



Science and Engineering of Casting Solidification

Doru Michael Stefanescu

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Casting of metals evolved first as witchcraft, gradually became an art, then technology, and became only recently a science. Many of the processes used in a metal casting are still empirical in nature, but many others are deeply rooted in mathematics. In whatever form, casting of metals is an activity fundamental in the very existence of our world, as we know it today.

Foundry reports indicate that solidification modeling is not only a cost-effective investment but also a major technical asset. It helps foundries move into markets with more complex and technically demanding work. However, to the best of the author's knowledge, there have been no attempts to synthesize the information that can be used for engineering calculations pertinent to computational modeling of casting solidification.

This book is based on the author's thirty years of experience with teaching, research and the industrial practice of solidification science as applied to casting processes. It is an attempt to describe solidification theory through the complex mathematical apparatus that includes partial differential equations and numerical analysis, which are required for a fundamental treatment of the problem. The mathematics, however, is restricted to the element essential to attain a working knowledge of the field. This is in line with the main goal of the book, which is to educate the reader in the fast moving area of computational modeling of solidification of casting. For the sake of completeness, a special effort has been made to introduce the reader to the latest developments in solidification theory, even if the reader has no engineering applications at this time.

The text is designed to be self-contained. The author's teaching experience demonstrates that some of the students interested in solidification science are not fully proficient in partial differential equations (PDE) and/or numerical analysis. Accordingly, elements of PDE and numerical analysis, required to obtain a working knowledge of computational solidification modeling, have been introduced in the text while attempting to avoid the interruption of the fluency of the subject. Numerous modeling and calculation examples using the Excel spreadsheet as an engineering tool are provided. The book is addressed to graduate students and seniors in solidification science, as well as to industrial researchers who work in the field of solidification in general and casting modeling in particular.

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