INTERACTIVE SESSION: TECHNOLOGY

Will Robots Replace People in Manufacturing?

For the past four decades, robots have been incorporated into manufacturing assembly lines in Europe, Japan, and the United States. These industrial robots—with mechanical arms that can be programmed to weld, paint, and pick up and place objects with predictable regularity—have not taken over many tasks performed by humans. The biggest users of robotic technology have been automobile manufacturing plants, where robots do heavy lifting, welding, applying glue, and painting. People still do most of the final assembly of cars, especially when installing small parts or wiring that needs to be guided into place.

For most manufacturing work, it has been less expensive to use manual labor than it is to own, operate, and maintain a robotics system, given the tasks that robots can perform. But this is changing. Robots have become smaller, more mobile, more collaborative and more adaptable, and their uses are widening. New robot models can work alongside humans without endangering them and help assemble all types of objects, as large as aircraft engines and as small and delicate as smartphones. They can also sense whether parts are being assembled correctly.

Robots are becoming easier to operate. Companies no longer need a software engineer to write program code to get a robot to perform a task. With some of today's robots, you can simply push a button, turn the robot's arm, and move it through the operation you want it to perform. The robot learns by doing.

A Renault SA plant in Cleon, France, now uses robots made by Universal Robots AS of Denmark to drive screws into engines, especially those that go into places people find hard to access. The robots have reach of more than 50 inches and six rotating joints to do the work. They also verify that parts are properly fastened and check to make sure the correct part is being used. The Renault robots weigh only about 64 pounds each so they can easily be moved around to different locations as needed. They are also "collaborative," designed to work in proximity to people. Using sonar, cameras, or other technologies, these robots can sense where people are and slow down or stop to avoid hurting them.

These new-style robots are moving into other industries as well. ABB Ltd of Switzerland and others have recently introduced robots to help assemble consumer-electronics items. The robots were designed to work close to people and handle small parts. JCB Laboratories is using robots at its Wichita, Kansas, plant to pick up syringes, fill them with medications, and snap on caps. The robots work five to six times faster than people.

This new generation of robots promises to bring major changes to the factory floor and perhaps the global competitive landscape. The Boston Consulting Group predicts that by 2025 the share of tasks performed by robots will rise from a global average of about 10 percent across all manufacturing industries to about 25 percent. In some industries, more than 40 percent of manufacturing tasks will be performed by robots. There will be dramatic productivity gains in many industries around the world (potentially boosting output per worker by 30 percent) and shifts in competitiveness among manufacturing countries.

Does this mean that robots will take over the production line? Unlikely. They still lack the flexibility, delicacy, and insight provided by humans. For example, today's collaborative robots often have to slow down or stop whenever people veer into their paths, disrupting production. Sales have been disappointing for Baxter, a two-armed collaborative robot from Rethink, which is used primarily for simple tasks such as moving materials, picking up parts, and packing or unpacking boxes. The robot's speed is restricted by safety considerations. For all their recent advances, robots still can't duplicate a human being's fine motor skills in manipulating materials and small parts. Robots still have trouble dealing with soft or floppy material, such as cloth or bundles of electrical wire.

Although robots are good at reliably and repeatedly performing defined tasks, they're not good at adapting. Mercedes-Benz had to cut back on its use of robots on the production line because the level of customization demanded by its customers requires a level of flexibility and dexterity that only humans can provide. Today's Mercedes customer wants to configure his or her own car, choosing among customization options such as carbon-fiber trim, four types of tire valve caps, and heated and cooled cup holders for 30 different models. Robots can't deal with the amount of variation in options that Mercedes cars have today.

Mercedes has found that if manufacturing focuses around a skilled crew of workers, it can shift a production line in a weekend. It would take weeks to reprogram robots and shift assembly patterns, and during that downtime, production would be at a standstill. Going forward, robots won't completely disappear from the Mercedes factory floor, but they'll be smaller and more flexible, operating alongside human workers. BMW AG and Volkswagen AG's Audi are also testing lightweight, sensor-equipped robots safe enough to work alongside people. Auto manufacturers are under continuing pressure to upgrade their models more frequently than the traditional seven-year cycle.

As robots become more widespread, manufacturing tasks performed by humans will become higher-level and more complex. Workers will be expected to supervise and perhaps even program robots, and there will be fewer low-level manufacturing jobs. Workers will need more sophisticated skills to succeed in tomorrow's manufacturing plants.

Sources: Bloomberg, "Why Mercedes Is Halting Robots' Reign on the Production Line," *Industry Week*, February 25, 2016; Harold L. Sirkin, Michael Zinser, and Justin Rose, "The Robotics Revolution: The Next Great Leap in Manufacturing," *BCG Perspectives*, September 23, 2015; "Industries and Economies Leading the Robotics Revolution," *BCG Perspectives*, September 23, 2015; and James R. Hagerty, "Meet the New Generation of Robots for Manufacturing," *Wall Street Journal*, June 2, 2015.

CASE STUDY QUESTIONS

1. Why have robots caught on in manufacturing? What knowledge to they require?
2. Can robots replace human workers in manufacturing? Explain your answer.
3. If you were considering introducing robots in your manufacturing plant, what management, organization, and technology issues would you need to address?

organizations make high-quality decisions with fewer people. Today, expert systems are used in business in discrete, highly structured decision-making situations.

How Expert Systems Work

Human knowledge must be modeled or represented in a way that a computer can process. Expert systems model human knowledge as a set of rules that collectively are called the **knowledge base**. The rules are obtained by carefully interviewing one or several "experts" who have a thorough command of the knowledge base for the system or by documenting business rules found in manuals, books, or reports. Expert systems have from 200 to many thousands of these rules, depending on the complexity of the problem. These rules are much more interconnected and nested than in a traditional software program (see Figure 11.5).

The strategy used to search through the knowledge base is called the **inference engine**. Two strategies are commonly used: forward chaining and backward chaining (see Figure 11.6).

In **forward chaining**, the inference engine begins with the information entered by the user and searches the rule base to arrive at a conclusion. The strategy is to fire, or carry out, the action of the rule when a condition is true. In Figure 11.6, beginning on the left, if the user enters a client's name with income greater than $100,000, the engine will fire all rules in sequence from left to right. If the user then enters information indicating that the same client owns real estate, another pass of the rule base will occur and more rules will fire. Processing continues until no more rules can be fired.

In **backward chaining**, the strategy for searching the rule base starts with a hypothesis and proceeds by asking the user questions about selected facts