which has caused problems during production.

In November 1993 Pickersgill - Kaye of Leeds undertook an evaluation of solidification simulation software using a component with which it had experienced problems obtaining a sound casting. The selected component was a shell moulded lock case produced in HTB1 casting alloy weighing I kg. Trial and error in the foundry had produced a sound casting at the third attempt. Could solidification simulation technology have achieved a 'right-first-time' result and reduced the development time and costs of the component?

Modelling the component

The casting geometry was modelled manually with the 3D solid modeller incorporated into the MAVIS software. The solid modeller has been designed to be extremely user friendly and fast, enabling most geometries to be created within a few hours. Casting shapes are generated within a variable (non-cubic) domain and can contain up to sixteen million elements. The lock case geometry was generated within an hour from standard two dimensional drawings .

The first method consisted of a single feeder and two gates at one end of the casting, this was modelled within a further 10 minutes. The next stage was to model method two which consisted of two additional feeders located at the end of the casting. Finally method three was modelled consisting of a feeder system with two gates located at the side of the casting. Prior to running the solidification analysis the casting geometry was checked by displaying the model from six different angles (fig 1)

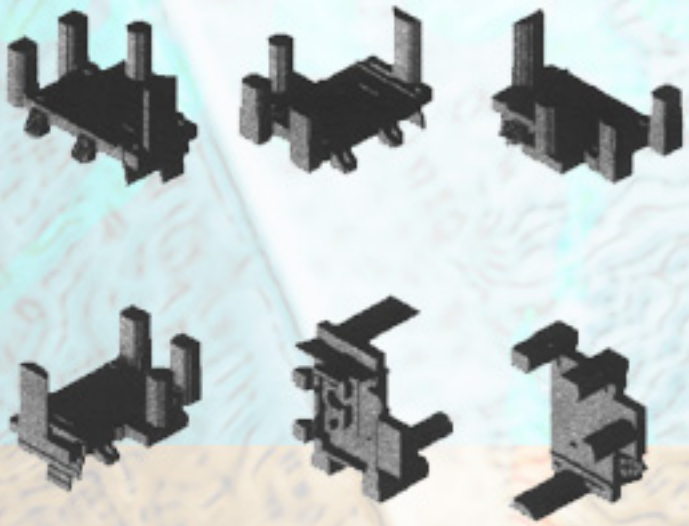

Fig 1. Solid model of the lock case and method 3

Solidification analysis

The solidification analysis requires parameters to be entered for the shrinkage percentage, mould conductivity, gate effects and the conductivities of any chills or insulators if present using sliding scales. The shrinkage percentage value used for HTB1 was 6%, and the conductivity of a shell mould was selected.

The x-ray analysis of the solidification simulation for the initial method predicted defects within the heavy sections furthest from the feeder, lug areas and the central boss (fig 2).

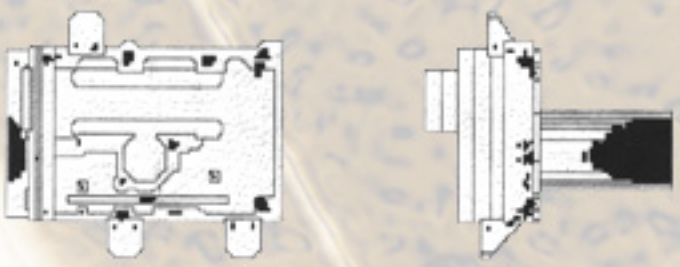

Fig 2. Simulated x-ray analysis of macroscopic defects for method 1

The simulated x-ray results for method two show that the defects at the end of the casting were effectively drawn into the feeders and eliminated, however porosity is still predicted in several areas (fig 3).

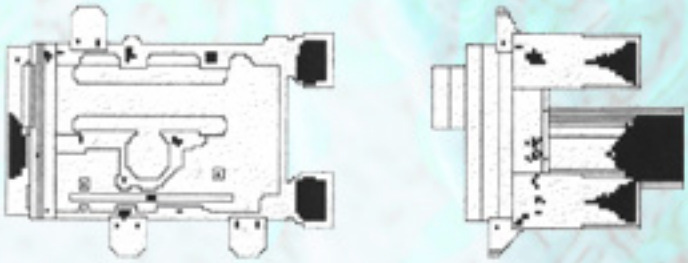

Fig 3. Simulated x-ray analysis of macroscopic defects for method 2

Finally method 3 was simulated and the results now predict the removal of the major defects at the end of the casting adjacent to the feeder (fig 4). The minor porosity within the lugs and the central boss resulted in very small surface sinks which were not considered to be a problem after machining.

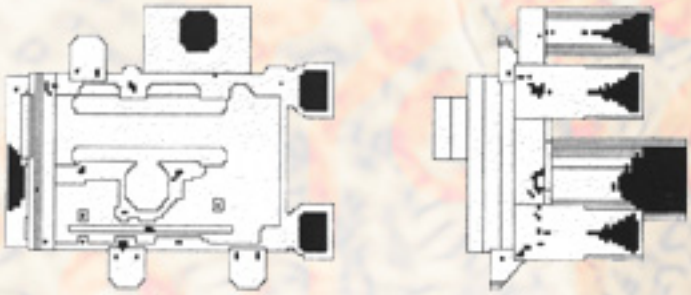

Fig 4. Simulated x-ray analysis of macroscopic defects for method 3.

Modelling of component shape	60 mins
Modelling of methods 1,2and3	30 mins
Simulation time for each method	30 mins
Total time for analysis	180 mins

Actual development time for pattern equipment 1 month

Alternative software facilities

The Mavis software can also predict the macroscopic order of freezing, this can provide very useful information for determining the feed paths within the component and also to locate any potential isolation of liquid metal (fig 5). Ideally the casting would be simulated without a method and assuming no volumetric contraction from liquid to solid. The macroscopic freezing pattern would then be used to determine the likely location of the feeders. With this approach it would have been possible to avoid methods one and two completely therefore reducing the time to achieve the desired result even further. A full finite difference numerical analysis could also be carried out on the final method in order to establish the solidification times, temperatures within the casting and mould, cooling rates and temperature gradients.

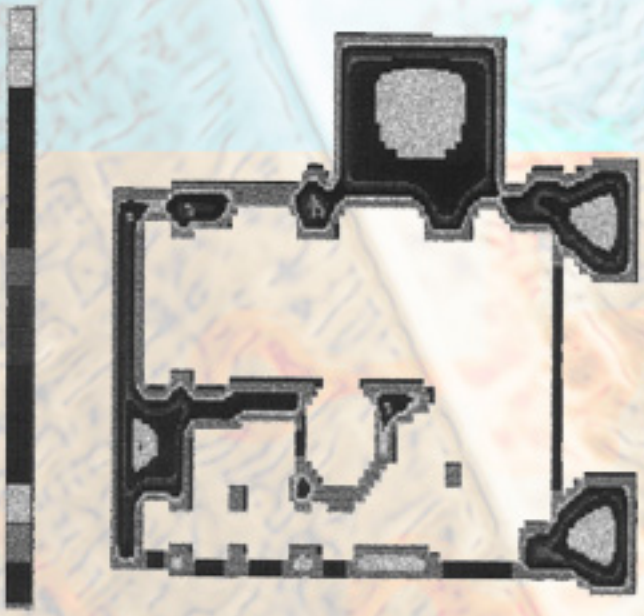

Fig 5. Predicted macroscopic freezing pattern for method 3.

Other considerations when evaluating software

The simulation results had clearly shown that Mavis would have produced a 'right-first-time' method for the casting within three hours, significantly reducing the time and costs of development. The software had been proven in terms of results but there were other considerations of near equal importance to be taken into account when deciding which package would suit the company best. The Mavis software was selected because it was extremely easy to use both in terms of solid modelling and simulating the solidification of components, it had the benefit of combining both rapid and full numerical simulators within a single package and was relatively inexpensive to purchase.

Pickersgill-Kaye now operates the Mavis software in conjunction with Pro-Engineer CAD system which enables 3D solid models to be imported directly into the Mavis software. Component parts can be simulated at the

design stage and potential problems highlighted before the final design has been approved. Also, the software has enabled the inhouse component designers to gain an appreciation of the problems associated with the production of castings. Significant improvements are now being realized in terms of casting yield and reduced scrap.

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