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

Part 6: Key-technology and Information Revolution

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Introduction

How Japanese paper industry responded to the paradigm shifts of the Japanese society was reviewed in the previous chapters. The review has exposed that the information revolution which started from around 2000 and is affecting the paper industry to a great extent is changing the traditional society which had started from the Industrial Revolution. This emerging society can be called information society, and be a successor to the industrial society, of which predecessor was the agricultural society. In the same way, human history has experienced the agricultural revolution, followed by the industrial revolution and now is in the information revolution.

The chapter of this issue starts from 6 due to consecutive numbering. References cited also are in consecutive numbering from Part 1.

6. Key technology and Information Revolution

6.1 Key technology

In Part 2 of this report, the solid state technology was explained as a key technology to the Japanese manufacturing industries in a period between 1960 and 1980 in which they made a big leap. The slow-down of their growth from the 1980s was due to the fact that they could not find a technology successive to the solid-state. As mentioned in a chapter on the stalemate in the process industries in Part 3, the design speed of paper machine reached a plateau at around 1990, and its width began to reduce its widening rate a year in around 1970, earlier than that of the machine speed. The total unit energy consumption of the paper industry also stopped declining at around 1990. A similar trend happened in the steel industry, which was one of typical process industries and led technological innovation in the world. The rate of increase of the volume of blast furnace per year became stagnated at around 1980, just like paper machine did

Then, devices used in solid state technology raised their ability and accelerated their processing speed. They drastically improved their cost performance as predicted by the Moor's law, and gave rise to a new revolution. This revolution, however, did not contribute to increase productivity of unit equipment so much.

The newly born was an information processing technology with which everything was optimized. The just-in-time system by Toyota was a predecessor and aimed to optimize manufacturing operations by exchanging information effectively. Then came the internet, which provided a new platform. After 2005, a type of information called big data increased its volume at an accelerating rate. It also aimed to reduce cost in every area by processing a big volume of data.

Regretfully, Japan got behind in this technological revolution as it concerned too much to manufacture real products. It was a big supplier of parts to I-phone, but could not make I-phone. It lagged behind in developing business models of using smart phone.

From around 2000, the technology of processing a big volume of data became influencing and its impact is observed in various areas of society. As discussed in Part 5, the society industrialized by the Industrial Revolution is now changing to the information society by the information revolution.

6.2 The Industrial Revolution and the Information Revolution

There are many papers on the Information Revolution by professionals and I am not qualified to be in the members. One view point of my own, however, discloses a certain fact.

Fig. 38 shows that the total GDP of the world kept increasing at the rate of something over 3% a year after 1980.

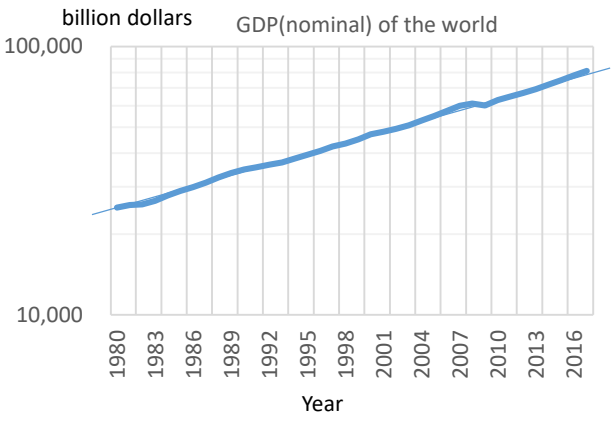

Fig. 38 Nominal GDP of the world
Unit: billion dollars, Yearly growth rate: 3.11%

The growth rate a year does not change even after around 2000 when the Information Revolution started. Does it mean that the Information Revolution will make the world prosperous at the same growth rate as before? Let us study this question.

First, let us see social change after the Industrial Revolution. Fig. 39 is summarized from Maddison Project Database [76]. Maddison Project or Maddison Historical Statistics Project, to which Groningen University in Netherland is responsible, is designed to compile economic indicators, like GDP and per capita GDP, of every country from its historical age to the present time into one database. It has two data series for per capita GDP. One abbreviated as cgdppc, real GDP per capita in 2011US$ for multiple benchmarks (suitable for cross-country income comparisons), is used in Fig. 39. Japan, USA, UK and China are taken out and their per capita GDPs are plotted against years.

As the plotted dots can be approximated to a liner line segment for a certain period of years, its gradient which is equivalent to a yearly growth rate is calculated. They are summarized in Table 15.

Table 15 Yearly growth rate of per capita GDP for the period (%)

	Year	Growth rate a year
Japan	1700-1870	0.11
	1870-1940	1.70
	1940-1970	8.30
	1970-2000	3.00
USA	1720-1830	0.48
	1820-1940	1.60
	1940-2000	2.30
UK	1700-1830	0.30
	1830-1940	1.30
	1940-2000	2.30

In the UK and the USA, the yearly growth rate of per capita GDP sharply increased at around 1830 which looked like an inflection year. These increased growth rates suggest that the social structure after the Industrial Revolution was different from that of previous years. Though there was some extra up in value from 1940 in both countries, the growth rate, as an approximation, was almost constant throughout 200 years.

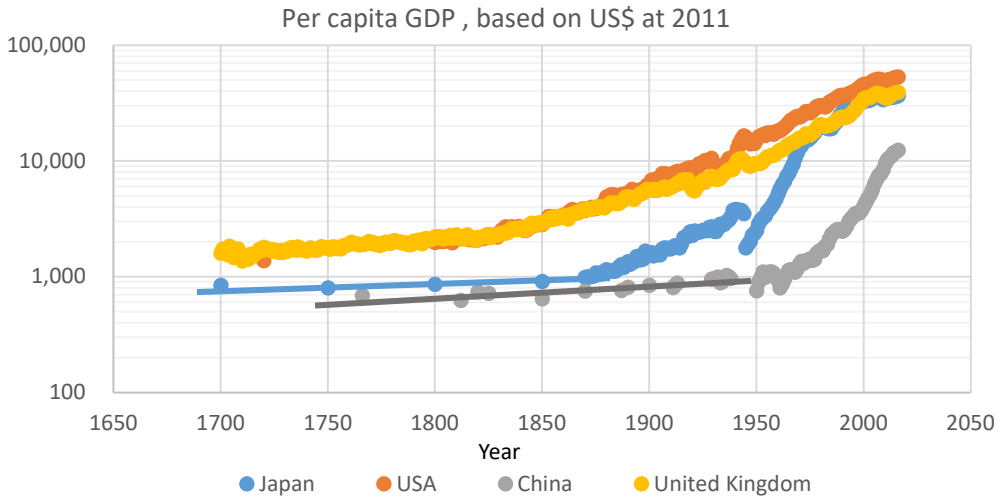

Fig. 39 Per capita GDP Japan, USA, China and UK Unit: US$ at 2011

Regarding Japan, its society was transformed to modern industrial one like those observed in the UK and the USA after the Meiji Restoration (1868). Its per capita GDP started to increase at a higher rate than before, and dropped down at World War II. Then it recovered quickly, and caught up those of the UK and the USA. China increased its per capita GDP at a vigorous rate after shifting its policy in the 1970s.

Though the year of an inflection point was different in each country, it was a year in which each country was transformed to an industrial society and started to increase its productive power. After an inflection point, it kept a higher growth rate. Though the Industrial Revolution produced many contradictions, it certainly made society rich as an average.

Then, the Information Revolution is changing society since around 2000. As not so many years have passed yet, it is difficult to see its trend in Fig. 39. But, in the developed countries, the growth rate of per capita GDP looked to begin to slow down after 2000. So, the Information Revolution will not promise what the Industrial Revolution did to its society. Its key technology, which is called information technology, will not accelerate GDP growth, but rather slow down its growth, different from one developed by the Industrial Revolution.

Fig. 38 showed that the world total GDP was still increasing at the same rate even after 2000, and the fact was contradictory to Fig. 39. It might be that high growth rates in developing countries have compensated declining growth rates in developed countries.

Personally, I understand that the technology after the Industrial Revolution made it possible to maintained high GDP growth rate by improving productivity of manufacturing. The information technology, on the other hand, has intended to improve efficiency of society, not to increase GDP.

For instance, networking every information at various stages of material flow from manufacturing to marketing to distribution will improve efficiency of society as a whole, and result in less energy consumption. AI, one of information technologies, will help to develop new products with less money and less man power, which means that the total energy needed will be less. Therefore, the efficiency of society will be evaluated with the energy consumption per unit GDP. So, taking Japan as an example, GDP (nominal) and the total energy consumption since 1990 were plotted in Fig. 40 [77), 78)].

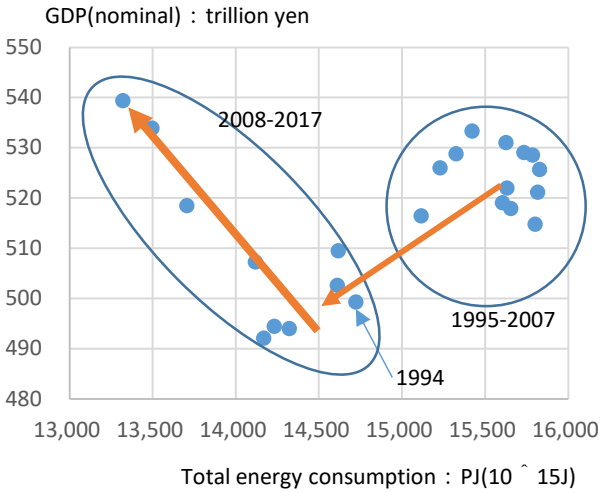

Fig. 40 Total energy consumption and total GDP (nominal) of Japan

As there seemed to be some relationship between them, the total energy consumption per nominal GDP was calculated and plotted against years as in Fig. 41.

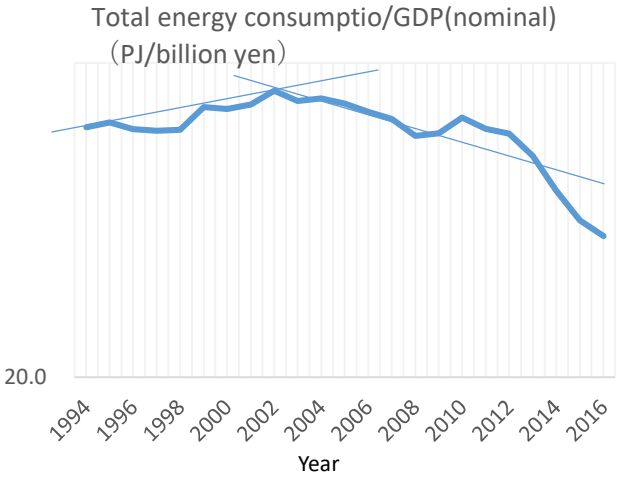

Fig. 41 Total energy consumption per GDP PJ/billion yen

The energy consumption per GDP increased until 2003, then started to decrease, 2003 being a turning point. As the y-axis was a logarithmic scale, its annual changing rate was calculated as follows.

1994-2003: +0.4%/year

2004-2016: -1.7%/year (fairly big variance)

The period from 2000 to 2010, in which Japan began to shift to information society was a zone of inflection for the index, the total energy

consumption /GDP. If this index keeps declining as it was, it would be possible to increase GDP at a yearly rate of 1-2%, without increasing the total energy consumption in society. I believe that this is one of fundamental characteristics of information society indeed.

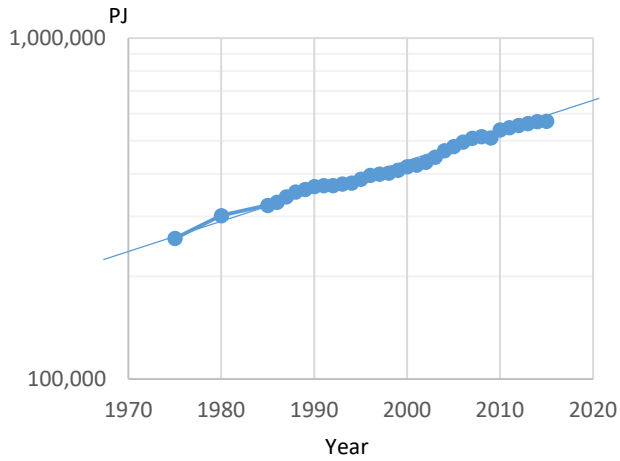

Fig. 42 Total energy consumption of the world [79)]

The total energy consumption of the world, on the other hand, is still increasing as in Fig. 42 [79)]. Its yearly growth rate is 3.2%, which is close to the yearly growth rate of GDP of the world, which was 3.1%. It is definitely impossible to keep supplying enough energy at a present growth rate from now on, as resources are limited on the earth. Someday, it will have to slow down and be stagnant. It will be hopeful that the technological revolution called the Information Revolution will improve the energy efficiency of society and make it sustainable, as Japan is doing.

References

76) Maddison Project Database, version 2018. Bolt, Jutta, Robert Inklaar, Herman de Jong and Jan Luiten van Zanden (2018) https://www.rug.nl/ggdc/historicaldevelopment/maddiso

77) Nominal GDP of Japan http://www.esri.cao.go.jp/jp/sna/menu.html

78) Total energy consumption in Japan https://www.enecho.meti.go.jp/about/whitepaper/2013html/2-1-1.htm

79) Total energy consumption of the world https://www.globalnote.jp