Cognishen Focus

Industry 4.0 and Smart Factory

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Our March 2023 newsletter described Smart Systems, an Industry 4.0 component and an important component of smart factories. To recall, a smart factory may be visualized as one equipped to collect data, analyze the collected data, and use the data to make intelligent operations decisions. We will continue to discuss the components of Industry 4.0 in simple terms in this newsletter.

Forefront technologies such as system integration, cloud computing, and cyber security help smart factories to gainfully use the basic necessities in order to be competitive. The forefront technologies fend off cyber invaders, use a firm resources wisely, and deploy well-integrated systems to achieve the strategic goals of an organization. Smart factories must use the "state-of-the-art" smart systems to be adept and agile. The forefront technologies and the smart systems must be in place and ready to be used in deploying **Intelligent Automation**. The components of intelligent Automation include Augmented Reality, Artificial Intelligence, and Robotics. Look at the Figure 1 below. The forefront technologies are used by the smart systems, which in turn drive the intelligent automation that is required of smart factories.

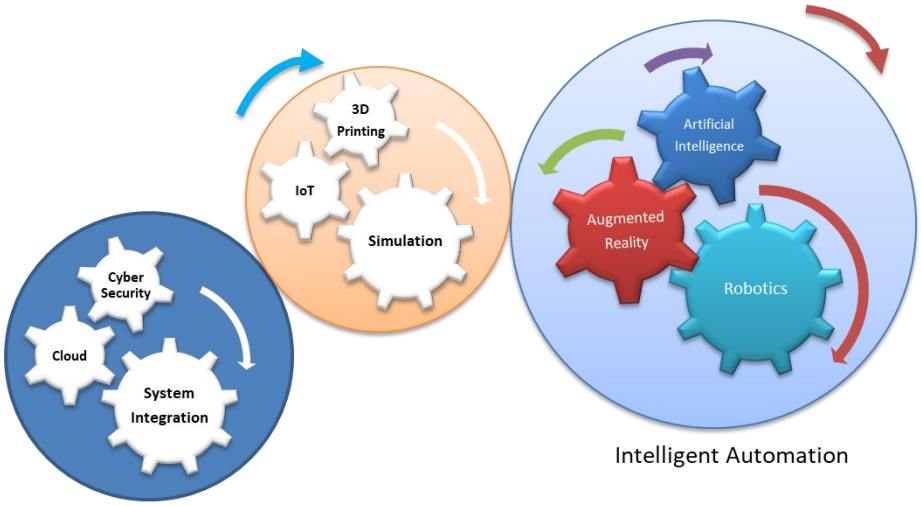

Figure 1 Digital Transformation Components of Industry 4.0

Augmented Reality

The operations activities in some firms use a technology called augmented reality. Augmented reality (AR) is a real-world computer simulation. It allows a user or an operator of a machine to see, move around, and interact in a 3D world through a computer screen as though it is real. AR in operations is defined as a computer system that is capable of generating information about a manufacturing or service system. AR devices use motion and position sensors for applications in the field, the plant, or on the factory floor to monitor the progress of an assembly, provide real-time feedback, and incorporate automated inspection for quality control.

AR has been used in different engineering applications such as product design, modeling, shop floor controls, process simulation, manufacturing planning, training, testing, and verification. By employing AR in various operations and supply chain processes, firms can prevent costly mistakes. AR can be used to enhance the collaboration of humans and machines and increase productivity in organizations.

Research Insight

"Using AR, remotely located employees can connect with machines, troubleshoot, and work on problems in business operations, thereby reducing manufacturing time significantly. AR can be a powerful tool for maintenance and service technicians. In a smart factory, the complexity of manufacturing requires an AR system to provide the maintenance staff with real-time diagnostics of machines, video recording of maintenance instructions, and assistance from an expert who is remotely located. For example, an AR device can provide engineering data to an expert who is located remotely, and that expert can guide a technician through a procedure. This enhances quality, reduces machine downtime, and increases first-time problem fixes."

Vaidyanathan, G. (2023). Operations and Supply Chain Management. Dubuque, IA: Kendall Hunt Publishers.

"Virtual assembly (VA) is a key component of virtual manufacturing and is the use of computer tools to make or "assist with" assembly-related engineering decisions through analysis, predictive models, and visualization. VM is mainly used to investigate the assembly processes, the mechanical and physical characteristics of the equipment and tooling, the interrelation among different parts and factors affecting the quality based on modelling and simulation. Virtual inspection (VI) makes use of the VM technology to model and simulate the inspection process, and the physical and mechanical properties of the inspection equipment. "

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Artificial Intelligence (AI)

Artificial intelligence (AI) is a computer-based technology designed to mimic human intelligence and behavior to accomplish tasks in OSCM. The intelligence in AI is from learning and adaptation of the environment around a manufacturing system and the ability to use various sources of information. There are three major sources for AI in firms including their vast amounts of information; innovative technologies to recognize images, voices, sounds, and written documents; and innovative technologies that solve problems, continuously learn, and improve based on learning.

Businesses generate vast amounts of data through the machines they employ at their facilities. The sensors and control systems of these machines transact data. For example, companies generate process data from sensors, such as coolant temperatures; operational data, such as machine downtime; and quality data from inspections, such as product dimensions. AI uses a technology called neural networks to process that data and help managers make intelligent decisions. Neural network is a computer software that discovers patterns in data and then uses those patterns to predict future data. For example, neural network software can learn from the machine downtime data of similar machines in different conditions and forecast future downtimes of those machines before they actually occur. AI can monitor manufacturing equipment from a host of sensors to detect anomalies while manufacturing. For example, noise changes in a machine can be identified as future problems with that machine. Mueller Industries, a manufacturer of industrial products, is testing a system that can predict future machine problems. With such predictions, firms can implement preventive maintenance to avoid or prevent costly downtimes.

Computer vision is a system where computers obtain vision data through cameras. Computer vision can perform many inspection tasks more accurately and efficiently than humans can. For example, an aircraft engine manufacturer applies computer vision to inspect turbofan blades. The vision system checks several hundred attributes of a turbofan blade in a few minutes, thus enabling the company to inspect every turbofan blade rather than random samples.

Robotics

Robotics in OSCM involves the operation and use of robots to replicate human actions. Robots are used to do repetitive tasks in manufacturing. For example, in a vehicle assembly line where car seats have to be placed in each car, robots are used to place the car seats. Robots also collaborate with humans in OSCM. In Amazon's fulfillment centers, robots work alongside humans. These robots, programmed to watch out for humans so they will not collide and cause accidents, bring items to human pickers so they can be packaged and labeled for dispatch. Robots are also employed in jobs that pose a danger or in jobs that can be harmful to humans. For example, robots are employed to handle corrosive or toxic materials. Robots can also work around the clock to do the most boring jobs. They are also used to perform repetitive tasks such as painting, spraying, and welding. For example, robots have been used to spray hazardous insulation material onto the external tanks that were used in NASA's space shuttle programs.

Industrial robots are programmable to perform routine tasks using computers and a control device called a teach pendant. For example, using the teach pendent, a robotic engineer can teach a robot to pick a part from a machine, lift it, move the part, and place it on a nearby pallet through multiple instructions. The robot's memory stores these instructions as sequence of actions. Upon a request for execution of these instructions, the programmed robot then plays back the sequence to perform the instructed actions over and over again.

Practical Insight

"Cognex Corporation, the American manufacturer, makes machine vision systems, software, and sensors used in automated manufacturing to inspect and identify parts, detect defects, verify product assembly, and guide assembly robots. The company has installed over 3.5 million systems products in facilities around the world. Cognex solutions help manufacturers to improve quality by eliminating defects. The vision and barcode reading capabilities lead to lower errors in production, which means lower manufacturing costs."

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"The National Football League (NFL) uses all sorts of statistics during a football game. Amazon Web Services (AWS) and NFL have teamed to use AI machine learning techniques to enable statistical models on the cloud. The models evaluate the quarterback passing performance. It computes the probability of completion of a pass from a quarterback based on the distance of the pass, the separation of a receiver from the defenders on the field, the amount of pressure from defense, and so on. The model can predict the 4th down conversion probability of an offense. The data from the box score, the data collected from the stadium, and other collected data are fed into algorithms as training set of data. They are processed by computers on cloud and used to predict the outcomes."

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