

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

Part 2-2: The Paper Industry in the 1970s --- Energy Saving and international Competitiveness

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Introduction

The period of time from 1970 to 1975 was a significant transition period in the history of Japanese society and its economy. How the paper industry responded to the transition was a theme of the second part of this series, continuing from Section 1. The chaptering starts from 2.7 following the last chapter in Section 1 of Part 2. Figures, tables and references are consecutively numbered from Part 1.

2.7 Energy

Oil price hike in the 1970s was a vital problem for the paper industry, typical energy eater, and coping with it became a theme of the whole industry like the environmental preservation reviewed in Section 1. Then how much did the industry consume energy? Table 6-1 was the statistics in 1992. For reference, that in 2011 was in Table 6-2, which will be discussed later.

Table 6-1 Breakdown of energy consumption in 1993³⁷⁾

Total energy consumption: 360 million kl (crude oil equivalent)

	(%)
Industry	50
Consumer	26
Transportation	24

Breakdown for industries	(%)
Chemical	12
Iron & Steel	12
Ceramic	4
Pulp & Paper	3
Other Manufacturing	12
Others	8

Table 6-2 Breakdown of energy consumption in 2011³⁸⁾

Total energy consumption: 14,306 PJ (PJ=10¹⁵J)

	(%)
Industry	47.1
Consumer	28.4
Transportation	24.5

Breakdown for industries	(%)
Chemical	14.8
Iron & Steel	11.4
Ceramic	2
Pulp & Paper	2.2
Other Manufacturing	14.8
Others	1.3

Though notorious as a big energy eater, the paper industry shared only 2-3% of the total energy consumption in Japan. The energy cost, however, occupied about 20% of the production cost in 1988 and mattered much. The way to deal with the problem was a very Japanese-style. The Japan Paper Association led action and the all-member companies followed. JAPAN TAPPI also supported the move and its energy committee repeated a survey, covering almost all of pulp and paper mills in Japan, on actual energy consumptions, such as unit energy consumptions of paper products as well as those at equipment like paper machine and digester. It also had a seminar discussing energy saving every year, and made the industry be conscious on the subject.

Table 7 List of surveys on energy consumption in pulp and paper mills by JAPAN TAPPI³⁹⁻¹⁾

Survey No.	Year	Subject of questionnaire survey	Number of mills
1st	1977	Unit energy consumption product base	79
2nd	1979	Energy saving projects	73
3rd	1981	Unit energy consumption product base	75
4th	1982	Energy saving projects	70
5th	1984	Heat efficiency on boilers and turbines	52
6th	1988	Unit energy consumption product base	85
7th	1999	Unit energy consumption product base	92

In the survey on actual energy consumption, a questionnaire was sent to all member mills of the Japan Paper Association. It asked to report the unit consumption of steam and power on every product. As for mills, it was an unexpected request and they would have denied it in a normal situation. The energy, however, was so important a subject that most mills, being led by large paper companies, cooperated. In the first survey ³⁹⁻¹⁾, the answer covered 94.4% of the total pulp production, 73% of the total paper production and 35% of the total paperboard production which was still not bad, taking into an account that there were many small paperboard mills. In the survey in 1999, 92 mills replied and the cover rate was 84% of the total paper and paperboard production. I searched whether this kind of survey was done in the world in the 1990s to compare with those of Japan, and could not get any information. It would be unbelievable to have this kind of survey overseas. The Japan Paper Association, furthermore, made a statistic report on energy consumption of the industry every year ³⁷⁾. Recently, JPA is interested in carbon dioxide emission along with energy consumption and the survey is going on.

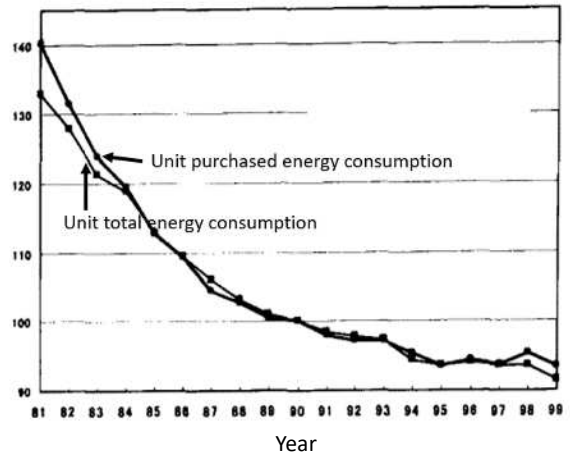


Fig. 16 Unit energy consumption since 1961 by index-number based on the value in 1990 as 100 ³⁹⁻²⁾

Fig. 16 depicts the result of energy saving efforts. Paper companies had been improving productivity and product quality to be competitive in the market. In some cases, equipment such as paper machine was modified with additional auxiliary equipment which inevitably increased the unit energy consumption. In spite of this situation, not only unit purchase energy consumption but also unit total energy consumption kept decreasing. As a result, the share of energy cost to total cost declined from 20% in 1980 to 7-8% in 1990 as in Fig. 17 ³⁷⁾.

Takahashi calculated an overall unit energy consumption of a country by simply dividing its total energy consumption by its total paper and paperboard production. That of Japan was two thirds of that of the US in 1993 ³⁷⁾.

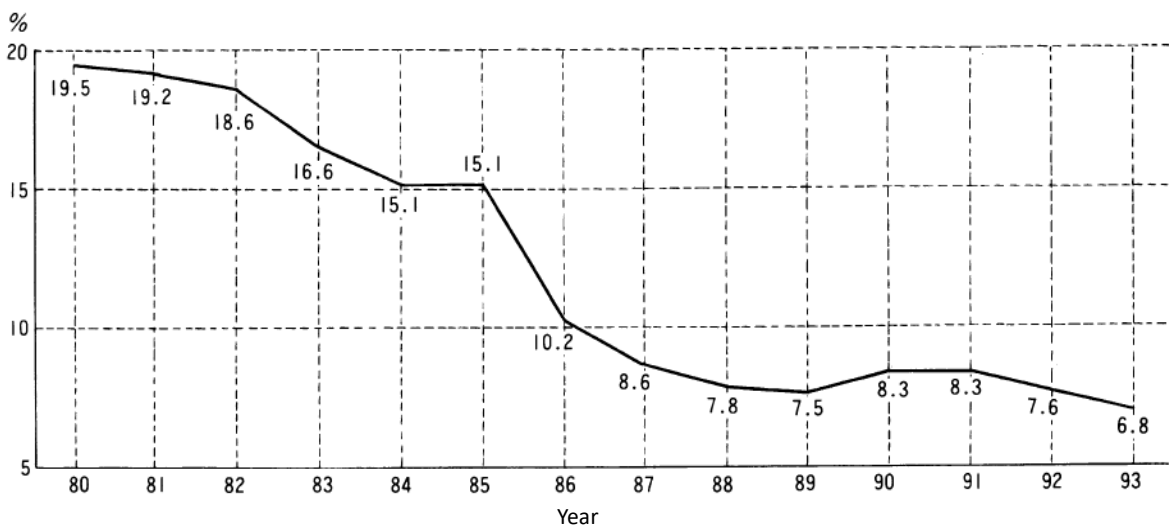


Fig. 17 Share of energy cost in total product cost

Table 8 Unit energy consumption of equipment ⁴⁰⁾

Unit energy consumption of paper machines

	Steam (t/t)				Power (kwh/t)			
	1999	1988	1977	1967	1999	1988	1977	1967
Newsprint machine								
With size press		1.77	3.00	3.71		519	600	520
Without size press	1.89	2.08			648	559		
Ave. Newsprint machine	1.89	1.83	3.00	3.71	648	533	600	520
Kraft liner machine	1.27	1.85	3.30	4.64	375	470	650	520
Jute liner machine	1.39	1.80	3.00	4.64	416	470	630	660

Unit energy consumption of pulping plants

	Steam (t/t)				Power (kwh/t)			
	1999	1988	1977	1967	1999	1988	1977	1967
LKP(unbleached)								
Digester	0.57	0.68			148	116		
Chemical recovery	1.27	1.36			68	85		
Total	1.84	2.04	3.60		216	201		
TMP	0.10	0.27			2107	2262		

Table 8 summarizes the unit consumptions of steam and power at paper machines as well as in pulping plants. At newsprint machine, installing size press increased energy consumption. Paperboard machine greatly reduced energy consumption in thirty-two years. Increasing its size and speed helped the saving, but technological developments like shoe press definitely contributed.

Following is a brief survey I wrote in the paper entitled "Systematic Survey on Newsprint Production Technologies in Japan" which was a part of the project by National Museum of Nature and Science on systemization of technologies ⁴¹⁾.

"Japan's energy utilization is very distinctive when compared to that of other countries. Though comparing electricity prices directly is difficult due to fluctuations in exchange rates, power in Japan is generally more expensive. As a result, technical developments in the energy sector have been aimed at lowering power consumption.

The Japanese paper industry has been working on reducing both energy prices and unit energy consumption. A rough estimation suggests that the Japanese paper industry produces paper using two-thirds of the unit energy consumption of the United States. This has been made possible not through revolutionary technologies, but through steady efforts to reduce energy consumption, as detailed below.

(1) Investment by management

A range of different investments have been made to reduce the unit price of electricity. These include increasing power self-sufficiency in mills by installing power plants (big mills are almost 100% energy self-sufficient), promoting co-generation (effective use of low pressure steam), and installing high-efficiency recovery boilers (better utilization of biomass energy). Manufacturing equipment has also been replaced by equipment which consumes less energy. These investments were not just about saving energy, but also ensure that equipment was modernized at the same time, leading to mill operations becoming increasingly stable and efficient: a change, which, needless to say, also saved them energy. Inverter controls were also added to every large electric motor as a way to improve the unit energy consumption of equipment. This trend towards equipment investment was further driven by the high cost of main electricity.

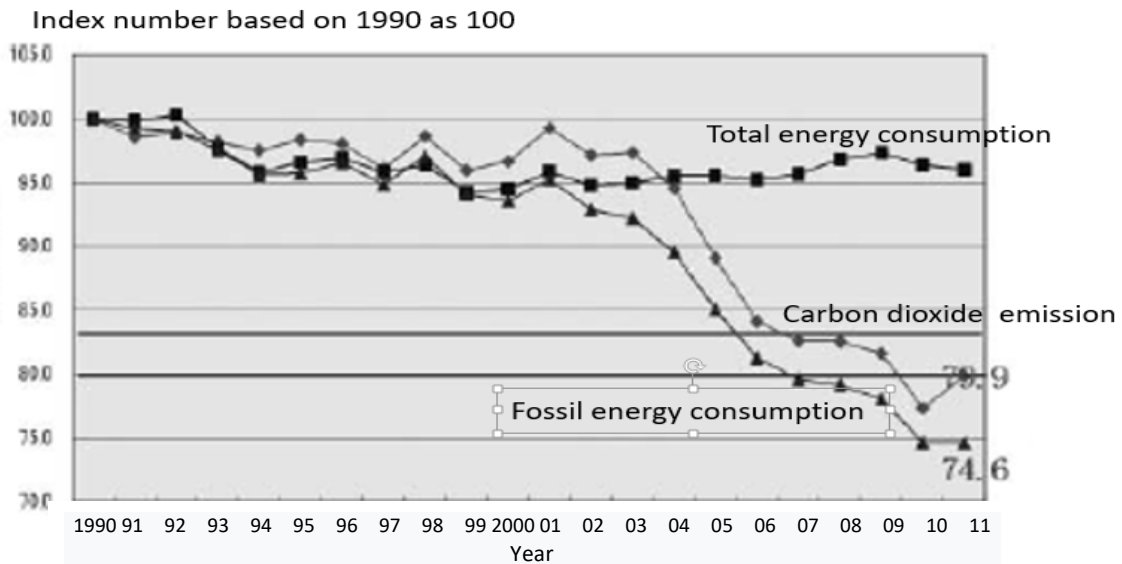


Fig. 18 Unit total energy consumption, unit carbon dioxide emission and unit fossil fuel energy consumption by index number based on 1990 as 100³⁸⁾

(2) Energy-saving efforts in mills

Minor savings at the small group activity level accumulate to major savings for the mill as a whole. To give an example, the process from pulping to paper making is a continuous process, and to ensure steady operation, the process involves a number of pulp slurry storage tanks in the process. Those storage tanks are agitated by a stirrer, and so keeping the level of stock in a tank as low as possible saves circulation energy. After the first oil price hike, every mill started doing this for all its storage tanks. Overall mill efficiency was improved as a result, though it required careful, detailed management. Reducing the volume of stock in the tanks also meant that impellers could be made smaller, further saving energy. These sorts of actions eventually added up to the development of energy-efficient mills, allowing them to maintain competitiveness".

I believe that paper mills in Japan were characteristically energy efficient, and there was a mill that did not buy any energy from outsiders, supplying all energy needed for paper making from its recovery boilers⁴²⁾.

The effort of improving energy efficiency, however, had a peak and the unit consumption was stagnated since 1995. Then, the Japan Paper Association took a step ahead and announced to reduce carbon dioxide emission originated from fossil fuel in its voluntary guide line against global warming. The target was to reduce the unit emission of carbon

dioxide from fossil fuel by 16% against that in 1990, starting from 2008 and ending in 2012. The result was in Fig. 18, and was successful. Exchanging fossil fuel to bio-fuel was one of ways taken in mills, as seen in the literature⁴⁰⁾.

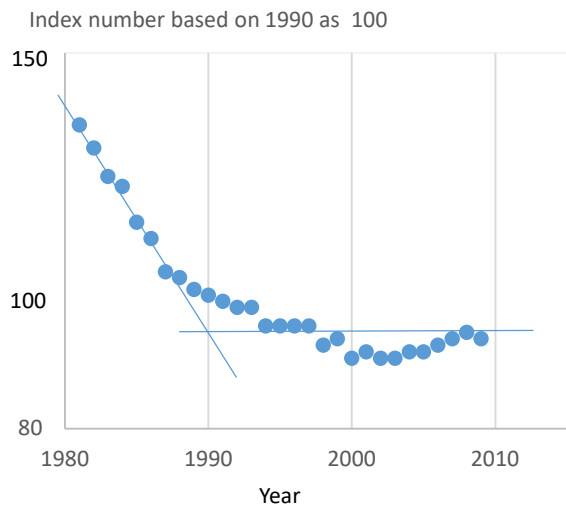


Fig. 19 Unit total energy consumption since 1980 by index number based on 1990 as 100

Let us survey the trend in energy saving in a longer term. Combining Fig. 16 and Fig. 18 into one graph, Fig. 19 is obtained, whose y-axis is logarithmic as usual. The unit energy consumption decreased and then stagnated at around 1990 probably due to stalemate in technological development. Then, the industry's concern has turned to reduce carbon dioxide emission from fossil fuel.

The yearly rate of change of the unit energy consumption between 1980 and 1990 was calculated with linear approximation, and was 0.956, which means that the unit energy consumption was decreasing at the rate of 4% a year, which was the outcome of technological efforts.

Please remember figures showing the transition of machine speed and machine width published in my previous paper (Part 2-1). They kept increasing with their constant rate, 3% for machine speed and 1.5% for machine width. It suggests that the productivity of paper industry was improving until 1990, which would be credited to the technological developments. Those figures along with Fig. 18, however, present that technology was stagnant after around 1990, and all manufacturing industries in Japan experienced the same problem. Right at that time, a revolutionary technology was appearing in the world, which will be discussed in the third and fourth parts of this series.

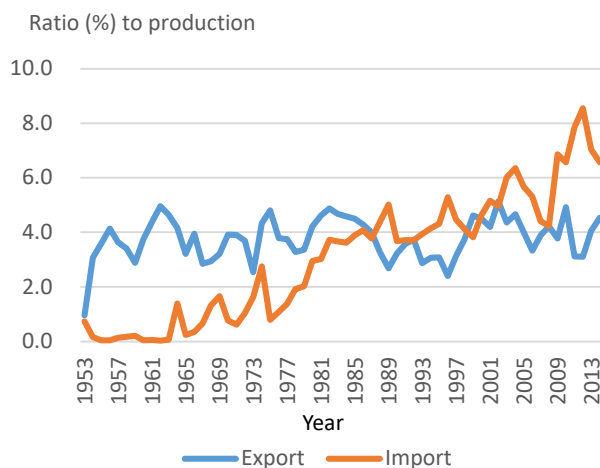


Fig. 20 Ratio of import and that of export to the amount of production

2.8 International competitiveness

Fig. 9 in the first part of the series was quoted again as Fig. 20. Though the volume of imported paper was gradually increasing since 1970, the paper industry could secure the domestic market.

It was accomplished by accumulating technological developments and offering products of superior cost-performance to domestic market against imported products. It was a typical Japanese approach, which I reviewed in my paper entitled "Technological Survey of Newsprint Production in Japan" published by National Museum of Nature and

Science ⁴¹). As in the report, a couple of factors helped the industry made it. As mentioned before, wood resource is not so sufficient in the world that not so many countries were export-oriented. Another reason is that paper products are bulky and, because of it, are less traded internationally than other commodities.

2.9 One episode

One episode that happened in the paper industry shows that the way of thinking and behavior in society had greatly changed in around 1970. It was on synthetic paper and synthetic pulp. Toyota mentioned in his paper as follows ⁴³). "In May, 1968, Resource Study Committee, Science and Technology Agency presented a report entitled "Recommendation on Fostering Synthetic Paper Industry". The paper says quote 'Japan is leading development of synthetic paper in the world, and is close to commercial production. If synthetic paper industry starts, big return will be expected such as eliminating problems relating to resource and environment, saving foreign currency and fostering related industries. To promote the project, solving problems in production, scaling up to mass production and developing new market will be needed, to which a large amount of investment will be required. Taking national merit into an account, setting up an aid policy is urgently advised unquote.' The paper estimated that the demand would be about 2.5 million tons in 1978 which would be about 20% of paper consumption. It made various industries be interested in and many companies in various industries such as oil refinery, chemistry, paper and plastics processing, some being in consortium, accelerated their development work ever before."

Regretfully, that prediction failed due to oil price hike, which substantially change the structure of the Japanese industries as a whole. How did the hike affect the industries?. Taking such industries as oil and coal, chemicals which were heavily dependent on oil, and paper as examples, their shares in the GDP are depicted in Fig. 21, quoted again from the paper by Yoshikawa ⁴⁴).

The former two industries which had been expected to grow as new industries after the war were severely damaged, while the paper industry

which had been disgusted was surviving tough.

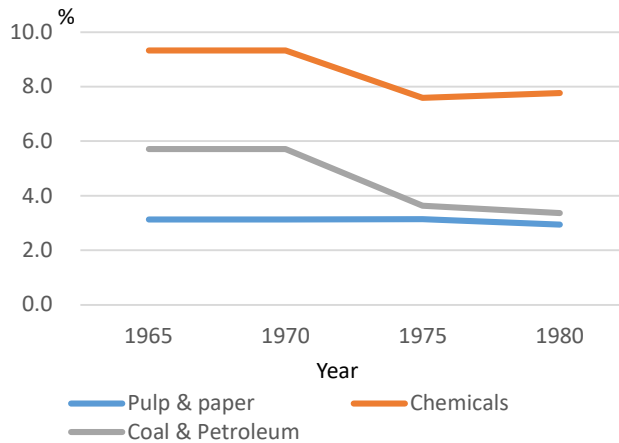


Fig. 21 Share (%) of output in GDP, Pulp and paper, Chemicals and Coal & Petroleum

2.10 Summary of the period of time between 1970 and 1990

Though the paper industry was unwelcomed and recommended to go away from Japan in the early 70s, Ohnishi commented in 1977 as follows. "Recently the reputation of the paper industry is gradually improving to a better side." ⁴⁵⁾

Nishi and Inoue lamented low profit margin of the industry in the early 70s. How was it then later? From the survey by the Development Bank of Japan, Inc. on manufacturing industries of Japan ⁴⁶⁾, the ratio of profit to net sales was compared among industries.

Fig. 22-1 is comparison between manufacturing and non-manufacturing sectors. The manufacturing sector kept losing its profit margin year after year, suggesting that it lost technological edges it had before 1970.



Fig. 22-1 Ratio of profit to net sales, manufacturing sector and non-manufacturing sector

Then, how did big process industries such as steel and chemicals performed? Their profit ratio to net sales repeatedly went up and down and declined like that of pulp and paper.

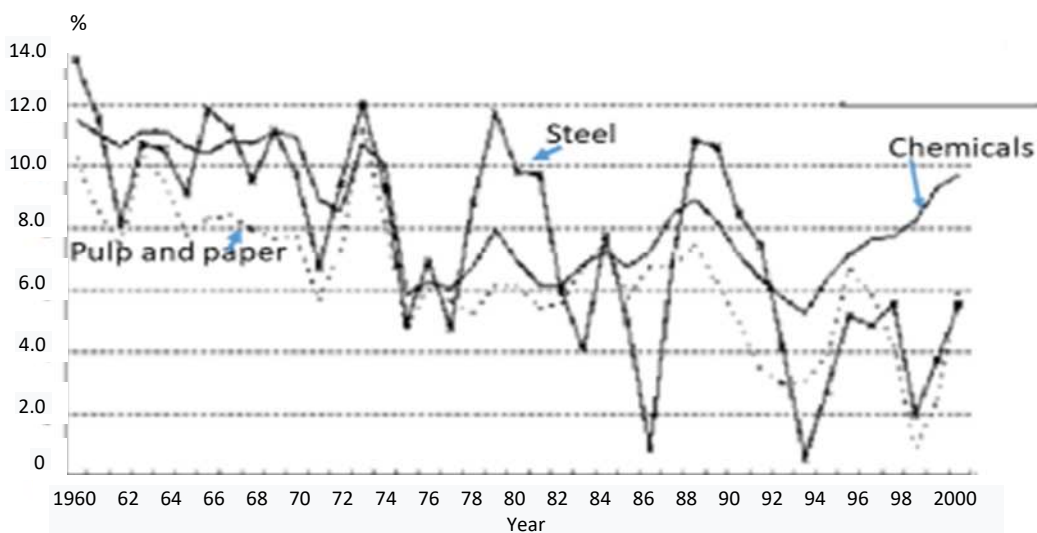


Fig. 22-2 Ratio of profit to net sales, Pulp and paper, Steel and Chemicals

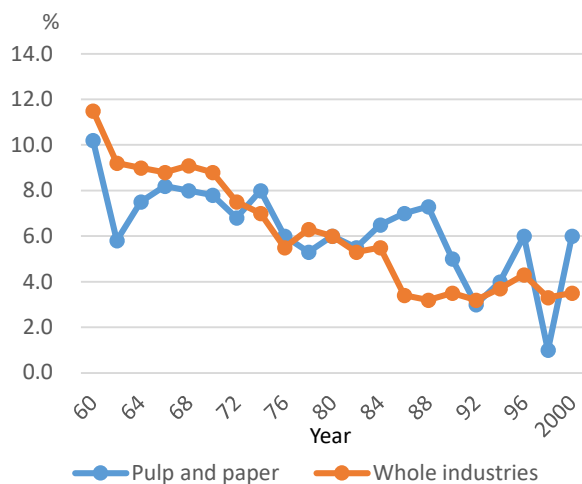


Fig. 23 Ratio of profit to net sales, pulp and paper and the average of all industries

Fig. 23 is prepared from data by the Development Bank of Japan, to see how the paper industry performed, compared to the average of all industries. The return on sales of pulp and paper industry was less than that of the all industries in the early 70s, but in the 80s and after, it was higher in most of years. It meant that the paper industry adjusted itself to the paradigm shift of Japanese society in the 70s, and its performance was better than the average of all industries, though the profit itself kept declining.

Regarding competitiveness in the world trade, as shown in Fig 20, the volume of import was increasing gradually since 1970, but it was not fatal. I believe that the sense of crisis urged the industry to cope with problems, and technology certainly helped it.

As a result, the paper industry dealt with the critical problems in the 70s. The environmental problems were cleared with huge investment. Imported chips helped deal with scarce wood supply. The menace of imported products was countered with better cost performance of domestic products which was outcome of actively taking new technologies and improving productivity and product quality.

Then, Inoue commented in October, 1984 as follows⁴⁷⁾. The old pulp and paper industry of Japan started with importing hardware as well as software from abroad. During the period of high economic growth, buying resources and energy from abroad helped the industry's expansion. Diligent efforts in taking new technology significantly improved productivity and product quality which are now in the highest level in the world. It now manufactures about 10% of the world production. The Japanese

paper industry which has handicaps in environment, resources and energy, and suffered from low profitability is performing better than those in Europe. It is worth being valued from abroad. "

Sometime later, Ohkuni made a comment in 1996 as follows⁴⁸⁾. "Let me consider the future of the pulp and paper industry.

Firstly, the industry is regenerative by planting wood which is its main resource.

Secondly, the demand is increasing steadily not only in Japan but also in the world.

Thirdly, competitors replacing paper are not in sight.

Fourthly, paper is eco-friendly to the earth. Its eco-friendliness has been demonstrated since the invention by Cai Lun 1900 years ago. Paper can be recycled, and be burnt as fuel with less stress to environment. Even after discarded, it is biodegradable, and returns to soil.

Fifthly, the industry uses energy more ecologically than other industries. In other words, the ratio of energy from fossil fuel against total energy consumption is characteristically small, because the industry burns bark and waste liquor as fuel.

In summary, the industry can be compatible to environment preservation, and is expected to have a sound future with steadily increasing demand. We have experienced to overcome many problems by technological efforts. Though we may face other problems, we believe that we could move forward to the 21th century with pride and confidence."

His speech addressed confidence for the existence of the industry, as the paper industry overcame the crisis in the 1970s, was regarded to be sustainable and was succeeding to use wastepaper as a new pulp furnish. Regretfully, there was not expressed any subject or guideline for the industry to follow in the future. Right at that time, as mentioned in the chapter on energy, technology of those days was stagnating, and a revolution in technology was beginning.

The next issue will cover the 1990s.

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