

Japanese paper Industry after the Meiji Restoration: How technology helped its growth

Part 7: Summary of the series and continuity from the Edo period

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Preface

The series from Part 1 to Part 6 are summarized in Chapter 9. Then, how cultures in the Edo period influenced the developments of technology in the Meiji period and thereafter is reviewed in Chapter 10.

9. Summary of the series

Before the Meiji Restoration, WSAHI, traditional Japanese paper, supported rich publishing cultures and was an important elemental material for daily life. Feudal lords encouraged paper production, which was well nurtured. Excluding Europe and America, the cultural level was probably the best and was above that of China.

Then, after the Meiji Restoration, a new culture and a new life type were imported and different kinds of paper which fitted to them were wanted, which were called YOSHI. The demand for YOSHI made a new paper and paperboard industry start in Japan and it has been progressing since then.

The new society demanded two kinds of paper products, paper for printing, mostly for letter press printing, and paperboard to help distributing goods.

They were imported at the beginning. Then, efforts were made to supply it domestically. Many pioneers failed, and it took time to take off. It was at about 1900, 30 years after the Restoration, that the domestic production made a noticeable growth. It was at 1915 that YOSHI exceeded WSAHI in the output.

Once getting in growth, the amount of production increased at a rate of 10 to 6% a year. As the GDP increased at a rate of about 3% a year, that of the paper was marvelous. The demand came from two newly born industries, printing and packaging. They also needed as a long time as the paper industry did to take off. In 1930, the output of the printing industry was close to that of the paper industry in money base. The packaging industry also grew sharply after 1915 and many paperboard manufactures started the business. With those active demands, the paper industry invested positively on plants and equipment, and took over

domestic markets from imported products. On the way, it developed its own industrial model.

Why could Japanese paper industry compete against foreign exporters? There had been suggestive cases historically in the world. The paper industry in Islam at the Middle Ages was prosperous. Then, Europe which had learned papermaking from Islam improved productivity and succeeded in manufacturing paper with lower cost. Their products flooded into Islam, and made its paper industry disappeared. America, on other hand, imported technologies from Europe, refined them and became a leader in the world in the 1900s.

After the Meiji Restoration, entrepreneurs who came to know new foreign culture, tried to manufacture paper with an imported paper machine. It started as a private business. The ventures could not compete the imported products, as rags were used, paper machines were small, and instructors invited were highly paid. It took 30 years for Japanese paper industry to take off. It was in those years that an industrial model which would guide the industry from that time on was developed.

It began with engineers of the first generation who studied paper making abroad such as Onodera, Murata, Ohkawa and Majima. Especially, Ohkawa was very sensitive to technological developments overseas, and led the paper industry to establish a Japanese model. Then, engineers of the second generation followed, most of whom were graduates of a technical school founded by the government to educate future leaders, and had a chance of studying abroad while young. They worked as key persons in constructing and operating paper mills. It is understood that they were indispensable for the industry to grow.

The US made its paper industry start by copying cylinder machine invented in the UK, and built up its technological capability. Japan copied an imported cylinder machine in 1872, four years after the Meiji Restoration, which meant that Japan already had such an engineering capability, which helped Japan to move forward to an industrialized society. As the

demand for paper grew up, and more and more paper machines were wanted, they were domestically fabricated. As a number of home-made machines increased, it surely improved a cost competitiveness of Japanese paper industry.

Regarding home-made machines, Japan was fairly smart. In an early stage, imported machines were of a middle-class size. Then, large and state of the art paper machines were imported in only about ten years after they got in use in the world. While operating those machines, latest technologies on them were trans-planted on home-made machines. One domestic supplier finished a 142-inch newsprint machine, a kind of the world standard, in 1925.

Auxiliary equipment such as wire, felt and canvas became also domestically available. They surely strengthen competitiveness of the paper industry. The same kind of progress occurred in Japan as a whole. The paper industry received benefit from progresses of other industries and could compete to the imported.

As the demand was increasing at an annual rate of 10%, and paper machines were being installed, a critical problem was how to feed enough pulp stock for paper making. It was being an important concern of the industry.

In the period of thirty years from the Meiji Restoration (1868) to the year in which Japanese paper industry took off (around 1900), several kinds of wood pulp were newly developed, became available and replaced rag pulp in the world. Groundwood pulp was produced by grinder machines, which kept increasing their capacity of size. Almost at the same time, sulfite process was developed. A rotary digester of a globe type with lead lining was replaced to a stationary digester with brick lining, which made it possible to improve productivity. Then, newsprint made of groundwood pulp and sulfite pulp which later became a standard of the product was in use. Kraft pulping (sulfate process) was completed by integrating its recovery process and kraft pulp was used for packaging commodities. Those innovative technologies were developed in the period of 30 years. Those pulping processes asked softwood, not hardwood.

Those technologies changed power balance among paper industries in the world, some getting prosperous and others getting declined. In the 1920s,

France lost its glory as it could not have enough softwood. The UK barely maintain the status of an inventor of paper machine, who was also in short supply of wood. Sweden, on the other hand, was emerging as a supplier of pulp and packaging paper, taking an advantage of abundant softwood. Germany was the largest producer in Europe, with its industrial power and constant softwood exploitation like afforestation. The US was the biggest producer in the world. It, however, could not manage to get enough softwood of good quality and Canada was delivering newsprint to the US instead.

Japanese paper industry was sensitive to the trend in the world, and became interested in softwood in the early stage of its development. In 1887, Tamaoki visited over ten mills in the US. Only one mill was manufacturing newsprint with its own sulfite pulp and groundwood pulp, which was so called an integrated mill. In those days, Oji Paper, under the leadership of Ohkawa, and Fuji Paper, under the leadership of Majima, were interested in domestic softwood, and tried to set up their integrated mills.

Groundwood pulp could be produced by importing equipment, as the process was relatively simple. Sulfite process, however, which involved chemical reactions was not easy to operate. Oji Paper spent ten years to get the operational know-how at its Keta Mill. The efforts, however, produced return. With the know-how, sulfite pulp mills were successively constructed in the mainland, and then in Hokkaido and later further in Sakhalin. By being able to produce sulfite pulp by themselves, the concept of an integrated mill became feasible. Engineers of the second generation actively engaged in the development, most of whom also had chances to visit and learn technologies overseas.

How was softwood forest in Japan? Once, forest in Japan belonged to feudal clans. Then, the Meiji government took over it and reserved as the national forest. It sold harvesting licenses to paper companies. The volume of softwood forest in the mainland, however, was not sufficient for the demand which grew at a rate of 10% per year. So, the industry was interested in Hokkaido where good softwood were plentiful, and constructed mills which was big enough to be able to compete imported products, such as Tomakomai Mill, Oji Paper and Ebetsu Mill, Fuji Paper. It may be said that

the quality of investment by the industry changed from a local development project to a real international business. As the Hokkaido municipal government needed money to exploit its territory, it was indispensable for the government to sell softwood to paper companies.

Then, after Russo - Japanese War in 1905, Japan took over Sakhalin where softwood forest was untouched and plentiful. Paper companies got harvesting licenses from the local government as they had done in Hokkaido, constructed mills one after another, and supplied pulp and paper products to markets in the mainland. Nishi wrote in 1925 as follows

"In Canada and the US, wages, and wood and coal prices were expensive compared to those in Japan. It will not be impossible for us to compete with Canada and the US if we improve the level of our technology and equipment." The price of wood in Japan might be relatively cheap, compared internationally, which helped the paper industry be competitive in the world.

Pulp wood supply to paper companies even in Hokkaido and Sakhalin became insufficient as a volume of wood consumed in other applications grew up. To get new wood resource, the industry expanded its territory to Manchuria and Korea. In the 1930s, red pine, domestic softwood in the mainland, could be used, overcoming inherent pitch troubles by technological developments.

How did WSAHI act? WSAHI improved productivity by introducing cylinder machines, exported paper of thin thickness such as copying paper and increased its output even after the Meiji Restoration. It, however, could not compete to YOSHI in two new markets, printing paper for letterpress and paperboard for packaging, and left behind YOSHI in the annual output after 1915. It, however, is still doing business as a supplier of functional papers, a new category of paper products which, taking an advantage of its thin thickness, specializes in specific applications.

10. Continuity from the Edo period

10.1 Similarity in technological developments between the Meiji period and the post-World War II period

While reviewing technological developments of

Japanese paper industry in the Meiji era, I found that there were not a few cases in which the ways of promoting technological developments looked similar to what we experienced in the Post -World War period. That is: being interested in up-to-date technologies, actively importing them, transferring them to home-made equipment, and becoming competitive internationally by improved productivity and product quality.

An atmosphere at starting up an imported paper machine looked similar in both cases, though there was an interval of 90 years between the two. Jujo paper Co. imported a newest newsprint machine of a world standard in 1960 and invited two instructors from Europe for the start up. How they were welcomed and worked cooperatively with Japanese operators was reviewed in Japan TAPPI Journal ¹⁾. It reminds us of a case where an imported machine was operated under the instruction of Rogers by Japanese operators, Naosaburo Ono being one of them, in the early Meiji era. Japanese operators quickly mastered operation and Rogers left the mill in a year. In a Jujo case, the machine increased its running speed and improved operating efficiency in a short time, and the instructors left the mill in less than a year.

In the Meiji era, the industry established manufacturing sulfite pulp by itself, stuck to the concept of an integrated mill, and exploited new wood resource in Hokkaido and then in Sakhalin. The industry, in the post-war era, took up kraft process which was versatile to various wood species, exploited wood resource such as hardwood and imported chips, and maintained the concept of an integrated mill.

They were sensitive to technologies overseas, took up cutting-edge technologies actively to which they added their own developments.

Technologies Japan had developed before the World War II were handed over even after the war and contributed much to the quick recovery of various industries. The memoir of Endo vividly described a case ²⁾. In fact, Japan could build the warship Yamato and Zero-fighter planes and the technologies still remained after the war, and helped the restart.

Likewise, the culture and technology in the Edo might have help the Meiji start effectively. Let us

study how they were in the Edo period.

10.2 Culture and economy in the Edo period

The culture of publishing in the Edo period, though its volume was less than that of the UK at 1790 when the UK started its Industrial Revolution, was affluent with many kinds of books and manuscripts³⁾. The literacy rate was high and was supposed to be in a level of the best in the world. Economically, the per capita GDP of Japan at 1900 when its society started to change, heading to industrialized one, was almost the same to that of the UK at 1770 when the Industrial revolution began³⁾.

In summary, the culture and economy at the end of the Edo period seemed to be not so much behind those of the UK at the beginning of the Industrial Revolution, judged by GDP and number of publications. So, let us survey them in details.

10.3 Science and technology in the Edo period

Science and technology in the late Edo period were introduced as follows⁴⁾.

The Edo period was not completely closed to science and technology overseas. The communication with Holland was maintained. Its books were translated into Japanese, and Dutch scholars were respected. In 1823, Siebold (Hilipp Franz Balthasar von Siebold) visited Japan and introduced medical science and biology.

In the late Edo period, Japan was interested in ship building and gun making, and actively imported advanced knowledge. In 1855, a first steam engine was self-made. Pompe (Johannes Lijdius Catharinus Pompe van Meerdervoort) introduced, from 1857 to 1862, the latest medical science at Nagasaki. The Tokugawa Shogunate opened kinds of schools at Nagasaki and foreign instructors systematically educated Japanese students. Their topics were physics, mathematics, metal refining and languages. Private schools by Japanese also opened and many able youngsters graduated them.

What was a level of science and technology in the Edo period?

Suzuki who was a chief of the history of science, National Museum of Nature and Science selected seven scientists and technologists, and introduced them as follows⁵⁾.

Shunkai Shibukawa (1639-1715): Japan kept using a calendar prepared in China at its Tang period. As it had been used for 800 years, the difference between a date in the calendar and a date in real grew to 2 days and troubles occurred. Shibukawa prepared his original calendar in 1684 to deal with the troubles. He became a chief of astronomy, and made an astronomical observation.

Takakazu Seki (1642?-1708): He was a famous master of wasan, Wasan is a mathematical system developed in Japan, and is different from that of Europe. Suzuki said that the level seemed to be no less than that in Europe. Seki correctly calculated the circular constant π to a number down to the ten decimal point by using a regular polygon of 131,072 sides.

Tadataka Inou (1745-1818): After retiring from a trade business, he studied astronomy and accomplished Dainihon Enkaiyochi Zenzu, which is a surveyed map of the whole of Japan. It was as good as the world's finest ones.

Seishuu Hanaoka (1780-1835): He was a practicing physician in Kii (Wakayama Prefecture). He was a master of traditional medicine based on Chinese one, studied Dutch medicine, tried to integrate them and invented his method. He succeeded in an operation under an anesthetic for the first time in the world. The drug was his own invention.

Ikkansai Kunitomo (1778-1840): He was a gunsmith. He happened to see a reflecting telescope made in Holland. He tried to make one by himself. His telescope could see an image twice as large as a Dutch one did. His mirror was really extraordinary, and even a professional today would need a year to make one like his. He made astronomical observation with his telescope and left a lot of records.

Hisasige Tanaka (1799-1881): The best masterpiece of his is "Man-nen tokei", perpetual clock. It is made of a hexagonal pillar. Each face presents a specific clock or a calendar such as Japanese clock, western clock and calendars. A hemisphere of glass at the top represents a celestial globe. Winding a spiral spring once a year, it maintains almost a correct time throughout. The amazing is a mechanism of Japanese clock. The Japanese clock is a kind of temporal system, a way of measuring time, by equally dividing daytime and nighttime, as

determined by the times at which dawn and dusk occur, called "indefinite time". For example, as the nighttime is longer than the daytime in winter, one unit of the nighttime is longer than one unit of the daytime. At around the summer solstice, one unit of the daytime is 165 minutes and that of the nighttime is 75 minutes, less than a half of the daytime. Tanaka's "Man-nen tokei" has a mechanism of automatically controlling that unit. It is the height of genius who understand astronomy as well as mechanical engineering.

Though technologies were exchanged under an unfree and restricted condition through a narrow communication route in the Edo period, creative and original activities were carried out in many categories and some were up-to dated.

Right at that time, the Industrial Revolution started in Europe. Regarding the progress of the Industrial Revolution, Khalid Mahmood Zia proposed a hypothesis⁶⁾. The inventions in its early stage were practical and mechanical. Then, scientific and chemical inventions followed which accelerated the revolution.

He studied the history of chemical industry which he regarded as a first industry based on science, and found that the first chemist in a strict definition was Antoine Lavoisier. His scientific thinking settled in Germany. The UK which started the revolution was rather interested in classical and theoretical thinking, and those who worked in industries with little scientific background promoted the revolution. It was true that the UK was a leader in chemistry in the early 19th century. But, the chemistry at that time was mostly inorganic and was like mining. Perkin was developing organic chemistry like synthesizing dyes. Then, Germany overtook the UK by 1880. For instance, out of thirty-one Nobel Prize winners of chemistry in the period from 1901 to 1931, fourteen were German⁷⁾. Many excellent researchers (Helmholtz, Fahrenheit, Roentgen, Hertz and et.al) and engineers (entrepreneurs) (Zeppelin, Daimler, Otto, Benz and et.al) other than chemists also appeared in Germany. Entrepreneurs are indispensable for developing scientific outcomes to major industries. Their efforts produced major industries of the coming generation such as chemical industry, automobile industry and electrical industry⁷⁾.

It is understood that how far science, chemistry being a part of it, was established and accepted in society would affect its outcomes. Take a look at the Edo period from this understanding. Those introduced (Kunitomo, Tanaka, Shibukawa and Inou) were practical and mechanical or industrial. Wasan did not offer a base for science, and became a closed organization like those of tea ceremony and flower arrangement. Medical science was far from a level in Europe. They mastered practical and mechanical talents of a relatively high level. On the other hand, scientific thinking and approach were not accepted in the Edo society yet. It, however, had possibility of accepting science, as its literacy rate was high enough.

Suzuki introduced as follows⁵⁾.

"What was the best seller in the Edo period? It was Koujinki, a mathematical book on practical matters in daily life. It was said that almost every family had one. There were no such countries at that time." Wikipedia introduced Kojinki as follows⁸⁾. It was written in 1627. It covers numeration, counting units, multiplication table and simple calculations such as measuring an area and so on. It compiles mathematics needed in daily life.

There were two big differences between Japan and Europe in the 19th century. One was a source of energy. Europe used old water wheels as well as newly developed steam engines. Water wheels were yet to be used in the early Edo period in Japan and paper was manufactured almost by manual works. The other was the exchange of information among people. As reviewed⁹⁾, these two surely advanced the Industrial Revolution, and the latter functioned even between Europe and America which were far separated by the Atlantic Ocean. In the Edo period, on the other hand, traveling was strictly controlled.

These two restrictions were removed after the Meiji Restoration, the social change which Europe had experienced during the revolution occurred in Japan in a much shorter period.

One indicator of social change is a population size. Historically, a period in which population grew up overlapped a period in which GDP increased and technology developed. The size of population was about 30 million throughout the Edo period. It increased by 10 million in 50 years in the Meiji era. In Europe, it was 56 million in 1500, 200 million in

1800 and 300 million in 1900 ¹⁰⁾.

10.4 Continuity from the Edo period

It may be understood as follows. Those who was intellectual and had enough mechanical capability had a chance of contacting up-to-date technologies without restriction. They also obtained a new type of energy. With free exchange of information among people and a new energy available, the rapid expansion of economy and technology in the Meiji era occurred. The paper industry was one of those new born industries.

In the course of technological advancing, technologies having mechanical characteristics were mastered quickly. Those having chemical characteristics were not easy to master, and took a long time. The paper industry copied an imported cylinder machine right after seeing it. It could produce mechanical pulp without difficulties. It, however, experienced a hard long time, almost ten years, to operate a sulfite pulp plant and to have know-how available for the future expansion, as it needed understanding chemical characteristics. In fact, Japanese steel industry also took a hard and long time to operate a blast furnace satisfactory in its beginning.

Japanese had a high level of mechanics in the Edo period which remained as one of characteristics of Japanese technology thereafter. It built Zero-fighter planes and the warship Yamato, though it could not invent a radar system and an atomic bomb. After the war, it has often been heard that mechanics was an origin of Japanese technology. That understanding has reacted adversely. Japan has been late in software development.

Japan seems still to have a legacy of the Edo period. It will be necessary to focus more on science and to accept scientific thinking.

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Postscript

Though I worked as an engineer for almost 50 years in the paper industry, I knew little how Japanese paper industry was born and grew, and dealt with successive social changes occurred after the Meiji Restoration. I found that few literatures covered, as an overview, the history throughout from the Meiji Restoration to the World War II, not to mention one specialized in technical viewpoint. I was afraid that a chance of recording the history might be lost, unless anyone ventured it as fast as possible.

In preparing the document, I referred to secondary sources such as research papers by scholars and professionals which could be searched in the internet. Without the internet, it would be impossible to finish the story.

Among them, I was amazed to find that not a few scholars of economy were interested in the growth of the paper industry after the Meiji Restoration, and studied it as a case of one of emerging industries. If their papers were written in English, they would be very suggestive to foreign scholars.

The other source I frequently referred to was JAPAN TAPPI Journal. Memoirs by many pioneers and seniors who made the industry advance with their hard work were very helpful. They also let me know that their memoirs were indispensable for documenting the history. Especially Itsuki Nishi and Yoshikuni Seki were much credited to it.

Finally, I thank JAPAN TAPPI Journal for publishing my work.