

Emerging Technology

Emerging technology is a term generally used to describe a new technology, but it may also refer to the continuing development of existing technology; it can have slightly different meanings when used in different areas, such as media, business, science, or education.

The term commonly refers to technologies that are currently developing, or that are expected to be available within the next five to ten years, and is usually reserved for technologies that are creating or are expected to create significant social or economic effects. Technological evolution is a theory of radical transformation of society through technological development.

Evolution of technologies: Introduction to Industrial revolution

The Industrial Revolution was a period of major industrialization and innovation that took place during the late 1700s and early 1800s. An Industrial Revolution at its core occurs when a society shifts from using tools to make products to use new sources of energy, such as coal, to power machines in factories. The revolution started in England, with a series of innovations to make labor more efficient and productive. The Industrial Revolution was a time when the manufacturing of goods moved from small shops and homes to large factories. This shift brought about changes in culture as people moved from rural areas to big cities in order to work.

The American Industrial Revolution commonly referred to as the Second Industrial Revolution, started sometime between 1820 and 1870. The impact of changing the way items was manufactured had a wide reach. Industries such as textile manufacturing, mining, glass making, and agriculture all had undergone changes. For example, prior to the Industrial Revolution, textiles were primarily made of wool and were handspun.

From the first industrial revolution (mechanization through water and steam power) to the mass production and assembly lines using electricity in the second, the fourth industrial revolution will take what was started in the third with the adoption of computers and automation and enhance it with smart and autonomous systems fueled by data and machine learning.

Generally, the following industrial revolutions fundamentally changed and transfer the world around us into modern society.

- The steam engine,
- The age of science and mass production, and
- The rise of digital technology
- Smart and autonomous systems fueled by data and machine learning.

The Most Important Inventions of the Industrial Revolution

- Transportation: The Steam Engine, The Railroad, The Diesel Engine, The Airplane.
- Communication.: The Telegraph. The Transatlantic Cable. The Phonograph. The Telephone.
- Industry: The Cotton Gin. The Sewing Machine. Electric Lights

Historical background

The industrial revolution began in Great Britain in the late 1770s before spreading to the rest of Europe. The first European countries to be industrialized after England were Belgium, France, and the German states. The final cause of the Industrial Revolution was the effects created by the Agricultural Revolution. As previously stated, the Industrial Revolution began in Britain in the 18th century due in part to an increase in food production, which was the key outcome of the Agricultural Revolution.

The four types of industries are:

- The **primary industry** involves getting raw materials e.g. mining, farming, and fishing.
- The **secondary industry** involves manufacturing e.g. making cars and steel.
- **Tertiary industries** provide a service e.g. teaching and nursing.
- The **quaternary industry** involves research and development industries e.g. IT.

Industrial Revolution (IR 1.0)

The Industrial Revolution (IR) is described as a transition to new manufacturing processes. IR was first coined in the 1760s, during the time where this revolution began. The transitions in the first IR included going from hand production methods to machines, the increasing use of steam power (see Figure 1.1), the development of machine tools and the rise of the factory system.



Figure 1.1 steam engine

Industrial Revolution (IR 2.0)

The Second IR, also known as the Technological Revolution, began somewhere in the 1870s. The advancements in IR 2.0 included the development of methods for manufacturing interchangeable parts and widespread adoption of pre-existing technological systems such as telegraph and railroad networks. This adoption allowed the vast movement of people and ideas, enhancing communication. Moreover, new technological systems were introduced, such as electrical power (see Figure 1.2) and telephones.



Figure 1.2 Electricity transmission line

Industrial Revolution (IR 3.0)

Then came the Third Industrial Revolution (IR 3.0). IR 3.0 introduced the transition from mechanical and analog electronic technology to digital electronics (see Figure 1.3) which began from the late 1950s. Due to the shift towards digitalization, IR 3.0 was given the nickname, “Digital Revolution”. The core factor of this revolution is the mass production and widespread use of digital logic circuits and its derived technologies such as the computer, handphones and the Internet. These technological innovations have arguably transformed traditional production and business techniques enabling people to communicate with another without the need of being physically present. Certain practices that were enabled during IR 3.0 is still being practiced until this current day, for example – the proliferation of digital computers and digital record.



Figure 1.3 High Tech Electronics

Fourth Industrial Revolution (IR 4.0)

Now, with advancements in various technologies such as robotics, Internet of Things (IoT see Figure 1.4), additive manufacturing and autonomous vehicles, the term “Fourth Industrial Revolution” or IR 4.0 was coined by Klaus Schwab, the founder and executive chairman of World Economic Forum, in the year 2016. The technologies mentioned above are what you call – cyber physical systems. A cyber-physical system is a mechanism that is controlled or monitored by computer-based algorithms, tightly integrated with the Internet and its users.

One example that is being widely practiced in industries today is the usage of Computer Numerical Control (CNC) machines. These machines are operated by giving it instructions using a computer.

Another major breakthrough that is associated with IR 4.0 is the adoption of Artificial Intelligence (AI), where we can see it being implemented into our smartphones. AI is also one of the main elements that give life to Autonomous Vehicles and Automated Robots.



Figure 1. 4 Anybody Connected device (ABCD)

Role of Data for Emerging Technologies

Data is regarded as the new oil and strategic asset since we are living in the age of big data, and drives or even determines the future of science, technology, the economy, and possibly everything in our world today and tomorrow. Data have not only triggered tremendous hype and buzz but more importantly, presents enormous challenges that in turn bring incredible innovation and economic opportunities. This reshaping and paradigm-shifting are driven not just by data itself but all other aspects that could be created, transformed, and/or adjusted by understanding, exploring, and utilizing data.

The preceding trend and its potential have triggered new debate about data-intensive scientific discovery as an emerging technology, the so-called “fourth industrial revolution,” There is no doubt, nevertheless, that the potential of data science and analytics to enable data-driven theory, economy, and professional development is increasingly being recognized. This involves not only core disciplines such as computing, informatics, and statistics, but also the broad-based fields of business, social science, and health/medical science.

Enabling devices and network (Programmable devices)

In the world of digital electronic systems, there are four basic kinds of devices: memory, microprocessors, logic, and networks. Memory devices store random information such as the contents of a spreadsheet or database. Microprocessors execute software instructions to perform a wide variety of tasks such as running a word processing program or video game. Logic devices provide specific functions, including device-to-device interfacing, data communication, signal processing, data display, timing and control operations, and almost every other function a system must perform. The network is a collection of computers, servers, mainframes, network devices, peripherals, or other devices connected to one another to allow the sharing of data. An excellent example of a network is the Internet, which connects millions of people all over the world

Programmable devices usually refer to chips that incorporate field programmable logic devices (FPGAs), complex programmable logic devices (CPLD) and programmable logic devices (PLD). There are also devices that are the analog equivalent of these called field programmable analog arrays.

Why is a computer referred to as a programmable device?

Because what makes a computer a computer is that it follows a set of instructions. Many electronic devices are computers that perform only one operation, but they are still following instructions that reside permanently in the unit.

HUMAN TO MACHINE INTERACTION

Human-machine interaction (HMI) refers to the communication and interaction between a human and a machine via a user interface. Nowadays, natural user interfaces such as gestures have gained increasing attention as they allow humans to control machines through natural and intuitive behaviors

What is interaction in human-computer interaction?

HCI (human-computer interaction) is the study of how people interact with computers and to what extent computers are or are not developed for successful interaction with human beings. As its name implies, HCI consists of three parts: the user, the computer itself, and the ways they work together.

How do users interact with computers?

The user interacts directly with hardware for the human input and output such as displays, e.g. through a graphical user interface. The user interacts with the computer over this software interface using the given input and output (I/O) hardware.

How important is human-computer interaction?

The goal of HCI is to improve the interaction between users and computers by making computers more user-friendly and receptive to the user's needs. The main advantages of HCI are simplicity, ease of deployment & operations and cost savings for smaller set-ups. They also reduce solution design time and integration complexity.

Future Trends in Emerging Technologies

Emerging technology trends in 2019

- 5G Networks
- Artificial Intelligence (AI)
- Autonomous Devices
- Blockchain
- Augmented Analytics
- Digital Twins
- Enhanced Edge Computing and
- Immersive Experiences in Smart Spaces