Accelerated Computing, AI and Digital Twins: A Recipe for US Manufacturing Leadership

Onshoring the most complex factories in history will require the latest technologies for long-term sustainability, and a workforce skilled in robotics, simulations and machine learning.

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A national initiative in semiconductors provides a once-in-a-generation opportunity to energize manufacturing in the U.S.

The CHIPS and Science Act includes an $13 billion R&D; investment in the chip industry. Done right, it's a recipe for bringing advanced manufacturing techniques to every industry and cultivating a highly skilled workforce.

The semiconductor industry uses the most complex manufacturing processes and equipment in human history. To produce each chip inside a car or computer, hundreds of steps must be executed perfectly, most already automated with robotics.

The U.S. government asked industry where it should focus its efforts on improving this sector. In response, NVIDIA released a 12-page document with its best ideas.

Supercharged with accelerated computing and AI, a modern fab is also a guidepost for all other types of complex manufacturing — from making smartphones to shoes — flexibly and efficiently.

Semiconductors are made in factories called fabs. Building and outfitting a new one costs as much as $20 billion.

The latest factories rely heavily on computers that are built, programmed and operated by skilled workers armed with machine learning for the next generation of manufacturing processes.

For example, AI computing can find patterns no human can see, including tiny defects in a product on a fast-moving assembly line. The semiconductor industry needs this technology to create tomorrow's increasingly large and complex chips. Other industries will be able to use it to make better products faster, too.

We can now create a digital copy of an entire factory. Using NVIDIA technologies, BMW is already building a digital twin of one of its automotive plants to bring new efficiencies to its business.

No one has built anything as complex as a digital twin of a chip fab yet, but that goal is now within reach.

A virtual fab would let specialists design and test new processes much more quickly and cheaply without stopping production in a physical plant. A simulation also can use AI to analyze data from sensors inside physical factories, finding new ways to route materials that reduce waste and speed operations.

Soon, any manufacturing plant with a digital twin will be more economically competitive than a plant without one.

Digital twins enable remote specialists to collaborate as if they were in the same room. They also take worker training to a new level.

Some of the most vital tools in a fab are the size of a shipping container and cost as much as $200 million each. Digital twins let workers train on these expensive systems before they're even installed.

Once trained, workers can qualify, operate and service them without needing to set foot in the ultra-clean rooms where they're installed. This kind of work represents the future of all manufacturing.

Factories designed with virtual twins also can optimize energy efficiency, water consumption and maximize reuse, reducing environmental impact.

Tomorrow's factories will need more computing muscle than ever. To deliver it, we need investments in energy-efficient technologies at every level.

The circuits inside chips need to use and waste significantly less energy. The signals they send to nearby chips and across global networks must move faster while consuming less power.

Computers will need to tackle more data-intensive jobs while increasing productivity. To design and build these systems, we need research on new kinds of accelerator chips, accelerated systems and the software that will run on them.

NVIDIA and others have made great progress in green computing . Now we have an opportunity to take another big step forward.

These are just some of the ways NVIDIA wants to help advance the U.S. semiconductor industry and by extension all manufacturers.

No company can do this work alone. Industry, academia and government must collaborate to get this right.

NVIDIA is at the center of a vibrant ecosystem of 3.5 million developers and more than 12,000 global startups registered in the NVIDIA Inception program.

The University of Florida provides a model for advancing AI and data science education across every field of study.

In 2020, it kicked off a plan to become one of the nation's first AI universities. Today it's infusing its entire curriculum with machine learning. At its heart, UF's AI supercomputer is already advancing research in fields such as healthcare, agriculture and engineering.

It's one more example of the transformative power of accelerated computing and AI. We look forward to the opportunity to take part in this grand adventure in U.S. manufacturing.

To learn more about NVIDIA's ideas on the future of semiconductor manufacturing, including how AI is critical to advancing lithography, electronic design tools and cybersecurity processes, read the full document . It's one of many ways AI can advance public policy .

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