

# Modernization efforts in science, technology and industry in the Ottoman Empire (18<sup>th</sup> and 19<sup>th</sup> centuries)

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The Ottoman Empire, which was established as a small principality at the turn of the 14<sup>th</sup> century, gradually expanded into the lands of the Byzantine Empire, both in Anatolia and the Balkans. After 1517, when its sovereignty reached Arab lands, the empire became the most powerful state in the Islamic world, covering a vast area extending from Central Europe to the Indian Ocean. For centuries the Ottoman Empire maintained a delicate equilibrium in their struggles with Europe. When the balance of power turned definitively against them, the Ottomans started to lose their lands. However, it is only following their defeat in the First World War that the empire disintegrated and, after 1923, disappeared from the world scene.

The empire was once very wealthy. Situated on the crossroads of the great trade routes between Asia and Europe, rich in mineral resources, it was influential in world trade and regulated the economic balance between the East and the West. In addition to the material superiority acquired after the conquest of Egypt in 1517, the Ottoman sultans also became the spiritual leaders of the Islamic world by assuming the caliphate, that is, the highest authority in Islam.

By the reign of Süleyman I (1520–1566) continuous military success in an area stretching across three continents had made the Ottoman Empire a world power. Yet, in the 17<sup>th</sup> century, fortune turned in favor of Europe. To illustrate the image the Ottoman sultans had of themselves and their empire during this period, let us quote the following lines by Sultan Süleyman the Magnificent :

I am God's slave and sultan of this world. By the grace of God I am the head of Mohammad's community. God's might and Mohammad's miracles are my companions. I am Süleymân, in whose name *hutbe* is read in Mecca and Medina. In Baghdad I am the shah, in Byzantine realms the Caesar, and in Egypt the sultan who sends his fleets to the seas of Europe, the Maghrib and India. I am the Sultan who took the crown and throne of Hungary and

granted them to a humble slave. The voivoda Petru raised his head in revolt, but my horse's hoofs ground him into the dust, and I conquered the land of Moldavia.<sup>1</sup>

The administrative and bureaucratic practices of the Ottoman Empire were a progressive continuation of the ancient traditions of the pre-Ottoman Islamic states. The sharing out of functions within the administration was in accordance with these traditions. Islamic political theory recognized the "Men of the Pen", *Kalemiye*, besides the "Men of the Sword", *Seyfiye*, and the "Learned Men of Religion", *İlmiye*, as three pillars of the administration. Above all these three groups were the sultan and the household of the palace who served him. Thus, the state was built upon four pillars.

Among the auxiliary institutions of the central government, a number of civil commissionerships such as those for the mint, customs, and cereals, and a number of military organizations, such as the Janissary corps, gun-foundry and arsenal, had their own offices. In the provinces, governors, *kadıs*' courts and numerous important *vakıfs* had their own secretarial staff. A commissioner, with a secretary to assist him, was appointed for all state undertakings, including construction, mining, manufacture, and agriculture. Thus, the total number of secretaries was far greater than the limited body who worked in the offices of the central government.

The Men of Religion were educated in the *medreses*, the Men of the Pen were trained in the scribal offices, and the Men of the Sword in the *ocaks* (Corps) and the *enderun* (the palace school); these three state pillars all received professional training together with a general education. The aim of this type of education based on Islamic tradition was to give the best possible training to the administrators and experts who governed state affairs. Several successful statesmen, lawyers, physicians, and astronomers were educated in these institutions.

These men were cultured, knowledgeable, and well-versed in Arabic and Persian as well as Turkish. They also had a thorough knowledge of classical Islamic literature, and contributed to the literary activities of their time. In addition to formal education, nearly all Ottomans, including the sultan, were affiliated to Sufi orders. The knowledge and experience provided by Sufism enabled them to become open-minded, self-controlled, and to conduct themselves with religious sincerity and tolerance. All these elements of cultural education and spiritual discipline were integral to the *adab-ı Osmani* (the Ottoman way of life).<sup>2</sup>

Charitable institutions in Islamic society, were established as *vakıfs*. This

ensured the continuation of public services, since a vakıf devoted in perpetuity the profits from a particular source to a charitable purpose, without touching the capital. In the *vakfiye*—the deed of endowment, recorded in the *kadi*'s register—the founder of a vakıf defined the endowment, its purpose, conditions and forms of management, and appointed the *mütevelli*, the endowment's chief trustee.

In general, the vakıf was a complex that included the following buildings grouped around a mosque: a medrese, an *imaret* for cooking and distributing food, a hospice (*tabhane*), a hospital, (asylum and *daruşşifa*), a bathhouse (*hamam*), caravanserai, and shops. This complex had the nature of a religious, cultural, and social institution. These vakıfs played a significant role in the construction of new cities, and the reestablishment of the *mahalles* (quarters) in the old cities. They helped build houses for the staff of the vakıfs, and funded municipal services such as water and sewerage systems. Each shop was allocated to masters of a particular trade and craft, such as bakery, mills, candle manufacturing, dyeing and butchery. So was the marketplace, which provided secure income for the vakıf.<sup>3</sup>

### **Ottoman social and economic background**

The Ottoman state had a powerful central authority and an effective bureaucracy. The state saw to it that the people lived in an orderly manner by enacting *örfi* (customary) laws, by enforcing the principles of the *shari'a* (Islamic law) and by applying the *töres*, the social rules and customs. In other words, the Sultan's central power organized economic, social and religious life. The people worked in trades, industry and agriculture in accordance with the needs and policies of the state.

During the Ottoman classical period, people of different ethnic origins and belief systems coexisted peacefully. The sultan held absolute authority over the state and, at the same time, he assumed the function of the caliph, i.e., the religious leader of the Muslims who constituted a majority of the society. As the absolute ruler of the empire, the sultan insured that subjects of various religions and ethnic groups would live together in peace under the social order known as the *Nizâm-ı Alem* (Pax Ottomana).

Legal and juridical problems in society were solved with the Islamic and the customary laws. The members of the learned-religious institution, who represented one of the four pillars of the state, ran the judicial system. Compared with the other three classes, the *ilmiye* received a longer education, and they organized Ottoman religious and educational life. The *kadı*, a member of the *ilmiye* class, supervised legal, municipal, and civil matters in both the cities, and the administrative and juridical districts of the provinces. Another important

member of the *ilmiye* class was the *müderris*, who influenced educational and scholarly life. The *şeyhülislam*, who headed the hierarchy of the *ilmiye* class, and the *müftis*, his representatives in the provinces, issued *fetvas* regarding religious and administrative matters, and also on subjects related to the daily life of the people.

Briefly, the *ilmiye* class played a key role in regulating law, administration and education. All their members were educated in the medreses, the main educational institution.

As the Ottoman state expanded and spread across three continents, its financial institutions gradually developed to meet the empire's growing needs. Though the essential characteristics of the financial system were inherited from the previous Turkish-Islamic States, the Ottomans developed them further.<sup>4</sup> One of the key principles of the classical Ottoman system was *provisionism*. Its purpose was to ensure that all goods and services would be cheap, plentiful, and of good quality. With respect to foreign trade, provisionism sought to maximize the supply of goods and services to the internal market. Exports were discouraged by prohibitions, quotas, and taxes. Imports, by contrast, were encouraged and facilitated.

A second important principle of Ottoman economic policy was *traditionalism*, namely the impulse to preserve existing conditions and look to the past for models, rather than search to accommodate changing circumstances. Traditionalism found its expression in the time-honored motto that one should not work against what comes from olden times (*Kadimden olagelene aykırı İş yapılmaması*). It remained unchanged as a vital component of Ottoman economic thought until the end of the 18<sup>th</sup> century.

*Fiscalism* was the third principle, and its goal was to maximize treasury income, and to prevent it from falling below already-attained levels. Influenced by the production capacity of the Ottoman economy and the degree of monetization, the growth in treasury income was achieved only slowly and with difficulty. Ottoman fiscalism thus developed mainly in the direction of preventing drops in income and reducing expenses. A rigid fisco-centrism evolved, which viewed all economic activity only in terms of the tax income they would yield.<sup>5</sup>

Towards the end of the 17<sup>th</sup> century, facing European military and economic superiority, the Ottomans came to recognize the inadequacy of their organization and the need to reform classical institutions. As Professor İnalçık rightly observes, the Ottomans were unable to adapt themselves to the changed conditions. They failed to understand modern economic problems, and remained bound by the traditional formulae of the near-eastern state. Against the

mercantilist economics of contemporary European powers, Ottoman statesmen adhered to the policy of free markets, their main concern being to provide the home market with an abundance of necessary commodities. Unable to formulate a comprehensive economic policy for the empire, they saw no danger in extending the capitulations, so that from the second half of the 16<sup>th</sup> century Europeans even began to control the transport between the empire's Mediterranean ports. The Ottoman government, bound by traditional concepts, encouraged the import of goods into the empire, but discouraged exports. They taxed imports and exports at the same rate, and prohibited the export of certain goods which could cause shortages in the home market. By keeping restrictions on corporations they hindered development in some branches of industry and exports.<sup>6</sup>

The weakness of the Ottoman army became apparent when it was defeated at Vienna in July 1683. Following this fiasco, the Ottomans began grudgingly to accept the superiority of the West in some fields. From then on, they entered a period during which they looked more attentively to the West for solutions to some of their problems.<sup>7</sup>

### **The Ottoman scientific tradition and the impact of the West during the 18<sup>th</sup> and 19<sup>th</sup> centuries**

Ottoman science emerged and developed on the basis of the scientific legacy and institutions of the Seljukid Turks. It greatly benefited from the activities of scholars who came from Egypt, Syria, Iran, and Turkistan, which were homelands of some of the most important scientific and cultural centers of the time. The Ottomans preserved and enriched the cultural and scientific heritage of the Islamic world, giving it new dynamism and vigor. Thus, the Islamic scientific tradition reached its climax in the 16<sup>th</sup> century. Besides the old centers of the Islamic civilization, new cultural and scholarly ones flourished in such places as Bursa, Edirne, Istanbul, Skopje, and Sarajevo. The Ottoman cultural and scientific heritage which developed in this period constitutes the cultural identity and scientific legacy of present-day Turkey, as well as of several Middle Eastern, North African, and Balkan countries.<sup>8</sup>

Geography and close historical ties made the Ottoman world the first nonwestern environment to which Western science spread. Proximity allowed the Ottomans to learn early on of European innovations and discoveries. The Ottomans began, already in 15<sup>th</sup> century, to transfer Western technology (especially firearms, cartography, and mining), and they also had some access to Renaissance astronomy and medicine through emigrant Jewish scholars. The interests of the Ottomans remained selective, however, because of their feelings

of moral and cultural superiority and the self-sufficiency of their economic and educational system.<sup>9</sup> They thus didn't track the scientific and intellectual developments of the Renaissance and the Scientific Revolution, during their heyday. It is anachronistic to say, as some modern histories assert, that they failed to realize that these developments would challenge them in the future.

As a result of our studies, it appears that from the 17<sup>th</sup> century to the beginning of the 19<sup>th</sup> century, Ottoman knowledge of the West came through three main channels: 1. translations made from European languages; 2. personal observations of Ottoman ambassadors who paid official visits to Europe; 3. modern educational institutions.

### *Translations and adaptations from European languages*

From the 17<sup>th</sup> century onwards, we find many translations of Western scientific writings. Here, we shall attempt to follow the introduction of modern scientific concepts to the Ottoman scientific milieu. As far as we can establish, the first work of astronomy translated from European languages was the *Ephemerides Celestium Richeliana ex Lansbergii Tabulis* (Paris, 1641), astronomical tables by the French astronomer Noel Duret (d. ca. 1650). The translation was made by the Ottoman astronomer Tezkereci Köse İbrahim Efendi (Zigetvarlı) in 1660 under the title, *Secencel el-eflak fi gayet el-idrak*. This translation was also the first book in Ottoman literature to mention Copernicus and his heliocentric system. The initial reaction of the chief astronomer of the Sultan was to declare the book a "European vanity", but after learning of its use and checking it against Uluğ Bey's *Zic* (astronomical tables), he realized its value and rewarded the translator. His first reaction, however, typifies Ottoman reluctance to accept Western scientific superiority.

Heliocentricity, which stirred such controversy in Europe, was viewed by Ottoman astronomers just as an alternative technical detail, and it didn't become a subject for polemics. One probable reason is that the heliocentric theory of the universe didn't conflict with any religious dogmas. Astronomy books subsequently translated from European languages also dealt mostly with astronomical tables.

Among the translations completed between the 17<sup>th</sup> and 18<sup>th</sup> centuries was a major treatise on modern geography by Abu Bakr b. Bahram el-Dimashki, which was based on Janszoon Blaeu's Latin work, the *Atlas major* (1685). In the 18<sup>th</sup> century, Müteferrika translated from Latin Andreas Cellarius' *Atlas coelestis* (1708). He completed the translation in 1733, and called it *Mecmuatü'l-hey'eti'l-kadime ve'l-cedide*, meaning the collection of old and new astronomy. In 1751, Osman b. Abdulmennan translated Bernhard Varenius' work from Latin, and

called it *Tercüme-i kitab-ı Coğrafya* (Translation of geographia generalis). In addition to these translations, classical Ottoman astronomy and geography and related scientific activities continued within their traditional framework.

A survey of scientific literature in Turkish thus shows that after overcoming their feelings of superiority, Ottoman scholars readily accepted new concepts, information, and techniques. The administration had a positive outlook, and the religious scholars (*ulema*) were not particularly hostile—as their response to the heliocentric system shows. There was no obvious conflict between religion and Western science at this stage.<sup>10</sup>

From the 16<sup>th</sup> century onwards, the arrival of physicians and diseases from the West introduced new medical ideas and methods of prophylaxis and treatment. From the 17<sup>th</sup> century onwards, the medical doctrines of Paracelsus and his followers began to appear in Ottoman medical literature under the names of *tıbb-ı cedid* (new medicine) and *tıbb-ı kimyâî* (chemical medicine).<sup>11</sup>

One of the most prominent followers of this trend was Salih b. Nasrullah (d. 1669). In his work entitled *Nuzhatu'l-abdan*, he quoted from various European representatives of the new medicine, and gave the compositions of remedies. Al-İzniki (18<sup>th</sup> century) likewise cited Arab, Persian, Greek, and European physicians together in his *Kitab-ı kunuz-i hayat al-insan kavanin-i etibba-yı feylesofan*, and presented new medicines alongside the old. Ömer Şifai (d. 1742), too, in his work *al-Cevher al-ferid* states that the remedies he gives were taken from the books of Latin doctors, and that he translated them from European languages into Turkish. In this way, recent medicine of European origin was practiced side-by-side with traditional medicine until the beginning of the 19<sup>th</sup> century.<sup>12</sup>

A characteristic of the 19<sup>th</sup> century scientific translations or compilations—some clear examples of which can be seen at the turn of century—is the coexistence of modern and Turkish-Islamic traditions. Examples can be found of works where the geocentric and heliocentric systems of the universe were introduced together; similar cases can be traced in medical writing. Eighteenth century Ottoman medical works transferred practical medical knowledge from Europe, but old concepts (such as the concept of humors) still prevailed in physiology and anatomy. Modern physiology was introduced to the Ottoman world through a work translated from Italian by Hekimbaı Mustafa Behçet Efendi (1774–1834) under the title *Terceme-i fizyolocia* (Translation of physiology), ca. 1803. The Ottomans became acquainted with modern anatomy through *Hamse-i Şanizade* (1820–1826), a five-volume work, by the Ottoman physician Şanizade Ataullah (1771–1826).<sup>13</sup> During the second half of the 19<sup>th</sup> century, particularly after 1870, when it was decided to conduct medical

education in the Imperial School of Medical Sciences in Turkish, several books on medicine were translated into Turkish and published, starting with *Lugat-ı tıbbiye* (Medical dictionary, 1873).

Towards the end of the 18<sup>th</sup> century, teachers at the *Mühendishane-i Berri-i Hümayun* (Imperial School of Engineering), which was established to teach modern sciences to army officers, started to translate and compile books from European scientific literature. In general, the instructors relied on from the textbooks used in European military technical schools. Among the first scientific books, which were published at the turn of the 19<sup>th</sup> century, were about ten books on mathematics and engineering compiled and translated by Hüseyin Rıfki Tamani (d. 1817), the first chief instructor of the *Mühendishane*. İshak Efendi (d. 1836), another chief instructor of the *Mühendishane*, published thirteen volumes based on Western sources, especially French. Among these, the four-volume *Mecmua-i ulum-ı riyaziye* (Compendium of mathematical sciences; Istanbul, 1831–1834) is particularly important, since it was the first large-scale attempt to present in one of the languages of a Muslim nation a comprehensive textbook of the various sciences, such as mathematics, physics, chemistry, astronomy, biology, botany, and mineralogy. İshak Efendi's efforts to find Turkish equivalents for new scientific terms and to transfer modern science had an influence that extended well beyond the borders of Ottoman Turkey to other Islamic countries.<sup>14</sup>

Instructors at the *Mühendishane*, as well as the graduates and instructors at the *Mekteb-i Tıbbiye-i Şahane* (Imperial School of Medical Sciences; reformed and opened in 1838), continued to translate European scientific books. After the proclamation of the *Tanzimat* (1839), modern education became widespread, civilian education was reorganized, and new scientific and technical books were printed. The mid-19<sup>th</sup> century thus witnessed an increase in both the number of printed books on modern science and techniques, and in the variety of subjects introduced. Earlier, between the establishment of the first Turkish printing press in 1727 and the proclamation of the *Tanzimat* in 1839, 28 books of science were printed; during the *Tanzimat* period (1840–1876) the figure jumped to 242. There was a numerical increase in the books printed on mathematics and medicine, but a decrease in the number of works published on geography, military sciences, engineering, astronomy, and navigation.<sup>15</sup> On the other hand, after the *Tanzimat*, some different subjects were tackled. For example, Derviş Paşa published the first chemistry book in Turkish entitled *Usul-i kimya* (Elements of chemistry; Istanbul, 1848), and Hekimbaşı Salih Efendi printed *İlm-i hayvanat ve nebatat* (Zoology and botany; Istanbul, 1865), the first book on these subjects in Turkish. Moreover, during the first three decades of the *Tanzimat*

period (1839–1869) four books were printed every year, but during the last seven years (1870–1876) this number rose to eighteen annually. These figures reflect the growing Ottoman interest in Western science.

The drop in publications on sciences such as geography, military sciences, and engineering indicates a shift of interest from the military to the civil realm. A parallel result can also be inferred from the prefaces of works compiled on the same subjects during the 19<sup>th</sup> century (before and after the Tanzimat). Ishak Efendi, in his *Mecmua-i ulum-i riyaziye*, mentions the importance of chemistry for the war industry, and Kırımılı Aziz Bey in his *Kimya-ı tıbbi* (Medical chemistry; Istanbul, 1868–1871) pointed out that chemistry, in addition to its usefulness for medicine, was the basis of several industries and technologies mainly of a nonmilitary character.

During the 18<sup>th</sup> and 19<sup>th</sup> centuries, the languages of Ottoman scientific literature were Turkish and Arabic. Although there were also Persian works, these were rather rare, less than 1%. However, the ratio of these languages differed in manuscripts and printed works. While nearly all of the books about modern science and technology printed during these two centuries (with a few exceptions) were in Turkish, most of the manuscripts were produced in Arabic. In the 18<sup>th</sup> century, for example, 72.1% of the manuscripts were written in Arabic, and 24.7% were written in Turkish. In the 19<sup>th</sup> century, the great majority of astronomical works were in manuscript form. Of these, 53.8% were in Arabic and 41.4% in Turkish. Thus, Turkish was increasingly used for writing on astronomy, but Arabic manuscripts remained more numerous. Although we do not have statistical figures for other branches of science, we may presume a pattern parallel to that found in astronomy. In sum, the scientific manuscripts of the 18<sup>th</sup> and 19<sup>th</sup> centuries were in Arabic and Turkish, while most of the printed literature was in Turkish.<sup>16</sup>

Broadly speaking, then, our survey of the scientific literature of this period may be summed up thus: with some exceptions, theory, experimentation and research—the major constituents of Western science—were largely neglected by Ottoman statesmen and scholars. Most of the modern scientific literature of this time was limited to textbooks for high schools and higher educational institutions.

#### *New educational institutions and the westernization of military technical training*

The second main channel through which the Ottomans became acquainted with Western science were the institutions of military technical training established from the first half of the 18<sup>th</sup> century. During the last decade of the 17<sup>th</sup> century, the rapid development of European military techniques led to a

series of Ottoman defeats. Until then, the Ottomans had managed to manufacture cannons, guns, and ships based on techniques imported from the West. It was not difficult early on for the Ottomans to keep up with European technology, for it changed relatively slowly. Large state enterprises such as the *Tersane* (Maritime Arsenal), *Tophane* (Arsenal of Ordnance and Artillery), *Baruthane* (Powder mill) and *Darphane* (Mint), functioned fairly successfully to meet the needs of the military, for the technological gap between the Ottomans and Europe was not yet great.

Forced into constant retreat in Central Europe, the Ottomans gave up their policy of conquest and began to follow European developments closely, turning their attention to the cultural and technical sources of European superiority. Thus commenced a period of affluence, called the Tulip Age (1718–1730); under Western influence, new developments emerged not only in the technical fields, but also in art and architecture. However, disagreements arose between the followers of a peace policy and their opponents, and erupted in a reaction against Nevşehirli Damat İbrahim Paşa, the Grand Vizier. Extravagance and luxury sparked the rebellion of Patrona Halil (1730), which marked the end of the Tulip Age.

The Tulip Age saw a change in Ottoman–European relations, and innovations such as the fire pump and the printing press were established in the Ottoman capital. Ottoman administrators who learnt about European daily life via European ambassadors also developed a great interest in nonmilitary European inventions. New ways of thinking and understanding emerged.

During the 18<sup>th</sup> century, innovation in European war technology began to accelerate, and it became harder for the Ottomans to keep pace. The Ottomans compared their armies with the military powers of Europe, and decided to transfer European technology in order to redress the imbalance in power. Naturally, they had to consult European specialists to apply this technology. Until the 1770s, the Ottomans tried to meet this need by employing European specialists who had converted to Islam.

The Ottomans sought gradually to import Western military science and to modernize their army. A first attempt was the creation in 1735 of the *Ulufeli Humbaracı Ocağı* (Corps of Bombardiers), under the supervision of the Comte de Bonneval. Besides undergoing drills, the bombardiers in this corps received theoretical training in geometry, trigonometry, ballistics, and technical drawing.<sup>17</sup>

In the second half of the 18<sup>th</sup> century, a group of French experts came to Istanbul within the framework of military aid agreements. One of them, the Baron de Tott, was employed in building fortifications, and in teaching new

European military techniques. He supervised the establishment of a new foundry where French workers cast new types of cannon balls. He also installed a European device called the St. Maritz, which was used for boring holes and polishing cannons. Another of his contributions was the founding of the *Sür'at Topçuları Ocağı* (known in French as the Corps de Diligents), where artillerymen were trained in the European manner. De Tott further played a role in establishing a school (Ecole de Mathématiques or Ecole de Théorie, 29 April 1775), where courses were given for the first time on theoretical mathematics and military techniques. He introduced European techniques to the Imperial Maritime Arsenal as well. In this period, the Ottomans began to import guns and gunpowder as well as warships, and they gradually became more dependent on European technology.

Despite Baron de Tott's personal ambitions, the policies of the French government and the objectives and needs of the Ottoman state were very different, perhaps even opposed. De Tott's cooperation with the Ottoman lasted six years, and he returned to France when local, French, and personal interests ceased to overlap.

France and England stood on opposite sides in the American War of Independence (1775–1783). The czarina Katerina II took advantage of their conflict to promote Russian expansion in Eastern Europe and the Ottoman lands. When the war in America ended, a new policy emerged in Western Europe to support the Ottoman state through military supplies and technical aid. This policy reflected the European perception that the Ottoman state could halt Russian expansion in the region. For their part, the Ottomans were greatly alarmed when they lost Crimea, and started preparing for war against Russia to regain this territory.

The Ottoman Grand Vizier Halil Hamid Paşa (1782–1785) requested technical assistance and a fleet from Europe, and also enacted laws for the training and discipline of the army. Between 1783–1788, numerous French military experts and officers came to Istanbul to work on various technical projects and the fortification of the Ottoman borders. The first task was to fortify the Bosphorus against a possible Russian attack. Over fifty engineers, supervisors and workers, with experience in gunnery, bombarding and shipbuilding, came to Istanbul for this purpose. Among them, two engineers by the names of Lafitte-Clavé and Monnier have a special place.<sup>18</sup>

The gunner and military engineer Saint Rémy arrived during this period, and persuaded the Ottoman statesmen in 1785 to establish larger and more modern gun casting furnaces. However, the new furnace, built at great expense, proved unprofitable, and Saint Rémy was sent back to France. Between 1785–

1787 the French shipbuilding engineer Le Roy and his team of ten people were employed at the Maritime Arsenal, and built more than a hundred warships of different sizes.

When the Ottomans went to war with Russia between 1787–88, an alliance was formed between Russia and France. All of the French experts and masters thus left Istanbul, and native Ottoman masters and workers were employed in their place. Likewise, the French teachers in military technical schools were replaced by Ottoman professors, the *müderris*, members of the *ulema* class, and technicians from other European countries such as Sweden. More French technicians came to Istanbul after the French Revolution, but they were sent back when Napoleon invaded Egypt.<sup>19</sup>

In the 19<sup>th</sup> century, European technical knowledge continued to filter through previously established schools of engineering and also through the students sent abroad to study in various fields. The Imperial School of Medical Sciences, created in 1838, played a crucial role in the introduction of modern medicine into Ottoman Turkey.

### **Ottoman technological transfer and the establishment of modern industry during and after the industrial revolution in Europe**

In Central Europe a period of mercantilism preceded the Industrial Revolution, which began at the end of the 18<sup>th</sup> century. Likewise, in the beginning of the 18<sup>th</sup> century, when the palace and officials in Istanbul were more receptive to Western influences than before, there was a similar period of transition between traditional artisanal society and the foundation of factories in the 19<sup>th</sup> century.<sup>20</sup> During this “period of manufacture” the guilds mainly dealt with small-scale production.<sup>21</sup>

The changes that took place in Ottoman industry in the 18<sup>th</sup> century were not comparable in any way to the explosive industrial growth then occurring in Western Europe. But neither was Ottoman industry totally stagnant; on the contrary, it displayed a complex pattern of development shaped by various regional influences and different industrial sectors.<sup>22</sup>

Around the beginning of the 18<sup>th</sup> century, the Ottoman state sought to meet the economic challenge of Europe and its own need for manufactured goods through industrial initiatives based on traditional technologies. As Mehmet Genç has noted, however, the situation changed after 1709 :

From 1709 onward, we come across two important changes. The first relates to the organization of the production: rather than being the exclusive prerogative of the state, management was entrusted to an entrepreneur with

his own capital and liability along the lines of profit and loss. The second concerns the quality of woolen production : the decision was made to locate and import technological know-how from abroad because it was realized that such skills were not to be found within the empire.<sup>23</sup>

During the early decades of the 18<sup>th</sup> century, workshops for wool, silk and porcelain were established in Istanbul. A *basmahane* (cotton printing manufacture) and a dye-house were established in the 1720s. A small paper workshop was founded in Yalova in 1744–1745. Although the wool and paper workshops were closed a few years later, the other enterprises continued to function for many years.<sup>24</sup> Genç observes :

The inability to obtain technology and the increasingly abundant and cheap manufactured imports made it imperative that the state apply a strictly protectionist regime over the long term. On the one hand, the Ottoman *Divan* (imperial council) provided every sort of advantage possible in the area of interest-free credit, even long-term capital without repayment. It also helped in securing supplies of raw materials, locating and settling workers, and offering broad tax exemptions. On the other hand, the state's guiding principle of provisionism in no way permitted any form of mercantilistic protectionism, either by curtailing imports, or by imposing duties that would raise domestic prices.<sup>25</sup>

Thus, according to Genç, the industrialization attempt was a failure from the beginning because it didn't apply the principles of mercantilism.

Fostered by the reforms of Sultan Mustafa III (1757–1774) and Selim III (1789–1807), the workshops established in the 18<sup>th</sup> century were generally designed to serve the military. The attempts to establish large-scale mechanized factories stimulated the transfer of technology from the West.

Following his accession to the throne, Sultan Selim III initiated a reform movement called the *Nizam-ı Cedid* (New Order), which reorganised the military. During the 1790s, Sultan Selim III took a personal interest in improving the manufacture of weaponry. As early as 1793–1794, he introduced contemporary European methods and equipment for the production of cannons, rifles, mines, and gunpowder. As late as 1804, for example, he undertook the construction of elaborate buildings to house a woolen mill for uniforms, and a paper factory near the Bosphorus, at Hünkar İskelesi. Following the overthrow of Selim III, in the first two decades of Sultan Mahmud II's reign, few, if any, industrial improvements seem to have been attempted, but a burst of activity followed this

gap. A spinning mill was built near Eyüp in Istanbul in 1827, a leather tannery and boot works in Beykoz were improved early in the 1830s, a part of the paper factory located at Hünkar İskelesi was converted to cloth manufacture in the same years.<sup>26</sup> After the abolition of the Janissary Corps (1826), the army adopted European-style equipment; this, however, worked against domestic self-sufficiency. By 1841, the need for a massive industrial program became obvious.<sup>27</sup>

A factory called *Feshane* was opened in 1832–1833 to manufacture the fez, the headgear for the soldiers of the *Asakir-i Mansure-i Muhammediye*, which replaced the Janissary Corps. The fez was also commonly worn by the general public. Originally imported from Tunisia, the fez began to be produced in Istanbul after 32 master craftsmen were brought from Tunisia. In 1839, when the building in Kadirga became too small, the *Feshane* was moved to its new building in the Defterdar quarter of Eyüp. In 1841, the Ottomans began to produce the fez with steam-powered machines. The steam engine used was bought from Belgium upon the advice of Belgian experts administering the factory. A large part of the fezzes produced in the *Feshane* were bought by the state to meet the needs of soldiers and officials. The rest were sold to the people in the *Feshane* shops. Since they were of good quality, they were popular among the people. Yet from the beginning the factory faced stiff foreign competition, and soon after its establishment, the French founded their own factory and started shipping fezzes to Istanbul and other Ottoman cities.<sup>28</sup>

The competition faced by the *Feshane* contributed to its success, because the Ottomans felt compelled to keep up with new technology. Between 1847–48, they increased production with machines imported from England and Belgium. Profits were invested in the new machines. With the partial exception of the *Feshane*, early attempts to introduce European industrial methods focused exclusively on the manufacture of goods for governmental and military use.

Upon the proclamation of the Tanzimat, a series of laws and legislations established new economic enterprises, most financed by the *Hazine-i Hassa* (the sultan's privy purse). The enterprises set up between 1847–48 can be called imperial factories. Among these were the Zeytinburnu Iron Factory, Izmit Woolen Cloth Factory, Hereke Silk Cloth Factory, Veliefendi Printed Wool–Cloth Factory, Mihalic State Farms, the School of Iron Ore and Agriculture in Buyukada. There were also plans to open *talimhanes* (training courses) on “mines, geometry, chemistry, and sheep-breeding.”<sup>29</sup>

The Zeytinburnu Iron Factory was another large heavy industrial complex. To serve the army's needs, the Gun Foundry and the Arsenal were installed with steam engines. The Arsenal at the Golden Horn (Haliç), provided with European

equipment and personnel, typifies the attitude of the Ottoman state toward technology transfer. Like the Feshane, it employed numerous foreign (particularly English, French and American) workers and administrators. Until the end of the century, Ottoman industries equipped with Western technologies depended largely on a foreign labor force.<sup>30</sup>

The main purpose of founding and building imperial factories was to produce the necessary materials for the army, and to meet expenses with internal rather than external resources. Different kinds of factories multiplied in the imperial domains. It was essential that production increase, and since these factories produced goods, the state encouraged them by not buying similar goods from abroad. Above all, the state applied measures of frugality to reestablish the balance of trade. The bureaucrats of the Tanzimat were aware that it was as important to encourage exports as to limit imports.<sup>31</sup> Nevertheless, this objective went unrealized because, as Donald Quataert states :

Other government policies and attitudes clearly retarded the pace of technology transfer and industrial development. The Ottoman regime continued to impose and maintain tariff structures that were very unfavorable to industry, for example, retaining duties on the flow of goods within the empire until nearly the end of the century ...

European insistence on low import duties was also a critical factor.<sup>32</sup>

As a Belgian worker in İzmit observed in 1848:

It would be very odd if we could not turn out a piece of the finest cloth occasionally, seeing that we have the best machinery from England and France, that the finest wools are imported, via Trieste, from Saxony and the best wool countries, and that we Frenchmen and Belgians work it. You could not call it Turkish cloth; it is only cloth made in Turkey by European machinery, out of European material, and by good European hands.<sup>33</sup>

These words indicate the degree of Ottoman dependence on Europe. During the first half of the 19<sup>th</sup> century, modest steps towards industrialization were taken with the establishment of the above-mentioned factories in Istanbul and its surroundings. However, these attempts were interrupted due to the Crimean War (1854–1856) and the resulting financial crisis.<sup>34</sup>

By building factories, the Ottomans aimed to stimulate the industrialization of the country. They thus attached high priority to spreading industrial education and they invited masters from Europe to teach modern techniques to

domestic workers and masters. The state also sent students to Europe to bring back new industrial technology. It further tried to ensure that these factories ran profitably by regulating external and internal trade, changing the customs policy, and finally, applying subventions.<sup>35</sup>

The industrial development program of the 1860s–1870s initiated by the official Industrial Reform Commission sought to mechanize several sectors such as tannery, shoemaking, and silverwire manufacture. But the program hardly advanced beyond the planning stage. This Commission seems to be the last example of a concerted state effort towards factory formation in the Ottoman empire. Thereafter, the state shifted its emphasis from building factories to encouraging their creation by entrepreneurs, though we shall see that it continued to found some factories.<sup>36</sup>

To reduce its economic dependence on Europe, the state reformed customs regulations in 1875, and enacted laws allowing the establishment of new factories. Machines and tools for factories using advanced technology were allowed to enter duty-free, and the yarn produced in these factories was declared exempt from all internal and export duties. Concessions were granted to individuals to found factories. The role of the entrepreneurs in industry gradually increased, and the number of factories grew significantly in the 1880s, when three-quarters of the Ottoman factories were established.<sup>37</sup>

The first factory, the Paşabahçe Glass Factory, was founded in 1884, and has functioned successfully to the present day. It was established with modern equipment, and its workers were imported from Europe, particularly Bohemia. By contrast, the Hamidiye Paper Factory, founded in 1886, proved a failure despite its modern machinery. Profitable production was made impossible by intrigues and financial maneuvering and the need to import all raw materials. This is just one of many examples of insufficient planning in Istanbul which, combined with European competition, forced numerous factories run by entrepreneurs to shut down.<sup>38</sup>

The civilian reforms undertaken by the state during the reign of the sultans Mahmud II and Abdülmeçid in the 19<sup>th</sup> century aimed at the prosperity of the country and the well-being of the people. In addition to their efforts in the economic sphere, the Ottomans started to transfer and apply modern transportation and communication technology from the West. The goal here was both to strengthen state central authority and to answer the needs brought about by social and economic change. In the cities, old structures such as the khans and caravansaries were replaced by buildings such as railway stations, warehouses, quays, and hotels. Traditional customs gave way to new hobbies and forms of entertainment such as the theater.<sup>39</sup>

The attempts in the 19<sup>th</sup> century to industrialize, and to transfer Western technology didn't yield the expected results. This limited success may have resulted from mistakes in Ottoman policies and the pressure of foreign powers. To begin with, it was very hard for the Ottomans to find the necessary capital for industrialization; western capital investments, which entailed heavy conditions and difficulties, did not develop in the direction that they wished. Instead, western investments favored the interests of the non-Muslim subjects and ethnic groups who had cultural affinities with Europe. Moreover, the West quite naturally made its investment decisions with an eye, above all, toward profits. Ottoman attempts in the 19<sup>th</sup> century to transfer modern technology and to found independent industrial enterprises were also hindered by deep-rooted European hostility.

Although the initiatives in heavy industry met with limited success, there was rapid growth in low-level technology transfer. For example, the yarn and dye technologies were adopted quickly and quite extensively. These cheap and easy-to-use examples of contemporary technology supported lively production in small-scale workshops and homes. There was considerable innovation and adaptability here. As Quataert asserts, this low-level technology transfer suited the interests of the European economy.<sup>40</sup>

From the establishment of the state at the turn of the 14<sup>th</sup> century until the end of the 17<sup>th</sup> century, the Ottomans were self-sufficient, and content with their cultural, scientific, and technological background. During this time, the Ottomans selectively transferred elements of western science and technology, but, with their feeling of superiority, they didn't feel the need to accept western science as a whole. Nevertheless, as the military balance with Europe tilted against the Ottomans at the end of the 17<sup>th</sup> century, their attitude became more receptive. Let us note, however, that the purpose of the Ottoman transfer of technology was to use, rather than to produce. From the beginning of the 18<sup>th</sup> century onwards, the palace and its surroundings started to feel the need to learn from Europe. Innovations were introduced into military organization, and traditional and modern elements existed side-by-side in education, science, and technology.

During the reign of Mahmud II, the hold of traditional factors grew weaker, while European influences gained strength. The Ottomans became more dependent on Europe in education, science, technology, and industry, thus triggering a conflict between the old and the new in society, and fostering dual norms in cultural life. Among the factors that hindered Ottoman development were: the endeavours of the European countries to dominate Ottoman markets, flawed policies in Ottoman dealings with the West, and the support which ethnic

and religious minorities received from outside the empire. But the most important obstacles were the absence of big capital accumulation, and Ottoman dependence on European sources.

The Ottomans' haste to bridge the gap with Europe and regain their old power led them to commit political errors. The Ottomans adopted modern science and technology mostly through "translations" and "purchase", and failed to produce science and develop a technology—failed, that is to establish an indigenous tradition in science and industry which would decrease their dependence on the West. I believe that this was the most critical factor that made the Ottoman experience different from that of Russia and Japan.

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## Endnotes

1. In order to comprehend the developments in the 18<sup>th</sup> and 19<sup>th</sup> centuries, which form the essential framework of the period under study, we present a summary of the historical background as well as the social and economic structure of the Ottoman Empire based on H. İnalçık's work *The Ottoman empire: the classical age 1300–1600*. In addition, we also refer to different parts of *Osmanlı devleti ve medeniyeti tarihi* (History of the Ottoman state and civilization) edited by Ekmeleddin İhsanoğlu. For the text quoted here see H. İnalçık, 41.

2. Bahaettin Yediyıldız, "Osmanlı toplumu," 464-465.
3. Ö. Lütfi Barkan, "İmaret sitelerinin kuruluş ve İşleyiş tarzına ait araştırmalar," 239.
4. Mübahat S. Kütükoğlu, "Osmanlı iktisadi yapısı," 513.
5. For a brief explanation of this concept, see Mehmet Genç, "Ottoman industry in the eighteenth century," 59-86.
6. H. İnalçık, 51-52.
7. Feridun Emecen, "Osmanlı siyasi tarihi : kuruluştan Küçük Kaynarca'ya," 56.
8. E. İhsanoğlu, "Ottoman science in the classical period," 23-24
9. E. İhsanoğlu, *Büyük Cihad'dan Frenk fodulluğuna*, 36.
10. E. İhsanoğlu, "Ottomans and European science," 41-42.
11. Nil Sarı, "The Paracelsusian influence on Ottoman medicine in the seventeenth and eighteenth centuries," 167-169.
12. E. İhsanoğlu, "Ottoman science in the classical period," 41.
13. Aykut Kazancıgil, Bedizel Zülfikar, *XIX. Yüzyılda Osmanlı imparatorluğunda anatomi*.
14. E. İhsanoğlu, "Başhoca İshak Efendi : pioneer of modern science in Turkey," 157-168.
15. Feza Günergün, "A general survey on Turkish books of science printed during the last two centuries of the Ottoman state," paper delivered at the "International Congress of History of Science" (18<sup>th</sup> : August 1-9, 1989, Hamburg-Munich).
16. E. İhsanoğlu, "Osmanlı döneminde astronomi literatürü tarihi," 22.
17. M. Kaçar, "Osmanlı imparatorluğunda askeri sahada yenileşme döneminin başlangıcı," 227-238.
18. M. Kaçar, *Osmanlı devletinde bilim ve eğitim anlayışındaki değişmeler ve Mühendishane'lerin kuruluşu*, 38-95.
19. *Ibid.*
20. Wolfgang Müller-Wiener, "15-19. Yüzyılları arasında İstanbul'da imalathaneler ve fabrikalar," 65-73.
21. In the Ottoman Empire the guilds were based on a closed economic system that united their members together around such sound moral principles as the enjoyment of work, professional discipline, honesty and contentedness. Thus, they provided economic and social security for the society. The guilds assured that the professions would remain respectable and, at the same time, maintained the standards and prevented unfair rivalry. In all these activities, the state did not intervene in the affairs of the guilds except for the quality, quantity, and price of the goods produced. H. İnalçık, 150-151 ; B. Yediyıldız, 475-476.
22. M. Genç, 59.
23. *Ibid.*, 71.
24. W. Müller-Wiener, 66-67.
25. M. Genç, 73.
26. E. C. Clark, "The Ottoman industrial revolution," 65-66.
27. Donald Quataert, *Manufacturing and technology transfer in the Ottoman empire 1800-1914*, 29-30.
28. Tevfik Güran, 235-237.
29. *Ibid.*, 236.
30. D. Quataert, 29-30.

31. T. Güran, 236–237.
32. D. Quataert, 10.
33. E. C. Clark, 75.
34. W. Müller–Wiener, 79.
35. D. Quataert, 10–11.
36. *Ibid.*, 31.
37. D. Quataert, 30.
38. W Müller–Wiener, 81–83.
39. E. İhsanoğlu, “Osmanlı imparatorluğunda çağımı yakalama gayretleri,” VII–XVI, B. Yediyıldız, 510.
40. D. Quataert, 10.