

# Scientific and Technological Revolutions and National Modernization: France

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## Summary

From the perspectives of modernization and the Scientific Revolution, there were mainly three enemies of national modernization that French had to defeat in the 16<sup>th</sup> and 17<sup>th</sup> centuries. The first one was the French feudal lord system, an obstacle of modern political and economic society. The second one was Catholic, which supported the feudal system and shaped traditional French education, social structure,

and ideology. The third one was Aristotelianism that Thomas Aquinas made to become the basis of Catholic doctrines and that therefore dominated natural philosophies at that time.

The absolute monarchy, which was established by Louis XIV by means of the enforcement of royal power, weakened the power of the local lords. The first enemy of modernization, feudal lord system, was conquered to a great extent. But the theory of “divine right of kings”, which was not a modern but pre-feudal one, revived as a traditional means of governance. The political elites of the Old Regime, Richelieu, Mazarin, Louis XIV and Colbert, can be seen as the pioneers of French modernization in the 17<sup>th</sup> century.

Frenchmen played a significant role in the development of the new science of the 17<sup>th</sup> century. Gassendi, Descartes and other French savants developed a new natural philosophy whose language was mathematics. Their work received attention and applause by the Royals in the second half of the 17<sup>th</sup> century. Cartesianism as a new knowledge tradition strived against the principles of scholastic Aristotelianism. And this was one of French contributions to the Scientific Revolution.

How did the Old Regime adopt the achievements of scientific revolution into its system? Bourbons had discovered the value of modern science. In order to incorporate it into the state power, Louis XIV and Jean-Baptiste Colbert constructed the Académie Royale des Sciences, an important institutional innovation at that time. From the very beginning, the Royal power had a very close control and cooperation relations with the Académie Royale des Sciences. Sponsoring and supporting of scientific activities had since become an important tradition of French science. The Académie Royale des Sciences not only attracted many excellent scholars from both at home and abroad to Paris for scientific researches, and its model was also widely admired. Until it was banned in 1793, the Académie Royale des Sciences had almost been synonymous with French science of that period, for its active and outstanding

achievements; meanwhile, Paris became the scientific center of the world in the 17th and 18th centuries.

Undoubtedly, the most important achievement of the Scientific Revolution was the Newtonian synthesis. By 1730, French analytical mechanics had no such direct association with Newton's legacy. Maupertuis's defense of Newtonian mechanics in 1732 was a key event in the history of the reception of Newtonianism in France. Depending on their power and prestige within the Académie Royale des Sciences, he and his partners successfully connected analytical mechanics with Newtonianism, and integrated the latter into French official establishment.

When Voltaire delivered the Newton's gospel to Frenchmen in his *Lettres philosophiques* in 1734, he launched the Enlightenment by a public, free criticism, defined it as a social movement, and forged a new style of critical, argumentative intellectual, the *philosophe*. Voltaire and Maupertuis, who were tied together by the dissemination of Newtonianism, among others, prepared the way of the acceptance of Newtonian thought within French official science and the public space, and liberated the French official science from the Cartesian traditions. Newtonianism made real contributions to the commencement of the French Enlightenment, which played an important role in the course of modernization.

Diderot and d'Alembert's *Encyclopédie* stood for the thought of the Enlightenment, and formed a community of men of letters based on Voltaire's new style of intellectual. The marriage of Newtonianism and French Enlightenment implied the intimate relationship between the Scientific Revolution and Cultural modernization.

Besides on culture, the Enlightenment had effects on technology and economics. It transformed the dynamics of technological progress, and adjusted the institutional mechanism by which technological progress affected the economy.

The system of science under the Old Regime was separated from that of technology or engineering, which could be generally divided into the sub-systems of State engineering and civilian engineering. The systems of science and technology couldn't spread technological knowledge effectively and make the technological progress successfully. The Académie Royale des Sciences, as an institution that quite approved the ideals of spreading technological knowledge, tried to produce a set of volumes describing the industrial and mechanical arts in France, but eventually failed in this mission. Its failure exposed the defect of the French system.

After the 1760s, France was impacted greatly by the first technological revolution and the Industrial Revolution originating from the Great Britain. Could the Old Regime promote French modernization and challenge the first industrial nation by virtue of science and technology? In the decades before 1789, French policymakers and entrepreneurs began to reform and strived to emulate the British approach to technological development, entrepreneurialism, and mode of state involvement in the economy.

Important figures from official scientific establishment condemned and suppressed the theories, such as Mesmerism and Vitalism, which were far away from rationalism and the Enlightenment. Because these theories could be treated as radical political thoughts in some sense, many future revolutionaries made use of them to resist the official system. Science and technology had a negative impact on established social and cultural orders at the end of the Old Regime.

How were science, technology, education and national interests formed into a new system during the French Revolution? Based on the modernizing reforms of the Old Regime, the establishment of the new regime promoted the process of political modernization. And the entire political, administrative, and social structures were transformed fundamentally during the Revolution. The modern institutional framework was established by the Napoleonic Code in 1802.

The system of science and technology was re-established during the Revolution. The old institutions, organizations and universities were abolished or rebuilt; the Catholic couldn't govern the universities any more. The Revolution provided an opportunity for the professionalization of science. The new system of scientific and technological education was mainly based on Grand Ecoles and application schools, which turned out many elites not only in the fields of scientific research, private industry, but also in public administration. This system represented the ideal of the Enlightenment that desires to apply science to technology.

The enormous achievements of science and technology made France to become a world scientific centre, and promoted economic growth. From the end of the 18<sup>th</sup> century to the first half of the 19<sup>th</sup> century, there were numerous great French scientists, who made brilliant scientific achievements in the unstable political environment. Because the reforms of the Bourbon state were brought to a halt by the French Revolution, French politicians, entrepreneurs and scientists had to devise different means of fostering industrial development after the end of the Terror. They transferred technologies from the Britain, facilitated the interaction of scientists, innovators, entrepreneurs, and bureaucrats to solve problems of production, emphasized mathematics and applications in French educational system, and popularized science and engineering in public institutions, in order to improve French technological competence and spread industrial knowledge and skills.

The institutions and modes of government supporting technological innovation and industrial expansion created between 1794 and 1804 turned into the regulatory framework for stimulating the French economy throughout the 19<sup>th</sup> century. Louis Bonaparte's policies tried to advance the economic development. Strategic Industries and institutions developed rapidly, such as metallurgical and textile industries, banking system was adapted to the needs of an industrializing economy, and railways were constructed. The Third Republic created the conditions to make the whole

infrastructure of the modern economy perfect, which included the railroad network, canals, and modern communications.

While the Britain remained powerful, and Germany and the United States were on the rise by virtue of the second technological revolution, France has been involved gradually in a highly competitive context since the middle of the 19<sup>th</sup> century. There was a period of relatively slow economic growth from the defeat by Prussia in 1870 to the 1890s, and a relative “decline” of science in France in the second half of the 19<sup>th</sup> century.

The decline of science in France relative to Britain and Germany was a complex phenomenon involving many factors. The system of science and technology set up during the Revolution was outside of the movement that had radically changed the mechanisms for producing new scientific and technological knowledge since 1860s.

From the end of the 19th century to the Great Depression, with the rapid development of monopoly organization and high degree of centralization of financial capital, France entered the stage of imperialism. Alongside of the second technological revolution, the French economy, science and technology made a very remarkable progress. New industries emerged and developed rapidly, especially metallurgy, automobile, electric power. They promoted urbanization process and social development, and France stepped into the modern society. In the meantime, many important scientists sprung up, such as Poincaré, Louis Pasteur, Curie family, Langevin, de Broglie, Jean Perrin, and Bourbaki school.

However, with the advent of the Great Depression and the World War II, France faced a very difficult situation. Economy and society suffered devastating damage, and science, technology have also been greatly inhibited. But the foundation of the French research system was laid just during this period, such as the French National Scientific Research Center (CNRS, 1939), the National Institute of Health and

Medical Research (INSERM, 1941), the National Center for Telecommunication Studies (CNET, 1944), the French Atomic Energy Agency (CEA, 1945), and the National Aerospace Research Center (ONERA, 1946), etc., which played a very significant role in the development of France after the World War II.

Many French scientists experienced deeply by the defeat in the World War II, and claimed that government should pay great attention to science and technology in order to maintain the national independence. With the Monnet Plan, as well as the American aids to France which proposed in the Marshall Plan, France gained the so-called “glorious thirty years” (1944-1974). Along with the third technological revolution, France realized a very fully economical, industrial, and social development. During this period, France achieved very remarkable breakthrough in the field of atomic energy, aerospace, medicine, communications and high-speed railway. With a forward-looking of energy crisis, the French government had attached much importance to research and use of atomic energy; today, France is the largest user of this energy source among the developed countries. The European Space Agency, which is led by France, plays an important role in the field of aerospace; the Ariane series of rockets, which have a very prominent position in the international aerospace market, undertake more than half of the commercial satellite launches annually. Meanwhile, France has a very unique contribution on high-speed railway, medicine, communications, and etc. Based on the European Union, France is expanding its scientific, technological, cultural, political influence in the context of globalization, continuing to improve its position as a world power.