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Industry 4.0 at Stanley Black & Decker: IIOT Machine Condition Monitoring and Analytics

Founded in 1843, Stanley Black & Decker, Inc. (SBD), headquartered in New Britain, Connecticut, is the world's largest tools and storage company, the second-largest commercial electronic security company, and a leading provider of engineered fastening systems. The company, which has 60,767 employees and operates 140 facilities in 60 countries, generated approximately $15.6 billion in revenue in 2020.

SBD's Industry 4.0 (Advanced Manufacturing Deployment) Team leads the efforts to rapidly adopt leading-edge technologies in manufacturing operations and leverage machine connectivity and data analytics to improve overall equipment effectiveness (OEE). As part of the continuous efforts to improve OEE, SBD brought in a student team from the Tauber Institute for Global Operations at the University of Michigan, consisting of **Janice (Yin Yin) Lau** and **Akshay Seth**, each of whom is pursuing Master of Science in Industrial & Operations Engineering degrees.

The Tauber team was tasked with developing three deliverables to improve machine reliability: four use cases centered around machine condition monitoring with a minimum value of $150,000 with less than two years of payback; a data analytics model that provides actionable insights; and a roadmap for scaling use cases across SBD sites in Danbury and New Britain, Connecticut and East Longmeadow, Massachusetts.

During the development phase of the four use cases, the Tauber team interviewed more than fifty stakeholders to understand machine failure modes, their impact on production, and the metrics to watch for condition monitoring, identifying more than fifteen potential use cases.

"The team did not have the time and capacity to fully develop all identified opportunities within the fourteen-week project duration," said Lau. "In order to prioritize these opportunities, the team developed a framework that evaluates each opportunity using two dimensions, value and effort."

The Tauber team developed this value-effort framework to evaluate potential condition monitoring opportunities (centered around vibration, temperature, and electric current monitoring) on the scale of value generation and implementation effort.

Above: Ashkay Seth and Janice (Yin Yin) Lau

"Whether it's understanding machine condition monitoring opportunities during Gemba walks, implementing quick wins on the production floor, or deploying data analytics models at the back end, we were very excited that we got to get our hands dirty."
Janice (Yin Yin) Lau

"We had three parameters to evaluate value," said Lau. "First was downtime, measured in terms of frequency of failure occurrence. Since this project was the first attempt to introduce machine condition monitoring systems to the plants, focusing on the most frequently occurring opportunities not only increased the rate of data collection, but also increased plant confidence in the technology."

"Second was potential savings, which ensured good return on investment," she continued. "Third was impact level, which considered the differences in plants' cost of transfers (COTs) and prioritized the most impactful opportunities at each plant.

Dr. Lennart Baardman
Ross School of Business

Dr. Line van Nieuwstadt
College of Engineering

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"As for effort, the team first looked at existing infrastructure, whether there was a presence of hardware infrastructure and network connectivity. The team also evaluated implementation effort, in terms of both hardware and software required. As a result, the team was able to focus on the potential use cases with highest value and lowest effort, with return on investment as high as 300%."

Finally, the Tauber team created a savings flowchart to capture potential savings categories such as overtime reduction, scrap reduction, and throughput increase.

When developing the data analytics model, the team applied the concepts of Statistical Process Control (SPC) to analyze machine condition data and establish alert threshold limits. The model results were delivered to the end users through real-time visualization dashboards. Using the models they developed, the Tauber team detected several instances of premature machine failures and followed-up with effective maintenance responses.

"In order to implement condition monitoring at the focused sites, the team carried out several Gemba walks on the plant floors to understand the bottleneck processes in the work-flow stream," said Lau. "The condition monitoring models developed for these critical processes will in turn reduce machine downtimes of the entire value stream, thereby increasing the quality and cost-effectiveness of the products manufactured.

"This bottleneck-hunting method helped the team drastically focus on machine breakdowns that were causing major disturbances to the production planning," she continued. "During this course, the team also implemented two quick wins: 1) Visual management on pressure gauges and 2) Sequential actuation of paint rollers to prevent collision.

Above: Akshay Seth actuates a paint roller while searching for quick wins on the factory floor

"In the first quick win, the team marked gauges with acceptable pressure ranges, using green tapes for easier identification, whereas in the second quick win, the team devised a new Standard Operating Procedure (SOP) of activating the levers which prevented the collision of paint rollers, thereby preventing scrap generation worth more than $30,000 a year. Both quick wins contributed to the ongoing efforts of lean manufacturing by the SBD organization."

The team also created a scalable roadmap that documents the step-by-step approach for how the use cases were developed and how the model can be generalized.

"The team built two data analytics models (Heat Treat Transformation Model and Motor Vibration Model), and conducted a pilot for one month," said Lau.

"During the pilot, the team worked closely with the local engineers and end users to enhance user interface, validate predictions and inform decisions," she said. "The Heat Treat Transformation Model greatly reduces the safety concern associated with manual measurement in heat treat ovens and provides a clear and informative visual that makes it easy to compare performance of different assets. As a result, the local engineer asked the team to extend this model to help monitor other critical metrics of the process. The Motor Vibration Model had an even greater success story. It successfully predicted a motor failure and since the process is the bottleneck, this in turn saved four hours of production time in the entire value stream."

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Above: Seth and Lau's Stanley Black & Decker project received first place in the 2021 Spotlight! *competition.*

According to Lau, the project was extremely hands-on.

"Whether it's understanding machine condition monitoring opportunities during Gemba walks, implementing quick wins on the production floor, or deploying data analytics models at the back end, we were very excited that we got to get our hands dirty," she said.

The Tauber team's conditioning monitoring has been fully implemented.

"Both of the condition monitoring models devised by the team are still up and running on the production floors of the plants," said Lau. "Inferences from these models help the production engineers, value-stream managers, and plant managers to make data-informed decisions, which in turn help take steps before the machine breaks down, thereby decreasing losses to the plants. The models now give more transparency about the state of the machines to the operators and the stakeholders."

By implementing the use case developed by the Tauber team, Stanley Black and Decker will be able to achieve more than $180,000 per year in savings with less than two years of payback, preventing more than 1,300 hours of downtime and more than $2 million of production losses.

Student Team:
Janice (Yin Yin) Lau – Master of Science in Industrial & Operations Engineering

Akshay Seth – Master of Science in Industrial & Operations Engineering

Project Sponsors:
Nathan Dietrich – Advanced Manufacturing Engineering Deployment Manager

Aditya Mairal – Advanced Manufacturing Engineer

Ziyan Xu – Advanced Manufacturing Engineer

Faculty Advisors:
Lennart Baardman – Ross School of Business

Line van Nieuwstadt – College of Engineering

About Tauber Team Projects

The 2021 Tauber Team Projects resulted in $989 million in savings according to sponsoring company calculations, an average of $43 million per project over 3 years.

Each two to three-person Tauber Team consists of graduate engineering and/or graduate business students. Along with receiving high-level corporate support from the sponsoring company, each team is advised by a College of Engineering and a Ross School of Business faculty member and overseen by a Tauber Institute Co-Director. The projects begin on-site in May and continue for 14 weeks. Students present the results of their projects and compete for over $40,000 in scholarships at the U-M Tauber Institute's annual Spotlight! Team Project Showcase and Scholarship event, held each September in Ann Arbor, Michigan. Spotlight! provides outstanding opportunities for students and corporate partners to establish relationships while exploring innovations in operations and manufacturing.

To learn more about the Tauber Institute for Global Operations, visit tauber.umich.edu or contact us at 734-647-1333.

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