A Manufacturing-Driven Approach to Advancing Community in Northeast Ohio

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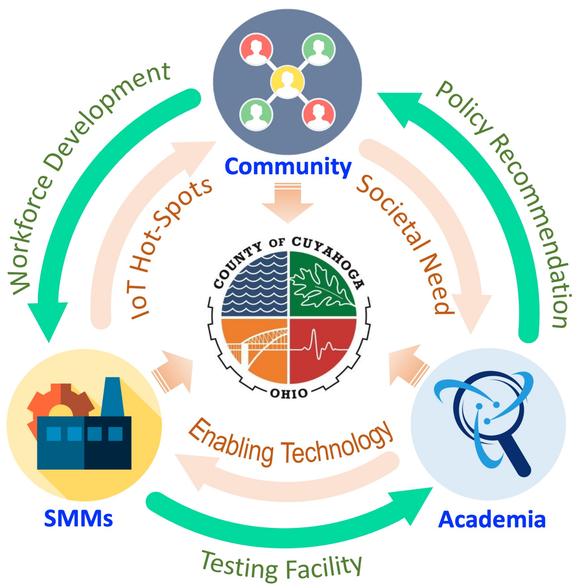
Project Challenges

This project aims to address challenges of:

- Transforming small-and mid-sized manufacturers (SMMs) into **smart enterprises** to capitalize on new markets and respond to supply chain dynamics;
- Rejuvenate SMMs through sensing/AI/IIoT **technologies** to benefit the manufacturing company and the community;
- Enhancing **workforce** development and **talent retention** in Cuyahoga Country and Northeast Ohio.

Intellectual Merit

- Developing integrated real-time monitoring system for SMM **asset health management and performance tracking** with edge computing to improve shop floor production observability and reduce unexpected down time;
- Designing an **ecosystem** to stimulate and optimize **resource sharing** for cross-SMM collaboration to improve resiliency and agility under production and supply chain variations;
- Conducting **socio-technical systems modeling** to prepare SMMs for organizational and workforce **transformation** to an IIoT-driven environment.



Major Outcome/Progress

Use-Inspired Research

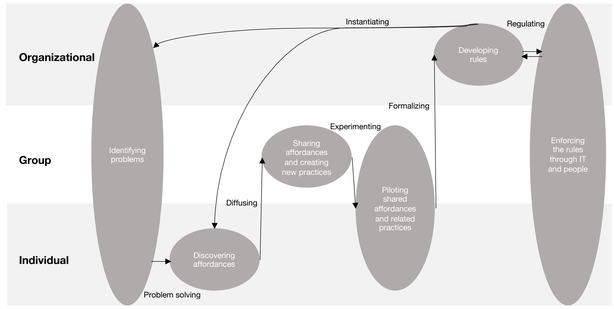
- Developed machine condition **monitoring system** with edge computing, demonstrated system in testbed with community collaborator Bennit-AI;
- Developed unified **modeling solution** to integrate process physics and data-driven AI with error homogenization, transferable across processes and systems seen in SMMs;
- Developed and implemented a system for real-time vibration monitoring, analysis and **fault diagnosis** in bearings, piloted at Rafter Equipment;
- Established a secure **Resource Sharing Platform** with a blockchain testbed, integrating manufacturing auction mechanisms and knowledge sharing;
- Devised an **Additive Manufacturing-as-a-Service (AMaaS) system** with a focus on market design, control algorithms, and security.

Engagement with SMMs

- Held 17 meetings with industry partners and economic development groups to understand needs and to study the **effects** of IIoT on SMMs;
- Analyzed survey data from Ohio manufacturers (2020) provided by MAGNET, shared overall **insights** and specifics for SMMs through presentations. Adopting IIoT is connected to process and workforce innovations, but there is a lack of organizational innovations.
- Conducted two detailed case studies of SMMs using IIoT to understand the process, workforce, and possible organizational innovations. Preliminary findings produced a novel implementation and assimilation process model (see below figure).

Education and Workforce Development

- Our partner LCCC expanded **Techno-Friday** program for high school graduates focusing on IoT and cybersecurity projects and developed a **mini-mech trainer** for automation lab courses, enhancing students' understanding of PLC operations in SMMs;
- Our partner CSU developed a detailed plan for 2024 **workshop** and **training program** for students and educators in collaboration with MAGNET, aiming to upskill local high school teachers and students in computer science and IIoT.



Future Goals

- Enhancing developed monitoring system's **efficiency** and **robustness** for testbed application, **deploying** fault diagnostics at a Rafter Equipment's customer, and creating secure SMM **auction** processes;
- Extending case studies for in-depth technology implementation **analyses;** extracting IIoT usage **patterns** from MAGNET's 2018-2023 surveys to understand changes over time;
- Developing automation **course modules** in collaboration with LCCC. Launching an **internship** program in partnership with CSU to provide training, mentorship, and industry exposure to students, promoting career development within SMMs.

Broader Impact

- Bring **science** and **engineering** to an economically and racially diverse community in Northeast Ohio, serving as a **model** for neighborhoods where manufacturing takes a leadership role;
- Lead to new ways of **engagement** and **interaction** among academia, community, and manufacturers to promote **fundamental** and **use-inspired** research that ultimately benefit education, workforce development, and economic advancement.