

# How the paper industry in Japan has technologically responded to the paradigm shifts of the Japanese society

## Part 1: The paper industry as a member of the industrial sector of the Japanese economy

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### Introduction

It is interesting for an engineer who worked for forty years in the paper industry to review how the paper industry has technologically responded to paradigm shifts of Japanese society and how it has coped with structural shifting of the industrial sector.

Technology of the paper industry has progressed, being interacting with various developments in other technical categories.

Historically, the paper industry has been classified by the term "pulp and paper industry" in national statistics. After the World War II, there were two groups of companies in the paper industry, one producing pulp for rayon manufacturers and the other for paper and paperboard production. In the 1950s, rayon pulp shared about 15% of the total pulp production, which was significant enough in the volume. Though only one mill is now producing rayon pulp, the term pulp and paper was used until 2015. So, the both terms, paper industry and pulp and paper industry, are used in this report almost as the same synonym.

### 1. The pulp and paper industry after the World War II

#### 1.1 Paper and paperboard consumption after the World War II

Fig. 1 shows yearly paper and paperboard consumption volumes since 1953 in Japan <sup>1)</sup>, its y-axis being logarithmic. If the volume increases at the same rate a year, the plotted data will form a straight line of which gradient corresponds to the yearly increase rate. Fig.2 shows the per capita consumption calculated with the data in references 2) and 3), the y-axis of which is also logarithmic.

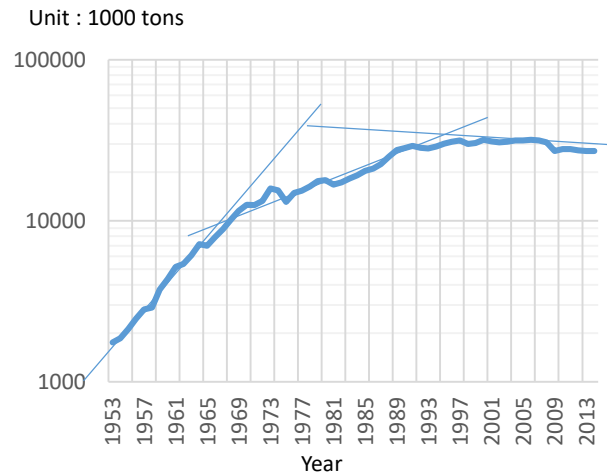


Fig. 1 Paper and paperboard consumption in Japan

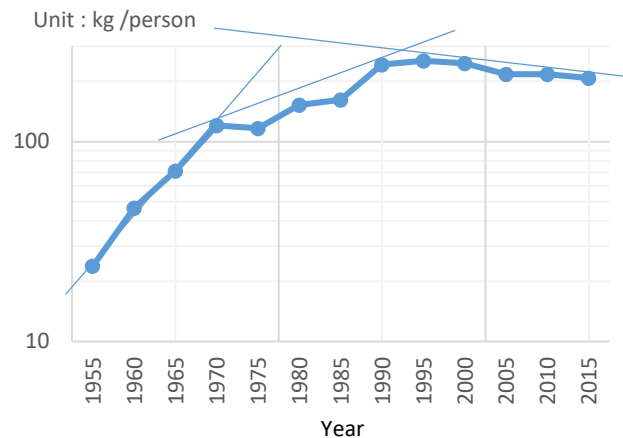


Fig. 2 Per capita consumption of paper and paperboard in Japan

In Fig. 1, the dots or the growth trend can approximately be divided to three different linear line segments at the years 1970 and 1994 as their inflection years. Fig.2 also shows the similar pattern.

A line segment suggests that the consumption increased at the same rate a year during the years the segment covers, and its gradient gives the growth rate per year by simple calculation.

So, a growth rate per year of each segment in Fig. 1 as well as that in Fig.2 are calculated and they are summarized in Table 1.

Table 1 Yearly growth rates (%) calculated from Figures 1 and 2

	1953-1970	1970-1994	1994-2013
Paper and paperboard consumption	13.2	3.8	-0.9
Per capita consumption	11.3	3.8	-1

The yearly growth rate of paper and paperboard consumption, which had been more than 10%, drastically lowered to 4% from around 1970, and became negative from 1995. These decreases suggest that the framework of paper and paperboard consumption in Japan greatly changed twice at around 1970 and 1995. The yearly production of paper and paperboard in Japan has also changed in the same way as the consumption did, though it is not presented. If it was plotted in Fig. 1 along with the consumption, they would overlap each other and little difference could be observed between them.

### 1.2 The paper industry as one of major industries in the Japanese economy

Then, how did the Japanese economy perform in those years? To check it, the data was extracted from the inter-industry relation tables published every five years by the Ministry of Internal Affairs and Communications. What is the inter-industry relation table? It is explained as follows<sup>4)</sup>.

The inter-industry relation table intends to clarify the overall structure of Japanese economy at an objective year, and offers basic data for analyzing "spillover effect" in the economy. Goods and services which are produced and sold for a certain period (one year in most cases) in every industrial sector are collected and compiled in a table of matrix.

One industrial sector buys raw materials and fuels from other industrial sectors, fabricates them to goods and services and sells them to another sectors. The sector, which buys them, uses them to produce another goods and services. So, the chained transfer of goods and services, "buy-produce-sell", is expressed in the table. When a new demand occurs in one industry, you can follow how it affects others as spillover.

With this table, the position of paper industry in the total Japanese economy can be calculated, and be compared to others based on money, not by output

volume. Using the table data, Yoshikawa made a skyline analysis on the development of Japanese economy every five years since 1960<sup>5)</sup>. Following data are from his report.

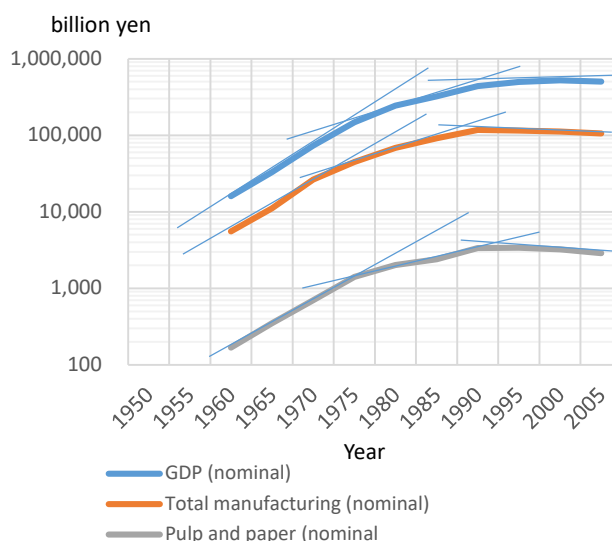


Fig. 4 Economic activity, GDP (nominal), product of total manufacturing industries (nominal) and product of the paper industry (nominal) (Note: Fig.3 is vacant.)

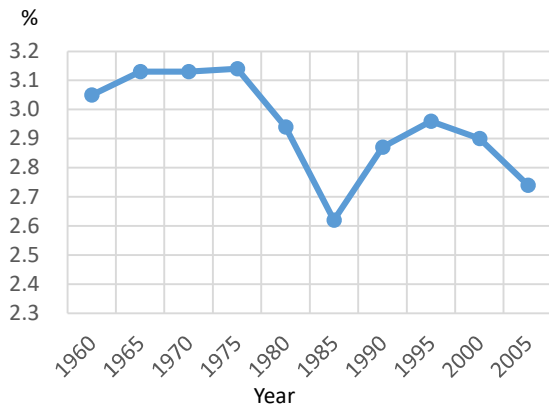
Fig.4 shows the gross domestic product (nominal), product of total manufacturing industries (nominal) and product of pulp and paper industry (nominal), all in money base, from 1960 to 2005. The y-axis is logarithmic, and if the rate of increase per year is kept constant for a period of years, the gradient of a line that covers the period will be constant. It is evident that GDP which represents Japanese economy had two transition periods, one from 1970-1975, and the other from 1990-1995. It is understood that the paradigm or framework of Japanese society made a great shift in those two transition periods. At the same transition periods, the total manufacturing and the pulp and paper behaved similar to GDP. That trend is exactly the same one observed in the paper consumption in Fig. 1 and also in the per capita consumption in Fig. 2. Drawing approximate line segments in Figure 4, gradients are calculated, and resulting growth rates per year are summarized in Table 2.

**Table 2 Yearly growth rates of economic activity (%)**

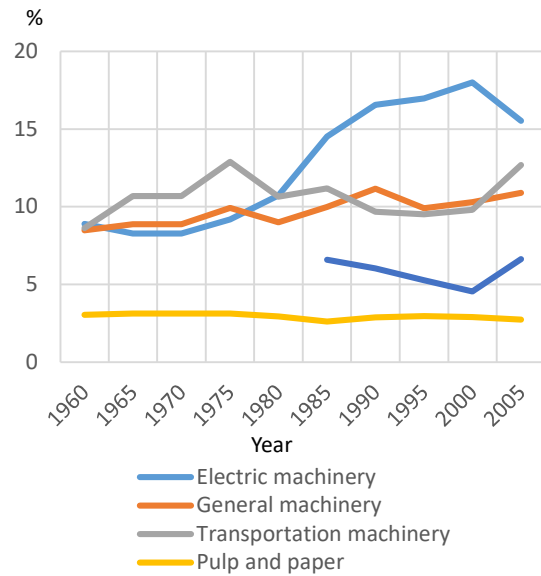
	1960-1975	1975-1990	1990-2005
GDP	14.5	8.6	0.0
Manufacturing industry	15.2	4.9	-0.1
Pulp and paper	13.0	6.4	-1.1

The pulp and paper industry had a growth rate as high as that of GDP in the early high-growth period (1960-1975). Its rate was less than that of GDP in the following plateau period (1975-1990), and became negative and was less than that of GDP after 1990. The growth rate of the total manufacturing industry was more than that of GDP in the early high-growth period, became a little less than that of GDP in the plateau period and was negative after 1990. This loss of the margin of the early period against GDP was due to structural change in economy in which the tertiary industry became major, replacing the manufacturing industry.

As for the pulp and paper industry, its share in the total manufacturing sector in nominal money base was plotted in Fig. 5<sup>5)</sup>. The ratio started to decrease after 1975, sharply dropped at 1985, quickly recovered, and then gradually went down.

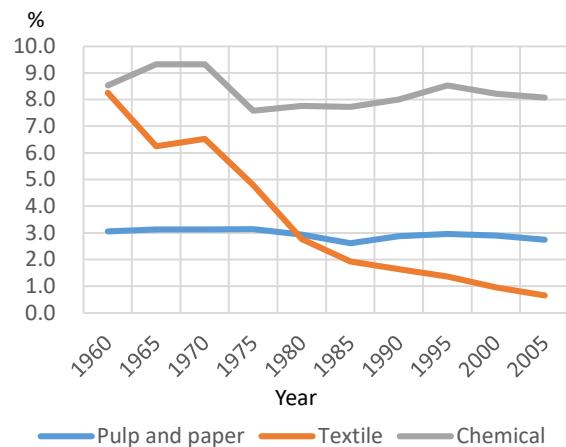


**Fig.5 Composition ratio (%) of the paper industry in the manufacturing sector**



**Fig. 6 Composition ratios (%) of several manufacturing industries**

Then, how did other industries perform? Fig.6 summarized shares of several major manufacturing industries in the manufacturing sector. They were representative exporters of goods. As the steel industry was classified among general metals until 1980, data on its performance in the 1970s in which it led the world production were not available. Its share at that time would be much higher than that in 1985. The pulp and paper, in contrast, looked to be constant. Let us check some other industries.



**Fig. 7 Composition ratios (%) of several industries in the manufacturing sector**

The textile industry once led the Japanese economy as a star of exporters before the World War II. It also played an important part in recovering after the war. It, however, lost its share, being defeated by imported products. It has been said that the

chemical industry was not competitive in exporting. It, however, maintained its share domestically. The pulp and paper industry was rather unique in keeping constantly its share after the war.

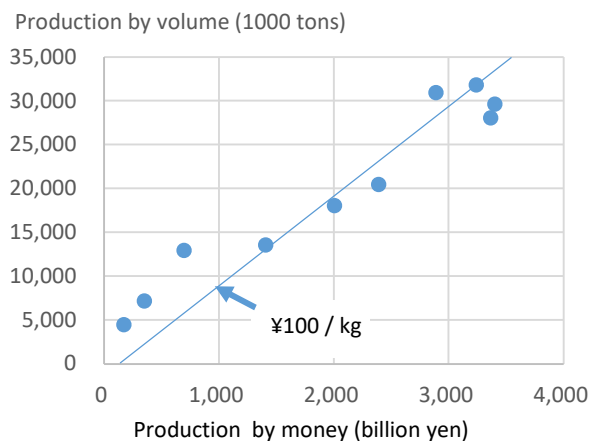


Fig 8 Relationship between the volume and the money of paper and paperboard production

Fig.8 gives the relationship between paper and paperboard production in volume base and that in money base (nominal). The fact that there is a fair linear relationship between them suggests that the nominal price of the product has been almost the same for 50 years after the war (about 100 yen per kg). It could not be done without diligent efforts of the industry, technological developments being one of main contributors. Because of it, the paper industry could be competitive against imported products. If not, it would have diminished like the textile industry.

### 1.3 Why orienting to domestic market

Many of manufacturing industries in Japan have been orienting to export. The paper industry, however, has not been so. Fig. 9 depicts the ratios of export and import against the total production respectively <sup>6)</sup>. Though the production volume increased very much in 60 years, the ratio of export against the production was rather constant (about 4%). The ratio of import was growing gradually, but still was about 8% at 2013.

Why have they been so small? The paper industry has been analogously compared to the steel industry. The latter imports iron ore aboard, of which yield is about 50-60% (my understanding). It is one of highly energy consuming industries. In spite of those handicaps, it once exported its products all over the

world. The paper industry, on the other hand, imports wood chips aboard, of which yield is about 50%. Though it is an energy consuming industry, its energy efficiency is supposed to be better than the steel industry, as some energy is recovered by burning waste liquor.

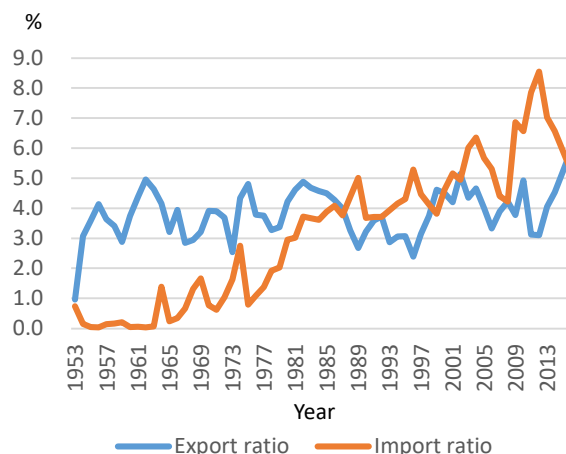


Fig. 9 Export and import ratios against production

While I worked in the paper industry, the menace that our domestic market might be taken over by imported products was repeatedly discussed with anxiety, and I wondered why the paper industry could not expand like the steel industry.

The main difference between the two industries is in their raw materials, wood and iron ore. There is no use for iron ore except being refined to steel. So, the steel industry is able to lead and control the supply and price of iron ore. On the other hand, wood have historically been used in various applications like lumber, fuel and so on. The share of paper industry in wood consumption has been about 15% in the world, and the industry has been competing to other users for securing the supply in the 20th century. So, the paper industry has always been defensive in wood market. The history of Japanese paper industry was always an effort of securing enough wood to supply for the demand of its domestic market, and there has been no spare wood for export.

Instead, the industry has been defending its domestic market by all means, and we can see its effort in the trend of the imported volume in Fig. 9, which was still below 10% to the total production in 2013. There was, however, something noticeable. The imported volume was gradually increasing after

1970, which was one of the turning points of the Japanese economy shown in Fig. 1. It may suggest that the industry has been changing its structure since then.

The other factor is that paper and paperboard produced in a certain economic block has been consumed almost in that block. As the consumption volume in a certain area has been statistically correlating to the GDP of that area, the district heavily populated and economically active has consumed lots. The EU has been one of such blocks and the USA has been another one. Japan has become one of such blocks, as its GDP grew.

Table 3 summarizes the production and trade of the developed and the developing countries in 1995 <sup>7)</sup>. Whether the developed or the developing, paper and paperboard was not a product of trade.

Table 3 Paper and paperboard production, import and export by regions (1995)

	million tons		
	Production	Import	Export
Developed	225.1	52.5	67.2
Developing	61.2	16.7	6.5
World	286.3	69.3	73.7

This trend is still existing, and paper and paperboard produced in an economic block is still consumed there. The report by MITI published in 2015 <sup>8)</sup> analyzed that Canada exported 70% of its paper production (paperboard not included) to the USA, and the three fourth of the export of the EU was traded in the EU itself. Regarding to paperboard, the USA exported about a half of its production to near-by countries (North and South America), and the three fourth of the export of the EU was also traded in the EU itself.

One of reasons of being traded mostly in a block is that the product is bulky and costly for transporting and handling.

#### 1.4 The paradigm shift of Japanese society in the 2000s

The Japanese paper industry that kept a status of being a member of major manufacturing industries of Japan faced a difficulty it had not experienced yet in the 2000s. As in Fig. 1, the paper and paperboard consumption started to decline at around 1995. This negative growth will be later discussed in Part 4 and

Part 5. In summary, Japanese society has been transformed from the industrial society to so-called information society. The way paper was used in has changed greatly like a paradigm shift, and the paper industry has been working to adjust itself to the change. Though paper consumption is declining by digital information network, the paper board consumption is increasing as society is more connected and net-worked by physical distribution. Paper, paper board included, is still one of important materials of society.

#### 1.5 Introduction to next issues

The paper industry, though faced successive crises, has maintained a certain status in the Japanese economy, and technology certainly has helped it. So, the history of technological development in the paper industry will be reviewed from the viewpoint of social and economic developments in Japan. In the next issue, how the paper industry responded to the structural change of Japanese economy starting from 1970, which could be regarded as a paradigm shift, will be reviewed.

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