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The Introduction to the Casting Manufacturing Industry

OBE (born 1938) is a British engineer and one of the world's leading experts in the casting industry with approximately 150 papers, and 20 patents. Campbell holds two Masters degrees from University of Cambridge and University of Sheffield, as well as two doctorates from University of Birmingham. He is a fellow of the Royal Academy of Engineering, and he was appointed to the chair of casting technology at University of Birmingham. The Institute of Cast Metals Engineers has named the "John Campbell Medal" after him.

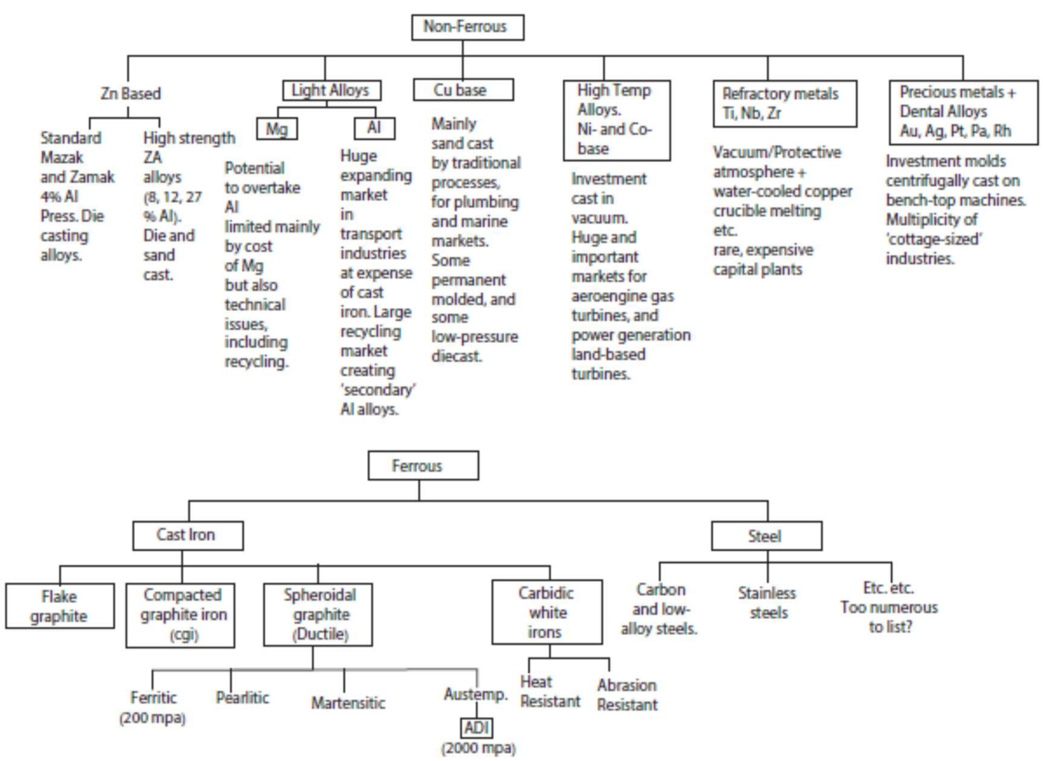
John Campbell is a leading international figure in the castings industry, with over four decades of experience. He is the originator of the Cosworth Casting Process, the pre-eminent production process for automobile cylinder heads and blocks. He is also co-inventor of both the Baxi Casting Process (now owned by Alcoa) developed in the UK, and the newly emerging Alotech Casting Process in the USA.

Words of a Leading Casting Exponent

The foundry world never ceases to amaze me with its kaleidoscopic mix of metals and processes. It has to be one of the most, if not the most, complex industry and difficult business to be in. Its complexity makes it a challenge to describe, but all the more interesting.

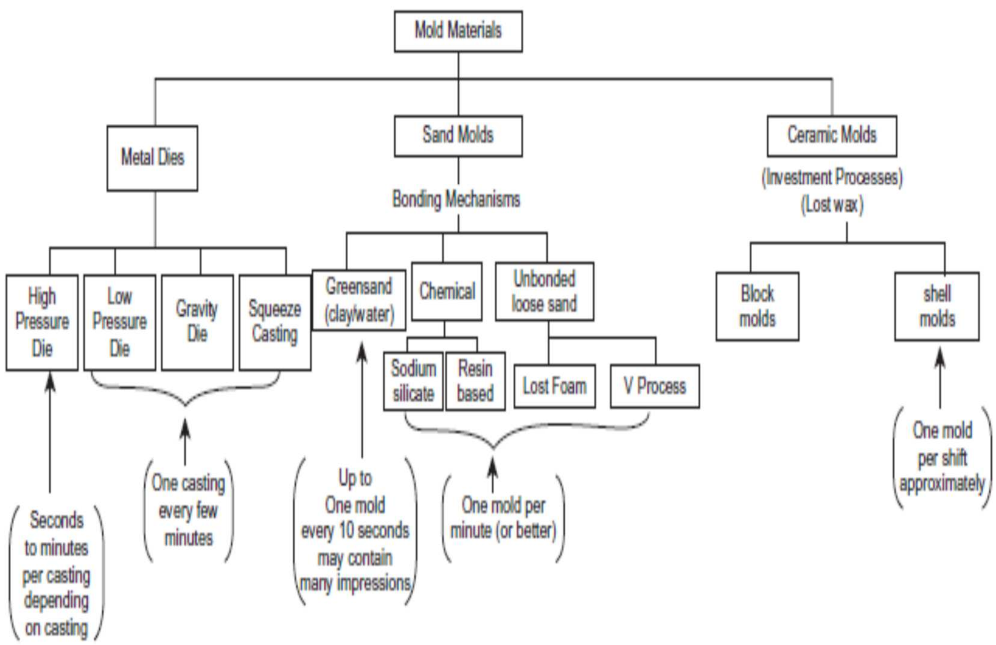
The main metal division are perhaps, naturally **ferrous and non-ferrous**. This split is presented in some detail in Figure 1.0. It is somewhat artificial in the sense that nickel (Ni) and cobalt (Co) base alloys share similar technology and grade smoothly into the various varieties of stainless steels. Even so, tradition has it that Ni and Co are non-ferrous, and it has to be admitted that a face-centered cubic (fcc) metals, they share many properties in common with Copper (Cu) and Aluminium (Al).

Figure 1: The structure of the casting industry by metal



The alternative common approach to categorizing the casting industry is in terms of its mould making, with greensand easily holding its magnificent first place in terms of productivity, but a wide variety of alternative molding processes (Figure 2)each designed for their own niches, and the niches sometime of huge size, such as pressure die casting, and the manufacture of Al alloy wheels by low-pressure permanent mould.

Figure 2: The structure of the casting industry by moulding technology



The main process divisions for manufacturing castings include moulding and casting. It is an interesting exercise to set up a matrix with a vertical list of moulding options and a horizontal list of casting options. Correlating these can be seen to fill nearly every box of the matrix, although there are interesting gaps that the reader can quickly discover.

However, the description of casting manufacture is not that simple, because in addition to the main processing steps of moulding and castings, there are very many other processes steps including melting, solidification which add complexity, so that the two-dimensional matrix quickly multiplies into multi-dimensional array. This it has not been possible in this account to tackle a description of the industry as a matrix. The processes are, so far as possible, are discussed as separate topics.

The processes include (1) melting, (2) moulding, (3) castings, (4) solidification control (sometimes) and (5) several post-casting processing operations. Each processing step has yet more options, making the attempt to summarize the industry even more problematic. Many of these processing steps have generally been selected for such laudable features as their rate of production, acceptable efficiency or low cost.

However, with regret, the previous choices of (1) melting and (3) casting processes have usually been selected badly, only in the terms of productivity and apparent cost; there are the weakest links in the production sequence. In fact, it has to be admitted that most of our melting operations and most casting operations in the casting industry are awful. Few are selected for the **quality** of the product, even though all will admit that a system that consistently produces nearly zero or actually zero scrap or rejects would constitute a major advantage. This major feature has been consistently overlooked. We shall go out of our way not to overlook it here.

Finally, before the processing is even considered, the casting technique has to be designed correctly. This is a non-trivial task. It must be got right. The new procedures evolved from significant research and past failures for the design of the filling systems for the castings, are with regret, often in conflict with much traditional practice. New research has revealed many of the reasons for the poor performance of tradition systems and has pointed the way to substantial and significant improvements.

The central problem within the metal casting industry is the **pouring** of our liquid metal.

Pouring occurs at multiple stages of our production processes. We have been lulled into complacency from the innocent images in our minds of pouring of a glass of water or a cup of tea, but have failed to appreciate that liquid metals are greatly damaged by such actions. The ease of pouring under gravity as an aid to making castings is a two-edged sword: gravity pouring is easy, but gravity accelerates our metals to unwanted and damaging speeds. As an interim solution, we can improve our gravity filling systems to reduce (but not eliminate) the damage associated with pouring. Ultimately, however, for most castings, we have to rethink our processing to eliminate pouring at every stage. This may sound alarming, but in fact is not such a daunting engineering challenge. An increasing number of foundries are now successful to eliminate their reliance on pouring.

In the meantime, referring ack to an interim possibility, there are some strategies for reducing the damage inflicted by pouring that will be helpful while more revolutionary systems can be put in place. The improved systems are repaying careful application in a number of foundries. The opportunities of success are far more than impediments.