Source: Magic Wand Media

LEVERAGING CUTTING-EDGE TRENDS

Once considered science fiction, Artificial Intelligence is now a vital technology for business sectors, especially manufacturing, where massive amount of data is generated. The following is a round-up of experts from the manufacturing world who have leveraged it for its array of benefits and better decision-making.

REJI VARGHESE
Managing Director
RV Forms & Gears LLP
fngreji@gmail.com

There is a popular funny saying on how Industry 4.0 will change manufacturing to require just two beings at the factory. One being the guard to ensure security and the other being a dog to ensure the guard doesn't touch any machine. While this may be an exaggerated thought, the power of Artificial Intelligence (AI) may pull us closer to the model of the guard and the dog.

Artificial Intelligence may sound high-tech, but it has now become part of our daily lives. Whether it's Siri, Alexa, self-driving cars, conversation-

al bots on e-commerce sites, e-mail spam filters, or Netflix and Amazon recommendations, AI has infiltrated almost everything we do.

Manufacturing and AI

In manufacturing, AI has made its presence felt with Smart machines and Smart factories. Industry 4.0, or the Fourth Industrial Revolution, allows manufacturers to have cyber-physical systems that enable us to have digital twins of anything that has an electric pulse on the shop floor, be it a machine, drill, or fixture; one can get a

Source: Yamazaki Mazak India Pvt Ltd

"Mazak controllers use 3D models, CAD data, and AI-enhanced machining process selection to automatically program parts in MAZATROL. For our machine spindles, we utilize AI technology to optimize cutting conditions by monitoring spindle vibration and adaptively altering cutting technology (Feeds & Speeds) to remove the vibration. With optimum processes achieved, the cutting technology characteristics for the tool are stored in the MAZATROL or EIA (NC) program."

Anil Bhardwaj
Managing Director
Yamazaki Mazak India Pvt Ltd

real-time play-by-play report of what is happening at one's plant while being miles away from all the action.

While having the ability to observe operations remotely is exciting, there is a high value in creating the ability to have a feedback mechanism for remotely controlling various entities.

Whether shutting down a machine in the extended downtime to save electricity or increasing the depth of a cut for a brand-new tool to gain precious minutes in production, Industry 4.0 has truly been thriving. But we then begin to ask ourselves, how much of this could just have been calculated and predicted in seconds instead of us running numbers and formulae every single time we had to make a new decision? Well, this is where harnessing the power of AI makes a difference.

Nikhil Rabindra, Head, SmartFix 4.0, says, "The most common form of AI in Industry 4.0 is Machine Learning which functions primarily in two ways—classification and regression. While both forms need prior data to train the model, the outputs vary. Classification gives a qualitative output. Some examples could be raw vibration sensor data that can detect the type of tool used based on the nature of the graph plotted or the use of computer vision where a camera can look at a component and identify all the parts assembled to ensure the quality of the final product. Regression is when the output is quantitative. A couple of good regression examples are: OEE calculation for your shop floor based on the historical data collected or even the ability to predict how much more life is left in a tool by checking the gradual increase in the power consumed as well as higher vibration signals caused as the tool begins to get blunter."

Machine Learning is just one strand of AI leveraged by Industry 4.0. However, the scope for AI in manufacturing is a lot more. The ability to predict various individual aspects still needs a lot of human intervention to triage all predictions to optimize both process and quality. The true power of AI can be felt when data-driven decisions are made all through the supply chain. Imagine the tool wear example from before can also lead to automating the depth of cut setting on the machine when there is a time crunch. That, in turn, predicts the cost of required inventory, which can be integrated directly into the ERP. All one has to do then is log in

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and approve the decision made by AI, or have the option to optimize the process further.

Anil Bhardwaj, Managing Director, Yamazaki Mazak India Pvt Ltd, says, "Mazak controllers use 3D models, CAD data, and AI-enhanced machining process selection to automatically program parts in MAZATROL. For our machine spindles, we utilize AI technology to optimize cutting conditions by monitoring spindle vibration and adaptively altering cutting technology (Feeds & Speeds) to remove the vibration. With optimum processes achieved, the cutting technology characteristics for the tool are stored in the MAZATROL or EIA (NC) program."

He adds, "We also have an AI Thermal shield that automatically compensates the machine for temperature changes. Machine Learning combined with Spatiotemporal modeling is used to increase the stability of processes with temperature change, further enhancing the machine's accuracy."

For many companies, the implementation of AI can seem daunting. Manufacturers can now generate billions of data points through smart machines, advanced sensor technologies, and intuitive computing power. Still, many are uncertain how to effectively use and manage this massive volume of data to increase productivity, reduce costs, improve quality, etc. They often attribute their hesitancy in the adoption of AI to cost, lack of IT requirements, or not being Industry 4.0 ready.

However, for companies to stay competitive, manufacturers must realize that AI is no longer a concept of the future but is now a reality that can be immediately implemented in one's plant.

Sunil Joshi, President, Sandvik Coromant India, says, "AI is opening up many opportunities for both producers and suppliers. It can be leveraged to optimize maintenance, refine processes, increase productivity and sustainability, and improve safety. In addition, it is driving increased automation through the use of collaborative robots, thereby increasing productivity and lowering costs. Sandvik is developing new concepts and solutions that can help manufacturers reduce waste and improve efficiency. Our digital machining solutions, which include software solutions, can strengthen the customers' value chain and facilitate data-driven decision-making."

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Areas in manufacturing where AI helps

Production Optimization

Optimizing processes can be a data-heavy task that involves a considerable amount of historical data sets. Deciding which process parameters produce the best quality and output is not an easy task. Questions like which parameters to use for the highest yield, etc., are best answered by AI that can crunch the data fast, constantly learning from the previous data points.

Jose Varghese, Director, Technology, DMG Mori Seiki India, says, "DMG Mori helps the customer transform their shop floor into a digital factory by taking advantage of the advanced technologies and contributes to significant improvements in productivity and profitability. DMG Mori Digital Factory transcends the five steps of planning, preparation, production, monitoring, and service. With the cutting-edge operating system, with CELOS at its core, it connects humans, machines, and factories to achieve visualization and analysis of information, which has been difficult in the past. Through factory digitization, DMG Mori identifies the challenges that the customers face and provides solutions best suited to their needs.

DMG Mori Digital Twin is one such specific AI tool developed to offer the following benefits to the customer:

- Continuous process improvement due to virtual programming and teaching machines.
- Development-related product optimization, leading to savings in time and money.
- Increase in productivity due to better system utilization.
- Quality improvement of the machine and automation solution by means of virtual tests."

Predictive & Preventive Maintenance

Some of the biggest potential

problems for a production operation can be the breakdown of a core piece of machinery or equipment. Often, preventive maintenance schedules are not optimized for real-time operating conditions. Now, with a whole range of IoT sensors, MES data, and Machine Learning algorithms, manufacturers can utilize many machine data points to predict breakdowns and wear and tear.

Bhardwaj informs, "Mazak has developed an AI-based system, in conjunction with the Industrial AI (IAI) Center at the University of Cincinnati, a leader in predictive analytics, the Mazak Spindle Health Monitoring System that uses EDGE Computing and Data Analytics algorithms to model each machine's spindle during a 60-second test run, establishing a baseline value for comparison in subsequent tests. Operators can conduct fixed cycle tests at any time and view Health Assessment and Fault Diagnosis screens on the machine's Smooth CNC. Predictive analytics diagnoses pre-failure conditions before any downtime occurs."

In its current configuration, the Mazak Spindle Health Monitoring System uses two high-definition data sensors, a data acquisition unit, and an industrial computer to acquire, process, and store machine data. A Neural Network Self-Organizing Map (SOM), also known as AI, compiles a growing profile of each machine, learning to assess its health through features extracted from a growing data set.

"Machine tools continue to get smarter thanks to AI that provides shops with advance warning of problems before they can derail productivity and profitability. The Mazak Spindle Health Monitoring System represents an ongoing development in OEM integration of smart features into high-tech machines," he adds.

Source: DMG Mori Seiki India

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As Varghese shares, "DMG Mori, as a pioneer in the Machine Tool industry, is at the forefront of AI applications. The cognitive systems are now a part of the machine tool assembly, augmenting human capabilities in handling machine tools with CNC systems at a superlative speed and Big Data scale. One such application is predictive maintenance. DMG Mori has collected comprehensive data from more than 3 lakh installed machines worldwide and has been exploring the causes of machine troubles and their solutions through the Product Problem Report system for more than 20 years. With the accumulated data as well as factor analysis of each error using AI, a robust predictive and accurate preventive maintenance mechanism is in place today."

He adds, "'Condition Analyzer' is a platform developed by DMG Mori for the visualization of machine sensor data. It records the data, detects machine and machining condition changes at an early stage, analyzes changes to minimize machine downtime, and provides access from any networked PC, mobile device, or CELOS interface. This AI-powered revolution is gathering momentum with every passing year in the DMG Mori world for the customers to reap the benefits."

Supply Chain Optimization

Supply chain networks can be very complex, with thousands of parts and hundreds of locations. Using Machine Learning algorithms, users can determine the best shipping routes, optimize inventory, etc.

Forecasting Yield

Yield prediction is another critical area where AI can be used in manufacturing. Using AI, forecasts can be made on RoI with a high degree of accuracy. Accurate yield forecasts can help a great deal in inventory and supply chain management. If outputs are lower than expected, this can alert the management to increase production time to meet demand needs. Yield prediction is a data-heavy, complex problem that AI can help solve.

Virtual and Augmented Reality

VR and AR use technology to create simulated environments that we can submerse ourselves

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into, while AI aims to outfit technological devices with the keen insight and perception of a responsive being. With Augmented and Virtual Reality technologies improving every day, more and more major companies are developing AR and VR for training, preventative maintenance devices, inspection, quickly identifying defective products and operational problems, etc.

Tool Optimization and Tool Wear Analytics

With a range of ultra-sensitive but tough sensors available and with the option of mounting these sensors on the fixture or the cutting tool as close to the cutting edge as possible, accurate data can be achieved regarding how a tool is performing, its life, and the cost per component per tool.

Joshi adds, "We are also developing sensorized tooling to provide data for smart decision-making during the machining process. We have also implemented smart manufacturing concepts at our plant in India. Development and implementation of AI solutions provide Sandvik with the ability to offer customers increasingly detailed and appropriate advice on how certain operations could be performed more efficiently and how their machines can be used optimally in specific situations to be more sustainable."

Rabindra shares, "SmartFix 4.0 has leveraged AI for multiple use cases. The most sought-after feature is the tool wear prediction that is served from vibration data captured from the fixture. The in-built AI model maps the sensor signals to the expected age of the tool, thereby allowing the customer to track tool wear."

In manufacturing, AI is also being used in energy management. It can monitor and collect information about energy consumption in the form of numbers, text, images, and videos.

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"DMG Mori's 'Tool Control Centre' provides a visual representation of a time sequence graph for monitoring and analysis of the axial and bending loads of every rotating tool. 'Easy tool monitoring' on the DMG Mori turning machines is a technology cycle with automated learning of load limits. It has a powerful algorithm for efficient monitoring right after the first part is machined," Varghese explains.

Energy Management

In manufacturing, AI is also being used in energy management. AI can monitor and collect information about energy consumption in the form of numbers, text, images, and videos. By evaluating what is observed, AI can manage energy usage. It can compress and analyze data to predict future problems and ultimately optimize energy consumption in the long term. Having an AI system look into the energy consumption of a production operation can significantly reduce operating costs. The reduced cost can allocate more funding for process improvement resources, leading to higher yield and quality.

Challenges with advantages

With all the benefits AI has to offer, there are some challenges to overcome with regard to manufacturing, starting with the challenge of investing in the new infrastructure that enables these advantages. The infrastructure includes buying new IoT-enabled machines and having robust network connectivity that allows the shop floor to be truly connected.

Next, there is the dilemma of where the data resides—local or cloud? And how secure is data if it is stored on the cloud? While local can be optimal for a single location, a cloud solution can be more beneficial for a multi-location setup. Solutions like SmartFix 4.0 address these problems by providing flexibility in the setup without burning a hole in the pocket of a legacy setup and also integrating with existing IoT solutions for a fraction of the cost. Finally, the philosophical question of how much human intervention and decision-making can be handed off to AI is always an ongoing process.

So yes, the forum is open to debate on how far AI can be implemented in manufacturing, but the above points are a top-level survey of all the potential paths that can be explored going forward and maybe seeing a factory smart enough to be managed by just a guard and a dog.