Abstract for Blue Sky Competition and David Dornfeld Manufacturing Vision Award

Language of Everything in Manufacturing (LEM)

1. Motivation

Language is the fundamental medium for communication, allowing us to exchange our thoughts, feelings, and intentions. Despite the comprehensive language understanding capabilities of Large Language Models (LLMs), primarily trained on human communication, have a limited role in industrial settings that require more sophisticated interactions between humans, machines, and themselves, which involve various languages including middleware and protocols. These fragmented communication methods result in inefficiency, resource consumption, and labor shortages, especially in modern manufacturing that ought to flexibly handle diverse and capricious customer demands. Smart manufacturing introduces advanced automation through Artificial Intelligence (AI), yet it is still challenging to transplant AI models into on-site systems due to the complexity of communication. Moreover, many production processes still depend on human skills and cannot be automated with AI due to the lack of methods to translate human behavior and intentions into machine-understandable formats. In response to these challenges, we propose "Language of Everything in Manufacturing (LEM)" as a lingua franca to facilitate seamless communication between humans and machines and themselves. This concept aims to streamline interactions and enhance efficiency in the manufacturing sector.

2. Vision

Our vision is to develop a unified language model in manufacturing, capable of comprehensive communication supporting the entire lifecycle from optimized product design to flexible process control and efficient production management. We plan to train the LEM by documenting all types of manufacturing language systems, including data communication protocols for industrial machinery and sensors; syntax of middleware and database; and programming codes for various related software. Unlike the passive responses of existing LLMs, LEM will support dynamic interactions with designers, operators, and managers in the manufacturing sector through active and continuous communication with big data, updated in real-time from factories and corporations. By integrating with an on-site database, Manufacturing Execution System (MES), and Enterprise Resource Planning system (ERP), LEM is envisioned not just as a tool, but as a specialized AI agent tailored to the unique operational needs of each company, facilitating unparalleled efficiency and innovation.

3. Broader Impacts

The manufacturing industry faces a national labor shortage of skilled workers and challenges in training novice workers due to complex communication methods between entities. To address this, we propose LEM, not merely as a standard, but as a novel artificial language designed to facilitate seamless communication within manufacturing environments. LEM will enable operators to control and manage machines through simple and intuitive interactions, without the need for advanced skills. Additionally, LEM seeks to capture and convey workers' know-how and intangible skills, translating human behaviors and intentions into machine-understandable formats. It could lead to more efficient machine operation with fewer actions and commands. LEM represents a groundbreaking approach to overcoming communication barriers in manufacturing. We aim to streamline interactions between humans and machines and among themselves. This initiative addresses the current labor shortage and training challenges and paves the way for more intuitive and efficient manufacturing processes. By embracing LEM, we envision a future where seamless communication enhances productivity and innovation in the manufacturing sector.