Thoughts and Reflections on Industry 4.0: Smart Die Casting - A Case Study

Dr. Adel M. Aneiba

Associate Professor in IoT
School of Computing and Digital Technology
Birmingham City University

Tuesday 23rd October – Magnesium Symposium 2018
Outline

- Industry 4.0: Overview
- The Blue Book
- Smart Die Casting Approach
Industry 4.0: Overview

• The definition for i4.0 was first announced in 2011 at the “Hannover Messe trade fair”

• The Germany Trade and Investment group (GTAI) has formed an i4.0 working and defines i4.0 as:

“A paradigm shift . . . made possible by technological advances which constitute a reversal of conventional production process logic. Simply put, this means that industrial production machinery no longer simply “processes” the product, but that the product communicates with the machinery to tell it exactly what to do”.

Meridian University
Motivation behind Industry 4.0’s Phenomena

The main motivation behind adopting the i4.0 initiative for many manufactures is to overcome the following hurdles, but not limited to:

- High cost and shortage of talented labour,
- Short production cycle time with short lead-time to market,
- Small volume production.
Recently a set of new digital technologies have emerged that will help the industrial sector to improve its productivity rate and reduce cost, some of these technologies have been discussed in the blue book.

Source: (PWC, 2016)
The Blue Book

• Partnership
• Collaboration
• Review the state of the art in the area of Industry 4.0
• Industry engagement
• Societal contribution
Why the blue book

The purpose of the book is to explore the importance of industry 4.0 as a digital enabler for the manufacturing sector – showcasing it as a strategic move, especially for automotive industry in terms of productivity, business growth and sustainability.
• High Pressure Die Casting process.
• HDPC Process Observations.
• HDPC Process defects.
• Possible Solution (i.e. Real-time process control).
• Conclusion
Die Casting Process

Source: The HDPC Process Cycle (Bonollo et al 2015)
Die Casting Machine

Basic Cold Chamber Die Casting (Customoartnet, 2018)
Die Casting Process Parameters and Their Effects

- Shot sleeve condition
  - Shot velocity
  - Shot rod condition
  - Shot tip condition
- The die opening/closing procedure
- The cavity condition
- The magnesium alloy material properties
- The moulding machine operator
  - Atmospheric conditions
  - Water temperature
  - Oil temperature
  - Oil and water carrier line conditions
  - Release agent mixture ratio variations
  - Release agent temperature
- Secondary operations within the fixed cell (if applicable),

Lack of control of the left factors can lead to the following outcomes:

- Less efficient process
- Increase operation cost (OPEX)
- Decrease the productivity rate
- Failure in meeting the manufacturing demand and target
- High scrap rate (In many foundries can be higher than 25%)
Smart Die Casting: The new approach
1. The die-casting process is a complex engineering manufacturing process.

2. Understanding the process thoroughly is key to providing a suitable solution for any defect that may happen during the operation phase.

3. Tuning the plunger speed to allow molten metal filling the sprue at low speed and filling the mould at high speed is best practice.

4. Preventing the surrounding air from entering into the die by closing the gate quickly and increasing the pressure helps to reduce porosity defects.

5. Installing advanced sensors in the domain of the HPDC machine to monitor and control the HPDC process in real time is essential, in order to gain insights into process parameters for producing good quality cast parts.

6. Efficient heat distribution must be achieved within the cavity by controlling the amount of heating/cooling flow over the time of the die casting production phase.

7. Multidisciplinary research and development work is needed.