Industries
Subtractive Manufacturing

Applications
Machine Learning
Data Analytics
Data Modeling

Solutions
Energy Savings

CESMII
THE SMART MANUFACTURING INSTITUTE

PROJECT CASE STUDY

Energy Management Systems for Subtractive Manufacturing

PROJECT LEAD

University of Connecticut

PROJECT TEAM

Johnson & Johnson, United Technologies Research Center, Connecticut Center for Advanced Technology

PROJECT OBJECTIVE

The objective of this effort is to reduce energy consumption in manufacturing facilities. Specifically, the project will implement hybrid machine learning models to improve efficiencies in subtractive machining processes.

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Medical parts manufacturer reduces costs by 25% by implementing Machine Learning algorithms on CNC machines

BENEFITS TO OUR NATION

Johnson & Johnson estimates that it costs $30k annually to power one of their precision CNC machines. In addition to energy costs, J&J estimates operating costs of $40k annually, plus scrap and unplanned downtime costs of another $40k annually per CNC machine. Combining energy, operating, scrap, and unplanned downtime costs results in a total cost of $110K for a single J&J CNC machine. A 25% reduction in these costs is equivalent to Johnson & Johnson saving $27.5k annually for a single CNC machine. Extrapolating this savings across all US Johnson & Johnson manufacturing facilities, J&J expects a savings of $55 million annually when precision CNC machining is optimized with machine learning derived Smart Manufacturing process controls. Implementing these machine learning tools across all precision CNC machines in the US would result in billions of dollars of savings annually.

BENEFITS TO INDUSTRY

Coordinated utilization of systems engineering, modeling, advanced controls, and data analytics will enable energy efficiency improvement in the precision machining and hybrid manufacturing across multiple industries, including metals & alloys, aerospace, and orthopaedics.

PROJECT DESCRIPTION

TECHNICAL APPROACH

Integration of the following modules in the Smart Manufacturing Platform for precision machining:

- Multi-level, heterogeneous and hybrid modeling of manufacturing and ancillary equipment
- Predictive analytics for anomaly detection using smart sensors and data analytics
- Context-driven supervisory control architectures enabling model/control interoperability
- Scheduling of manufacturing operations to maximize energy savings
- Big data analytics
- Secure IoT communication protocols

ACCOMPLISHMENTS

- Designed a supervisory control for deployment of energy efficient optimal operation and scheduling
- Devised data encryption protocols for secure smart manufacturing IoT communications
- Completed an advanced smart precision machining testbed at the Connecticut Center for Advanced Technology facility

DELIVERABLES

- Developed complete modeling framework for smart precision machining
- Developed varying fidelity models for all precision machining components
- Developed complete machine learning models for audio, video, and vibration data
- Validated models with data from the Connecticut Center for Advanced Technology (CCAT)
- Developed a data analytics tool for analyzing energy consumption in manufacturing facilities

REUSABLE OUTCOMES

- Predictive models for precision machining
- Process health monitoring application for machining tool wear
- Optimal CNC machine job shop scheduling application
- Tool wear aware fault-tolerant control system
- Experimental database of tool wear data

RESULTS

25%↓

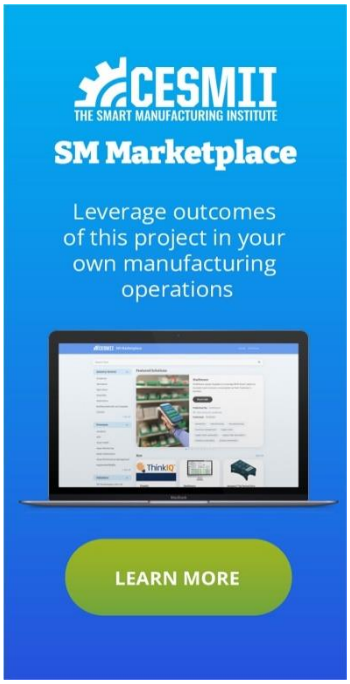
Implementing machine learning models resulted in a 25% reduction in energy usage, operational costs and unplanned machine downtime for precision CNC machines

$27.5k/yr

Operating cost savings per CNC machine when implementing machine learning models

50%↓

50% energy consumption savings enabled by machine learning models at United Technologies manufacturing facilities



PROJECT DETAIL
Budget Period: BP2 – BP5
Submission Date: 04/05/22
Sub-Award (contract) Number: 4550 G WA333
SOPO: 235

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Insert Acknowledgements