Business

Oxford Engineering Advises on How to Navigate the Complex Chess Game of Low-Volume, High-Complexity Production

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By: Maria Williams

Manufacturing, especially in industries dealing with low-volume, high-complexity products (LV/HC), faces a significant challenge: waste. A staggering [$8 trillion globally] is attributed to inefficiencies such as material waste, mismanagement of labor, excess inventory, and process variability. Companies working on intricate, custom-engineered products like aerospace components, medical devices, or industrial reactors are vulnerable. In these industries, the stakes are high, and the margin for error is slim.

Oxford Engineering is a winner of a national competition in artificial intelligence. Chairman, Karim Sekkat, offers a deep dive into this complexity, drawing an analogy between manufacturing and a game of chess. “In the manufacturing world, much like chess, every move you make comes with rewards and penalties,” Karim explains. “If you take the wrong path, misallocate resources, or fail to predict a machine’s availability, it’s like losing a pawn or even a rook on the chessboard – you might even lose the whole game.”

The main issue lies in the complexity of modern manufacturing where achieving world-class quality is not optional. Manufacturing is filled with variables, ranging from the drawing designs, machines, tools, setups, programs, fixtures, cutting strategies, materials sizes, and their respective tolerances and properties, skill levels of the operators, process hold points, witnessing, quality control plans to the supply chain dynamics. Without a complete understanding of how these variables are interdependent, you can very quickly end up with a major bottleneck that is very costly to resolve. The traditional, reactive approach is like a chess player focusing only on the immediate moves without planning several moves ahead. Karim compares this to the challenges companies face today: “In chess, you might sacrifice a piece to win the game later. Similarly, in manufacturing, sometimes you need to make small sacrifices for long-term efficiency. We call this dynamic optimization.”

At the beginning of any chess game, every player starts with all their pieces in place, much like how manufacturing companies approach their planning horizon. However, many of these companies fail to capitalize on their advantage because they lack the data needed for true AI-driven decision-making. They quickly lose ground, akin to novice chess players losing important pieces in the opening moves.

“Today, AI is a buzzword,” says Karim. “You see many companies claiming they have AI, but often, these tools are simply based on brute force algorithms or simple rule-based scenarios, which don’t bring meaningful impact as they lack data set volumes to learn from. Real AI in manufacturing requires learning from the outcomes of various scenarios and improving over time – something most systems aren’t doing yet; the data sets and the tools are nonexistent,” the chairman notes. Most chess players will know the fundamental opening moves but quickly lose in the middle game.

As Karim Sekkat delves into the role of reinforcement learning in AI, this chess analogy becomes even more relevant. Just as a chess grandmaster calculates multiple possible outcomes before making a move, AI can simulate millions of production scenarios and choose the efficient path. “You need to start with certain rules, like knowing how the machines work or how materials behave. But the key is that AI must learn from each outcome. It’s not enough to have algorithms; the AI needs to improve with each iteration,” the visionary emphasizes.

One of the biggest challenges in high-tech manufacturing is dealing with scrap and rework. In LV/HC environments, the cost of scrap can be astronomical – not only in terms of material but also time. “Some of the materials we work with cannot be easily replaced due to traceability requirements. If you scrap a part, you may have to wait months for a new batch of material,” Karim explains. This ties directly into the importance of reducing waste, which AI can help mitigate by improving real-time decision-making.

In traditional manufacturing, quoting for a project is often a static process. Companies provide a price based on current conditions without analyzing the difficulty of achieving the customer requirements. This static approach leads to inefficiencies. These conditions are also subject to change. “If the route selected proves to be the wrong one, you might just have lost your Queen. You can’t run manufacturing like that anymore. You need real-time decision-making to ensure you’re not taking the wrong path or wasting time and resources. AI can do this by constantly evaluating all variables in real-time,” Karim adds.

The Oxford Engineering chairman is candid about the misuse of the term ‘AI’ in the manufacturing industry today. “People are quick to label anything as AI to make it sound sophisticated. But many of these tools are just better calculators, not truly intelligent systems. Real AI needs to predict, learn, and adapt – not just follow static rules,” he states.

What differentiates Oxford Engineering’s approach from many others in the field is its commitment to data-driven, reinforcement-learning-based AI tools. The chairman emphasizes that building AI in this space requires time and data. “You’re building the tool while it’s learning. Every machine, every product, every operator has different characteristics, so the AI needs to gather and process all that data to become effective,” Karim points out.

This ongoing improvement process is vital, especially in industries where products are customized and processes change with every new project. “In low-volume, high-complexity manufacturing, the process is never the same twice. It’s not like mass production where you can refine a single process and stick to it. Every part is different, and every setup is unique. So, you need a system that can adapt to that complexity,” Karim adds.

Another key component of Oxford Engineering’s strategy is what they call ‘optimizing globally’. Many manufacturers focus on optimizing one aspect of their production line, such as cutting down setup time or speeding up a single machine. However, this short-term thinking can lead to inefficiencies later in the process. In contrast, a global optimization strategy, according to Karim, considers how each part of the production process interrelates with the others. By doing so, manufacturers can make smarter decisions, such as assigning a less efficient machine to a less critical task, and saving the more efficient machine for a high-risk, high-reward job, as quality is paramount.

The future of manufacturing lies in adopting AI tools that are not just sophisticated calculators but dynamic systems that learn, adapt, and optimize. In Karim Sekkat's vision, the companies that succeed will be the ones that approach manufacturing like a game of chess – thinking multiple moves ahead and making sacrifices today for a better, more efficient future.

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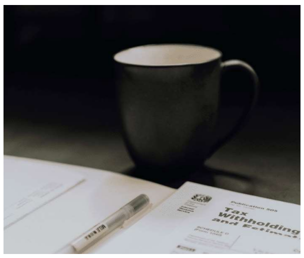

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