ISSUES OF INTELLECTUAL PRODUCTION DEVELOPMENT

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Modern technologies such as the Internet of Things (IoT), cloud computing (CC), big data analytics (BDA), and artificial intelligence (AI) have significantly stimulated the development of smart manufacturing. A key enabler of smart manufacturing is cyber-physical integration, which is increasingly being adopted by manufacturers. As the preferred means of such integration, cyber-physical systems (CPS) and digital twins (DT) have attracted considerable attention from researchers and practitioners in the industry.

With the development of data collection systems, information technology (IT), and networking technologies, manufacturing has entered the digital era. Against the backdrop of digitalization, the manufacturing industry faces global challenges associated with the rapid advancement of digital technologies [1]. Smart manufacturing has been used since the 1980s as an area of intersection between artificial intelligence (AI) and manufacturing [2,3]. The term "intelligent manufacturing" refers to a future state of manufacturing in which real-time data transfer and analysis from across the product lifecycle, coupled with modeling and model-based optimization, create intelligent capabilities to positively impact all aspects of production [1-4].

CPSs are multidimensional and complex systems that integrate the cyber world and the dynamic physical world. Through the integration and collaboration of computing, communication, and control, CPSs provide real-time sensing, information feedback, dynamic control, and other services [5].

Digital twin (DT) is another concept related to cyber-physical integration. DTs create highly accurate virtual models of physical objects in a virtual space to simulate their real-world behavior and provide feedback. As a result, DTs enable companies to predict and detect physical problems more quickly and accurately, optimize production processes, and produce higher-quality products.

Both CPS and DT are paving the way to intelligent manufacturing by creating a closed loop between the cyber/digital and physical worlds, based on state measurement, real-time analysis, scientific decision-making, and precise execution. However, thanks to its virtual models, DT provides more intuitive and effective means of design improvement. Virtual models can be used as a complement to enrich the composition and functionality of CPS, so DT technology can be considered an essential foundation for building CPS and paving the way for their implementation. The combination of CPS and DT will help manufacturers achieve more precise, high-quality, and efficient management.

Intelligent manufacturing is a value creation process spanning design, production, logistics, and maintenance, involving multiple actors.

The Internet of Things, computer-aided communications, business intelligence (BI), and artificial intelligence (AI) are key elements of new IT. In

manufacturing, due to digitalization, production resources using industrial technologies generate large volumes of various types of data (Figure 1).

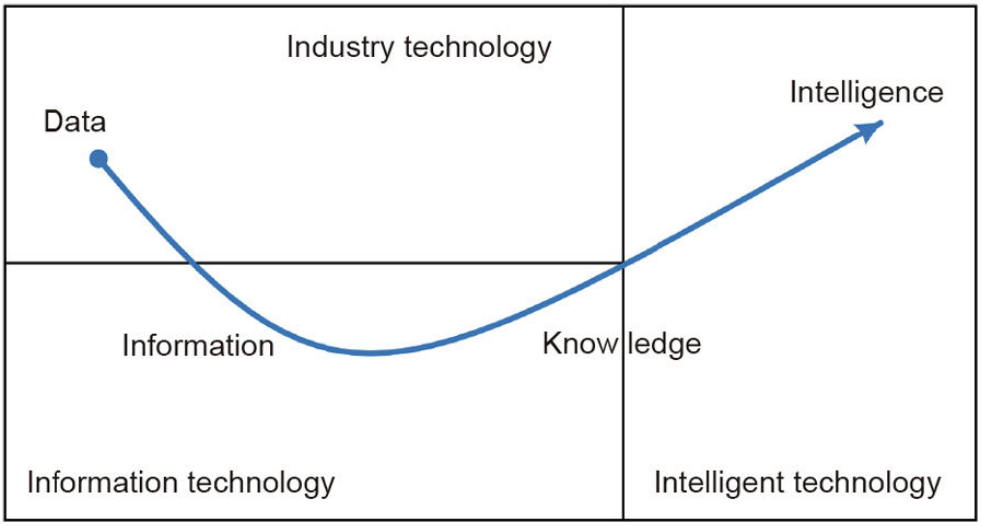


Fig. 1. Integration of industrial, information and intelligent technologies.

The functional implementation of both CPS and DT aims to improve the efficiency, resilience, and intelligence of physical processes. Given their respective core elements (e.g., sensors and actuators in CPS, and models and data in DT), CPS and DT have different priority areas of application. However, both systems must integrate with new IT solutions.

Thus, intelligent manufacturing has become an inevitable trend, and achieving cyber-physical interaction and integration in manufacturing is an essential prerequisite for intelligent manufacturing. CPS and DT are the preferred means for achieving this goal.

References.

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