Corewood : docking the dog's tail

Part II, The need to particularise

What is wood quality?

Discussion on wood quality revolves around stiffness and instability, mirroring the preoccupations of the sawmilling sector, and neither are effected by density in the manner so popularly presumed. Even in this narrow context discussion is dreadfully confused. While both stiffness and stability are important in the structural market, only stability is desired for board grades (plus good finishing characteristics).

Maud (1996) appears to confuse the two issues — of stiffness and stability — when he says "another factor contributing to radiata pine's lack of stiffness and strength is the increasing trend of machine grading over visual grading, particularly in high-density growth areas where high machine-grade yields can be achieved". Machine stress grading sorts timber by stiffness into the appropriate grade and by definition cannot contribute to poor stiffness; indeed it weeds out the least stiff timber. Rather the point which needs to be made, is that in high-density growth areas more corewood will make structural grades, F5 and better, than in low-density growth areas and this has the potential to cause difficulties.

High-density corewood of equivalent intrinsic quality to low-density corewood is less stable — it will shrink more on drying and move more in service by virtue of its higher density. To reiterate this point, poor intrinsic wood quality is the result of a large cellulose microfibril angle and short tracheids, severe spiral grain and compression wood. If these characteristics are present equally in high-density growth areas and in low-density growth areas, then the problems and downgrading will be greater in the high-density growth areas because high-density wood shrinks more on drying and moves more in service, amplifying any propensity of the wood to warp. This is despite the timber being stiffer in the high-density growth areas. Seeking higher density doesn't work here. Density does not determine warp and instability; it merely magnifies the effects of intrinsic wood quality characteristics, whether good or bad. Hence, in high-density growth areas it is possible that one needs to ensure that a larger percentage of the least-stiff corewood is not sold as structural timber, regardless of whether it is stiff enough to make a structural grade or not (10-20% would be my wild guess). Furthermore, dense timber is harder to restrain from moving than less dense timber, so the precise cut-off percentage for this low-quality, distortion-prone tail in the population will depend on the calibre of the drying and storage practised: the Chileans, with their denser pine, apply heavier weights (1500kg/m^2) to their kiln stacks.

The same point can be made even more effectively when considering outerwood. Outerwood is less prone to warp and instability because the intrinsic wood quality of outerwood is far superior to that of corewood and not because it is of higher density. Occasional zones of compression wood in outerwood need to be watched for, as poor wood quality and high density spell real trouble.

In a broader frame, differing sectors value or rank wood properties differently and this is reflected in the price they pay for wood. If one lists the most damaging property for particular products — poor tear strength in packaging-grades of paper, inadequate hardness for furniture (marking of soft surfaces), low stiffness in framing timber — it is clear why superior density helps. However a specific strategy for each industry would be more effective and efficient than a broad emphasis on density: seeking longer fibres for kraft pulp; more permeable timber for furniture (easier, more uniform impregnation by wood-hardening chemicals); a smaller microfibril angle for structural timber; I am unsure what wood properties MDF would value most — light colour, high lateral compressibility? The FRI has the beginnings of a workable methodology to determine appropriate wood properties for particular end-uses (Table 1). It is rudimentary as most listed properties are actually wood quality characteristics. For example, stiffness (not listed) is a property which is greatly influenced by the two interrelated characteristics of (micro)fibril angle and fibre length (both listed). Also there is double counting, as it would be difficult to distinguish between extractives and heartwood. Similarly the end-use groups are either grossly aggregated (pulp and paper with no distinction even between chemical and mechanical processing), or finely separated (preservation). It is a most useful initiative which needs to be developed more rigorously.

The trees are too young

We are told (anon, 1997) that Juken Nissho offered to double the price for a 24-year-old stand if held for another four

Table 1. FRI wood quality selection matrix (Meder et al., 1995).

	Component furniture	Structural (Dry)	Plywood	MDF	Preservation	Fingerjoint	Pulp & Paper	TOTAL
Density	3	3	3	1	1-2	2	3	16
Spiral grain	3	3	3	1	1-2	3	1	15
Fibril angle	2	2	1	1	1	2	2	11
Extractives	3	1	2	1	3	3	3	17
Fibre length	1	1	1	1	1	1	3	9
Chemical composition	1	1	1	1	1	1	3	9
Lignin distribution	1	1	1	1	?	?	3	7
Stability	3	3	3	1	2	3	1	16
Heartwood	3	1	1	2	3	1	3	14
Compression wood	3	3	3	1	2?	3	1	16
Branching	3	3	2	1	1	1	1	14
Branch spacing	3	2	1	1	1	3	1	12

Key: Priority: 1 low, 3 high

years. The marginal rate of return — the only important decision variable if you owned this 24-year-old stand — is a handsome 19%; but we don't know how low a price was offered originally, and whether delayed felling increased the internal rate of return from a miserable 4% to 6% or from 7% to a generous 8.6%. However, we are also told of the Aussie selling 50-60-year-old trees to CHH's plywood mill — pity the Aussie grower, as that cannot be economic. While Juken Nissho may be happy to offer a sizeable premium for deferred felling, there is no evidence that others will follow suit. Macalister (1997) suggests a premium of only 20% for "older logs", all a little vague.

The point which people seem to miss is that extending the rotation age does nothing for the existing corewood. It is unchanged, as good or bad as it ever was, overlaid by more outerwood. In absolute terms there is quantitatively as much corewood as before, although proportionately there is less. The argument in favour of extended rotations is simply to grow more outerwood to wrap around the corewood. This does not offer any new opportunity for using the corewood. At the operational level, the key to our industry's prosperity lies in particularising and not generalising about corewood quality. For far too long we have been lazy. We have contented ourselves with considering the average properties of stands, trees and timber. Now we have the opportunity to focus on the specific properties in individual logs. The reason why this is important is simply that the poorest 10-20% of the logs are likely to be processed at a loss. Early felling of stands is not a problem. The problem is the increasing proportion of less stiff logs from such stands being inappropriately processed.

Variability and corewood

Engineers are familiar with examining properties of wood at the tail of a distribution. In machine stress grading the grade values (strength, stiffness etc.) are determined at the 5th-percentile level, i.e. 95% of the timber in the packet must be stronger and stiffer than the grade value. The engineer is not interested in how strong or stiff the piece is or might be — it could be two or three times better than the grade values. In practice, the engineer is interested only in how weak the piece might be and that is taken to be the lower 5th-percentile value. Similarly, but less consciously, industry seeks to eliminate the worst pieces in a packet of non-structural boards. If a single board in a ceiling lining or wall panelling warps or cracks, the effect is disastrous. When one considers wood quality in timber one must focus on the properties of the poorest pieces admitted, not on the average properties.

In reworking an earlier study on 48 trees from a single stand of unpruned 25-year-old pine growing on the Canterbury Plains near Dunsandel, Addis Tsehaye et al. (1997) sought to characterise both the mean properties of the timber in the stand by log type and position of the timber relative to the pith (Table 2) and then compare these values with those for the worst 10% — the five worst logs — for butt, middle and top logs (Table 3). They demonstrate that the worst trees are indeed undesirable, and that the entire stand (the average properties) is maligned by the worst trees. In this manner the tail wags the dog. There is the option of sorting logs by stiffness (Tsehaye *et al.* 1997a) which, if used to exclude the least stiff logs appears capable of weeding-out some of the worst wood with regard to a range of properties — low stiffness and strength, moderate spiral grain (Table 4). The Holy Grail for the sawmilling industry is to find the working tools to efficiently identify those bum logs and so learn to dock the dog's tail. This kind of sorting must distinguish in terms of wood quality between visually similar logs; it goes beyond current sorts for log size, knottiness and clearwood content. This development is crucial to the sawmilling industry which has to focus on and live with — and within — tree variability. It is not critical for the fibreboard, particleboard and paper industries as they mix up the wood and deal in average properties. New Zealand has the expertise to develop such a docking/log-sorting system, but it needs the commitment and support of industry to develop and implement the scheme. If successful, why not a 15-year rotation, unpruned sawlog regime with the poorest 20% of logs going for fuelwood, pulp or panel products while the balance provides quality timber — both stiff and stable?

Breeding dreams

Michael Milken, the disgraced junk-bond dealer turned philanthropist, recently described the biotechnology revolution as the greatest disruptive force in society (Glassman, 1997) — disruptive in a wonderful, positive, energising sense. Such creativity contrasts with the more-of-the-same, backward-looking extrapolations into the future.

At a more prosaic level, there is the opportunity to transform plantation forestry practice: to improve corewood properties and dramatically reduce rotation age by focusing on stiffness and stability for solid-wood products, and on tracheid length for paper; or, more seductively, to add value to a 15-year-old pine corewood

Table 2. Mean within-tree variation of modulus of elasticity, tensile strength, density and spiral grain.

		BARK				PITH			BARK	
Distance from the pith (boards)		4	3	2	1	1	2	3	4	
Top log	Spiral Grain (°)	–	2.5	2.5	4.0	11.9	15.8	18.0	–	UTS (MPa)
	Density (kg/m³)	–	464	463	452	5.3	6.7	8.2	–	MOE (GPa)
Middle log	Spiral Grain (°)	2.4	2.9	3.2	4.7	14.2	17.2	21.8	26.8	UTS (MPa)
	Density (kg/m³)	486	476	464	451	5.2	6.5	8.6	8.5	MOE (Ga)
Butt log	Spiral Grain (°)	1.3	1.7	2.8	4.0	14.2	19.7	26.0	29.4	UTS (MPa)
	Density (kg/m³)	521	505	487	475	4.5	6.5	8.5	9.6	MOE (GPa)

Table 3. Between-log variation of stiffness, strength, density and spiral grain, sorted according to the best and worst 10% of the logs within each log type (butt, middle and top log) for each property.

Log type	Rank	MOE (GPa)	UTS (MPa)	Density (kg/m³)	Spiral grain (°)
Top	Best 10%	8.2	23.9	510	0.8
	Worst 10%	4.7	8.3	414	6.3
Middle	Best 10%	9.2	25.5	520	1.1
	Worst 10%	4.9	11.1	419	6.8
Butt	Best 10%	9.8	32.1	545	1.0
	Worst 10%	4.1	11.3	441	6.0

crop by introducing the aroma of camphor; or wouldn't it be exciting to use 12-year old pine thinnings for peelers as in the southern United States (Walker, 1993 p. 384)? Long-internode breeds have a major role to play in short-rotation forestry.

Tree breeders dislike using very young wood to predict prospective wood quality, probably because environmental effects, of site conditions and wind, are especially acute and create so much "noise" in the data. If you reverse the logic, even with superior breeds there will always be "noise" attached to the corewood of elite stems which will make superior wood quality variable and less predictable. So one will need always to dock the dogs tail and sort. At least we will know why we are doing it.

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Table 4. Between-log variation of stiffness, strength, density and spiral grain, for the best and worst 10% of logs sorted according to stiffness.

Log type	Group	# of trees	# of boards	MOE (GPa)	UTS (MPa)	Density (kg/m^3)	Spiral grain (°)
Top	High stiffness	5	22	8.2	18.1	461	2.0
	Low stiffness	5	22	4.7	9.5	492	5.0
Middle	High stiffness	5	30	9.2	24.5	482	1.6
	Low stiffness	5	30	9.2	24.5	482	1.6
Butt	High stiffness	5	40	9.8	29.9	523	1.3
	Low stiffness	5	40	4.1	13.4	480	3.7

High stiffness = best 10% of logs; low stiffness = poorest 10% of logs.

Certification

Forest and forest products certification have been hot topics in New Zealand forestry circles over the past few years. Driven by environmental concerns certification seeks to ensure that forestry practices are environmentally acceptable. To this end certification considers both the management processes that are being undertaken and the standards that are being achieved.

In New Zealand the debate has largely centred around two certification processes — International Standards Organisation (ISO) and Forest Stewardship Council (FSC).

ISO is the international body involved in setting up product standards throughout the world, based in Geneva. Only comparatively recently has ISO moved into the area of management systems, of which ISO 14 000 is concerned with environmental management. A number of New Zealand forestry companies have ISO 14 001.

FSC was set up in 1993, largely through the efforts of international non-government environmental organisations, to ensure that forests are subject to good forest management. Plantation forests are also included within the FSC mandate. Based in Mexico FSC is active worldwide and already in New Zealand two companies have achieved FSC certification.

ISO 14 001 and FSC are compatible systems. ISO 14 001 certifies that management processes are environmentally acceptable, whereas FSC certifies that defined standards are being achieved. ISO 14 000 can also be applied to management of forestry processing companies but neither FSC nor ISO set processing standards.

Both ISO 14 001 and FSC seek continuous improvement in the operations that they certify. Six monthly audits by independent auditors ensures certification in the first instance and that standards are being maintained or improved thereafter.

Detractors of FSC have expressed concern that FSC's principles are based on ideology, with one set of standards to apply across the globe. There is also concern that the standards may become too strict, costing forestry companies who have already been certified considerably more in order to maintain compliance.

ISO 14 001 on the other hand relies on companies to set up their own environmental standards. There are concerns that this may lead to companies making it easy for themselves. Partly in response to this ISO is also moving in the direction of setting up environmental standards, but this process may take some time.

FSC has made in-roads into international markets particularly in the Northern Hemisphere. Some building suppliers in the United Kingdom are now requiring that their wood purchases are FSC certified, stating there are no other credible certification bodies. ISO 14 001 certification is not acceptable for this purpose because ISO only certifies management processes, not product.

Some countries, such as Canada, have proceeded to develop their own certification processes which they are now testing in the market place. New Zealand, through the Forest Industries Council, is also trying to develop a "report card" type process, based on the Canadian model. This would enable forestry companies to list their environmental credentials, such as having an environmental management