THE PROMISE OF A NEW ERA

The influence of the Manufacturing Engineering Division on Industry neXt.

BY LAINE MEARS, INCOMING MED CHAIR

Convergence of digital technologies and data from processes, software systems, predictive models, as well as people has revolutionized manufacturing and manufacturing systems over the decades.

This knowledge-enabled vision, which many have shared in the past few decades, is built upon a broad base of the understanding of the fundamental behaviors of process physics, and methods by which data can be converted to information and information to knowledge through modeling, and a concurrent quantification of uncertainty.

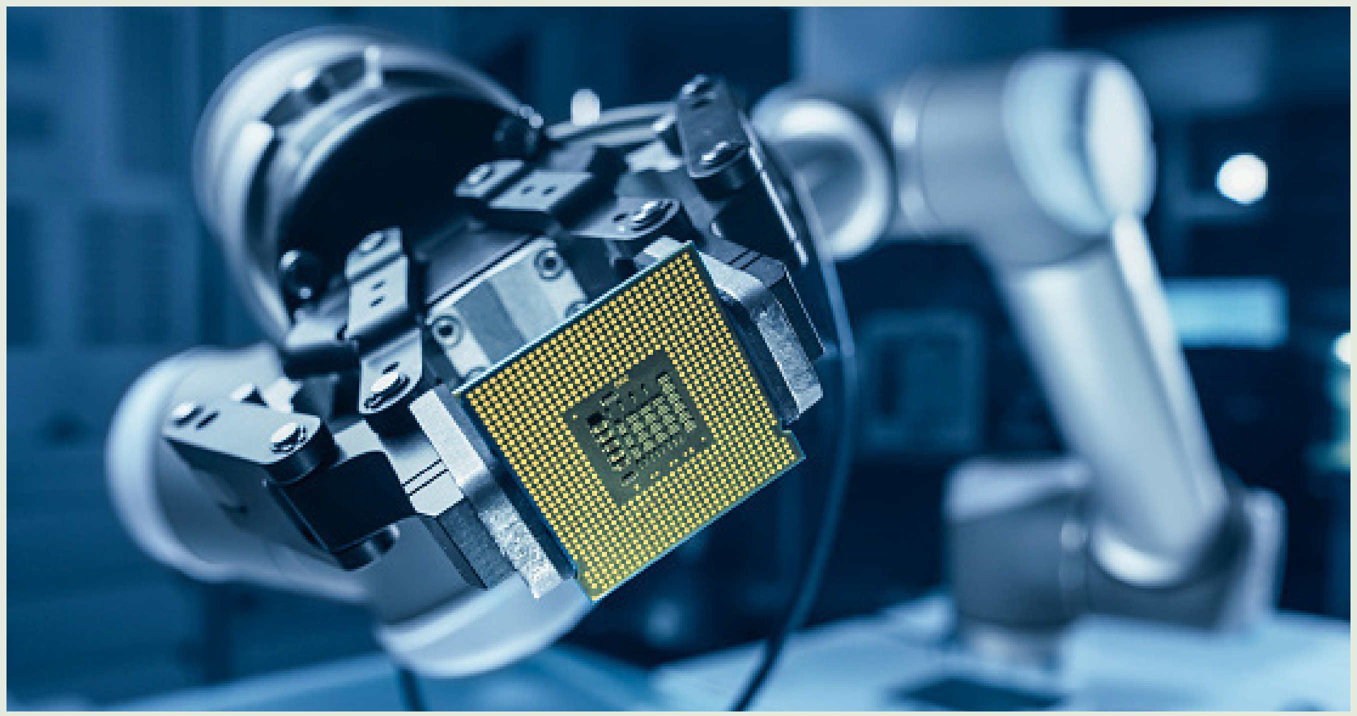
This convergence has many descriptive terms, but the most representative in my view is "Industry neXt," which represents the movement into the next evolution of manufacturing at the crossroads of disparate yet convergent scientific, engineering, and social disciplines.

As the ASME Manufacturing Engineering Division (MED; formerly the Machine Shop Division, then Production Engineering Division) reaches its 100-year milestone this year, the influence of its members on the collective body of knowledge supporting the Industry neXt transformation should be acknowledged.

Early efforts comprised empirical studies of machining techniques resulting in rules and guidelines promulgated through books, such as ASME member Frederick Halsey's original *Handbook for Machine Designers, Shop Men and Draftsmen*, published in 1916. Such efforts reflect the spirit of ASME MED to be not only a group to derive knowledge, but also to bring that knowledge to the people that need it.

As MED grew, so did the range of knowledge generation. Previous chairs of the division contributed to fields beyond metalcutting such as grinding, resultant stresses and conditions of materials, tooling and fixturing, material handling, metrology and gauging, dynamic response of machines, and control approaches. All of these areas feed into a common knowledge stream made up of data sets and generalized models of behavior that today is becoming the foundation of the next evolution of the manufacturing industry.

As the manufacturing industry moves into this new knowledge era, the MED membership has increased focus on investigating how information is generated and communicated.



Industry neXt is a result of a shift across industries—from collections of individual manufacturing processes to a network of intelligent and connected agents. This transition has ushered in the era of cyber-physical systems, comprising not only this concept of networking, but also a concurrent virtual world linked to the real world through data, modeling, and prediction of system behavior.

This virtual concept opens new avenues for experimentation and system-level understanding, when one can rapidly rearrange the digital twin of a line, plant, or entire manufacturing enterprise and accurately understand the effect of change through models that have been robustly validated in the real world.

Perhaps the most fascinating aspect of this revolution is the discovery of hidden information from patterns that researchers and engineers have been able to extract from data to inform manufacturing networks. In addition to the advancements in sensor development, vision systems, and noise rejection and estimation methods, the concept of sensor fusion has given value of the generated data as a whole that exceeds that of the sum of the individual sources. Information is being gathered "between the lines" of individual sensing paradigms, better aligning the information of the outside world with natural perception.

The progress in automation, control and robotics has also influenced the Industry neXt revolution. MED members study and deploy open-architecture control systems such as the Robotic Operating System (ROS) in innumerable applications, to automate previously manual processes such as bin picking, part delivery, simple assembly tasks, and a variety of collaborative robot (cobot) applications.

A paramount area that we look forward to celebrating and better understanding as we move to the new century of MED is the role of people in manufacturing. Humans are differentiated from all other living beings and machines by the ability to envision that which does not yet exist; What implications does that have when that ability is partnered with the advancing technical capabilities outlined above?

As manufacturing evolves, this creativity and vision will need to be leveraged such that the Internet of Things will evolve to become an Internet of People and Things, working in better harmony. Research will continue turning toward understanding and redefining the role of the associate on the production line, the operations manager, the engineer, and product and process designers.

It is important to understand the physics of the way a process behaves, but the influence of people's decisions and actions on how the process performs is also important to quantify. Even our first MED chairperson, W.A. Viall, considered learning and the building of collective intelligence around manufacturing by questioning "Has the Need for Apprenticeship Passed?" [ASME, Education and training for the industries, 1927], and even the need for diverse perspectives in manufacturing with his century-old article "Employment of Women in Our Industries." [American Machinist, vol. 48, 1918].

> **"Understanding manufacturing as a business of people is foundational to the future."**

A later MED chair, Daniel Koenig, researched extensively into relationships among maintenance practices, employee management strategies and quality through an extensive publication record. This understanding of the nature of manufacturing as a business of people is foundational to the future as artificial intelligence and decision systems are developing and finding their way into the manufacturing enterprise.

Today, as we look back to survey the beginnings of the Industry neXt manufacturing revolution and forward to the obvious technological leaps to follow, we can also see how the advancements in smart manufacturing are carrying over to other industries, and also being informed by them.

A closely aligned and complementary industry is transportation, where the most recent innovations have been in automated driving. As vehicles move through a network, so do parts through a manufacturing system. Lessons manufacturing can teach include estimation of physical phenomena with concurrent uncertainty quantification, temporal and spatial sequencing of operations, and control architectures adaptive to variation. Lessons manufacturing can learn from transportation and automated driving include system-level perception, autonomous guidance and control, human integration to automated environments, and design for human use. Such relationships exist within other industries, including energy, healthcare, construction, and particularly design and product development. These complementary relationships with aligned industries will continue to foster innovations in manufacturing and beyond.

At this exciting time, I look forward to leading the MED into the next 100 years. Manufacturing will look very different at the next centennial celebration than it does today. There will be new markets, new models of ownership and production, new environments of manufacturing, new processes for materials, new paradigms of intelligent automation, and a new understanding of the human influence and application of human ability.

The MED will continue to collaborate with and contribute to aligned disciplines through fostering, investigating, and reporting a scientific understanding of emerging engineering problems and solutions. Just as we have done in the past, we will continue to build knowledge to usher in the intelligent revolution of manufacturing. **ME**

LAINE MEARS is the incoming chair of the Manufacturing Engineering Division Executive Committee (2020-2021). He is the BMW SmartState chaired professor of Automotive Manufacturing at the Clemson University International Center for Automotive Research, home of the world's first graduate program in Automotive Engineering.