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20 YEARS OF RESEARCH PROJECTS TARGETED TO ZERO DEFECT MANUFACTURING IN DIECASTING

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1. Introduction

Metal manufacturing is a relevant part of whole GDP of industry sector in Europe. In particular, the field of non-ferrous foundry, led by Aluminium casting technology, is constituted by about 2700 European companies, with more than 4 million tons of castings produced in 2016. The last survey carried out by CAEF individuates Germany and Italy as producers of 60% of Aluminium alloys castings in Europe.
The key-process, in this field, is High Pressure Die Casting (HPDC), which had an enormous evolution in last 20 years, and is facing relevant challenges in next years. One of the main driving forces for this evolution has been the effort for achieving the Zero Defect Manufacturing (ZDM) target.
Various R&D projects strongly contributed to generate innovation, thanks to well-balanced public-private funding. This paper reviews the most relevant EU-funded research and education projects carried out in the field in the last 20 years, showing the approach that created the best synergy among all strategic elements needed for an intelligent, efficient and innovative Aluminium foundry.

2. The innovation path

Innovation is the results of several and concerted actions, as summarised in Fig.1. A key-issue is certainly training and education, which was targeted since 1999, with the Leonardo Pilot Project Coprofound, aimed at improving the use of process simulation as a powerful tool to achieve a better knowledge on foundry processes.
The FP5-IDEAL research project (2002-2005) was devoted to Integrated Development Routes for Optimised Cast Aluminium Components, in the context of vehicle weight reduction through sustainable use of light alloys.
The FP6-NADIA research project (2006-2010) contributed to the development of New Automotive components Designed for and manufactured by Intelligent processing of light Alloys, in the context of

- nanotechnologies and nanosciences,
- knowledge based multifunctional materials,
- new production processes and devices.

The FP7-StaCast Coordinated Action (2012-2014) allowed the elaboration of two new EN Standards:

- classification of Defects and Imperfections in Aluminium castings,
- evaluation of Mechanical Potential of Aluminium casting alloys.

The FP7-MUSIC research project (2012-2016) was addressed to the digital transformation in HPDC process. In detail, MUSIC was referred to MUlti-layers control&cognitive System to drive metal and plastic production line for Injected Components in the context of Smart Factories: Energy-aware, agile manufacturing and customization. The challenge of MUSIC was to transform a production-rate-dominated manufacturing field into a quality/efficiency-driven and integration-oriented one, to exploit the enormous (and still underestimated) potential of HPDC through collaborative research and technological development, along the value chain with research groups, design, engineering and manufacturing companies and through advances in manufacturing, ICT and model process technologies.

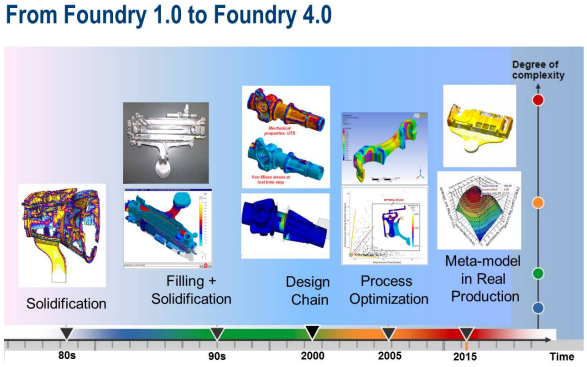

Fig. 1. Evolution and Innovation in Aluminium foundry processes: from Foundry 1.0 to Foundry 4.0

These projects collect a budget of about 28 millions of €, with a EU contribution of about 16 millions of €. More than 50 Partners have been involved, with an effort of almost 3000 person month.

3. The new challenges

Several challenges are still open in the field, with some common elements:

- further knowledge must be achieved for properly linking multi-scale material properties and transformation processes (solidification, cooling, heat treatments);
- material modelling, virtualization of processes and factory digitalization need to increase their use and penetration level in foundries;
- skills of all the persons involved in foundry processes have to be improved and developed, paying strong attention to individuation of new profiles and competences.

The intelligent management of these elements in next years will generate competiveness in the global market and in the supply chain, taking into account also eco-sustainability issues, based on circular economy and adoption of decision support system including energy and cost models.

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