PROJECT CASE STUDY

Improving Energy Productivity & Sustainability of Foundry Metal Casting Operations

CO2 results for the BCI foundry in different scenarios
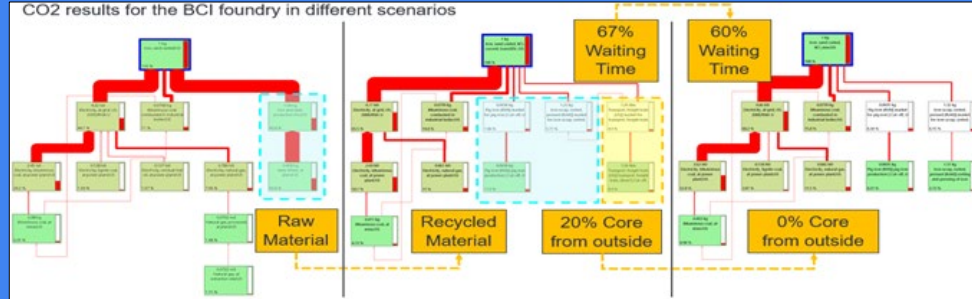
PROJECT LEAD

Purdue

PROJECT TEAM

BCI Solutions

PROJECT OBJECTIVE

Develop a sustainability product lifecycle management (SPLM) framework that can be used as a decision support tool to guide the casting industry to perform energy lifecycle analyses of the entire foundry process. Output from the lifecycle analyses can be used to optimize manufacturing processes.

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Sustainability Product Life Cycle Management Tools Reduce CO$_2$ Emissions at Metal Foundry

BENEFITS TO OUR NATION

Sustainability Production Lifecycle Management (SPLM) tools benefit the nation by enabling industries to optimize resource use, reduce waste, and minimize environmental impact throughout the product lifecycle. These tools help manufacturers design energy-efficient processes and reduce greenhouse gas emissions. Additionally, SPLM tools enhance competitiveness by lowering production costs and reducing scrap.

BENEFITS TO INDUSTRY

Sustainability Production Lifecycle Management (SPLM) tools benefit industry by enabling companies to design and manufacture products in ways that minimize environmental impact while maximizing efficiency. These tools help optimize resource use, reduce waste, and improve energy efficiency throughout the product lifecycle, leading to cost savings for manufacturers. SPLM tools foster innovation, enhance brand reputation, and create long-term value, helping businesses remain competitive in a rapidly evolving market focused on environmental sustainability.

PROJECT DESCRIPTION

TECHNICAL APPROACH

- Develop a novel SPLM model in Python using knowledge graphs to represent interrelationships among casting lifecycle processes.
- Develop a data pipeline to connect, collect, and analyze foundry data.
- Design processes to reduce dependency on labor and supply chains, using smart manufacturing technologies (Digital Twin, AI/ML, AR/VR, and Smart Robotics), which will automate core making processes and improve gating design to increase casting yield.

ACCOMPLISHMENTS

- Developed a comprehensive knowledge graph documenting sand-casting processes and parameters, adaptable for other foundries to implement within their own operations.
- Collected detailed foundry operational data through the CESMII Life Cycle Assessment (LCA) Questionnaire.
- Conducted a series of life cycle assessments comparing baseline data with smart manufacturing implementation outcomes.
- Developed a graphical user interface for the sustainability product lifecycle management framework. This will enable any sand-casting foundry to independently conduct life cycle assessments and environmental impact analyses.
- Developed a smart manufacturing framework that enables users with minimal robotics experience to assess the viability of implementing robotics for core making operations.

DELIVERABLES

- Delivered an SPLM framework and energy lifecycle analysis model for analyzing energy productivity and environmental impact for metal casting foundries.
- Delivered a smart manufacturing framework for core-making operations, tested and validated for deployment in metal casting foundries.

REUSABLE OUTCOMES / SM MARKETPLACE

- Sand casting process knowledge graph
- Sustainability product lifecycle management (SPLM) framework
- Smart manufacturing framework for core-making operations
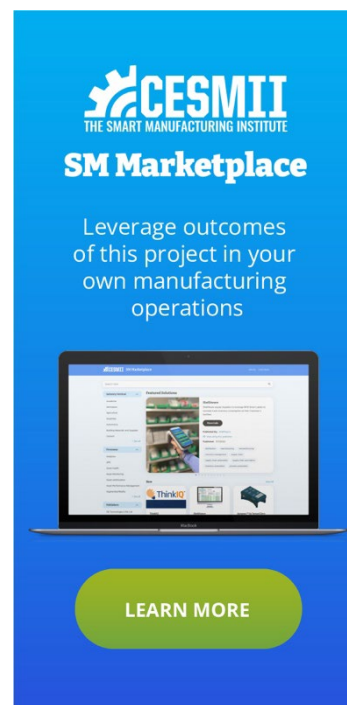- Smart Manufacturing Profiles for metal foundry machines and equipment

RESULTS

↓ 6%

6% expected reduction in CO_2 emissions when implementing smart manufacturing tools at the BCI foundry.

↓ 31%

31% expected reduction in equipment downtime when implementing smart manufacturing tools at the BCI foundry.
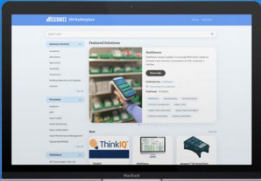
↑ $233 k

A 31% reduction in equipment downtime will result in $233k in annual savings at the BCI foundry.

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SM Marketplace

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PROJECT DETAIL
Budget Period: BP5
Submission Date: 01/08/2025
Sub-Award (contract) Number: 14000802
SOPO: 2356

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