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Commentary

# Digital Transformation of the Design Process Using Computational Fluid Dynamics in Foundry Industry

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## DESCRIPTION

Various industrial-process tasks are often performed based on the experience and intuition of engineers developed over many years. Therefore, differences in the technical skills of engineers could result in differences in the time required for design, product quality, and productivity efficiency. In Japan, the birthrate is declining, and the population is aging rapidly. By 2070, the population over 65 years would reach about 40% of the total population. In addition, in recent years, there has been a call for decarbonization, and a Cabinet decision in Japan has set a goal of a 46% reduction in greenhouse gas emissions by FY2030 compared to the FY2013 level. Thus, under labor shortage and the decline in technical skills due to population aging, there is a need for ever more efficient production to decarbonize the industry. Therefore, there is a vital requirement for Digital Transformation (DX) in industrial processes in Japan now.

Japan has a thriving automotive industry, and many automobile parts are manufactured by casting. Casting is a production process in which molten metal is poured into a mold and cooled to harden, allowing a high degree of freedom of product shape and making it suitable for mass production. On the other hand, casting defects can occur due to various factors such as temperature and humidity, which depend on the day's weather, the condition of the mold, and the materials used because casting is a complex process. In addition, it is difficult to identify when, where, and what caused casting defects to occur because the inside of the mold could not be visually inspected. Therefore, research has been conducted in the foundry industry to collect big data by setting up various sensors inside casting machines and molds and to have machine learning identify defective products and the causes of casting defects until the quality assessment inspection process is conducted. In addition, research has been conducted to simulate the molten metal flow inside the mold by using Computational Fluid Dynamics (CFD) to design the gating system (mold shape) and casting conditions, such as injection and pouring speeds.

Our research group has been developing an automatic optimum design system for the gating system and casting conditions by using CFD. In particular, the system first generates 3D mold shapes by operating a CAD system. Next, the system simulates the molten metal flow using the generated shapes using CFD. Finally, an optimization algorithm evaluates the simulation results, determines the next shapes, and operates the CAD to generate new shapes. The system entirely and automatically repeats these processes to design the optimal shapes and conditions automatically. Therefore, the system enables anyone to perform optimal design automatically without depending on the experience and intuition of engineers. This Commentary paper introduces an automatic optimal design system developed for the die-casting overflows design process [1].

In die casting, if the gas entrained during injection molding could not be discharged completely and becomes trapped inside the product, casting defects would occur, and product quality decrease. Therefore, overflows should be designed in die casting mold to exhaust gases outside the mold as much as possible. Conventionally, additional overflow design is often repeated if casting defects occur during prototype production. However, because the flow of molten metal inside the mold changes before and after the overflow is redesigned, the position of the trapped gas also changes. Therefore, unnecessary overflow design can result in poor molten metal flow and increase the trapped gas volume inside the product. In addition, because the overflow is the waste part, unnecessarily increasing the overflow volume reduces the yield rate and increases the energy required to remelt the material.

Therefore, we developed the system to design the position and volume of the overflows automatically by estimating the direction of the molten metal flow inside the product using CFD. This enabled the automatic optimal design of the minimum necessary overflow, considering the direction of molten metal flow. Finally, actual die casting experiments were conducted to verify the effectiveness of the developed system. As a result, there were no casting defects using the mold with automatically designed overflows, and the system is expected to enable the stable production of good castings.

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# CONCLUSION

Our research group is working to improve the efficiency of the casting process, which supports the Japanese automobile industry, by using DX technology. Due to the direction of the flow of molten metal, this allowed for the automatic optimal design of the least necessary overflow of suppose the introduced research is widely put into practical use. In that case, it is expected to help Japan deal with labor shortages due to a declining birthrate and aging population and help decarbonize the country.

# REFERENCES

1. Minamide D, Yano k, Sano M, Aoki T. Automatic Design of Overflow System for Preventing Gas Defects by Considering the Direction of Molten Metal Flow. Computer-Aided Design. 2023:163;103586.