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Historians of science from two countries—one at the eastern end and the other at the western end of Asia—have assembled here to pursue a comparative study of the introduction of modern science and technology to their lands. Owing to their contrasting geographic locations, Japan and Turkey had very different historical relations with Western Europe, the birthplace of modern science and technology. Ottoman Turkey was a huge empire that spanned Asia, Europe and Africa. The direct political, economic, and military interactions of Turkey with Western Europe long provided constant stimulus to both sides. By contrast, Japan came in contact with Western Europe for the first time at the end of the 15th century, in the Age of Navigation. As I will explain later, the encounter with the West would become a major turning point in Japanese history; but for the time being, contact remained quite limited. For 220 years, trade with the West was restricted to the Dutch. It was only in the mid-19th century that Japan finally opened to full-scale military and political contact with Europe and America. Both geography and history thus separate Turkey and Japan. That differences in politics, economics, religion and other elements also divide the two countries goes without saying.

Yet in the period that we are going to consider the two countries faced a common challenge. Confronting a West which already in the 18th century surpassed them in military and economic power, and which attained overwhelming superiority in the 19th century, Japan and Turkey both began to strive for a “rich country, strong army” (*fukoku kyōhei*) through westernization and industrialization.

Although all non-European countries were confronted with this task, and Turkey and Japan belonged to the minority group of countries that escaped being colonized by Western imperialism. Both countries went on to build modern nations, and in both far-reaching reforms transformed not only political, economic, military and educational institutions, but also everyday life. Modern science and technology played a pivotal role in these transformations.

In some previous work, I have pursued comparative analysis of the introduction of modern technology to China and Japan from the mid-19th through the early twentieth centuries. I was able to show that by and large, these two countries, in spite of the great differences in their regimes, traced the same pattern of failures and successes by a ten-year time lag. Despite numerous differences in detail between the two countries, in other words, there was an identical pattern of development. I believe that this was due to the common tasks that had to be addressed, and to a certain kind of universality in modern science and technology—a similarity in the technological and economic conditions that have to be met for successful technology transfer.

We seek at this meeting to compare the experience of scientific modernization in Turkey and in Japan. It is relatively easy to discern differences between these two countries and their distinctive features. However, I feel it important to go beyond the differences and distinctive features and also uncover the similarities and commonalities that exist between them. In the later half of the 20th century we have witnessed the formation of a global culture based on a shared science and technology. In reality, however, this culture first began to take shape in the era that we have chosen to analyze. And that is exactly why we have chosen to focus on this period. It is only on the basis of a clear understanding of their similarities and commonalities that we can fully appreciate the rich variety differentiating the experiences of the two cultures, and lay the foundation for mutual understanding.

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In the case of Japan, the reception of modern science began in the 1720s. Eighteenth century Japan stood poised for a major transformation. All the elements that can be considered to be indices of a modern society were emerging—in politics, economics, education, and scholarship. I consider the 18th century to mark the beginning of a global modernity; Japan and China belonged to the East Asian wing of this incipient development.

From a global perspective, we can divide the history of Japan up through the end of the 19th century into three broad periods. The first period extends from the ancient period to the end of the 15th century; the second period from the beginning of the 16th century to the Meiji Restoration in 1868; and the third period runs from the Meiji Restoration to the end of 19th century. In the first period, we might picture the Japanese worldview as a circle with China at the center and Japan at the periphery. Although Japan was profoundly influenced by Chinese civilization, the sea that separated China and Japan always buffered

the latter from Chinese political, economic, and military pressure. The sea was not so wide as to hinder the Japanese from importing the technology, political system, scholarship, and religion of China; but whenever the need arose, the Japanese could temporarily block or restrict mutual communication by sea. In this way, the Japanese were able to accept selectively the elements of Chinese civilization, assimilate it over a long time and develop a unique culture that was not merely a derivative imitation. At the same time, the fact that Japan was always in contact with China since the dawn of history helped foster the idea that there existed this great model of civilization across the sea, and the belief that it was only natural to learn from it.

The second period saw the emergence of Western Europe as a second focus of attention. During this period, the center of world civilization shifted from traditional Asian civilizations like the Chinese and the Ottoman, to the capitalist West. In the early 19th century, the dominance of Western Europe became decisive. During this time the position of Japan can be imagined as a point on an ellipse with the two foci being China and Western Europe. Here again the sea acted as a buffer between Japan and the West for over one and a half centuries. However the Opium War, which took place between China and Britain in 1840, proved to the world that wide oceans could no longer protect a country from Western military, nautical, technological, and economic prowess.

It is at this time that Japan came in full contact with Western Europe. The ultimate result of this encounter was the Meiji Restoration. In the third period, after the Meiji Restoration, the ellipse with China and Western Europe as its foci changed to become a circle—this time with Western Europe at the center. The Sino-Japanese War in 1894–95 would mark the end of the worldview that had, since ancient times, seen China at the center of the circle. The Russo-Japanese war of 1904–05 then revealed a Japan that was no longer content just to be at the periphery of the circle with Western Europe at its center.

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Let us now shift our attention to what was happening in Japan. The political and social system that took shape in the early part of the 18th century under the leadership of the Tokugawa Bakufu is known as the Bakufu System. The term refers to a system built around the ruling *Bakufu* (shogunate) and its subordinate *han* (domains). The Bakufu was the largest lord. Besides the regions under its direct jurisdiction, it also controlled major cities like Edo (modern day Tokyo), Osaka, Kyoto, and Nagasaki; it further regulated the mines and highways, overseas trade, and the minting of currency. Politically and economically, the

Bakufu was in a position of overwhelming dominance compared with the 200 odd *daimyōs* governing the various han. However, the administration within the han was carried out by the respective daimyōs.

The Tokugawa era is also known as the Edo period because the Bakufu was centered in Edo. The most prominent feature of the society at this time was the segregation of the samurai or warrior class from the peasants. It would be no exaggeration to say that the development of Japanese society from the 18th century onwards was brought about by this structure. In the medieval period, the samurai, as small landowners, had been at the center of agricultural management; in the Edo period, however, they became strictly segregated—socially and geographically—from the peasants who farmed the lands. The ruling class of samurai, who made up just 6 % of the population, was now concentrated in the castle towns which served as the capitals of the Bakufu and the various domains. Besides the samurai, two other classes, the artisans and the merchants, also lived in the castle towns and played a central role in political and economic life. On the other hand, the peasants who had been forced to give up their arms, spread out from the foothills which, in the middle ages, had been their main abode, to the alluvial plains downstream. The art of cultivating rice in flooded paddies was developed, and small farms became the general rule. Although there are no precise statistics, it is estimated that in the first 100 years of the Edo era, the area of land under cultivation rapidly increased and the population also tripled to reach the figure of 30 million. This population figure of around 30 million held steady through the 18th and 19th centuries.

Japan in the Edo period was a remarkably stable society, with the Bakuhan system, the social system separating the samurai and peasants, and trade restricted to commerce with just the four countries of China, Korea, Holland and Ryukyū. During its so-called period of isolation (*sakoku*), Edo Japan was a peaceful society that knew no internal disturbances and external wars for over 230 years. And in the 18th century, especially from the latter half, Japanese society began to develop all the elements of modernity.

First of all, in the political arena, there was the formation of a bureaucracy. It was among the samurai who, separated from the land and living off salaries, that bureaucratization developed. In the beginning, much weight was given to the status of the family, with only samurai from good families gaining important posts. But by the beginning of the 18th century, in order to cope with rapidly changing social and economic circumstances, the Bakufu set up independent departments to take charge of civil administration and finance. These subsequently emerged as the pivotal government departments. In these departments, even if they were of a lower class, younger and talented

bureaucrats might be selected to the positions of department head or assistant head. Quite a number of samurai of lowly birth rose to such positions. At the end of the Bakufu period, when contacts with Western European world powers began, two more departments, that is, foreign affairs and military were added to the departments of civil administration and finance. The situation was similar in the domains as well. It was the young and talented political bureaucrats who took the lead in the “rich country, strong army” movement at the end of the Bakufu period, and went on to accomplish the Meiji Restoration. They formed and carried out the Meiji Government policies of industrialization and modernization.

The legal system also underwent change between the latter half of the 17th century and the first half of the 18th, becoming essentially a system of modern law. From a legal system based on the powers of domainal lords and sovereign privilege, it changed to one of rule by law. Laws became the standard of daily life, and their unification and universalization was promoted. A system of trials and litigation was established, and legal justice became chiefly defined by procedural justice.

In the economic field, the later half of the Edo period saw the formation of a market economy. Throughout the country, prices varied with supply and demand. A nationwide distribution network emerged centered in the three major cities of Osaka, Kyoto, and Edo, in which the major players were wealthy wholesale merchants called *tonyas*. However the market dominance achieved by these merchants in the flourishing cities would soon be broken by the rise of rural industries.

In the area of manual industries, the major cities, as exemplified by Kyoto, enjoyed an overwhelming superiority during the early Edo period, with respect to both technical level and productivity. In the latter half of the period, however, it was rural industries that became ascendant. Throughout the country many rural manufacturing districts emerged, and these villages began to produce pottery, cotton and silk textiles, paper, sake, dyes, cast iron, and the like. Further, recent research has shown clearly that there was an extremely high degree of population mobility between the farming villages and the cities.

Though the Edo period itself cannot be said to have given birth to industrialization, it did lay the groundwork, shaping a society that could begin to industrialize in response to external stimulus. One of the noteworthy conditions that prepared the way for industrialization was what a historical demographer has called the “Industrious Revolution”.

The great majority of the population was farmers, but big landowners and rich peasants were the exception. Until the middle of 18th century, especially in

the plains, small farms supported by family labor was the general rule. Since there were no new frontier lands left for cultivation, production for the market was founded on highly labor-intensive techniques, that mimimized cost and land. In other words, in order to get the maximum yield from the land, peasants sought to raise productivity per acre by increasing the investment of labor. By this strategy, they succeeded in achieving the highest yield per acre of land in the world. It seems likely that farmers cultivating small farms, who now formed the core of the agrarian economy, became keenly conscious of the value of long hours of intense labor for raising their standard of living. And in fact, many agricultural treatises from the end of the 17th century onward lauded the virtues of hard work. Philosophers, too, began to praise industriousness. The most important consequence of this was the formation of an industrious nation. If Protestantism prepared the way for the Industrial Revolution of Western Europe, the roots of Japan's industrialization lay in an earlier Industrious Revolution.

A basic problem confronting Japanese society in the 18th and 19th centuries was that of limited natural resources. All land had been completely developed and, with the exception of coal, all underground resources that could be mined at that time had been exhausted. The *Bakufu* consequently carried out a nationwide survey of products and began to promote the indigenous production of imported commodities. Chinese silk goods and medicinal drugs from Korea and China are examples of products with regard to which the government made concentrated efforts to obtain and diffuse technical knowledge in order to carry out their indigenization. The official government policy of isolation prevented Japanese from seeking opportunities abroad. Within the country there were no more frontier territories to develop. One sociologist has argued that this combination of the disappearance of a frontier and limited natural resources gave rise to a sort of "competitive society" in which people try to increase their prestige and status by means of work.

Another thing that we cannot afford to forget is the diffusion of education and the high literacy rates. Literacy was not the exclusive property of the samurai elite. From the middle of the 17th century, schools for the education of the samurai were established in all the domains and the *Bakufu*. These schools were centered around Confucianism, and designed to train future bureaucrats. By the end of the Edo period, military and medical studies were also established, and a part of these schools was also made open to non-samurai. There were over 250 such schools around the country. Further, many of the domains set up village schools to educate the general population. With the dawn of the 18th century, private schools called *terakoya*, which taught reading, writing, and

soroban (abacus), became more common. At the end of the Edo period there were over 16,000 of them scattered throughout Japan.

Besides primary schools, there were schools of higher education. The teachings of Chinese neo-Confucianism were officially endorsed by the Bakufu and all of the domains. From the latter half of the 17th century to the early years of the 18th century, however, Japanese scholarship and philosophy began to break free from the shackles of neo-Confucianism, and to develop in new directions. Participants in this movement included not just the samurai, but also thinkers of commoner origins. Scholars, philosophers, and doctors alike, irrespective of their school of learning, opened up private schools of higher learning, and commoners were also allowed to attend these lectures. In Osaka and other major cities, wealthy merchants set up institutions of higher education for the common public. The publishing industry flourished in Osaka, Edo, and Kyoto. It is estimated that the literacy rate for men was 40% for the whole country, and in a city like Kyoto it was close to 80%. Quite possibly, the spread of education was associated with the formation of a society keen on prestige and status. In any case, it certainly helped promote subsequent industrialization and the forging of a modern nation.

Finally I might also add that Japan in the Edo period was a secular society, free from religious control. This, as well as the fact that the Bakufu never ceased to obtain information about the world through Dutch merchants, was one reason why they were able to respond quickly to the implications of the Opium War.

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Thus far I have summarized the chief features of Japanese society in the 18–19th centuries and the various elements of modernity that emerged in this time. But I now want to focus on the acceptance and introduction of modern science and technology into Japanese society.

In 1724 the Bakufu permitted the importation of writings on Western science and technology which had been translated into Chinese by Jesuit missionaries. The science that entered Japan in the 16th century before the isolation through the Society for Jesus was medieval science. The one foreign technology that had a decisive impact on the Japanese of the time was firearms. Originally invented in China and then developed in Western Europe during the military revolution after the 15th century, it was brought into Japan by a drifting Portuguese ship. Based on their strong tradition of forging swords, the Japanese quickly learned to make the guns themselves.

In the 16th century, in the midst of the so-called Warring States period,

Japan gained the dubious status of being the country with the greatest number of guns in the world. For it was those with superior firepower who became the supreme rulers of the age of the Warring States. However, the peace that followed removed any impetus to improve firearm technology. Towards the end of the Bakufu period, when the time came to confront the military powers of Western Europe, Japanese guns were still frozen at the level of the 16th century matchlock.

Chinese science had reached the peak of its growth in the Song and Yuan dynasties (mid-10th~mid-14th century). In the Ming dynasty (mid-14th~ mid-17th century), it entered a period of systematization and integration. Japanese scientists had basically absorbed all the major fruits of Chinese by the beginning of the 18th century.

For example, the most brilliant result of Chinese astronomy was the compilation of the *Shoushi* calendar in 1281; Japan revised this and adopted it in 1684 under the title of the *Jōkyō* calendar. During this time the Japanese also developed a high-level mathematics called *wasan* (Japanese mathematics). Wasan mathematicians learned the calculation techniques used in the *Shoushi* calendar and Song and Yuan dynasty mathematics, and developed a higher mathematics that encompassed the infinitesimal calculus. Doctors studied Ming dynasty compilations of Song and Yuan dynasty medicine and forged a distinctive approach to medicine called *kampō*. 1697 saw the publication of a major treatise on agricultural technology, based on *Nongzheng quanshu*, the great Ming agricultural compendium of 1639, but adapted to the special circumstances prevailing in Japan. Similarly, the *Yamato honzō* was inspired by, but significantly recast, the monumental Ming treatise of materia medica, the *Bencao gangmu* (1596). Its publication in 1709 marked the establishment of natural history in Japan.

In this way, by the time that the embargo on Chinese translations of Western writings of science and technology was lifted, Japanese scientists had already assimilated most of the major achievements of traditional Chinese science, and begun to develop an original science of their own. This is a matter of importance as a precondition for the reception of modern science and technology.

Even after Japan had banned Christianity and expelled all missionaries, the Jesuits in China worked to introduce Western science and technology, primarily through translations. The missionaries believed that this was the best way to convert the ruling elites. By the end of the Ming dynasty, the Jesuits transmitted ancient, medieval, and Renaissance science ranging from Euclidean geometry to Tycho Brahe's theory of the universe. They also introduced the heliocentric theory, the telescope, and other scientific instruments, as well as the

manufacturing technology of firearms. At the beginning of the Qing Dynasty, missionaries not only transmitted Kepler's astronomy and Galileo's kinematics, but they also undertook such scientific activities as land surveys of all the Chinese territories and the charting of maps. The 1740s brought the scientific activities of the Jesuits in China to an end, but by then they had communicated the chief results of the early stage of the scientific revolution represented by Galileo and Kepler. Japanese study of modern science began with the introduction of the Chinese translations of these texts.

Immediately after lifting the ban on Chinese translations of scientific and technical writings, the Bakufu ordered brilliant mathematicians like Takebe Katahiro (1664–1739) and others who had researched the *Shoushi* calendar to translate the works of the Qing dynasty mathematician and astronomer Mei Wending (1633–1721). Mei Wending was a scientist who had a profound and accurate understanding of the Western mathematics and astronomy introduced by the Jesuits, and had compared these with Chinese mathematics and astronomy. He worked under the strong belief that science as such, whether in the East or the West, was basically the same, and he thus tried to forge a kind of hybrid science. The writings of Mei Wending represented the summit of Chinese understanding of Western science at that time. The Bakufu's decision to translate his work first was thus a shrewd choice.

Another work called *Lixiang gaocheng* (1723) was published in the same year as Mei's treatise. In this work, Chinese astronomers recompiled the mammoth translations in astronomy carried out by the Jesuits at the end of the Ming Dynasty correcting their errors. It reveals that they fully understood the theories of Tycho Brahe. A sequel, *Cheng houpian* (1742), was the last scientific translation undertaken by the Jesuits. It introduced calculations based on Kepler's elliptical orbits. An astronomer in Osaka named Asada Gōryū (1734–1799) and his pupil Takahashi Yoshitoki (1764–1804) studied these two works, and mastered the calculating methods of the former in 1780, and of the latter in 1790. This was the highest point of Japanese understanding of modern science by way of Chinese translations.

Meanwhile, direct study of Western scholarship began in the 1740s. In 1740, the Bakufu ordered two scholars (a Confucian scholar and a doctor) to study the Dutch language; in 1745, it permitted the three interpreters at Nagasaki to read and translate writings in Dutch. These pioneers laid the foundation for what would eventually be called Dutch studies (*Rangaku*) or Western learning (*Yōgaku*). Until the Opium War, doctors and interpreters lead the way in Dutch studies. In the 1770s, a number of translations of Dutch texts began to appear. The very first was the anatomy text, *Kaitai shinsho* (1774). This publication not

only transmitted detailed and precise knowledge about Western anatomy, but also stimulated broader investigations into Western learning and technology. At first, the overwhelming majority of translations was related to medicine, followed by translations of works on astronomy and geography. In the beginning of the 19th century, books on natural history and military technology also started to be translated. By the end of the 18th century there were several private schools teaching Dutch medicine to a total of 100 pupils.

The high level of scientific understanding during this era can be illustrated by the case of astronomy. For example, Shizuki Tadao's (1760–1806) translations of the writings on astronomy and physics of John Keill (1671–1721), Professor of Oxford University, reveal quite clearly that he thoroughly understood Newtonian dynamics. In the first decade of the 19th century, Takahashi Yoshitoki and others completed an abridged translation of the Dutch version of the famous *Astronomie*, 2nd edition (4 volumes, 1771–81) by the French astronomer L. De Lalande (1732–1807). In other words, by the start of the 19th century the top tier of Japanese scientists had reached a stage where they were able to understand an outline of Newtonian physics and the outlook of a mechanistic universe.

The deepening consciousness of the world among scholars of Dutch studies, their sense of crisis, and their critical views of politics triggered a government crackdown on one group of such scholars in 1839. But news of the Opium War in China effected a complete change in political conditions. Dutch studies quickly expanded to include the science and technology of Germany, Britain, and France, and became Western learning. Leadership passed from doctors to samurai, and the focus of interest shifted to military and navigational technology. Works on mathematics, chemistry, and industrial technology also began to be translated. For example, the private school set up in Osaka by the doctor Ogata Kōan (1810–1863) produced not only doctors, but also politicians, career officers, scientists, engineers and philosophers. One specialist in the history of technology estimates that towards the end of the Edo period there were almost 2000 scholars engaged in Western learning.

In the 1850s Japan had already entered an era where the study of modern science and technology was no longer solely from books, but also from Western-style education and study abroad in Europe and North America.

We must not forget that science itself was undergoing great changes during this time. After the French revolution, science began increasingly to serve as the

foundation for technology. Science was institutionalized and incorporated into education, specialists in science began to emerge, and research centers and scientific societies were established. Science was no longer natural philosophy, but changed into a system of knowledge that everybody could master by carrying the stages step by step. The science that Japanese elites had studied in Chinese translation and Dutch texts had still been wrapped in natural philosophy. This is why, for example, Shizuki Tadao in his translations had to replace the Western natural philosophy with the traditional Chinese philosophy of qi. However, the science that the Japanese people were now learning from their Western European professors was linked to technology and stripped of natural philosophy. Moreover, the science had not yet become so specialized so as to be inaccessible to the young Japanese elites.

The news of the defeat of China in the Opium War was a great shock to these elites. In 1841 the Bakufu started training a Western-style rifle corps, and in 1845 it established a department of Naval Defense. In the 1850s, the Bakufu and the powerful domains of the southwest like Saga and Satsuma embarked upon a campaign of building a “rich country, strong army”. Since this began as a movement to emulate Western military strength, the initial objective naturally focused on developing a “strong army”. However, with the realization that military strength required a foundation of national wealth, the emphasis gradually shifted to creating a “rich country”—or better still, a rich country with a strong army. I have explained the course of this development in a simple chronological appendix, which enumerates a first instance initiating each undertaking.

This movement started with the establishment of factories for the manufacture of weapons. Following the arrival of the North American fleet led by Commodore Perry to open Japanese ports, the government began trial production of steamships and the construction of shipyards. Facilities were established systematically to study, translate, and research scientific and technical writings; schools started to train students in navigational techniques. Until this time, the Japanese had mostly studied technology from the Dutch. However, when diplomatic envoys went to North America in 1860, the Japanese were able, entirely on their own, to make the crossing back across the Pacific by a military vessel purchased from the West. Henceforth, Western Europe, North America, and Russia all came to loom larger in the thinking of the governing elite, and students were sent to these countries to study such subjects as science, technology, and military affairs, and further, politics, law, and philosophy. As exemplified by the construction of shipyards under the guidance of French engineers, a clear movement emerged to seek out technology far more

sophisticated than the Dutch.

In 1868, the coalition of southwest domains led by Chôshû and Satsuma overthrew the Tokugawa Bakufu, thus ushering in the Meiji Restoration. The building of a modern nation proceeded in earnest. In the previous year, the Satsuma domain erected a Western-style spinning mill; we may perhaps date the beginning of the shift to the “rich country” policy from this time. The Meiji Government established the Ministry of Industry and promoted industrialization by means of government-run enterprises.

The most remarkable venture undertaken by the government at this time was the dispatch of a special mission to Europe and America, which included most of the toplevel government officials. As they toured and observed Europe and America for over two years, the future image of the modern Japan took on concrete form in their minds. In order to nurture the skilled technicians and engineers indispensable to industrialization, Japan adopted the system of technical education that originated from the French *École Polytechnique* and established the engineering department at the University of Tokyo. As the economic and technical limitations of government-run enterprises became clearer in the 1880s, all these enterprises, with the exception of industries like iron and steel and munitions, were privatized. Japan entered its own of industrial revolution.

Bibliography

1. OISHI Shinzaburo and NAKANE Chie eds. *Tokugawa Japan : the social and economic antecedents of modern Japan* (Tokyo : Tokyo University Press 1990).
2. NAKAYAMA Shigeru and David SWAIN eds. *Science and society in modern Japan* (MIT Press, 1974).
3. HAYAMI Akira. “Kindai Nihon no keizai hatten to industrious revolution,” in Hayami Akira et al., *Tokugawa jidai kara no tenbô* (Japanese) (Dôbunkan, 1989).
4. YAMADA Keiji. *Science and technology in the modern period* (Asahi Shinbunsa, 1982).
5. YAMADA Keiji. “The intellectual isolation and opening of Japan and China,” in *The transfer of science and technology between Europe and Asia, 1780–1880* (Kyoto : IRCJS, 1974), 3–7.
6. WILL, P. E. “Chine moderne et sinologie,” *Annales HSC* 1 (1994).
7. IMAZU Kenji. *Kindai Nihon no gijutsuteki shojôken* (Japanese) (Yanagihara-Shoten, 1989).
8. TSUJI Tetsuo. *Nihon no kagaku no shisô* (Japanese) (Tokyo : Chuôkôronsha, 1973).
9. BARTHOLOMEW, James. *The formation of science in Japan : building a research tradition* (Yale University Press, 1989).

STEPS IN THE DEVELOPMENT OF A STRONG ARMY

Manufacture of Weapons	Establishment of refractory oven by Saga domain and Bakufu Establishment of Satsuma Refinery	1850 1851
(Politics)	Arrival of Commodore Perry	1853
Trial production of small ships	Trial manufacture of a small steam ship by Satsuma	1855
Technology assimilation	Establishment of Nagasaki Naval Shipyard with guidance from the Dutch Navy Institute for Bansho-shirabe-sho established (Present Tokyo University)	1855 1856
Ship Building	Start of Nagasaki Shipyard (Dutch technology)	1857
(Politics)	Japanese mission crosses the Pacific on board the Kanrin Maru	1860
Overseas Study	Dispatch of students by Bakufu for overseas study — Holland " — Russia " — England " — France Dispatch of students from the Chōshū domain to England Dispatch of students from the Satsuma domain to England	1862 1865 1866 1867 1863 1865
Ship Building	Dispatch of the Yokosuka Shipyard (French technology)	1865

STEPS IN THE DEVELOPMENT OF A RICH COUNTRY

Spinning	Establishment of Western-style spinning mills at Satsuma	1867
(Politics)	Meiji Restoration	1868
Mining	Development of Takashima Mining	1868
Telegraph	Telegraph lines between Tokyo and Yokohama	1869
(Politics)	Establishment of Ministry of Industry (Encouraging government-run enterprises)	1870
Shipping	Start of Mitsui and Mitsubishi Shipping Agency	1870
(Politics)	Dispatch of special envoy of top government officials to Europe and America	1871
Railway	Railway service between Tokyo and Yokohama opened	1872
Technical Education	Start of technical schools affiliated to the Ministry of Industry (Present Tokyo University) Founding of Mitsubishi Marine School Sapporo Agricultural School founded University of Tokyo founded	1873 1875 1876 1877
Iron Works	Government-run Kamaishi Iron Works established Start of the Mitsubishi coal mine	1874 1881
Spinning	Hiroshima Spinning Mill established Osaka Spinning Mill established	1880 1882
Privatization	Nagasaki shipyard becomes Nagasaki-Mitsubishi Shipyard	1884
(Politics)	Abolition of the Ministry of Industry	1885