

WHITEPAPER

Five Key Components for Smarter Manufacturing

Published by Jicara Media in partnership with Lenovo and Intel.



Introduction

Perhaps the most visible aspect of Industry 4.0 is the concept of the 'smart factory', a term that typically conjures up images of automated factories leveraging AI, big data and robotics to make manufacturing more efficient, innovative and ... well, smarter.

That's a simple take on what in reality will be a complex undertaking that will be an evolutionary journey that manufacturers will take over the next decade or so. Consequently, it's helpful to approach the smart factory concept in terms of what parts of the existing manufacturing process you want to make smarter, and the foundational technologies that will help you achieve that.

The answer will of course differ from one OEM to the next. But at a high level, much of the smart-factory paradigm starts with a robust high-performance computing (HPC) architecture that can support the AI that provides the "smart" part of the equation. That in turn puts an emphasis on things such as storage and green technologies to make data centers more energy-efficient. And all of this will take place in the context of digital transformation initiatives that will free up departmental data that will fuel intelligent-driven outcomes, resulting in a truly smart factory.

Smart manufacturing in 2022

A cursory glance at the history of modern manufacturing tells us that HPC technology has been a cornerstone of manufacturing for some time now in the areas of development and design.

Manufacturing involves a lot of engineering, mathematical formulas and work streams to design the product to be manufactured. In the old days we used slide rules, pens and paper to calculate and simulate various aspects of design. These days, design is mainly done 'in-silicon' using CAD software to design things and CAE (Computer Aided Engineering) software to analyze the design and calculate things such as optimization and stress analysis.

One result of this has been much faster time-to-market, which in itself is a game-changer for industrial manufacturing, which at heart is based on the idea of building or updating products that meet consumer demand in the shortest possible time – ideally before customer demand moves on to something else.

The capabilities of CAD and CAE are naturally dependent on the amount of compute power available. As compute capacity has become higher, more available and cheaper for over the years, they have added more functionality and deeper levels of computation, which today includes early implementations of AI, as well as AR/VR applications such as digital twins, which take design and simulation of physical products to all new levels.

This is why HPC is arguably the basic foundation of modern manufacturing. Put another way, no one is going back to using slide rules if they can help it.

Smart manufacturing in 2032

While it's a fool's game to make predictions of where we will be in ten years – especially as the manufacturing sector itself is currently in a state of flux as companies finds ways to digitally transform themselves and adopt the Industry 4.0 paradigm – it's reasonable to calculate that the smart factory of 2032 will at the very least a more advanced version of manufacturing as it exists today.

This means that the software stacks and applications doing computational fluid dynamics, stress analysis, etc, will be better than today, as will the processing power behind them as GPUs become more prevalent in the overarching drive to develop Web3 and the metaverse (whatever either turn out to be). HPC equipment will be smaller, cheaper and faster, which will be able to support the evolution of AI functionality and capabilities.

That's key, because AI will play a crucial role in speeding up the time-to-market process in at least two key ways.

First, AI will endow in-silicon design with more proactive, predictive analysis capabilities, to include making suggestions on, say, the best predictive design for a front sectional chassis crossmember in an automobile, which means a much faster design process and thus faster time to market.

Second, as digital transformation breaks down the silos between business units, AI will be able to combine historical and current data from the design, engineering and sales and marketing divisions to make even smarter decisions about what customers want, which widget will serve that demand, and when it's time to either upgrade that widget or come up with a new one as market trends change.

Five key components for smart manufacturing

Like with anything complex, smart factories have a plethora of moving parts, so it's hard to narrow the list of essential components down to just five. But the following five comprise the most critical and foundational technologies and trends without which the smart factory as described above cannot exist, either today or ten years from now.

1. HPC infrastructure

As discussed, a robust HPC infrastructure is easily the foundational technology for supporting the “smart” component of the smart factory, as the HPC infrastructure has to be capable of supporting the compute demands of machine learning and deep learning software suites.

The combination of Moore's Law and advances in silicon miniaturization is making both edge devices and HPC infrastructures increasingly powerful – Moore's Law is now doubling compute power every seven months instead of every 12 to 18 months, while advanced fabrication techniques have shrunk chip sizes to 7 nm and below, enabling GPUs that provide the required level of power at the backend to compute AI/ML applications.

Meanwhile, as HPC infrastructures get smaller, so will the cost – what costs millions of dollars today will be reduced to tens of thousands of dollars for the same amount of compute. All of which means that by 2032, HPC infrastructures will deliver to smart factories unprecedented levels of computing power that far outstrip what's available today, and for far less money.

2. AI

Obviously, AI (which includes machine learning, deep learning, etc) provides the “brains” of the smart factory. AI will be applied in a number of different ways – to include things we can't even imagine today – but for the purposes of the present discussion, smart-factory AI will play in a few key areas:

Design: Deep learning and machine learning will take product design to all new levels by not only enabling better prediction and stress analysis, but also making recommendations to designers and engineers. Armed with data from other business departments within the company as well as external data, AI algorithms will be able to take a variety of design factors into consideration, to include anticipating future developments such as market trends or changes in specifications and safety regulations.

Production: AI will also play a role on the factory floor with apps such as “AI vision” that inspects product components on the line, looking for everything from design flaws in a silicon wafer to incorrect labelling. This means smart factories will have more advanced quality control whilst simultaneously increasing efficiency on the production line. AI has already helped quality of product increase dramatically over the last number of years and will only increase exponentially as we go forward.

Supply chains: As we've seen in the last couple of years, supply chains are subject to disruption, whether it's from trade wars or a global pandemic. Manufacturing supply chains are incredibly complex simply because manufacturing itself is complex. Not only do you need to gather together all of the necessary materials and components needed to build your widget, you also need to work out how to get the finished product to the customer, which is more complicated than just putting it on a ship or a truck at Point A and sending it to Point B. AI is already proving useful as a tool to make supply chains more efficient – for example, by incorporating GIS and weather data into the decision-making process. It can also harness data such as current economic conditions of a given market to inform decisions about where to build a new factory (or use an existing one) and the associated costs, proximity to suppliers, and so on.

3. Storage

As AI and data become more prevalent components of the smart factory, this naturally has implications on storage demand. As CAD/CAE becomes more sophisticated and employs the use of digital twins and AR/VR, storage requirements will increase. Apps such as AI vision that feature image resolutions from HD and 4K to 8K will generate huge amounts of data that has to be stored. Meeting that requirement raises a number of questions – for example, should the storage be nearline, in a public cloud or an on-prem data center? (Note that the answer will often depend on the type of data being stored, regulatory requirements, etc.)



Storage technology is already evolving to meet these requirements. Data center storage is becoming increasingly efficient, and the number of terabytes and petabytes per square foot has increased dramatically. Parallelization of data streams allows companies to shift and remove bottlenecks that arise with massive data accumulation so that data can be processed much faster.

CIOs will also have to think about hierarchical storage management systems for environments where storage is a mix of nearline and online, which will require some in-depth design with an eye on whatever regulatory requirements are in play. There's also a cloud aspect to this in terms of backups and disaster recovery, so that data is protected in the case of a natural disaster or a ransomware attack.

4. Cooling / carbon negativity

The increasingly central role of HPC, AI and data in manufacturing also raises issues with energy consumption and its subsequent environmental impact. As HPC infrastructures become faster and more dense, they require more power to run. This also results in an exponential growth in heat, which raises cooling requirements, which in turn raises the amount of power required. And that in turn raises operating costs, because power isn't cheap, and typically accounts for a significant amount of opex.

This dilemma isn't limited to manufacturing – it's an issue for data centers of every stripe. That's why HPC equipment makers and data center operators alike have been innovating ways to keep data centers cool with an eye on staying carbon neutral and even carbon negative. For example, warm water cooling uses water at tap-water temperatures – this not only saves power from not having to keep the water cold, but also creates hot water that can be reused for other purposes. In essence, the HPC equipment heats the water, which can then be used to heat buildings on the same campus.

5. Digital transformation

Equally important to the technological innovations spurring the evolution of smarter manufacturing is the context in which it's happening – namely, the digital transformation initiatives being planned and implemented by more and more companies racing to keep up with digital native start-ups. The COVID-19 pandemic has been credited with accelerating that trend over the last couple of years, and that momentum is likely to be maintained.

This is key because one of the hallmarks of digital transformation is the restructuring and streamlining of business units to make the overall business more innovative and efficient. Tearing down organizational silos frees up the data generated within each unit, enabling better collaboration and fresh insights, while DevOps processes streamline the process for everyone, resulting in a more efficient and flexible business where everyone is on the same page and can respond in real time.

And as we've seen, this will be essential for the smarter manufacturing paradigm in which, for example, manufacturing design will be tightly linked with sales and marketing. Product design will be informed by insights from the sales and marketing side in terms of what customers want, what they like about the current design, what they think is missing, how much they're willing to pay for it, is it more cost-efficient or more suitable to the customer's needs to make a new widget rather than modify the existing one, etc. The means more efficient production and (perhaps more importantly) faster time to market.

The work in each department will have direct ramifications on other departments. As mentioned above, predictive AI will play a role in harnessing the data from different departments and elsewhere to make recommendations – but that's only possible when the organizational structure has been transformed into an agile, digital-first operation that enables those departments to collaborate. Without that, the usefulness of AI is severely limited – and the manufacturer is less smart as a result.

Published by



In partnership with



Jicara Media
135 Middle Road, Bylands
Building, #05-03,
Singapore 188975

+65 9026 0649
+65 6815 2996

contact@jicaramedia.com
www.jicaramedia.com

