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# INDUSTRIAL DEVELOPMENT REPORT 2020
# BRIEF NO 3

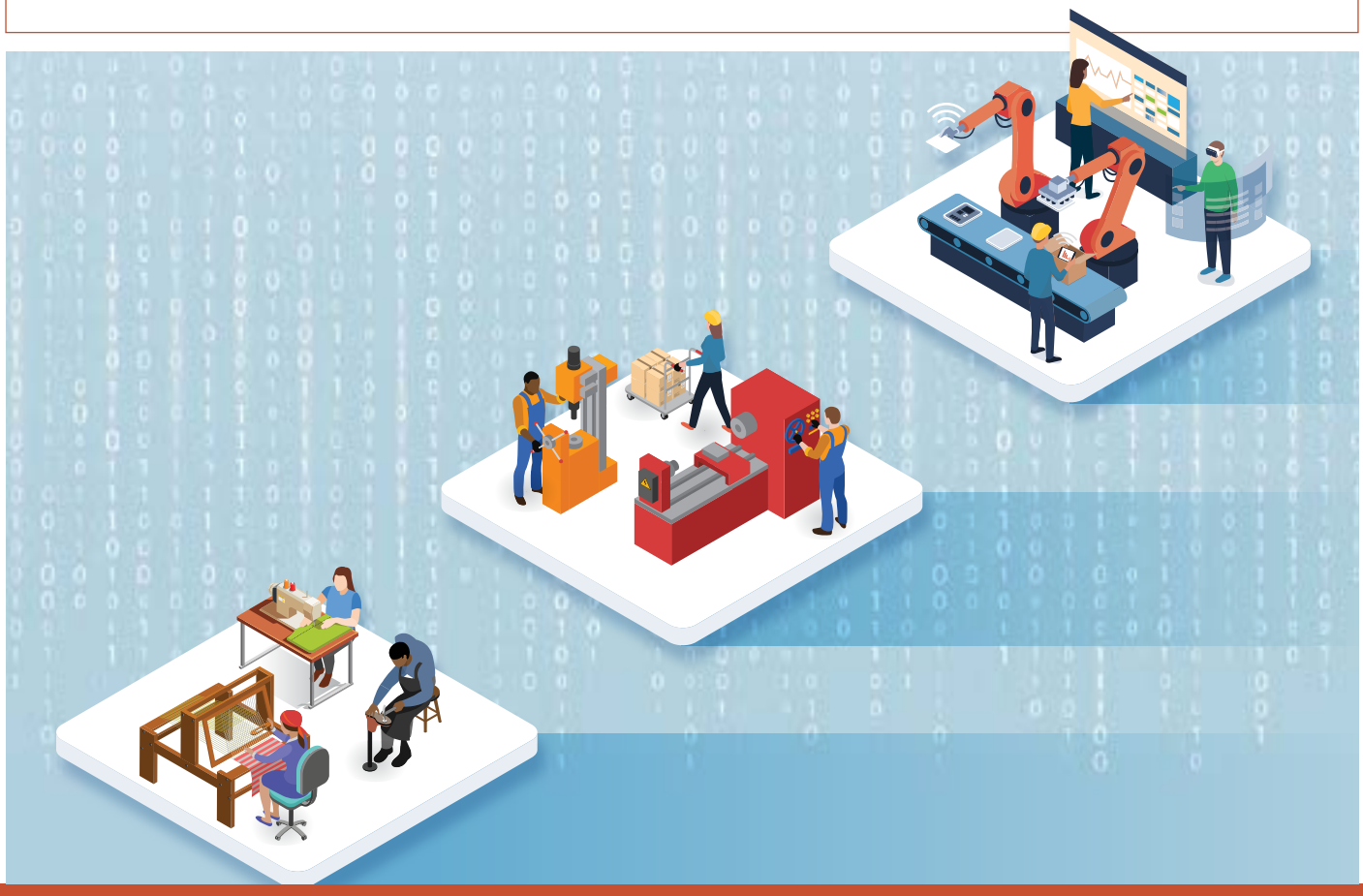
## A new technological wave shaping industrialization: advanced digital production (ADP) technologies

### Executive summary

The new technologies associated with the Fourth Industrial Revolution (4IR) are often described as the result of rapid and disruptive bouts of innovation. These technologies are in fact best understood as originating from an evolutionary transition process. They build on ongoing scientific and technological advancements in hardware, software and connectivity. What sets them apart are the novel ways in which these three dimensions are being reconfigured and integrated to achieve ever more ambitious goals. Advanced digital production technologies (ADP) enable the collection and analysis of vast amounts of data, the seamless interaction between smart machines, and the combination of the physical and virtual dimensions of production. As a result, opportunities for efficiency gains in manufacturing are extremely large.

**Key findings**

- The concept of the Fourth Industrial Revolution (4IR) is based on the growing convergence of emerging technology domains and their complementarity in production.
- ADP technologies include the industrial internet of things (IoT), big data analytics, artificial intelligence and 3D printers for additive manufacturing.
- ADP technologies have emerged from the engineering and operational principles of previous industrial revolutions. They are best understood as the result of a process of evolutionary transition rather than revolutionary disruption.



## Which new technologies are reshaping the industrial landscape?

The industrial revolutions that have shaped the modern world have all been preceded and accompanied by scientific discoveries and the diffusion of new technologies. Just as the invention of the steam engine was among the technologies that gave rise to the first industrial revolution (1IR), the advent of electricity and the development of increasingly sophisticated semiconductors heralded the 2IR and 3IR, respectively. Now a new wave of technological breakthroughs seems to be giving rise to a new industrial revolution—the 4IR.

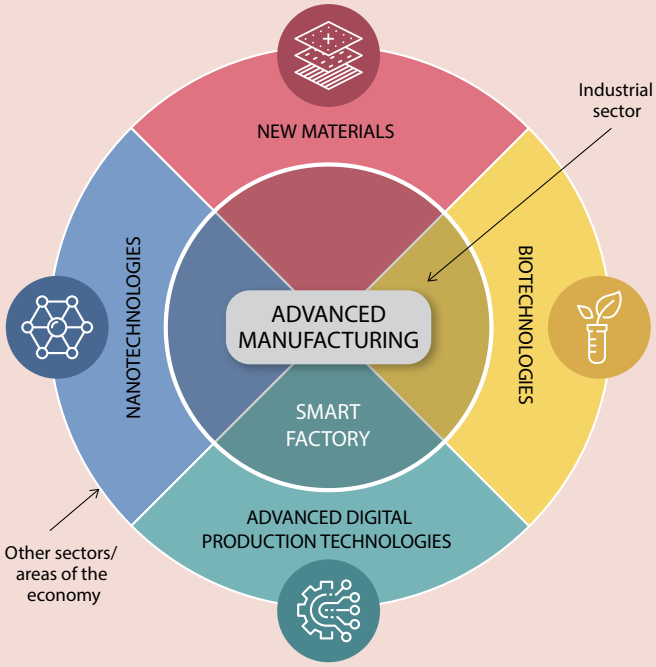
The concept of the 4IR is based on the growing convergence of emerging technology domains and their complementarity when employed in production. All classifications of 4IR technologies showcase the importance of what we define as ADP technologies, alongside advancements in biotechnology, nanotechnology and new materials. Applications of these technologies are found across the economy, from the delivery of health services to retail. Applied to industrial production, they give rise to advanced manufacturing systems (Figure 1).

Production technologies lie at the core of all industrial revolutions, past and present. They encompass a wide range of machine tools and complementary equipment that produce goods at the required volume and quality when used in a coordinated and synchronized manner. Some ADP technologies are certainly new. Many others, however, have evolved from the engineering and organizational principles of previous revolutions.

Consider, for instance, the case of automation technologies. Automating processes hark back to at least the 1IR, while the first modern industrial robots were already being installed in manufacturing plants in the 1960s. While the availability and quality of data—the fuel of any digital technology worthy of its name—has increased exponentially in recent years, improvements in operational management and engineering have always relied on the collection and analysis of data.

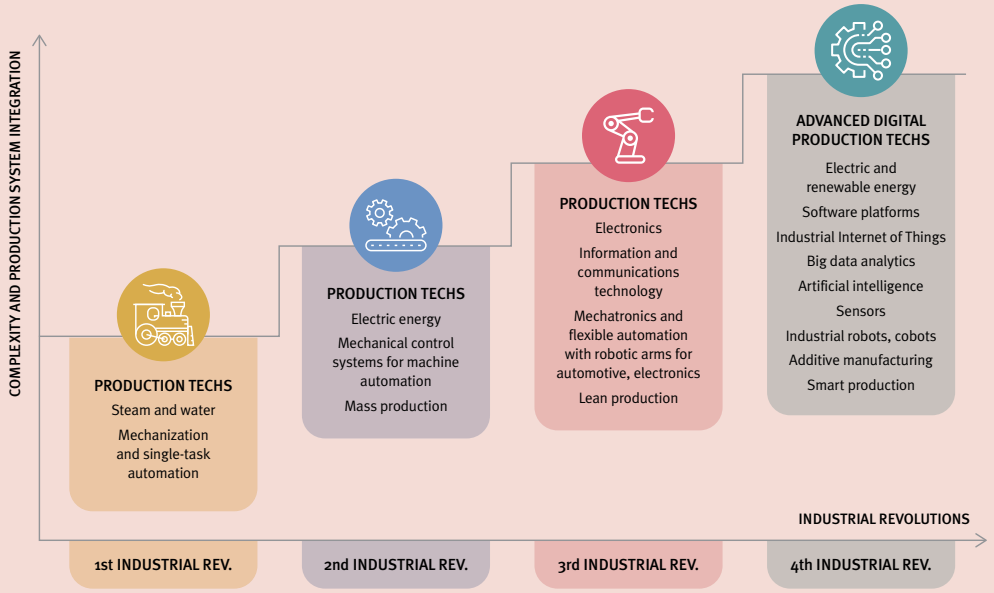
These observations suggest that the origin of the advanced production technologies underpinning the 4IR, such as the 3D printers employed in additive manufacturing (Box 1), or the sensor-enabled industrial robots and collaborative robots (see Box 2) populating the shop floors of many automakers, lies in a process of evolutionary transition rather than revolutionary disruption (Figure 2s).

**Figure 1**
**From the 4IR to advanced manufacturing: zooming in on the smart factory**




Source: UNIDO IDR 2020 Figure 1.7, page 38

**Figure 2**
**The evolutionary nature of the Fourth Industrial Revolution**




Source: UNIDO IDR 2020 Figure 1.8, page 39

## Box 1. What do 3D printers do?

Additive manufacturing, commonly referred to as 3D printing, is a novel manufacturing process that converts a digital 3D model into a physical object by adding layer upon layer of multiple materials, such as aluminium or titanium. 3D printing is considered the opposite of traditional production methods where objects are constructed by successively cutting and removing material from a solid block. 3D printing is gaining momentum in several industries, including aerospace. Additive manufacturing allows for easy production of models and prototypes without the need for complex and expensive moulds. A less material-intensive production process, 3D printing enhances manufacturing's environmental sustainability.

## What are the main features of ADP technologies?

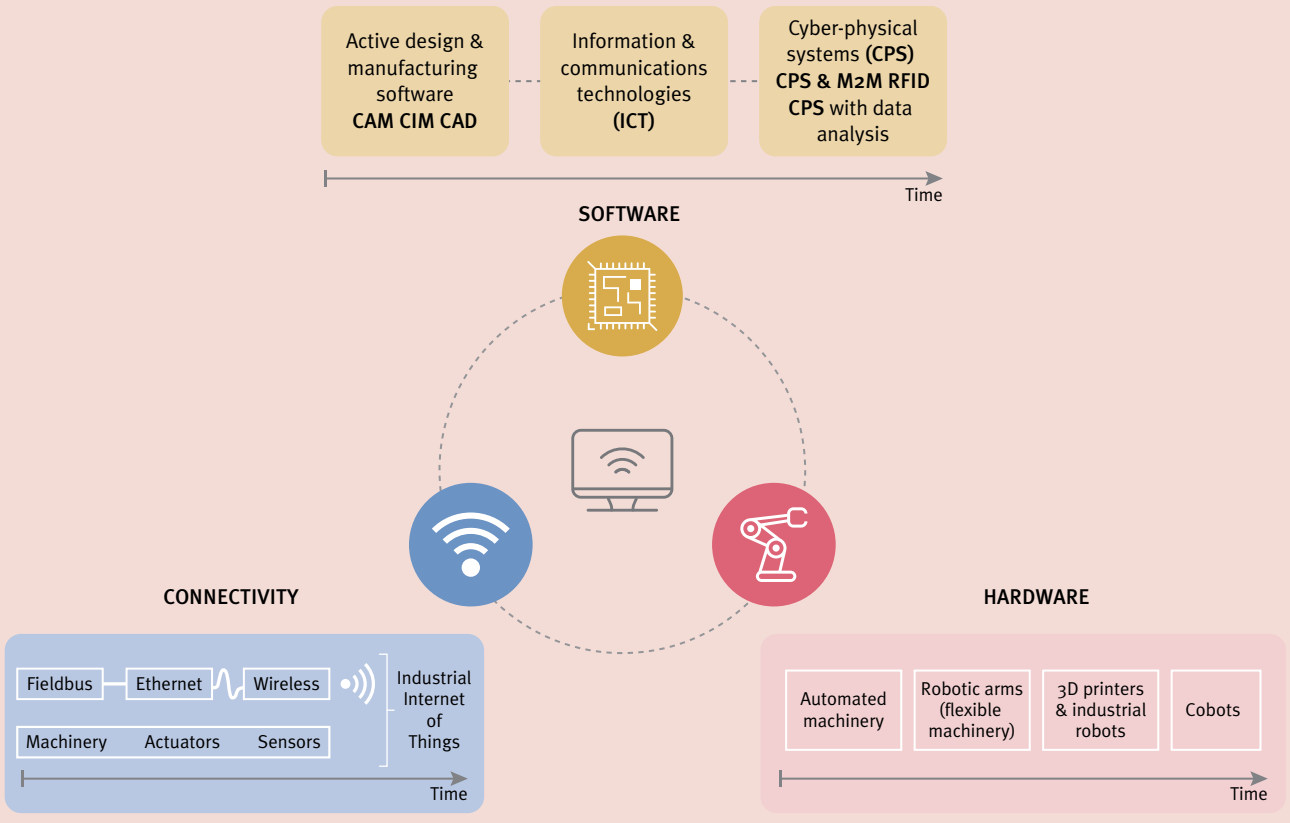
What characterizes ADP technologies and sets them apart from older production technologies? ADP technologies' three building blocks are hardware, software and internet connectivity (Figure 3). Hardware includes the tools, tooling and complementary equipment necessary to operate modern industrial robots and intelligent automated systems, as well as co-bots and 3D printers. These are largely similar to their predecessors in the 3IR. What sets these machines apart is their connectivity and flexibility.

Connectivity in ADP technologies is achieved by equipping hardware with sensors and actuators. Once industrial machinery starts "sensing" the environment within which it operates and is capable of detecting changes in the production process as well as in the material and functional properties of products and components, it is also capable of collecting data and transmitting them through the bloodstream of the 4IR: the industrial internet of things (IoT).

Production technologies only become fully digital when their connectivity is enhanced by software allowing for big data analytics—that is, tools that are able to process vast quantities of data in near-real time. Building upon software advancements in computer-aided manufacturing (CAM) and computer-aided design (CAD), the software underpinning the 4IR has opened the door for the creation of cyber physical systems (CPSs).

Networked systems endowed with embedded sensors, processors and actuators, CPSs are designed to interact with the physical world and support real-time, guaranteed performance in applications. The combination of advanced software technologies and connectivity enables the integration of production processes on multiple levels—both within a single firm and along the supply chain— leading to significant efficiency gains in the use of resources.

**Figure 3**
**The building blocks of ADP technologies**




Source: UNIDO IDR 2020 Figure 1.9, page 41

### Box 2. Cobots improve productivity, quality and working conditions

Collaborative robots—cobots—are designed to collaborate with workers in shared workspaces, ensuring that tasks are performed with greater accuracy and precision. Cobots are also equipped with cameras that check and record task quality and allow for real-time monitoring of performance. These features help improve product quality and reduce manufacturing costs. Moreover, the design of cobots includes features to ensure that they do not cause harm when a worker comes into direct contact with them. These include lightweight materials, rounded contours, padding, "skins" (padding with embedded sensors) and sensors at the robot base or joints that measure and control force and speed and ensure that they do not exceed defined thresholds if contact occurs. Cobots are therefore safer to use, improving the working conditions of workers on the shop floor.

## Conclusions

- ADP technologies have evolved from scientific and technological advances that have been ongoing since the onset of the 3IR.
- ADP technologies bridge the virtual and physical dimensions of production while also generating vast amounts of operational data, greatly enhancing the efficiency of manufacturing production.
- ADP technologies improve productivity. They can also have important knock-on effects on the working conditions of manufacturing workers and on the environmental sustainability of production.

## Bibliography and/or suggestions for further reading

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