Matching wood fiber characteristics to pulp and paper processes and products

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ABSTRACT: In 1990, a task force investigated our wood flow from forest to process with the objective of developing a system to allow the optimization of the allocation, flow, and quality of the annual pulp fiber supply. The recommended system was introduced in early 1991, and, although it is still not fully operational due to supplier constraints, substantial improvements in wood flow consistency, process control, and product quality have been realized. Additionally, the existence of a wood segregation system allowed us to manage our way through a major change in our wood supply mix over the past two years.

KEYWORDS: Characteristics, mixtures, New Zealand, paper, processes, products, pulps, quality, supply, wood fibers.

During the past 10 years, the New Zealand pulp and paper industry has gone through a period of major change, as has the rest of the New Zealand forest industry sector. There has been a significant change in the fiber characteristics of the pulpwood supply; at the same time, pulp and paper customers have become far more discerning and specific about the type of product they want and the specifications of that product. This is not a phenomenon unique to the pulp and paper industry. It is just the reality of the competitive global market in which we operate.

For the pulp and paper industry in New Zealand to survive in the world market, we must continually strive to improve the efficiency of our operations and the quality of our products. Our pulp and paper products on the whole are sold into a commodity market that is characterized by falling real prices over time, which is in line with most world commodity markets. Every new plant that is built is designed to produce a better quality product at a faster rate than existing plants.

Given the competitive and demanding market in which we operate, it is critical that we fully understand the requirements of our customers and that we understand the relationship between raw material characteristics and the pulp and paper end-product characteristics associated with those raw materials.

In this paper, I will outline the fiber characteristics that are most important in terms of the impact on final product quality, with reference to Tasman's operations, and show how variations in fiber type can affect final product quality and therefore customer satisfaction. I will describe the system that we have developed to manage our variable and changing fiber supply and summarize the improvements in fiber mix control and product consistency that have been realized since the introduction of the fiber management system.

Plant configuration and fiber characteristics affecting product quality

To put the mill fiber requirements into perspective, it is necessary to understand Tasman's plant configuration and the products that we make. **Figure 1** is a simple flow chart that traces the fiber flow from the forest through the mill processes to the markets. We have two separate feed stocks leading to two separate mechanical pulp production plants. The refiner chip silos supply chips to the refiner mill to produce refiner mechanical pulp, which provides approximately 30% of the newsprint pulp furnish. The block pile supplies 1.2-m-long roundwood billets to the stone groundwood mill to produce stone groundwood, which provides approximately 50% of the newsprint pulp furnish. The remain-

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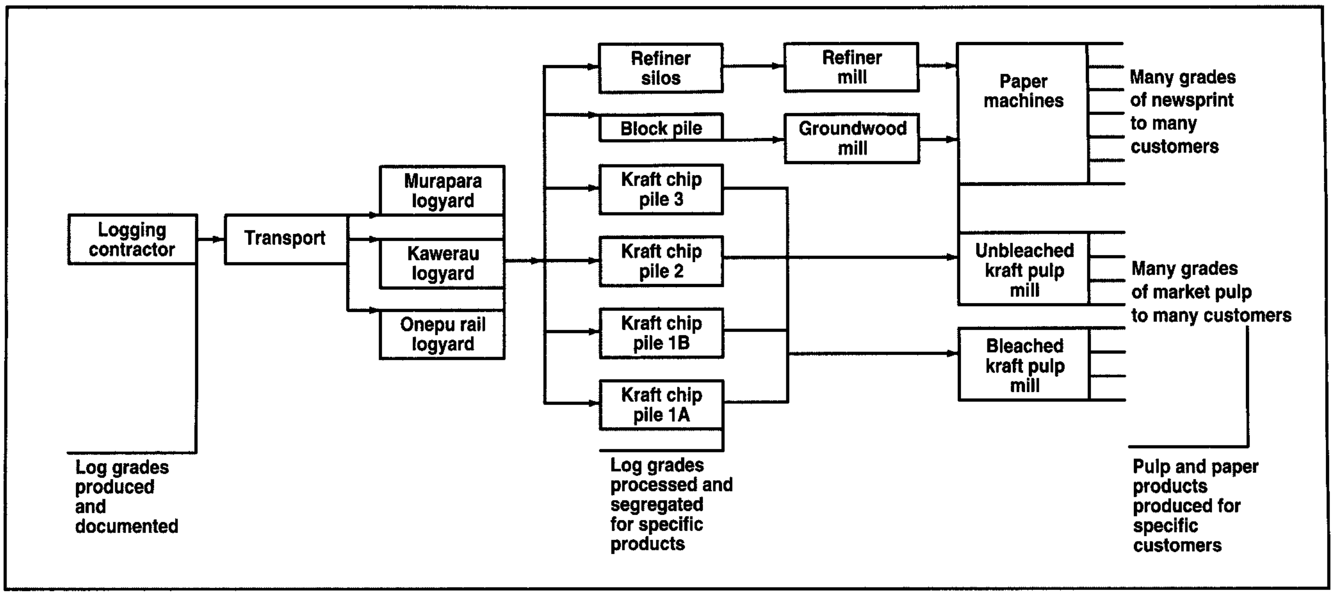
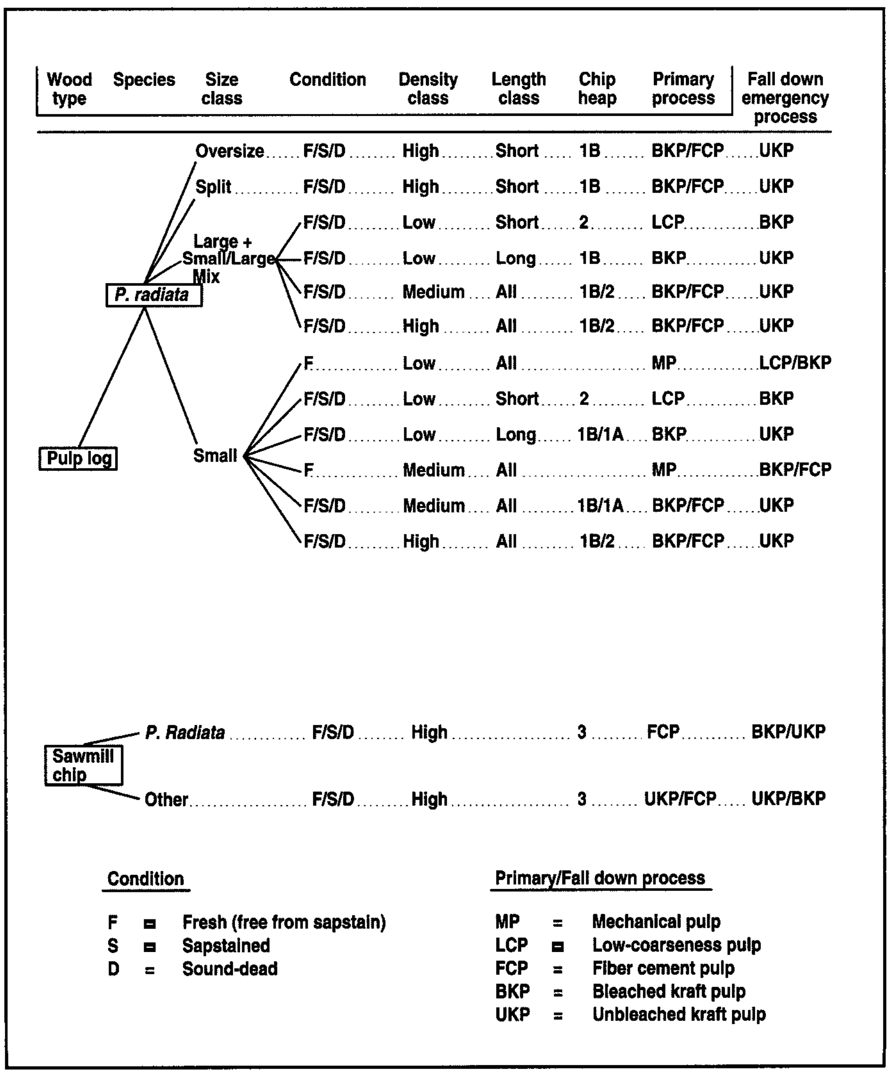
1. Fiber flow from forest to markets



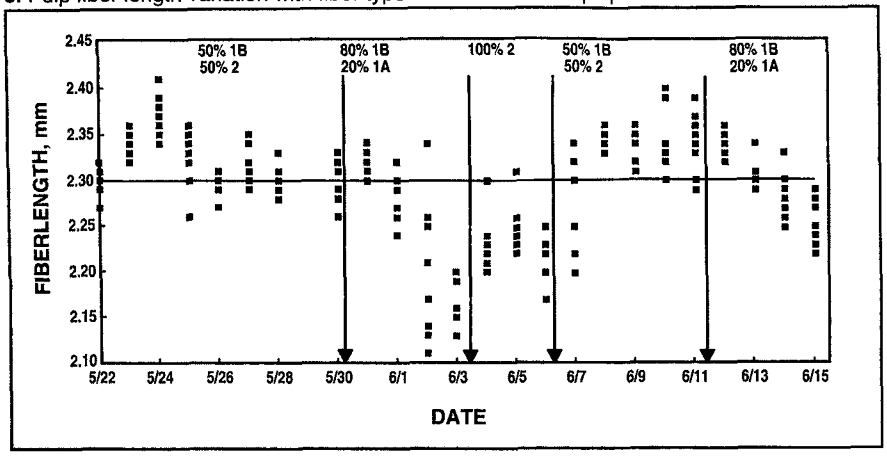
ing 20% required in the newsprint furnish is kraft pulp produced on site by one of the two continuous digesters (CDs) in the kraft pulp mill. The feed stock for the two CDs is chipped to four chip piles, each with different fiber types on them, from which various chip recipes can be pulled to match target pulp properties. Tasman produces newsprint on three paper machines and kraft pulp in two CDs. About two-thirds of the production of one CD is used in the newsprint furnish. The remaining third and 100% of the pulp production from the other CD is sold as market pulp to various customers.

Figure 2 traces the path of specific fiber types from logs and chips to pulp and paper products. Looking first at the requirements for mechanical pulp (MP under the primary process heading), Tasman can utilize pulp logs only as a primary supply for mechanical pulp due to the wood preparation plant configuration. There is a large-end diameter restriction for mechanical pulp logs of 40 cm, and all mechanical pulp logs must be fresh and free of sap stain; any discoloration or dirt in the raw fiber translates into discoloration or dirt in the finished product. There is some ability to take out discoloration by chemical addition, but it is expensive. It is possible for us to use signifi-

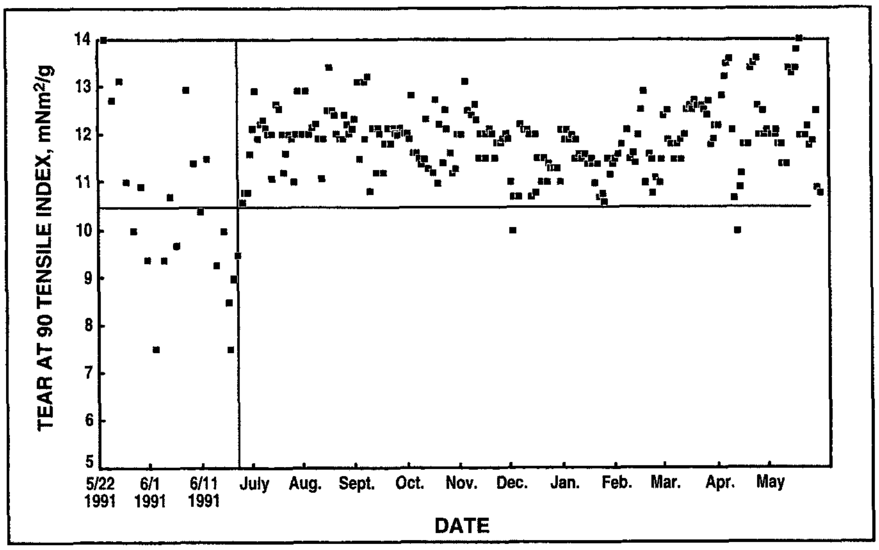
2. From logs and chips to pulp products



3. Pulp fiber length variation with fiber type for bleached kraft pulp



4. Bleached kraft pulp stack strength



cant volumes of low-density fiber in mechanical pulp, but generally low-density mechanical fiber in the furnish needs to be balanced with kraft to give the required paper strength.

The process products are defined at the bottom of Fig. 2. Generally, all the pulp product specifications are dependent on a specific range of basic densities (o.d. kg/green m^3) that relate to fiber length and fiber coarseness (related to the thickness of the fiber wall). Hence, basic density is really the key market kraft fiber variable. The key newsprint fiber variable is also basic density as it relates to paper strength, but wood age (the time from tree stump to process) is also an important variable in the mechanical pulping process.

Effect of raw material quality on final product quality and customer satisfaction

There is a very good correlation between raw material quality and fiber characteristics and final product quality. To illustrate the dramatic effect that fiber mix has on market kraft product quality, I will outline a specific problem relating to bleached kraft pulp (BKP) strength that occurred during May and June 1991. **Figure** 3 plots fiber length (related to basic density) against time. The target minimum fiber length is marked on the graph at 2.3 mm. A major dip below the minimum specification occurred between May 30 and June 5. This coincided with a change in chip feed recipe as recorded on the graph as 80% 1B:20% 1A. The 80% and 20% represent feed to the CD and the 1A and 1B are the chip pile reclaims (see Fig. 9). Short-fiber-length chip is stored on pile 1A; the fiber length problem occurred when the 1A chip feed was introduced. Again on the 10th of June, when chips from pile 1A were introduced the fiber length fell below acceptable levels.

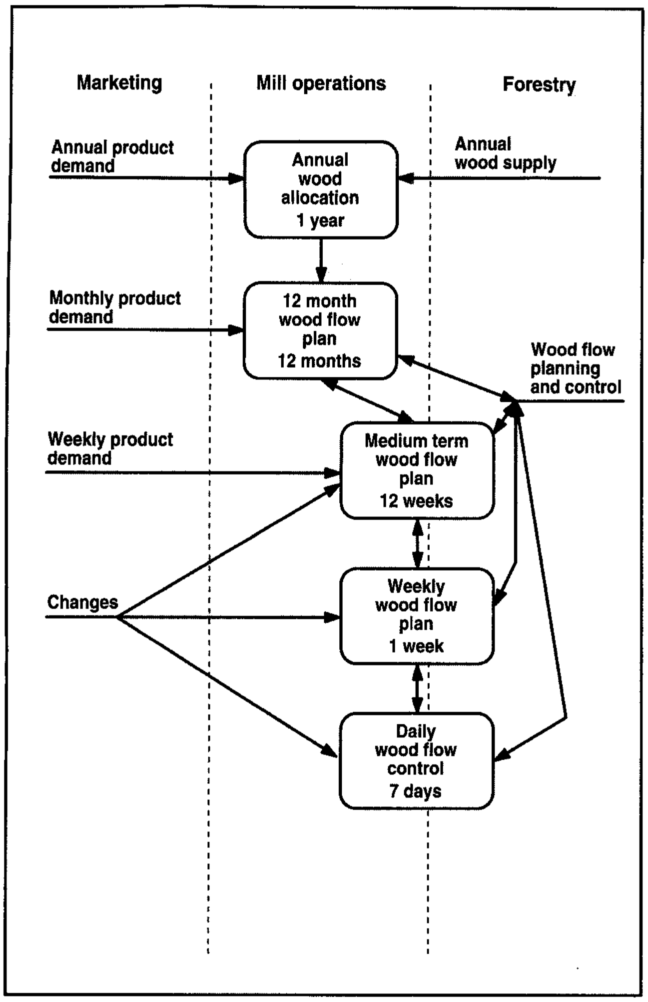
Figure 4 plots a measure of pulp tear and tensile strength against time with a minimum target line shown at 10.5. The period plotted on Fig. 3 is on the extreme left of the graph, with the June '91 to June '92 period expanded to the right. To achieve a strength index above the target level shown on Fig. 4, we looked very closely at the composition of the pile 1A chip supply and set up a system to meter a known consistent mix of fiber types with known fiber characteristics onto the 1A chip heap. The total fiber supply mix did not change significantly over the time period shown, but the way in which we allocated fiber to product was closely controlled and monitored.

These variations in wood supply resulted in market pulp downgrading with consequent reduced selling margins. It was clear that we had to gain control of our wood resource supply.

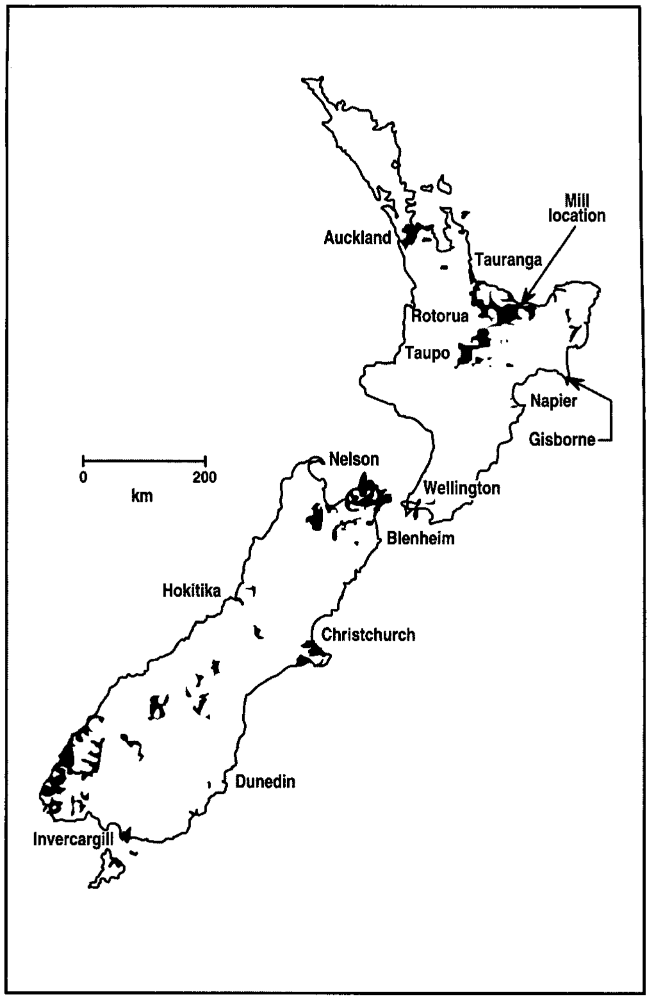
Managing raw material variation and wood-flow control

A quick glance back at Fig. 2 will show that we receive a wide range of fiber types in terms of basic densities and wood age as well as supply in the form of log and chips from various geographic locations. If we were to try to make products from a totally randomly sorted wood supply, the consistency of product would follow wild swings related to the extremes of the range of raw material characteristics. Most of the products we make have a minimum strength specification. In the days of high-density old crop resources, we literally had strength to spare, so the consistency of the fiber mix was no-

5. Wood allocation, control, and planning flow chart



6. Map of New Zealand



where near as important as it is today. The old crop is now almost exhausted, and today's much younger wood demands that we manage the fiber flow from forest through processing to the product if we are to maintain final product qualities.

Figure 5 illustrates Tasman's wood allocation, wood flow planning, and control systems. The diagram shows the interaction and data flows required between our marketing, mill operations, and wood supply agents to plan the product mix and balance the fiber supply to that product mix.

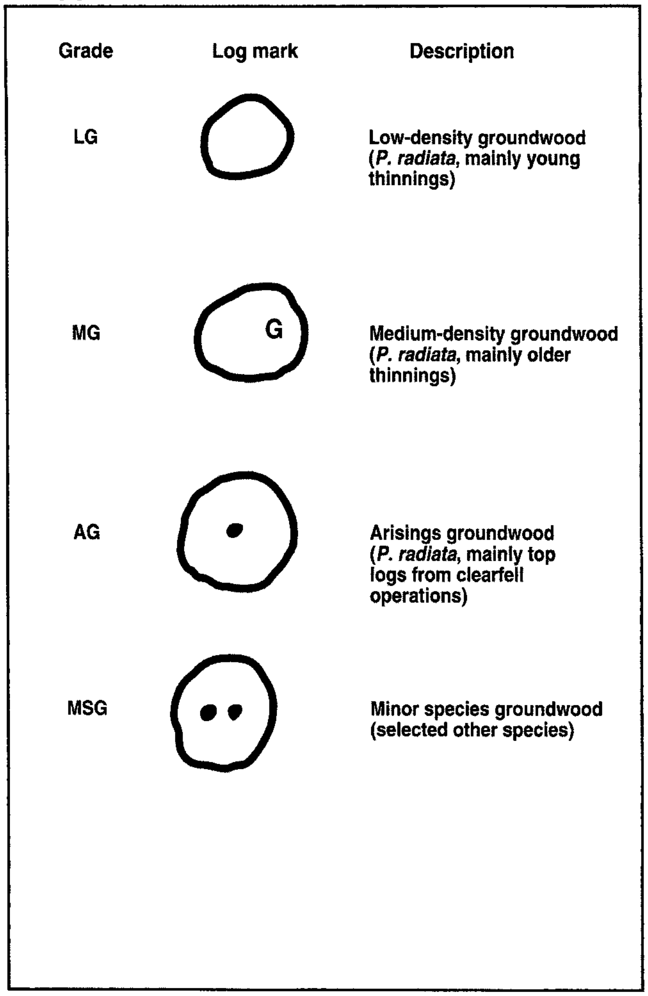
A task force carried out an investigation during May and June 1990 to look at the fiber flow from forest to process.* They recommended a system for identifying, documenting, and segregating specific fiber types within our total wood supply. The system was introduced in early 1991 and has been evolving ever since, within the constraints of cooperation from our various fiber suppliers. The system has enabled us to work toward effectively managing the different fiber types through our storage and wood preparation processes and into target pulp and paper processes and products. The system relies on fiber characteristic differentiation based on the basic density (o.d. kg/m^3) of our fiber supplies.

Pinus radiata basic density is affected by tree age, geographical location, altitude of the growing site, and position in or portion of the tree. To illustrate the diversity of Tasman's fiber mix, in May 1993 wood was delivered from 200 plus logging crews working in over 50 different forests and wood lots and from 10 different saw mills spread from Nelson in the north of the south island to north of Auckland in the north island, an area taking in coastal high-density forests and the high-altitude forests of the southern central plateau of the north island south of Taupo (**Fig. 6**).

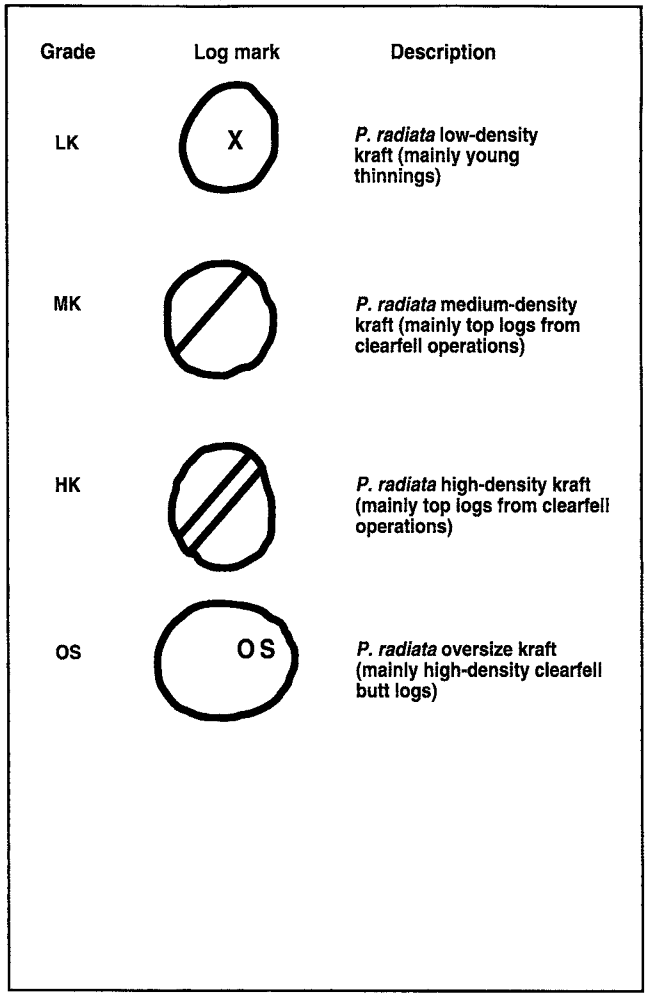
Total volume delivered to the mill for the year ended June 30, 1993, was approximately 2.2 million m^3. A small proportion of the total was produced as pulpwood exclusively for Tasman pulp and paper, just over 300,000 m^3 was saw mill chip residue, and the majority was pulpwood produced as a residue from export and sawlog operations. The current annual fiber mix has an age range from 10-year-old thinnings to 60-year-old clearfellings. This results in a wide range of fiber

Wood flow From Forest To Process—Final Task Force Report, Tasman Pulp and Paper Co. Ltd., Kawerau, New Zealand, 1990.

7. Log grades for mechanical pulp



8. Log grades for kraft pulp



characteristics due to age. A wide range of fiber types also occurs as a result of wood being sourced from a range of geographical and latitudinal locations.

Figures 7 and 8 show the eight different pulp-log grades that we differentiate. The *P. radiata* grades are segregated within basic density ranges. The low-density grades are produced from stands where the growing site and tree age indicate a basic density of 385 o.d. kg/m^3 or less. The medium-density grades result when growing site and tree age indicate a basic density of between 385 and 410 o.d. kg/m^3, and the high-density grades have indicated basic densities of greater than 410 o.d. kg/m^3. Some selected minor species are segregated out and metered into our mechanical pulp system.

Figure 7 illustrates the groundwood grades that are metered into the mechanical process wood preparation plant in prescribed ratios that are matched to the incoming wood supply. Figure 8 illustrates the kraft pulp-log grades; also, we use sawmill chips in the kraft process. The kraft grades are metered onto the kraft chip piles in prescribed ratios to give consistent pile mixtures.

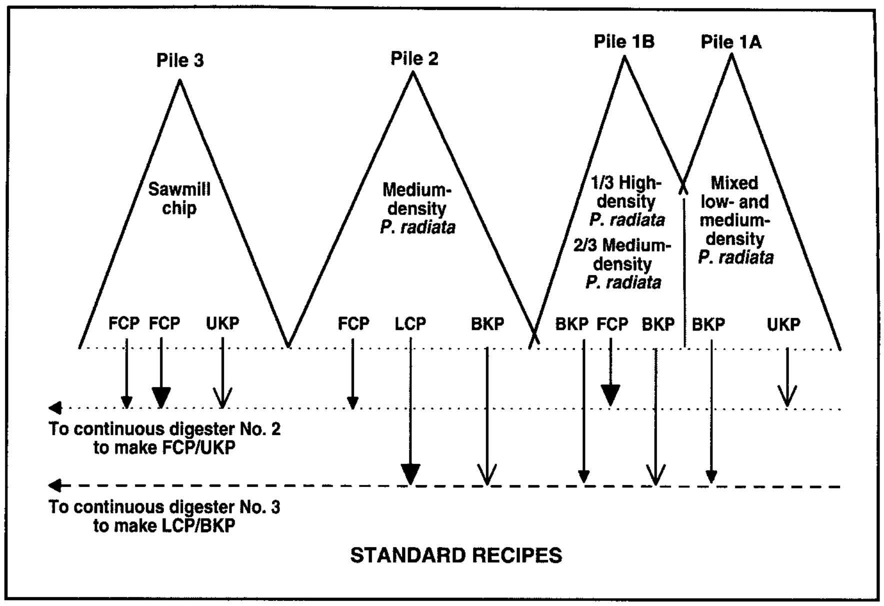
Figure 9 is a representation of the Tasman kraft chip reclaim system. The diagram shows the chip piles and continuous digester in-feeds with the recipes that are pooled from each pile to make the product indicated. To interpret the diagram, the size of the vertical arrowheads determines the standard chip feed recipes applying at any one time. Starting at the left side of the diagram we see FCP (fiber cement pulp) associated with the small, solid arrowhead pointing to continuous digester No. 2 (CD2) in-feed. Moving right to pile 2 there is another small, solid arrowhead that has FCP associated with it and which points to the chip in-feed for CD2. These two arrows indicate a chip feed to make FCP through CD2 using proportions of sawmill chip and medium-density *P. radiata*.

Moving further right to pile 1B we see a small solid arrowhead associated with BKP pointing to the No. 3 continuous digester in-feed. Moving further right to pile 1A, the next small, solid arrowhead with BKP associated with it points to the CD3 in-feed. This indicates that while CD2 is producing FCP from a blend of sawmill chips and medium-density *P. radiata*, CD3 is being fed with a mixture from pile

1B and pile 1A to make BKP. As a further example, by tracing large solid arrowheads on Fig. 9, you can see that while we are making LCP (low-coarseness pulp) from low-density *P. radiata* from pile 2 we are making FCP from sawmill chips and *P. radiata* from pile 1B.

The ability to segregate fiber types allows us to break out of the typical commodity products of the pulp and paper industry. Tasman is now concentrating on making products and developing markets for specialty newsprint products such as telephone directory paper and hibrite newsprint as well as niche fiber cement pulp and low-coarseness pulp. These niche products have particular specific fiber requirements. Our fiber segregation system allows us to identify and blend the right fiber to match the required niche product specification.

9. Kraft chip reclaim system



Pulpwood quality requirements and the impact on log suppliers and processors

As the competition in world pulp and paper markets intensifies and as New Zealand's pulp fiber resources move toward the lower-density top logs of 25–30-year rotation clearwood regimes, it is clear that the pulp and paper processors must meet the challenges by effectively managing the fiber flows through their processes. This must be done in a way that produces quality products from wood supplies that have lower average basic densities and therefore less inherent fiber strength.

To manage this change while maintaining or enhancing quality the pulp and paper producers need a lot of help from the wood producers. As outlined in the previous section, our approach to managing the variable nature of our fiber supply was to set up a wood segregation system that is heavily reliant on the cooperation and abilities of the log makers, the loader drivers, the dispatchers, the wood flow controllers, and the logyard managers, as well as all the people on the ground within the mill system.

Pulp and paper processors cannot meet the fiber quality needs of the markets without the full cooperation of the harvesters. To maximize productivity and efficiency, the mill needs to receive well presented, flush trimmed, "in spec" wood that is correctly marked to enable efficient log yard and wood preparation plant control of the different fiber types. If we don't achieve this level of control, we are unlikely to meet the quality requirements of our customers. The perception that pulpwood is the rubbish that requires a minimum amount of presentation effort needs to be corrected. It is true that pulpwood is the lowest-value wood type, and is likely to remain so, but to meet the quality requirements of the market, log presentation, marking, and documentation is a key requirement that can be effectively met only on the forest landing or in the processing yard.

Summary

The fiber classification that is currently being followed at Tasman is as follows:

Mechanical pulpwood

- Low density (<385 o.d. kg/m^3). Basically young thinnings (100% fresh *P. radiata*)
- Medium density (385–410 o.d. kg/m^3). Basically older thinnings (100% fresh *P. radiata*)
- Medium- and high-density mixed (>385 o.d. kg/m^3). Basically clearfell arisings (100% fresh *P. radiata*)
- Minor species groundwood. Selected suitable other species (100% fresh other species).

Kraft pulpwood

P. radiata (100% *P. radiata*, ideally fresh):

- Low density (<385 o.d. kg/m^3)
- Medium density (385–410 o.d. kg/m^3)
- High density (>410 o.d. kg/m^3)
- High density (oversize splitwood).

This system adequately meets the fiber segregation objectives of matching fiber characteristics to pulp and paper products, but full implementation of the system currently is being limited by some supplier constraints.

Conclusions

The last two and a half years have demonstrated to us that it is possible to successfully segregate our total fiber supply into density ranges for *P. radiata* and into preferred and non-preferred other species.

A key requirement of a successful fiber segregation system is the full flow of information between the marketers and manufacturers of pulp and paper products and the fiber suppliers.

We have made progress in matching the highly variable wood supply to various pulp and paper products, but we still have a very long way to go before we can say we have achieved the optimum fiber-to-product match within the constraints of the available wood supply. We still have some communication problems, but generally we have a good working relationship and a growing measure of understanding between the people involved in producing and delivering our wood supplies and the people who process them and market the finished products.

There are still many improvements that can be made in the management of wood flows from forest through mill process at Tasman, and with the commitment of everyone involved these improvements will continue to be realized.

In conclusion, raw material quality has a major effect on the pulp and paper industry in New Zealand. Wood presentation directly affects plant productivity and efficiency, and the quality management of a consistent mix of correctly identified fiber types matched to target products is the key to maintaining and growing market share for our pulp and paper products. TJ

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