



SECURE TOMORROW SERIES TOPIC PRIMER: ADVANCED MANUFACTURING



WHAT IS ADVANCED MANUFACTURING?

Advanced manufacturing describes the use of innovative technologies and processes—such as artificial intelligence, automation, robotics, 3D printing, sensors, and big data analytics—to make existing products and create new ones. Advanced manufacturing technologies have already increased efficiency, safety, and productivity in various industries, including the aerospace, automotive, chemical, and electronics industries (see Table 1).

Table 1: Example scenarios of how industries are applying advanced manufacturing

Application	Sample Scenario
Equipment maintenance	An electronics company has a persistent problem in microchip production: an automatic solder-dispensing machine is failing to consistently deposit solder, producing faulty circuit boards. By installing sensors and using artificial intelligence analytics, the company correlates the machine sensor readings from the solder-dispensing machine with data from other machines on the assembly line, enabling predictive maintenance.
Inventory and supply chain management	An automaker connects sensors in its supply chain to cloud services on a global scale, allowing the company to (1) track inventory in real time, regardless of the component or its place of origin and (2) send the data to an enterprise resource planning system that automatically alerts when a component needs to be reordered.
Production process and quality control	A manufacturer of high-precision parts for the aerospace industry implements a comprehensive software system (i.e., a manufacturing execution system) to help automate assembly and ensure quality control. Sensors on the factory floor capture processes down to the number of times a screw has been turned; the software system then uses these data to adjust assembly functions.
Sustainability	A medical device manufacturer uses 3D printing to create components that are recyclable, replacing plastic parts with organic materials that break down upon disposal. The company also employs sensors and automation to monitor and track production in real time, allowing for more efficient energy and water usage.
Workforce safety	An ammonia production plant installs sensors to detect hazardous gases, allowing plant workers to monitor the safety of employees in real time from a central site located safely away from any exposure concerns.

WHY SHOULD PEOPLE CARE ABOUT ADVANCED MANUFACTURING

Advanced manufacturing is changing the way we work and the way we produce and consume goods. Innovations in manufacturing provide opportunities to address pressing problems, such as reducing carbon footprints and increasing supply chain resilience. Large-scale 3D printing, for example, can aid the development of wind turbines with larger energy generation capabilities and accelerate the availability of critical supplies and materials (e.g., housing) in the aftermath of natural disasters.

Because of dependencies among manufacturing materials, products, and systems as well as the subsequent use of these products, disruptions to advanced manufacturing systems have ramifications for all 16 critical infrastructure sectors and 55 National Critical Functions. The large-scale deployment of cutting-edge technologies such as semi-autonomous and digital manufacturing will also amplify previously known vulnerabilities and create new ones. By bringing more components of their manufacturing online and interconnecting them, manufacturers are potentially increasing risks that malicious actors can disrupt manufacturing processes, tamper with products, and steal intellectual property and sensitive data. As manufacturing becomes more decentralized and timeframes from design to production become shorter, manufacturers will experience challenges related to product safety, consistency, and reliability. Furthermore, as advanced manufacturing is implemented, it can significantly disrupt existing supply chains and markets, leading to risks arising from a U.S. workforce insufficiently ready for these technologies and foreign competition.

WHAT IS DRIVING CHANGE IN ADVANCED MANUFACTURING THAT COULD LEAD TO EMERGING AND EVOLVING RISKS IN THIS DECADE?

Several trends will affect advanced manufacturing in the next three to seven years, including the following:

- Decentralization of production will create a more dynamic network of suppliers and manufacturers.
- Rapid prototyping methods that combine 3D printing, printed electronics, and fabrication capabilities will enable products that are tailored to individual needs and shorten design-to-production lifecycles.
- Digitalization of production (e.g., the use of digital representations) will allow manufacturers to capture data throughout the product lifecycle, allowing for digital traceability.
- Advances in algorithms for smart machines will increase use of autonomous systems and necessitate new approaches for human-machine interactions.
- The production of sensors and smart machines will be an area of tremendous growth.
- Demand on cloud computing will increase, which will be partially met by readily available 5G or WiFi-6 connectivity.
- The emphasis on supply chain innovation will grow to ensure raw materials are sustainably sourced and products are recycled.