FOREST PRODUCTS IN THE 1980s

A. F. WILSON*

INTRODUCTION

How does one go about attempting to forecast the future of the forest products industry in New Zealand? If we accept that the major limitation to the future growth of the industry will be the availability of wood, then it is possible to use the type of approach set out below. This approach will be used in this paper:

(1) What will be the future domestic demand for existing forest products?

(2) Will there be any distinctly new forest products in the 1980s which will create a further demand for wood?

(3) What is the total quantity of wood that can be harvested from the forests in the future?

(4) Having satisfied the domestic demand, how much extra wood will be available for export forest products?

(5) What are the factors that will decide just how much of this wood will be exported as logs, chips, sawn timber, pulp and paper, panel products, etc.?

(6) Are there any other constraints that could affect future growth?

The Forestry Development Council, in preparing its National Forestry Planning Model, used a similar approach, and this Model, particularly the updated 1972 version, will be referred to in this paper.

FUTURE DOMESTIC DEMAND

Figures 1 and 2 show the expected growth rates for domestic forest products in roundwood requirements. These data were derived in the 1972 Planning Model by noting recent trends in per capita consumption for the individual products, estimating likely increases in per capita consumption in future years, multiplying these figures by the estimated population of New Zealand in those future years and then determining the roundwood equivalents.

Note the very large increases expected in the consumption of plywood and particle board. Fibreboard production is ex-

expected to grow at a slower rate and sawn timber at a slower rate still. Indeed *per capita* consumption of sawn timber is expected to decline over the period and only the increase in total population will maintain the positive growth that is indicated. *Per capita* and hence overall consumption of paper grades is expected to increase at a steady rate. *Per capita* consumption of all paper grades is expected to rise from 118 kg in 1970 to 195 kg in 1990. If the figure of 195 kg seems unreasonably high, it is worth noting that *per capita* consumption of paper in the U.S.A. was over 270 kg in 1972!

**Fig. 1: Forecast of domestic demand for forest products.**
Fig. 2: Forecast of domestic demand for sawn timber and industrial paper.

When the individual roundwood requirements are added, we obtain the total roundwood requirements shown in Fig. 3. Interestingly, the volume required for domestic products in 1990 is close to the roundwood volume that will be harvested this year to satisfy the present local demand and the demand for wood exports in the form of logs, chips, sawn timber, pulp, paper and panel products.

NEW FOREST PRODUCTS FOR DOMESTIC CONSUMPTION

When one examines the forest products being marketed in other countries, particularly the U.S.A., Canada and Sweden, where per capita consumption is so high, one does not find many products that are not made in New Zealand. On the whole these countries use more of the same types of products that are made in New Zealand rather than different products. There are some exceptions to this, however. Thus, markets are growing in Sweden and in North America for bleached kraft pulp to be used in babies' disposable diapers and in sanitary napkins. It is likely that by the 1980s these products will be made in New Zealand from locally-produced pulps.
Some paper board is made in New Zealand for milk shake and ice cream cartons, but no cartons are made for milk packaging. In New Zealand the cost of the carton is high relative to the cost of the milk it contains. There is little evidence that carton packaging will make any significant inroads on other systems for packaging milk, juice and beer in New Zealand by the end of the 1980s.

Large tonnages of dissolving pulp are made in North America for rayon fibre and cellulose production. The markets for these products in New Zealand are not large and production of dissolving pulp in this country would only be justified if nearly all of the production could be exported.

The quality of pulp required for cellulose sponge production is less critical and this product may be made in New Zealand.

It is difficult to predict what other distinctly new forest products will be made in New Zealand in the 1980s. We should, however, see an improvement in the competitive position of forest products vis-a-vis products based on other natural or synthetic raw materials. And this is likely to result in the production of some new forest products by the 1980s and in
turn lead to a demand for more wood from our forests to supply that demand.

AVAILABILITY OF WOOD

How much wood can we expect to harvest in the 1980s or, more to the point, having satisfied the domestic demand, how much wood is available for export products? With a new planting rate of 18,300 ha/year, the estimate used in the 1972 Model, wood volumes available for export in future years are shown in Fig. 3. The estimates have been extended to the year 2000 to show the very large increase in the wood available for export products from 1990. This reflects the returns from the large areas which are now being planted.

The volume of wood that can be harvested in future years will be even higher if the area planted each year can be further increased. Can the net planting rate of 40,000 ha for 1973 be sustained? Can a rate of 40,000 ha be sustained? Improved breeding and the use of fertilizers will also increase the volume of wood available. But a number of approaches to making more wood available for export products lie within the province of the forest products utilization industry and it is to these approaches that we now turn.

APPROACHES TO INCREASE WOOD AVAILABLE FOR EXPORT PRODUCTS

(a) Greater Waste Paper Utilization

The 1969 Planning Model allowed for an increase in the utilization of waste paper, and 41,000 tonnes of waste paper were recycled in 1973, most of it through Whakatane Board Mills' two board machines. However, 41,000 tonnes of fibre amount to only 9.2% of the fibre fed on to the country's paper machines. In some overseas countries the percentage is over 30. N.Z. Forest Products Limited have announced their intention of increasing waste utilization by setting up a Paper Recovery Division. As a target it is expected that 100,000 tonnes a year will be recycled by 1980. If this were achieved, and particularly if kraft waste can be used on paper machines in place of virgin kraft, a saving of up to 450,000 m³ of wood per annum might be achieved. With the current production capacities, and the announced expansions in new machines which will be installed by 1976, over 700,000 tonnes of fibre will be dried into paper by that year. So even if 100,000 tonnes of waste can be recycled by 1980, the waste will still account for only 14% of the fibre supply to the country's paper and paper board machines. Every effort must be made to increase this percentage even though this will be difficult, for by 1980 close to half of the paper made will be exported and the specifications for these export grades are likely to demand the use of predominantly virgin fibres.
(b) Greater Utilization of Forest Residues

Can we increase the utilization of wood residues in panel production or pulping? Slabwood, from sawmills, is currently an important source of pulpwood chips, and increased efforts will be made to utilize increasing quantities. It is desirable that this wood reach the pulp mill free of bark for although the bark can be separated in a flotation tank after shipping, a lot of good wood is rejected with the bark in this process.

N.Z. Forest Products Limited has installed a continuous digester that, in addition to producing neutral sulphite semi-chemical tawa pulp for corrugating medium, may produce sawdust kraft pulp. Start-up trials have been run in this digester pulping chip fines. Further work has to be done, particularly in running trials on paper machines to determine how much chip fines and sawdust can be utilized and in which particular grades. Sawdust fibres have a length of only 1 mm and therefore give pulps that are weaker than chip pulps. However, there is good evidence from overseas experience and laboratory work in New Zealand that quite high percentages of sawdust kraft pulp can be used in grades where strength is not critical, in fine papers for example. Even in packaging grades such as linerboard it may be possible to use some sawdust pulp.

The Forest Service is planning to make a survey of the sawdust available in New Zealand. Their present estimate, on the basis that one tenth of the log input to sawmills yields sawdust, is that 450 000 wet tonnes of sawdust are produced each year. By 1990 we will see a significant proportion of this total collected and pulped, and used in New Zealand paper grades or exported as market pulp.

What of the prospects of utilizing other wood residues? Surely it is time some New Zealand ingenuity was applied to removing stumps from the ground and using them. At least one mill in the southern U.S.A., Interstate Paper Corporation, is using stumps to make kraft pulp for linerboard. Stumps are rich in wood chemicals such as turpentine and tall oil and it could well be economical to extract these chemicals before pulping.

This leads to the subject of whole-tree pulping and there is indeed a lot of activity in this area overseas. A number of papers have reported work on branches or whole-tree chips containing up to 15% bark. Some papers have claimed that improved economics can be achieved, particularly when wood costs are very high. Even satisfactory bleachable kraft pulps can be produced. At a recent Appita meeting Howard and Boon (1973) of Tasman Pulp and Paper Co. Ltd reported on work done in their company to pulp wood containing bark. In pulping 44-year-old ponderosa pine logs containing up to 17% bark they reported lower yields, dirtier pulps and higher chemical usage. In work on radiata and Corsican pine thinnings, the yield on a wood-charged basis did not drop. Thus in pulping 100 g of oven-dry wood they obtained the same yield of pulp as when they pulp 100 g of the same wood with up to 7 g of bark added. Clearly pulp yield on the basis of total
solids charged to the digester was lower when bark was included, so that the bark added did not yield any pulp fibres. Pulp strength and ease of refining were not adversely affected by the inclusion of bark. In contrast to the bark from many other species, such as Douglas fir, radiata pine bark contains no fibres. So if bark is pulped it will occupy digester space, and therefore reduce pulp capacity; it will consume pulping chemicals, and any solid residue remaining after pulping will not contribute significantly to pulp strength.

The prospects for whole-tree pulping in New Zealand are, then, not very bright. It would be preferable to develop methods to separate bark mechanically from small branches rather than to achieve separation by chemical means in a digester. The other prospect for branch or whole-tree utilization is to use the chips and bark in particle board.

(c) Increasing Pulp Yields

There is yet another approach which can be used to increase the wood available in the 1980s for export products. It is to build our houses and make our pulps using less wood. Can we change the constructional designs of our houses so that less wood is required to build them? There are signs that we can. Some in the industry might argue against this approach but there will be such a shortage of wood in future years that we must attempt to reduce the needless waste of sawn timber by over or poor design. In much the same way we must try to satisfy the local and export demands for paper and board by using high yield pulps or less pulp. A number of companies in the U.S.A. have recently announced policies to do this. Thus Georgia-Pacific Corporation has recently announced that it is reducing the grammage of newsprint by 5% “because of wood supply and energy problems”.

Yields in New Zealand pulping processes range from 96% in the case of groundwood pulping to 43% when bleached kraft pulp is being converted into bleached paper grades. In the groundwood process the only substance loss is sugars extracted by the water used in the process and there is also some fibre loss. In kraft pulping 100 oven-dry tonnes of wood will give about 47 oven-dry tonnes of unbleached pulp. With fibre losses from the pulping process, with a loss of substance of at least 5% of the pulp on bleaching, and more fibre loss from the bleach plant and in paper making, this figure can be reduced to 43% or even lower. So we pay a very heavy price for the advantages that kraft pulping gives — the advantages of versatility in utilizing different species, of giving flexible, strong fibres that will conform so easily and bond so well in a paper to give strong papers, and that can be bleached economically. Even in newsprint production, close to 20% of the furnish is kraft pulp to give the wet web sufficient strength so that it can be run at high speeds on the paper machine and not give too many machine breaks.

In fact, on the average, it takes over 1.6 tonnes of oven-dry wood to make a tonne of paper in this country. The 0.6 tonne of material that does not end up in a reel of paper is being
burnt in a recovery system or leaves the mill in effluents from which it must be removed, or in which it must be treated.

Some steps are already being taken to utilize higher-yield pulps in papermaking, N.Z. Forest Products Limited has begun to make N.S.S.C. tawa pulp for use in corrugating medium. The yield is about 70%. The N.S.S.C. tawa fibres with more lignin retained in the cell wall are stiffer and this can give an increase in the crush-resistance of the medium. For many years Whakatane Board Mills has been operating this process on softwoods at the rate of 28 tonnes of pulp per day.

In nearly every other grade of paper, though, the use of high-yield pulps is not likely to improve paper machine run-ability, or paper properties. With a 48% yield pulp there are twice as many fibres per gram of paper compared with a 98% yield pulp. Fibre surface area, and hence fibre bonding potential, will be at least doubled. Fibre flexibility is greater in lower-yield pulps, individual fibre strength is higher, and bonding material for a given fibre surface area is also higher. For all this, we shall see increased efforts to use higher-yield pulps in our papermaking processes. Linerboard is being made in the U.S.A. from 55% yield pulp, compared with 48% in New Zealand. So 13% less wood is required to make a tonne of linerboard in those U.S. mills. By the 1980s newsprint will be made in New Zealand with far less added kraft pulp than the 20% which is currently being used. Some overseas mill are already claiming to make newsprint with very little added kraft fibre. We shall see white paper board made with an unbleached substrate and a thin bleached laminate or coating on the top. Perhaps the trend to using very high-brightness pulps will have been reversed.

The Swedes chase 92 brightness in their market pulps only to use large tonnages in disposable diapers. Using such high-brightness pulps next to a baby's bottom seems to be carrying aesthetics a little too far. There is also some evidence that high-brightness book and magazine papers cause eye strain. We pay a high price in added processing costs and wood yields in seeking a few extra points of brightness. Many U.S. companies are saying that they are not prepared to pay this price. Thus at least one company has switched paper towel production from bleached to unbleached in its institutional and industrial products to conserve energy and chemicals. A Swedish company is developing a new, fluffy, flash-dried, peroxide-bleached refiner groundwood pulp for use in diapers and napkins. It is said to have comparable properties to chemical pulps.

Pulp yields could be increased if the strength properties required in many grades of paper, particularly packaging grades, could be reduced. There seems little possibility that this will happen, for while the competitive position may have changed to its advantage in the last few years, paper still has to remain competitive with other packaging materials. Still, there is a responsibility on the converting industry to design its boxes and bags, and the machines that make them, so that unnecessarily high demands, and therefore high costs, are not placed on the paper and board that it uses.
A lot of time has been devoted in this paper to the efforts that must be made to increase the volume of wood available in the 1980s. Without these efforts we may not see many new major developments taking place. Indeed the Forest Service attitude is that major expansions are unlikely to take place because the wood will not be available. In his address to the Appita Conference in New Zealand last year, the then Director-General of Forests, A. P. Thomson, referred to a development pause in the period 1975-90 unless utilization of beech forests takes place, or it becomes economic to install pulp mills with less than 500 tonnes per day capacities. Many would argue that this is a pessimistic view and, to be fair to him, Mr Thomson allowed that this may well prove to be the case. One argument against delaying developments until 1990 is that, from that period on, major developments such as a new 600 tonnes per day pulp mill are likely to take place every two to three years, and such a rate of development might well be beyond the capital, energy and manpower resources of the country. A fair argument for delaying development is that there is at present intense work proceeding on new pulping processes, and it is more than likely that by 1990 we shall have low or zero effluent, higher-yield pulping processes that will offer many advantages over current pulping methods. If the markets exist in the 1980s for pulp and paper products, and they can be sold at prices that will give a high return on investment, then the pressure will be on to advance the development of new complexes or additions to existing ones, rather than to delay development.

FUTURE MARKETS

Will the markets for forest products exist in the 1980s? Let us look first at future demand for paper and paper board. The 1972 FAO report (Tappi, 1973) has predicted that to meet the expected demand for pulp in 1985, world pulp production will double from 109 million tonnes in 1970 to 218 million tonnes. For this increase to occur we shall have to see, on average, one pulp mill of 600 tonnes per day capacity going up somewhere in the world every ten days.

We are not seeing anywhere near this build-up in capacity taking place. In North America, in particular, where there is in many areas sufficient wood available to begin new pulp mills, forest products companies are very lukewarm about investing in new pulping capacity. As an example, Boise Cascade Corporation announced recently a $1100 million capital programme for the next five years. However, construction of new pulp mills is not included in the expansion plans. The announcement stated that funds could be made available if future product pricing promises to give a satisfactory return on investment. The prospects for future pulp and paper exports from New Zealand are, then, very bright. There are good signs that demand will continue strong and that the effect of economic downturns in the major producing countries, such as the current U.S. recession, will be less severe on pulp and paper production than they have been. It is highly significant that, of the expected world pulp production of 218 million
tonnes in 1985, production from areas relatively close to New Zealand and in which we have already developed marketing ties (Oceania, Africa, China, Asia and the Far East) will amount to only 18 million tonnes — less than 10% of the total — even though these regions have well over half of the world's population. It is also significant that the latest FAO report (1973) on future output has forecast a much slower increase in production than the 1972 report.

Demand should be just as strong for most other forest products. A 1% world increase for timber production is expected in the next few years. For particle board the increase will be about 22%, while fibreboard should maintain its recent 7 to 8% growth rate.

The latest information on exports is for the year ended 30 June, 1972. The quantities of wood required for exports in that year, and for the two previous years, are shown in Fig. 4. The latest estimates of future exports were given in a paper presented at the recent Forwood Conference in Canberra. The individual exports have been converted to roundwood requirements and these wood volumes are also shown in Fig. 4.

Fig. 4: Volumes of wood required for export products.
It appears that some additional wood remains for export development, but this gap may not be a real one. Thus, since these estimates were prepared in February this year, new expansions have been announced. H. Baigent and Sons, Ltd have announced plans for a groundwood mill at Nelson. There is talk of a fourth newsprint machine at Tasman Pulp and Paper Co. Ltd, and an incremental expansion in pulp and paper production at Kinleith before the end of this decade. Furthermore, the plans of Carter Oji Kokusaku Pan Pacific Ltd to install newsprint machines in 1979 and 1982 were not provided for in preparing the export forecasts. Moreover, it would not be surprising if a small gap continues to exist between wood available for exports and the wood being used. After all, some of the wood becoming available will be growing in areas where utilization will not be economical for a number of years. Details of existing production capacities of New Zealand pulp and paper companies, and announced expansion plans, are given in Appendix 1.

Developments in fibreboard and particle board production are also taking place at a rapid rate, with the Fletcher Timber Co. Ltd planning to increase Bisonboard production in their new Thames mill, and Canterbury Timber Products Ltd planning to operate a refiner groundwood fibreboard plant before the end of 1975.

It seems, however, that most export-oriented developments will be to make pulp and paper rather than other wood products. The increased labour content, the greater overseas earnings, and the lower freight costs in relation to the volume of wood used to make pulp and paper are advantages which favour development of export pulp and paper. Note, for example, from Fig. 4, that log exports are expected to make up only 5% of the wood being exported in 1981-2, whereas they consumed 57% in 1969-70. The decisions by New Zealand companies to build new pulp and paper mills in the future will, however, only be made if secure markets exist and the returns from the large investments required are satisfactory.

NEW MANUFACTURING OPERATIONS

The kraft and mechanical pulping processes will remain the most important pulping operations in New Zealand in the 1980s. However, there will be many changes in the processes, particularly in new installations. Efforts to decrease air and water pollution levels and to increase yields will result in modifications to kraft pulping. Some modified kraft processes have already been announced. Thus, MacMillan Bloedel Ltd claim that pre-treatment of chips with hydrogen sulphide before kraft pulping can give an increased yield of 8% and a wood saving of 12%, with marginal drops in pulp strength. Kraft batch and continuous digesters will be computer-controlled and this will give more uniform and stronger pulp at higher yields. For example, a typical distribution curve for kraft pulp permanganate numbers, and hence yields, is shown
in Fig. 5. This shows that, when a mill is trying to achieve a particular permanganate number, or residual lignin content, because of variation in the raw materials and problems in process control, a range of results will be achieved. The limit to increasing permanganate number above the aim shown will normally be the need to limit the quantity of pulp made with too high a permanganate number, for shive levels may be excessive above a certain permanganate number. Clearly, if the distribution range can be narrowed, the target permanganate number, and hence yield, can be increased.
Time of impregnation of chemicals into the fibres in chips during cooking is a major constraint in chemical pulping as is the diffusion process that allows the extracted lignin to diffuse from the fibres into the pulping liquid. Within 15 years we should see a trend to pulping smaller chips. Kraft pulping can be carried out in a few minutes if the chips are thin and can be impregnated and heated quickly. Methods are available to reduce the thickness of chips without reducing fibre length as in sawdust. Most modern continuous digesters, however, have to be fed with relatively large chips to prevent transfer problems and the blocking of liquor extraction screens.

The conventional process for making mechanical pulps will also give way to new, improved processes aimed at reducing the power requirements and at increasing fibre strengths. There appears to be great potential for the new thermomechanical pulping processes, and paper mills will in the next few years be investigating how they can maximize the use of such high-yield pulps in different grades of paper. As well, we shall certainly see radically new pulping processes in New Zealand by 1990. We must be interested in overseas developments to use oxygen as a pulping and bleaching chemical. When Tasman Pulp and Paper Co. Ltd have completed their pulping expansion, New Zealand will have to import about 36,000 tonnes of sodium sulphate each year for kraft pulping. It would be desirable to have new pulping processes which are based on raw materials, such as oxygen, which are available in New Zealand. And before many more years some chemist somewhere in the world may find a new method for treating lignin so that it becomes a stable, colourless, water-attractive polymer capable of combining with cellulose and increasing fibre-fibre bonding strength and not reducing it. Even if pulping processes are developed in which little of the cellulose or hemi-cellulose in the fibres is removed in pulping, a large increase in yield would be obtained.

In papermaking a major development will be the computer control of the process. In this new approach to papermaking the important properties of paper are measured continuously before the paper is reeled, and the results are used by a computer to send out signals to control such important processing variables as stock flow to the paper machine and steam supply for drying. N.Z. Forest Products Limited are installing computer control on at least one of their paper machines within a few months. Computer control should give steadier running with less down time and more uniform quality. Indeed, such improvements in quality and uniformity will be necessary as paper and converter machine speeds increase and the use of additional higher-yield pulp takes place.

High consistencies will be used in papermaking to reduce the size of machines, buildings and storage chests. Some very interesting pioneering work is being done in Sweden on forming paper at 5% consistency compared with current 0.5 to 1.0%. Wire length is greatly reduced in this method. Dry forming is being done on a limited basis in specialty operations. It relies on chemical adhesives to bond fibres together and will
become a major papermaking process only if very small quantities of cheap adhesives can be used. Drying of paper is basically an inefficient process and it is surprising that little has been heard of the Papridrier developed at the Pulp and Paper Research Institute of Canada. The principle has been under development for many years and is based on the application of a vacuum to one side of the sheet to draw hot air through the paper. Development in the use of synthetic fibres with conventional pulp fibres in papermaking has also been slow. A few long, strong, synthetic fibres mixed with conventional pulps should be able to give substantial increases in wet web and dry web strengths.

Some attempts have been made to fractionate different fibres — e.g., into long and short fractions — before papermaking, on the grounds that certain types of fibres should be used in particular grades of paper. The idea is a good one but methods to fractionate the fibres are still in the development stages.

Chemical additives will be used in increasing amounts to improve fibre retention on the paper machine and also to improve the properties of papers.

**TYPES OF FIBRE NEEDED**

What types of fibre should be grown for our future forest products? The utilization industry will have little grounds for concern if the forester’s primary objective is to maximize the weight of oven-dry fibre grown per hectare per annum. It seems that, to achieve this, the average stand age at clear-felling will drop to 25 years or even 15 years. There should be no serious problems in pulping 25-year-old trees; after all, our industry began pulping trees of about this age in 1953. With even younger trees there will be a drop in fibre length and a further increase in the percentage of springwood fibres. This will lead to kraft pulps with higher burst and tensile properties but lower tear strength. For some grades, for example sackkraft, this drop in tear strength may make it more difficult to achieve strength specifications. Since wood specific gravity will decrease, less wood can be contained in a digester and pulping capacities will be reduced.

Is it possible, though, to find a pulping process in which the lower basic density and thinner fibre walls of youngwood fibres can give faster impregnation and pulping rates than when older trees are pulped?

There are some supplementary objectives which foresters should set as targets in breeding and growing policies, and these are:

1. To ensure that some hardwoods are grown for use in printing and writing papers.
2. To breed, if possible, for higher cellulose content in wood fibres, and lower lignin content.
3. To breed for maximum fibre length. Some work has been done overseas to examine the factors that affect individual
fibre strength. There is evidence that strong fibres are regularly shaped, with few irregularities or deformities. The microfibril angle also seems to be important. This is the angle between the axis of a fibre and the direction of the microfibrils in the main wall of the fibres. The angle appears to be genetically controllable. Some work should be done in New Zealand to see whether we want a low microfibril angle for high tensile strength fibres, or a greater angle for higher extensibility and hence toughness in individual fibres.

(4) To breed for minimum compression wood content, fibre length and high specific gravity.

BY-PRODUCT DEVELOPMENT

Tall oil and turpentine are currently produced in New Zealand and production is increasing with the kraft pulping expansions. When Tasman Pulp and Paper Co. Ltd have completed their expansion, the total tall oil production in New Zealand will be about 7,300 tonnes/annum. A small quantity of tall oil is used in New Zealand, but most of the crude oil is exported to Japan. There is little doubt that within a few years tall oil will be fractionated in New Zealand into its two major components — resin and fatty acids. There is a domestic market for the resin acids in sizing paper, but the fatty acids would have to be sold overseas.

Turpentine selling prices have not held too well in recent years, but the potential exists for fractionation of turpentine into its two main components — α-pinene and β-pinene. These components, in turn, could well be the source of high-priced derivatives.

Bark utilization had received a lot of attention, especially at the Symposium held on this subject in Canterbury last August (School of Forestry, 1973). There is a large quantity of bark available, about 450,000 tonnes by 1980. Some of the developments discussed at Canterbury should reach commercial fruition by 1990. Among these are the use of bark for chemical extraction, with the use of chemicals as adhesives in panel manufacture, the use of bark with chips in particle board, and as a composting or mulching material in horticulture and agriculture.

As well, by 1990, we may see as by-products commercial lignin derivatives, activated charcoal, and amino acids and proteins from waste liquor, bark or branches.

OTHER CONSTRAINTS TO GROWTH

Wood supply is the key constraint to future growth, but others may also arise. Chemical raw material supply is unlikely to emerge as a constraint, and the industry is producing more of its raw material requirements than in the past. Energy supply is a serious future problem. The pulp and paper industry has a continual demand for about 170 mega-watts of electric power, so a moderately large hydro-electric power station, such as Arapuni, is required to meet this de-
mand. Approximately 500 tonnes of oil are burnt each day in the industry's boilers. Bark, woodwaste and waste liquor supply about 35% of a pulp mill's demand, but the use of these to generate steam will not increase as they will be used to make other forest products. Transportation costs for our export products will increase in future.

Pollution costs will also increase substantially in the future. A recent study in the U.S.A. has estimated that for pulp and paper mills to achieve zero discharge of effluent by 1985, the cost of making a tonne of paper will increase by $32. Noise is another potential constraint, and a recent Occupational Safety and Health Act in the U.S.A. has called for noise levels of less than 90 db within a metre of operating equipment. It has been estimated that refiner costs may have to be doubled to meet these new standards.

Most of these constraints will result in higher costs of operation, but few should be serious enough to stop new mills being built, or to close old mills. Thus return on investment is the ultimate constraint. If it does not promise to be adequate, new mills will not be built. Already in our industry we have seen the ratio of capital costs to sales go from about 1:1 fifteen years ago to 2:1 today. But while these constraints may sound a pessimistic note, most of them affect manufacturing processes in other industries in similar or even more critical ways.

We must conclude this review, then, on an optimistic note. There are problems ahead, but there is no reason why the cost of wood supplied to our converting mills should not remain among the lowest in the world. With large processing units, and the economies of scale which go with their size, pulping and papermaking costs will also be competitive with those in overseas mills. Supply of the other important resource — the human resource — seems to be adequate and there should be no serious problems in ensuring that a steady supply of capable young men and women keep coming into our industry.

REFERENCES

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APPENDIX

NEW ZEALAND PULP AND PAPER COMPANIES AND THEIR ACTIVITIES

*Carter Oji Kokusaku Pan Pacific Ltd, Whirinaki*

Began production from sawmill and refiner groundwood plant in March 1973. Pulp production capacity 122 000 tonnes/annum, to be expanded to 245 000 tonnes/annum by mid-1976. Pulp is flash dried and shipped to Japan. Plan to install two 140 000 tonnes per year newsprint machines in 1979 and 1982 for export of newsprint to Japan.
Caxton Paper Mills Ltd, Kawerau

Make refiner groundwood pulp for export and conversion to 30,000 tonnes/annum tissue and lightweight papers on two paper machines. A new 25,000 tonnes/annum tissue machine will begin production in 1974.

N.Z. Forest Products Limited, Kinleith and Penrose

Have expanded kraft pulp production at Kinleith from 210,000 tonnes/annum to 420,000 tonnes/annum. A second bleach plant has been installed to increase bleach plant capacity from 42,000 tonnes to 147,000 tonnes/annum. 265,000 tonnes/annum of pulp can be converted into unbleached packaging papers and bleached writing and printing papers on six paper machines, while the remaining 155,000 tonnes/annum can be dried on two pulp driers. Tall oil and turpentine are produced as by-products of kraft pulping. At Penrose a refiner groundwood plant produces 44,000 tonnes/year of pulp for insulating board and hardboard manufacture.

New Zealand Paper Mills Ltd, Mataura

Two paper machines making 20,000 tonnes/annum specialty unbleached and bleached papers from North Island and overseas pulps and waste paper. Subsidiary of N.Z. Forest Products Limited.

Tasman Pulp and Paper Co Ltd, Kawerau

Now making 105,000 tonnes/annum kraft pulp and 182,000 tonnes/annum of stone groundwood pulp, and is expanding capacity to 236,000 tonnes/annum kraft pulp and 295,000 tonnes/annum groundwood pulp. New fully-bleached pulp plant of 70,000 tonnes/annum capacity being added to present semi-bleached pulp mill of 70,000 tonnes/annum capacity. A second pulp drier of 110,000 tonnes/annum output has increased market pulp capacity to 170,000 tonnes/annum. Tall oil and turpentine are produced as by-products. Two machines are currently making 220,000 tonnes/annum of newsprint, with a third newsprint machine to begin production of 130,000 tonnes/annum in 1975.

Whakatane Board Mills Ltd, Whakatane

Produce stone groundwood pulp and nearly 10,000 tonnes/annum high-yield neutral sulphite semi-chemical pulp, and use waste paper with some imported and New Zealand market pulp, to make 67,000 tonnes/annum paperboard on two machines. Have announced plans for a third machine with a capacity of 60,000 tonnes/annum paperboard to begin operation in 1976. Subsidiary of N.Z. Forest Products Limited.

H. Baigent and Sons Ltd, Nelson

Have announced plans to install a 78,000 tonnes/annum groundwood mill in 1977, and eventually a newsprint machine.

Canterbury Timber Products Ltd, Rangiora

Plan to produce medium density fibreboard late in 1975 by refining wood chips. Output 30,000 tonnes/annum.