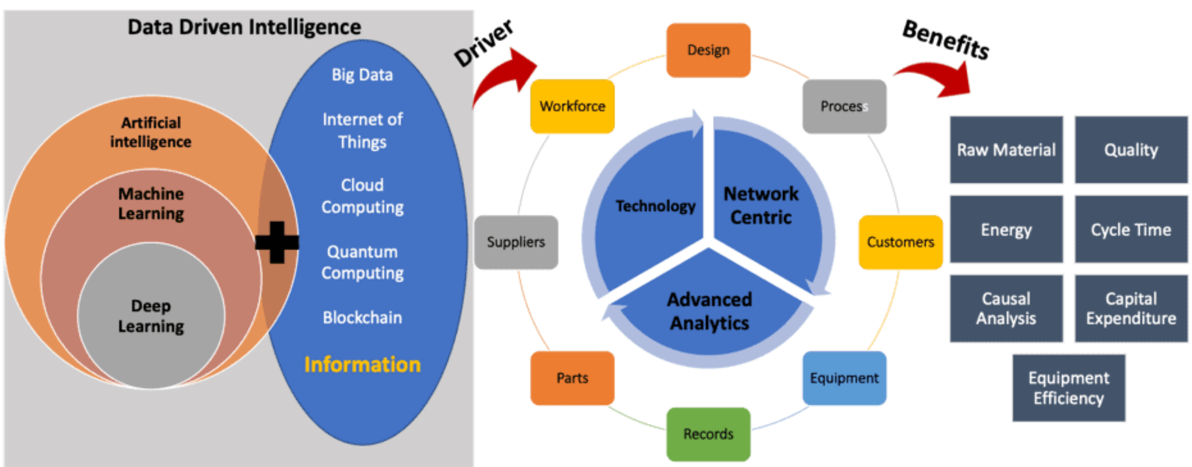
Overview

The aim of the project is to help foundries alleviate porosity levels in the casting, by using machine learning to improve their overall cognition of the process. Furthermore, we want to use novel and specialized techniques to understand the unbalanced, semi supervised and heterogeneous nature of the data in order to add value to the operations of the foundry.

We utilize machine learning techniques for predictive maintenance in order to comprehend the most important factors that are responsible for porosity control, and in turn the quality of the cast component.

The long-term goal would be enhancement of the process via simulation modelling, in order to improve yields, save resources and reduce the defect rates in the foundry.



We are working in an era where manufacturing is undergoing significant changes. Specifically, the nexus of Artificial Intelligence (AI) and metal processing which has opened a vista of opportunities that could not have been realized previously. Researchers at ACRC and at UCI's Hub for manufacturing – **Industry 4.2^{TM}** have been pursuing a set of ambitious projects in this domain. We feature, specifically, a project addressing data (or lack of data).

To use AI and machine learning for optimizing manufacturing processes, the first step is to get the data right. The amount and quality of the data collected is key to good data driven modelling of these processes. Thus, it is important to keep track of the quality details when collecting and aggregating the siloed datasets. Data quality management plans are at the core of Industry 4.2^{TM} and smart manufacturing in the digital transformation age. Data management plans comprise the entire lifecycle of the data from collecting data, integrating the different sources into a coherent format, data normalization and storage to analyzing the data for instant plant action as well as offline. Data cleansing and pre-processing are pre-requisite to transform the raw data collected into knowledge via such a lifecycle. Due to the diversity in the types of data collected at the foundry, for example, data in different formats, at different levels of granularity and time periods leads to datasets that are siloed, noisy and incomplete in nature.

The focus of our work is on the application of deep learning methods to treat such data quality challenges and to develop data-driven models and obtain insights into the manufacturing processes. This work addresses different dimensions of data quality which are essential for materials processing and manufacturing companies interested in machine learning (as featured in this figure). We provide solutions for these which can be easily incorporated into the existing frameworks of the foundry. Moreover, the models developed enable the manufacturing companies to do machine learning for applications, such as identifying primary drivers of defect formation, anomaly detection, part quality prediction and predictive maintenance, even when a gold standard data management plan is not readily available.

Click here to learn more about this project and our other groundbreaking research.

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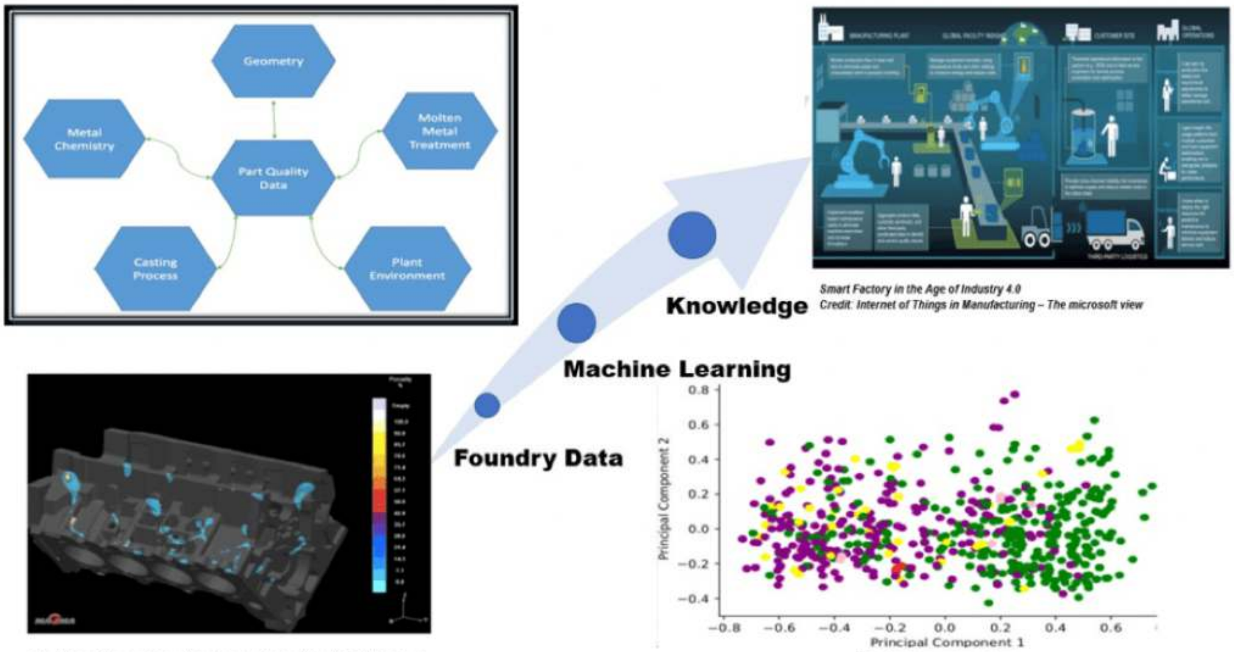
Focus Group Members
Pratt & Whitney
Mercury Marine
Atek Metal Technologies
Palmer Foundry
VJ Technologies
General Motors
Magma Foundry Technologies

Category: Funded by ACRC Consortium



Smart Factory in the Age of Industry 4.0
Credit: Internet of Things in Manufacturing – The microsoft view

Simulation of the porosity profile of the cylinder head (Credit: Eck Industries)

PCA plot of one casting dataset

Problem Statement:

Modern foundries have the capability to capture a vast amount of process data on a daily basis. However, the data is collected at different stages of the manufacturing cycle and is kept in silos. The utility of the data is limited and it is a lost opportunity for the foundry unless there is a way to integrate, fuse, analyze this siloed data, and understand the most important factors that control the quality of the casting.

Project Overview:

It was recognized that foundries routinely collect significant amounts of process data to monitor their casting process. If several key processing data are being gathered along with the part quality data, then it’s our expectation that an expert system could be built to correlate process with part quality even if the various interactions of process parameters are very complex. The basis for the expert system would be sophisticated mathematical treatment of the data by Data Analysis combined with Machine Learning Technology, and it should be adaptable and exploitable by all foundries.

To fulfill this, we are going to develop strong machine-learning-based models using real-world process data that will allow all consortium foundry members to enhance their casting processes by utilizing the vast amount of data they generate but perhaps might not currently fully exploit. This project is aimed at construction of a system of tools that will do just that and function as a knowledge base for the casting process and a framework for continuous learning. The premise being that without continuous learning one cannot continually be at the leading edge. The project can be described as the development of a platform whereby data and information are transformed into knowledge.

The expected outcome is that ACRC consortium members will have an enabling framework and procedures to illuminate the impact of all process parameter on their part quality from a porosity standpoint. It is envisioned that this tool, when integrated into the foundry production process, will be able to alert engineers of process parameters that need adjustment to avoid an impending porosity problem.   Furthermore, the tool will continue to enhance its own predictive capability as it integrates and learns from ever more process and quality data refining its model in the process.