MAREK MICHALSKI[1]

# FROM THE FIRST TO THE FOURTH INDUSTRIAL REVOLUTION[2]

In 1769 James Watt, Scottish engineer received patent protection for his steam engine model. Like many other engineers he had been testing the atmospheric pressure and water vapour pressure already since the 17th century. The aim was to create a new source of propulsion for a variety of situations to replace muscle and labour for both humans and animals, or water power to dry wetlands, supply water to cities and homes, pump water out of mines, extinguish fires, and turn mill wheels. Already in early 18 century, the so-called Savery machine established its place at homes and other places as gardens in and around London, before being ousted by Newcomen machine. The latter with time became quite popular not only in England, but also in mainland Europe[3]. Already in 1733, a company was founded to operate the Newcomen machine, in universal use in England by 1860s. However, steady work on the improvement of the machine was underway to reduce energy loss – so significant that fuel costs far outweighed the benefits.

The solution to the problem was found in the invention of J. Watt, who defined the claim in the patent application as "to reduce the use of steam and fuel in fire engines"[4]. Patent protection was one of those momentous circumstances that contributed to the widespread use of steam engines in practical applications, as important for the booming English economy as the textile industry. The invention was initially used as auxiliary machinery for hydraulic equipment, but over time it replaced the hydraulic motor. The second - more intensive - phase of production mechanization commenced, for nearly all the work had already been done by machine. The above has born on its organization and forced a new division of labour. Starting with the implementation of a steam engine for industry, up to 1,000 horsepower was added year-after-year. The widespread use of the steam engine also meant that it found its way to new

[1] Full Professor, The Faculty of Law and Administration, The Cardinal Wyszyński University in Warsaw.
[2] Artykuł przetłumaczony ze środków finansowanych przez Ministerstwo Nauki i Szkolnictwa Wyższego na działalność upowszechniającą naukę (DUN), nr decyzji 810/P-DUN/2018. Article translated from funds financed by the Ministry of Science and Higher Education for the dissemination of science (DUN), Decision No. 810 / P-DUN / 2018.
[3] Cf. P. MANTOUX, *Rewolucja przemysłowa w XVIII wieku,* Warszawa 1957, p. 285 et seq.
[4] *Ibidem*, s, 290.

branches of emerging industry, such as engineering, mining, ironmongery, and next, transport. When the patent protection for J. Watt's invention expired around 1800, about 5000 steam engines was working in England alone, this construction, and dozens of steam engines on the continent. Europe was definitely shifting from a handicraft model leveraging from physical strength, or hydroelectric power, with the manufactory system as its higher form, to capitalism[5], which ushered people to industrial civilisation.

Admittedly the Industrial Revolution was not a direct source of transmission capitalism, which dates back to earlier times[6]. On the other hand, the process has definitely accelerated. A new class of workers emerged, accordingly, triggering changes in the social structure. Industrialisation progressed and industry concentrated in certain centres, hence urbanisation process intensified and so did population migration, mainly from rural areas to developing cities. Changed affected legal systems, as the transition from the state society and feudal economy gave rise to the first modern legal codifications of universal scope, as implemented: (i) the Act of 20 ventôs XII (21 March 1804) *Code civile*[7] and (ii) the Act of 25 September 1807. *Code de commerce*[8].

The industrial revolution transformed textile industry, steel industry and metallurgy. Further, it boosted development of a new mode of transport, namely the railway. Railway sector had been developing since 1825, along with a new segment of industry producing tracks, locomotives and cars. Respectively, numerous production plants emerged, supplemented with new ways of financing economic ventures. Developed at the turn of the 16th and 17th centuries, a trade company foreran a joint-stock company – a new form of organization and pursuit of business, a common model for the organization of industry at the turn of the 18th and 19th centuries. 1825 saw more than 630 joint-stock companies in England[9]. This new legal structure was in line with the new business needs. On the one hand, it made possible material investment funds, necessary to finance major economic undertakings, and on the other hand it could separate the personal property of the businessman from that of the enterprise. Whereas the latter was viewed as an independent participant in legal transactions, the former ran no risk of failure of the planned project. This activating factor fostered creativity. *Registration, Incorporation*

[5] Cf. also W. KULA, *Początki układu kapitalistycznego w Polsce w XVIII w.,* Przegląd Historyczny 1951, no. 42, p. 47 et seq.
[6] Cf. for example A. MANIKOWSKI, *Toskańskie przedsiębiorstwo arystokratyczne w XVII w.*, Warszawa 1991, p. 159 et seq.
[7] Cf. K. SÓJKA – ZIELIŃSKA, *Wielkie kodyfikacje cywilne. Historia i współczesność*, Warszawa 2009, p. 192.
[8] Cf. A. KLIMASZEWSKA, *Code de commerce* – francuski kodeks handlowy z 1807 r., Gdańsk 2011, p. 70.
[9] J. KACZKOWSKI, *Zasady prawa akcyjnego,* Warszawa 1917 ==. 97.

*and Regulation of Joint Stock Companies Act and Facilitating the Winding Up of the Affairs of Joint Stock Companies Act of 1844*, new legal solutions, considerably accelerated and simplified the process of establishing new companies. As many as 4049 of them had been established in the UK by 1855[10]. Thanks to those new legal instruments, 1840s saw very rapid development of railway lines. The adopted new legal solutions ensured the inflow of private funds as the basic sources of financing for the progressing industrialization.

On the other hand, the English model, based on the dominance of the innovative factor, was not the only model of development. France followed a different way to industrialisation. In the French model, the political factor of the Great Revolution of 1789 came to the fore. The ensuing political and socio-economic changes initiated the transition from state society and feudal economy to industrial capitalism. With reference to a similar criterion as in the case of the English economy, it should be noted that at the end of the 19th century France already posted over 6,300 joint-stock companies, that is large capital enterprises[11]. The number of joint stock companies, especially their growth rate measures technological development and the participation of the relevant economy in the first industrial revolution. By way of illustration, in Austria, until the early 20th century, only a little more than 780 joint stock companies - excluding railway companies - were registered[12]. As is clear from the statistics, amidst slow transition to industrial capitalism this form of business was not well-developed. The Austro-Hungarian Monarchy was definitely distanced not only by the leading United Kingdom in this area, but also by France and the German Reich.

The changes initiated by the First Industrial Revolution transformed the image of 19th century Europe irretrievably. First, by overcoming the barrier of energy shortage, its basic sources, such as physical strength of people and animals, wind and water power gave way to the work of machines. In effect, thriving factory industry materially cut production costs. Changes also affected interpersonal relations. As early as 1819, juvenile working hours were reduced to 12 hours, and in 1833, child labour under 9 years of age was banned in England[13]. The developments failed to improve working class living conditions, although it made a clear attempt to curb the worst abuses. In the 1830s, a floor inspection was also established to ensure compliance with the rules of work in industry, and in 1824 the ban on workers' associations was

[10] *Ibidem,*, p. 108.
[11] *Ibidem*, p. 96.
[12] *Ibidem, p.* 153.
[13] Cf.e.g. J. SKODLARSKI, *Historia gospodarcza*, Warszawa 2014, p. 119, and also B. RUSSELL, *Wiek XIX*, Oświęcim 2016, p. 77.

lifted[14]. Railway technology has materially supported economic development. Route mileage in England peaked at 8022 km in the years 1848-1912, by comparison it ran low at 2047 km in France, and only 484 km in the Kingdom of Poland[15]. These industrialisation processes coincided with demographic processes, such as rural to urban migration and urban development coupled with the spread of new industrial districts and significant changes in the employment structure. The working class came into play in the social structure.

As a result of the First Industrial Revolution taking its root in Great Britain, its economy rose to dominance in the 19th century, gaining its advantage from winning as much as 1/3 share of global output. However, at the turn of the 1830s and 1840s, the group of industrialised countries was joined by France, the United States and Germany, with the latter two gaining an upper hand as from the second half of the 19th century. Between 1880 and 1914 it was Berlin, New York and Boston that earned the position of "technologically advanced industrial centres of the world", while London slowly became only their pale shadow[16]. This marked the transition to the Second Industrial Revolution. Though arbitrary, the time frame of the latter falls on the 1870s and 1880s.

The Second Industrial Revolution shifted the center of gravity towards Germany and the United States, running on the scientific progress in the second half of the nineteenth century, which originated in rapidly developing universities, where science ranked up. New technical universities were also established, conducive to the development of technology. This pronounced technological progress was accumulated in many new industries, which financed scientific research in their own centres. The main strength of the Second Industrial Revolution is the development of electricity, although such inventions deserve mention as chemical synthesis, which gave rise to the development of the chemical industry, steel, mass-produced, facilitating the development of heavy industry and machinery, combustion engine, which opened the door to the automotive industry, but also aviation, and finally the telegraph and telephone. The symbol of the Second Industrial Revolution will be the assembly line for mass production.

The Second Industrial Revolution ran on electricity. Thanks to this invention, all other areas where innovation was applied were linked, so that they could develop so fast[17].

[14] Cf. B. RUSSELL, *op. cit.*, *p.* 77.
[15] Cf. C. KUKLO, J. ŁUKASZEWICZ, C. LESZCZYŃSKA, *Historia Polski w liczbach*, Warszawa 2014, p. 368.
[16] Cf. M. CASTELLS, *Społeczeństwo sieci,* Warszawa 2011, p. 73.
[17] *Ibidem, p.* 75.

Widespread electrification definitely influenced the shape of transport and information development, and changed the way cities live and people work in industry.

Meanwhile, the Third Revolution, the so-called science and technology revolution, closely links to the mass use of electronic systems and information technologies, which have contributed to the spread of connections between different areas of technology. The technological breakthrough that commenced the changes towards the scientific and technological revolution began in the 1970s[18]. Thanks to the then inventions, including technologies, technology could be mass-applied both in a commercial and - as M. Castells emphasizes - "civil" dimension[19]. In other words, technologies could be disseminated in a non-military dimension. The first innovations in the area of information transfer and processing, that is ARPANET, predecessor of the Internet, stemmed from research and design works pursued by the US Defense Department's Advanced Reaserch Project Agency, closely related to the development of military technology during the Cold War. However, the process of qualitative changes in science, technology and production, which opened the transition to a new stage of civilization development, commenced already in the 1940s.

The key inventions and technologies that paved the way to scientific and technological revolution include the microprocessor invented in 1971. This will contribute to the spread of microelectronics and microcomputer, constructed in 1975, and marketed as early as 1977[20]. At the same time, with Internet project networks evolving since ARPANET and enhanced abilities to send graphics, scattered and isolated micro-computers and supercomputers migrated to a connected global network in late 1990s[21]. Respectively, IT boom produced links among individual fields of science and technology. The Third Industrial Revolution yielded computerisation, automation of production processes and optimised means of communication, especially the mass media and transport. For sure, the Third Revolution also impacted a rapid expansion of the so-called high technology industry.

In the context of historical reference to the "industrial revolution", IV Industrial Revolution also referenced as *Industrie 4.0* - covers mutual use of automation, processing and data exchange for the needs of techniques and rules of manufacturing processes. This promotes the value chain organisation while taking reference to the Internet of Things, cloud computing and systems controlling physical processes reproducing real world elements for the needs of

[18] *Ibidem, p.* 89.
[19] *Ibidem.*
[20] *Ibidem.*
[21] *Ibidem, p.* 87.

this process[22]. The Revolution 4.0 has its symbol: design of an intelligent factory, where work is based on automated production lines with the use of robots replacing human work via autonomous decision-making process.

Like earlier processes of technological changes, also Revolution 4.0 is not limited to the sphere of technology, but interferes in other areas, this providing it with a civilizational and cultural dimension. For the revolution, the earlier formation of the information society was essential, with a decisive impact on the so-called information economy. As M. Castells emphasizes, economy became informational, because the productivity and competitiveness of natural and legal persons (both individual and collective, such as regions and countries) to a considerable extent depends on their capacity to produce, process and effectively use knowledge-based information[23]. The information economy, which has become the environment for Revolution 4.0, is a global economy where individual participants remain in a network of diverse connections, which gives rise to a claim about its networking[24]. Clearly, information and knowledge have been always driving economic development, and behind it also civilisation development, which was clearly visible already during I and II Industrial Revolution, still in the epoch of Revolution 4.0 - as M. Castells states - information can become a product of the production process, in other words the products of new industries included technologies for information processing[25]. This results in new economic phenomena, such as the process of economic liberalization.

[22] Cf. also K. SCHWAB, *The Fourth Industrial Revolution*, 2017, p. 6 *et seq.*

[23] Cf. M. CASTELLS, *op. cit., p.* 109 *et seq*.

[24] *Ibidem, p.* 110.

[25] *Ibidem.*