

Foundry Education Through The Use of Numerical Simulation

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Abstract

This paper examines the use of numerical (computer) simulation of the casting process as an educational tool to demonstrate basic metal casting fundamentals. This is done utilizing a specific steel casting example with a focus on pouring techniques. The resultant information provides an insight and opportunity for metal casting knowledge transfer which ultimately is targeted at the trainee or equivalent level of employee.

Introduction

As experienced employees leave or retire from our industry, a wealth of knowledge goes with them. This knowledge needs to be 'rediscovered' by younger and / or new foundry employees. Couple this with the ever changing evolution of the foundry worker and the management of effective education of foundry employee's becomes a significant challenge.

We read how to make good castings in text books. We see how the liquid metal flows into the mould while in the foundry. We even observe defects through casting inspection after knock out. But what really happens and how can this be explained to those new to the industry? How do you teach empathy for what has been described through the ages as 'a black art'?

Computer simulation can be used to experience the important details of metal casting. The gap that once existed in the use of casting simulation has closed. With the increasing speed and power of affordable desktop computers and the continual advancement of applicable software codes, there is no longer reason for the casting process to be considered as a black art.

An Example Format – Preparing to Pour Quality Castings

The following example outlines an educational presentation developed primarily for the training of metal pourers emphasising the aspects of pouring to achieve quality castings. It utilises the results of a computer simulation project conducted on a basic steel plate type casting. Here we will discuss the framework of the presentation outlining the relevant thinking and use of simulation to effectively and graphically demonstrate general casting principles throughout.

This example is specifically of a steel casting being poured with a lip pour ladle however the underlying principles are common. Generally speaking they are equally applicable for any common metal / pouring combination.

The Presentation

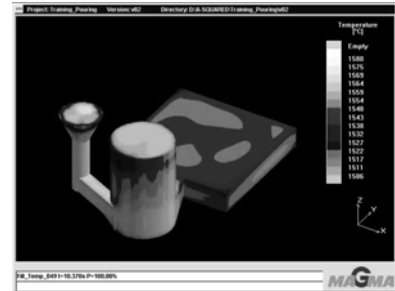
Slides 1 – 4 are introductory type slides. The overall range of the educational session is introduced to students. The aim is also to introduce simulation and simulation type images early for exposure, explanation and understanding as it is assumed the concept will be new to a majority of students.



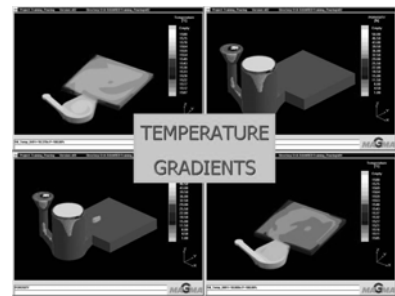
Slides 5 & 6 introduce the topic of 'pouring time'.

To achieve the best quality castings when pouring molten metal, our aim is to pour as fast as possible with as low a temperature as practical.

Slides 7 to 13 visually demonstrate through filling simulation the effect of pouring time on the general fill profile and the resultant temperatures within the mould. Emphasis on the rate of rise is stated and its importance is reinforced. This is illustrated directly through isometric and side views which show the melt rising within the cavity in two different filling configurations. The results of both configurations are then compared graphically side by side.



Slides 14 to 20 concentrate on melt distribution and the resultant temperature gradients that are established within the mould cavity. The use of 'tracer particles' from simulation are used to show the formation of these gradients. This is supported through porosity results obtained through subsequent solidification simulation which show a porosity defect as a result of the slower pouring times. Simulation 'thermocouples' are then used to track the specific temperatures within the mould at the completion of pouring and directly expose the differences in temperature between the two.



Slides 21 and 22 summarise the topic of pouring times.

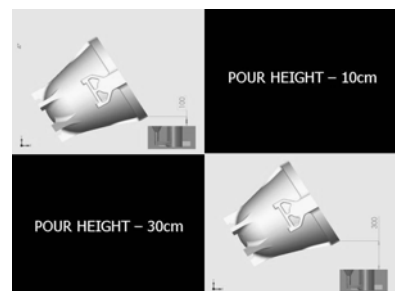
Summary – Pouring Times

- Aim → to keep the pouring cup full.
- Find out what it is you are pouring.
- Be aware of the 'target' pouring time.
- Check/measure the actual pouring time.

Important!!!

- Identify moulds where problems are encountered for inspection and investigation in after cast.

Slides 23 to 25 explore the influence of pouring height on casting quality. Using velocity results from the fill simulations conducted, students can clearly see the dramatic increase in velocity along with a visual appreciation of aspiration within the melt. Erosion results are then used to show the negative effect of the increased melt velocity on overall casting quality along with a discussion of other deleterious factors.



Slides 26 and 27 summarise the topic of pouring height.

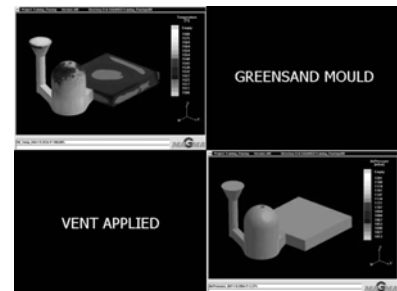
Summary – Pouring Height

- Aim → to keep pouring height 'low'.
- Keep the ladle as low as practicable.
- Use a ladle of right proportions to the mould.
- Do not overfill the ladle.

Important!!!

- Identify moulds where problems are encountered for inspection and investigation in after cast.

Slides 28 to 36 highlight the effect of venting within the mould in various configurations through the use of air pressure results obtained through simulation. Here students can relate to other influencing factors when pouring a mould, what to potentially expect, and why. Underlying is the principle of obtaining an awareness of the whole casting process from moulding through to pouring.



Slides 36 to 40 summarise the topic of air pressure and bring the educational presentation to conclusion.

Summary – Air Pressure

- Aim → identify and adjust your pouring technique to the situation.
- Note if blind or open risers are used.
- Determine if venting is used, and clear.
- Be aware of the mould medium.
- Look for draining of risers.

Important!!!

- Feedback problems encountered and identify those moulds for inspection in after cast.

Conclusion

Effective education of employees within our industry is a difficult task. Much time and money has been spent on various programs in an attempt to find the right formulae. Some have been successful, others not so. There is a wealth of information available but how do we transfer this knowledge? How can we make it more understandable? Computer simulation can form the corner stone of this transfer of knowledge.

Computer simulation of the casting process should be established as a key tool when preparing educational type materials. Information can be simplified or enhanced through effective graphical representation. No other medium is able to document, catalogue, secure and thereby transfer practical knowledge with the same efficiency. Potential also exists to enhance and strengthen both practical and theoretical experience with effective cross referencing and correlation of simulation type information.

New generations of foundrymen are coming through our industry. These generations will not understand what it was like without computers. There will be an ever increasing capability to understand and capitalise on this form of communication. Perhaps the development of these tools may sound foreign to some, but they should be expected and, more importantly, demanded.