

TECHNOLOGICAL ADVANCEMENT AS THE MAIN RESPONSIBLE FOR THE ECONOMIC REVOLUTIONS THAT CHANGED THE WORLD

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ABSTRACT

This article aims to demonstrate that technological advancement was mainly responsible for the occurrence of the four agricultural revolutions, the Commercial Revolution and the four industrial revolutions that changed the world throughout the history of humanity.

Keywords: Agricultural revolutions, Commercial Revolution, Industrial revolutions, Technological advancement.

Introduction

This article aims to demonstrate that technological advancement was mainly responsible for the occurrence of the 9 major economic revolutions that changed the world in the history of humanity, described below in chronological order: 1) 1st Agricultural Revolution (6000 BC); 2) 2nd Agricultural Revolution (between the 12th and 15th centuries in the Low Middle Ages); 3) The Commercial Revolution (between the 12th and 18th centuries); 4) 3rd Agricultural Revolution (in the 17th and 18th centuries in England); 5) 1st Industrial Revolution (1780-1830); 6) 2nd Industrial Revolution (1860-1900); 7) 4th Agricultural Revolution (between the 1960s and 1970s of the 20th century); 8) 3rd Industrial Revolution (1970s); and, 9) 4th Industrial Revolution or Informational or Post-Industrial Revolution today [1].

1st Agricultural Revolution

The 1st Agricultural Revolution that took place in 6000 BC contributed to the settlement of human beings in certain regions and to the emergence of great civilizations such as the Egyptian in Antiquity [2] [3] [4]. It represented the large-scale transition of many human cultures from the animal-hunting, fruit-and-vegetable-gathering, and nomadic lifestyle to the agricultural and sedentary lifestyle. It is during this period in the history of humanity that man discovers fire. This discovery makes it possible to begin controlling techniques to master food production. The rustic

tools from the Paleolithic period (3.5 million BC to 8 thousand BC) are perfected for agricultural activity. This is why this phase is also called the Neolithic Revolution. The agricultural communities that emerged during this period gave rise to the first urban centers. The first urban revolutions occurred during this period. As they ceased to be nomads, the tribes were concentrated around agricultural activity. For the 1st Agricultural Revolution to occur, the discovery and use, for example, of seeds, which led to the development of production techniques and specialization of work in agriculture, was of fundamental importance. The science and technology of irrigation that emerged in Mesopotamia and also the primitive science and technology of storing agricultural products emerged in Mesopotamia and also in Egypt. The Sumerians were the first to use animal-drawn plows. The plows of this time only tore the land, without turning it over as more modern plows do. The impact of the invention of the plow was so great that today it is considered a milestone of the 1st Agricultural Revolution.

2nd Agricultural Revolution

The 2nd Agricultural Revolution occurred in the Low Middle Ages in Europe, which corresponds to the period between the 12th and mid-15th centuries [5]. Technical developments made it possible to cultivate new lands and increased the diversity of agricultural products, which supported a rapidly growing population. Population growth and increased agricultural productivity allowed for a strengthening of urban life. The cities grew and became centers of commerce and crafts, abandoning their agrarian dependence around castles and monasteries. Many European cities, called burghs, ended up becoming free from servile relations and the rule of nobles (feudal lords), transforming themselves into islands of capitalism on a feudal continent. During this period, there were a series of transformations that occurred in agriculture with the development of new technologies (horseshoes, crop rotation, plows, etc.). Based only on improving the wooden plow pulled by man and some stone utensils, it took centuries for the dragging work done by man to be replaced by animal power, freeing man from such arduous work. With the emergence and cheaper of iron, the plow was improved. There were several technical achievements with the iron plow and the development of new ways of harnessing the plow to animals in order to allow them to be used at full strength, in addition to replacing the ox with the horse, as a draft animal. The plow was one of humanity's greatest inventions because it allowed the production of increasing amounts of food. The plow is an instrument that is used to plow the fields, turning the earth with the aim of loosening it and, thus, enabling better development of plant roots. In addition to this primary objective, plowing allows greater aeration of the soil, which enables the development of useful organisms, such as earthworms, in addition to, in some cases, allowing the mixing of nutrients (fertilizers, chemical or organic; acidity correctors, etc.).

The Commercial Revolution

The Commercial Revolution was the result of the new times experienced in Europe, between the 12th and 18th centuries, with the transition from the medieval to the Modern period, overseas expansion and mercantilism preparing the advent of modern capitalism [6] [7]. The Commercial Revolution [11] happened in parallel with the 2nd Agricultural Revolution. The Commercial Revolution was the result of the transformation seen in the European economy, especially from the 15th century onwards, because of the considerable commercial development of the second half of the Middle Ages and the discoveries of the New World [10]. Navigation and commerce on the high seas gained momentum with science and technology that contributed to the construction of new types of vessels and the improvement of cartography and instruments such as the compass, which are extremely important in navigation. The Commercial Revolution resulted in profound transformations in the European economy [8]. The world was beginning to integrate economically [9]. It was the Commercial Revolution that triggered the process of globalization and for this to happen there was the contribution of technological advances in the field of maritime navigation.

3rd Agricultural Revolution

The 3rd Agricultural Revolution took place in England in parallel with the 1st Industrial Revolution with agricultural innovations, which was a process that began between the end of the 17th century and the end of the 18th century, in England and the Netherlands (United Provinces), countries with an intense commercial activity. When we talk about the 3rd Agricultural Revolution, it is mostly about Great Britain, and it occurred in the 18th century. It then extended to its colonies in America and Asia. There was mass application of technological advances that led to the production of large quantities of food. During the 17th and 18th centuries, large English landowners (nobles and bourgeoisie) increased the size of their lands by annexing vacant land, resorting to land consolidation and enclosures (enclosures) which enabled increased livestock farming. New agricultural techniques increased land productivity, such as the use of horses as draft animals, the production and consumption of legumes (which improved the quality of life), the three-year rotation of crops, and new technology for draining swamps and lakes. New agricultural techniques and greater investment in agricultural machinery led to an increase in agricultural production that was market-oriented, generating greater profits in agriculture that are invested in starting the industrialization process. The 3rd Agricultural Revolution in England was an important factor in triggering the 1st Industrial Revolution (1780-1830), which laid the foundations of industry that spread throughout the world, supported by inventions that promoted extraordinary changes in the productive and transport sectors [12] [13].

1st Industrial Revolution

The 1st Industrial Revolution occurred in England at the end of the 18th century (1780-1830) [14]. At the beginning of the 19th century, factories multiplied, which were created in England at the end of the 18th century, whose development was remarkable, particularly in the most dynamic sectors of the time, textiles and metallurgy. The 1st Industrial Revolution was characterized by two important inventions: the steam engine and the locomotive. Both were decisive in boosting industrial production and the transport of raw materials, people and distribution of goods, giving a new panorama to the means of moving and producing. The use of new technologies, such as the steam engine, occurred at the end of the 18th century and beginning of the 19th century. Mechanical practice was introduced, with steam and coal machines, salaried work, and society stopped being rural to urban. The main peculiarity of the 1st Industrial Revolution was the replacement of artisanal work by salaried work with the use of machines. The use of machines in industries, which provided great strength and agility powered by coal energy, provided extremely high and growing productivity, making the industry an exceptional economic alternative that spread throughout the world.

2nd Industrial Revolution

The 2nd Industrial Revolution became known as the “age of steel and electricity” [15]. The 2nd Industrial Revolution (1860-1900) has its bases in the metallurgical and chemical sectors. Steel becomes a basic material and the chemical and automobile industries assume great importance. Unlike the 1st Industrial Revolution, countries such as Germany, France, Russia, Italy and the United States also industrialized. Among the inventions that emerged at this time were the Bessemer process for transforming iron into steel, which allowed the production of steel on a large scale, the dynamo, which allowed the replacement of steam by electricity and the internal combustion engine, which allowed large-scale use of oil, creating conditions for the invention of the automobile and airplane. The use of steel, the use of electrical energy and fuels derived from petroleum, the invention of the internal explosion engine and the development of chemical products were the main innovations of this period. During this period, steel became such a basic material that it was in it that steelmaking gained its greatest expression. The automobile industry assumed great importance during this period. The technique and work system of this period is Fordist, a term that refers to businessman Henry Ford, creator of the assembly line in his automobile industry in Detroit, United States, a system that became the paradigm of technical regulation and work known across the industrial world. The characteristic technology of this period is steel, metallurgy, electricity, electromechanics, petroleum, internal explosion engines and petrochemicals. Electricity and oil are the main forms of energy.

4th Agricultural Revolution

The 4th Agricultural Revolution or Green Revolution that occurred between the 1960s and 1970s of the 20th century contributed to the invention and dissemination of new seeds and agricultural practices that allowed a vast increase in agricultural production in the United States and Europe and, in the following decades, in other countries [16] [17]. The Green Revolution was a broad program designed to increase agricultural production in the world with the intensive use of genetically altered seeds (particularly hybrid seeds), industrial inputs, fertilizers and pesticides, mechanization, mass production of homogeneous products and reduced management costs. The Green Revolution is also credited with the extensive use of technology in planting, irrigation and harvesting, as well as in production management.

3rd Industrial Revolution

The 3rd Industrial Revolution [18] that occurred in the 1970s is inspired by Toyotism whose characteristics were developed by engineers at Toyota, the Japanese automobile industry, whose method consisted of abolishing the role of specialized professional workers to make them multifunctional workers [19]. The characteristic technology of this period is microelectronics, information technology, the CNC machine (Computer Numerical Control), the robot, the system integrated with telematics (computerized telecommunications) and biotechnology. Its basis mixes Physics, Chemistry, Genetic Engineering and Molecular Biology. The computer is the machine of the 3rd Industrial Revolution. It is a flexible machine, made up of two parts: the hardware (the machine itself) and the software (the program). The circuit and the program are integrated under the control of the chip, which makes the computer, unlike a common machine, a reprogrammable and even self-programmable machine. Toyotism began to be definitively implemented in 1962 and its main characteristic and objective is to produce only what is necessary and in the shortest time. It's just-in-time. Unlike Fordism, where there is production for stock to meet demand, in Toyotism, demand determines production, that is, only what is ordered is produced with a minimum of stock, which is why it is produced faster and better and with lower inventory and production costs. Toyotism emerged as a solution to the Fordism crisis. A multipurpose, flexible, team-integrated, less hierarchical work system emerges. Computerized, the set's programming is passed to each sector of the factory for team discussion and adaptation using the CCQ - Quality Control Circles, which becomes a task rotation system that establishes the possibility of creative action by workers in the sector. A large part of the leadership network is eliminated through reengineering. All this technical and work flexibility becomes more adaptable to the economic system, especially the relationship between production and consumption, through Just-in-Time.

4th Industrial Revolution

The 4th Industrial Revolution or Industry 4.0 is characterized by the integration of so-called cyber-physical production systems, in which intelligent sensors inform machines how they should be processed [20][21][22]. Processes must be governed in a decentralized modular system. Smart production systems begin to work together, communicating wirelessly, either directly or through an Internet "cloud" (Internet of Things or IoT). Rigid centralized factory control systems are now giving way to decentralized intelligence, with machine-to-machine (M2M) communication on the factory floor. The Internet of Things (IoT) represents the logical connection of all devices and means related to the production environment, sensors, transmitters, computers, production cells, production planning systems, strategic industry guidelines, government information, climate, suppliers, everything being recorded and analyzed in a database. The Machine to Machine (M2M) concept represents the interconnection between production cells with the systems exchanging information with each other, autonomously, making decisions regarding production, cost, contingency, safety, through an artificial intelligence model, complemented by IoT.

Conclusions

It can be concluded, from the above, that the various economic, agricultural, commercial and industrial revolutions that occurred throughout the history of humanity and changed the world broke out with technological advancement as the main responsible.

Author

Fernando Alcoforado is a PhD in Territorial Planning and Regional Development from the Barcelona University, Spain. He graduated in Electrical Engineering from UFBA - Federal University of Bahia, Brazil, and Specialist in Engineering Economy and Industrial Administration from UFRJ - Federal University of Rio de Janeiro, Brazil. He received the Brazilian Medal of Merit of Engineering from the CONFEA (Federal Council of Engineering and Agronomy of Brazil) and he is a member of the Bahia Academy of Education, Brazilian Society for the Progress of Science (SBPC) and Polytechnic Institute of Bahia (IPB), holds the position of professor of postgraduate courses in Administration, Economics and Engineering from several Brazilian educational institutions and as a Consultant in the areas of strategic planning, regional planning, planning of systems of science, technology and innovation and planning of systems of energy. He held the positions of Coordinator of Strategic Planning of CEPED- Research and Development Center of the State of Bahia, Secretary of Planning of City of Salvador, Undersecretary of Energy of the State of Bahia, President of IRAE - Instituto Rômulo Almeida of Higher Studies, Director of the Faculty of Administration of the Faculties

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