METAMODELING FRAMEWORK AND TOOLS FOR INTELLIGENT CASTING MANUFACTURING

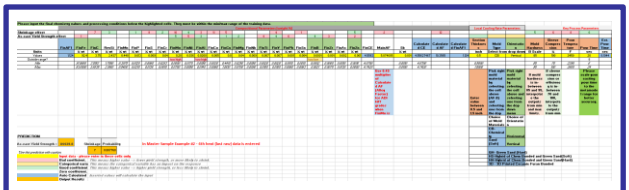
AMC
AMERICAN METALCASTING CONSORTIUM

Program Overview and Objectives: Numerous interacting variables in metalcasting result in process uncertainty and variability, resulting in scrap and non-conformance issues that cause longer lead times and higher costs for Department of Defense (DOD) castings. Traditional Design of Experiments (DOE) are used to resolve issues isolated to several interacting variables, but are largely ineffective when dozens or more variables are involved. More recently, metamodels are being used in place of DOE in other industries when the number of interactive variables becomes overwhelming. Metamodels are advanced mathematical algorithms developed using modern Artificial Intelligence (AI) / Machine Learning (ML) techniques, uncertainty quantification, and historical data to create an integrated predictive and prescriptive tool. In metamodeling of castings, ICME and data from multiple DOE can be used to populate missing data into its algorithm.

SUCCESS STORY

Problem: There are so many variables influencing shrinkage and non-conformance to mechanical properties in most castings that existing methods for predicting and enacting solutions are often insufficient.

Solution: Under AMC's Innovative Casting Technologies (ICT) program, the American Foundry Society (AFS) developed a framework for generating metamodels for metalcasting. In validating the framework, a verified metamodel containing 55 unique influencing variables was developed to accurately predict as-cast yield strength and shrinkage probability in ductile iron. The metamodel was successfully used to compute corrective actions in near real-time during production at multiple DOD casting providers.



G10YS – As-Cast Yield Strength and Shrinkage Predictor Calculator

Pictorial of Metamodel Prescriptive Process

Benefits: The framework and metamodels developed should reduce costs, increase casting quality, and enable rapid procurement due to the elimination of scrap caused by property non-conformance and shrinkage by permitting the user to determine corrective actions prior to pouring. They can also be used by ductile iron foundries to reduce consumption of key raw materials currently in short supply such as Ni, Ti, Mg, and pig iron. The framework is applicable to other casting processes and alloys as well.

"The metamodel that has been developed will assist us in moving from reactive to proactive and will help us to start showcasing the benefits of big data in improving productivity."

Lizeth Medina Balliet, Sr Manager, Automated Production & Data Science, Neenah Enterprises

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