An overview of wood quality issues and their impact: A personal view

Wayne Miller[1]

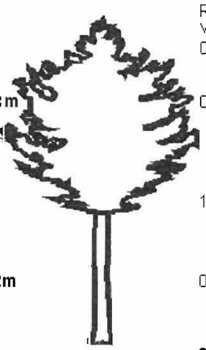
Wood quality is currently receiving considerable attention from the whole forest industry. One of the reasons for this is that wood quality is a measure of how successful our forest growing practices have been. Breeding, establishment, and silviculture all contribute to the wood quality of the final forest harvest. This creates an immediate 'stress point' between forest growers and processors. Often the needs of the processing industry and the end use are poorly understood, particularly with end uses which are relatively new for radiata pine (e.g. mouldings, windows) or where our experience is limited (e.g. USA and Japanese markets).

This article represents the author's view on some aspects of wood quality with a focus on the important appearance segment of the solid wood market.

Focus on Solid Wood Properties

In terms of importance to forest growing it is the solid wood sector that provides the economic returns that justify forest planting. Currently over 90% of the planted New Zealand forest estate is radiata pine (Douglas-fir makes up a further 5%). Of this radiata pine some 70% has been, or will be, pruned to produce clearwood.

Fig. 1 indicates the recoverable volume, value and typical products obtained from these forestry practices. Some 98.5% of the value is derived from the pruned and unpruned sawlogs.



	Recoverable Volume (m3)	Value (%)	Products
Waste **5m**	0.10	0.0%	
Industrial Logs **8m**	0.25	1.5%	Pulp, paper, PB, MDF
Sawlogs **16.8m**	1.48	38.5%	Knotty Appearance, Structural, Packaging lumber, veneer
Pruned Logs **5.2m**	0.58	60.0%	Clear boards, mouldings, veneer
Stump **0.2m**			
TOTAL	**2.41m3**	**100%**	

Source: NZ Forest Industry Facts & Figures.

Fig 1: Recoverable volume, value and typical products obtained from pruned radiata pine at age 30.

Wood quality needs to focus on those areas that provide the greatest financial impacts. Unfortunately in the past, little attention has been paid to the quality of the clearwood produced from the pruned log, despite it making up some 60% of the value of the tree. It has been assumed that if a log is 'knot-free' then it has clearwood values. Defects like: bark blemishes, resin pockets and streaks, needle fleck, birdseye, and internal checking downgrade the clearwood.

The end uses and the important properties affecting performance for solid wood can be categorised:

- Structural Uses: Stiffness, Strength (especially tension), Creep, Stability, Distortion, Shrinkage, Treatability.
- Appearance uses: Internal checking, Stability (in processing and in use), Resin pockets, Blemishes, Treatability, Shrinkage.
- Packaging Uses: Mainly covered above - but there may be some additional special properties of importance.

Our wood quality studies and knowledge need to encompass all the above.

Requirements of Export Markets

Another key reason for the increased focus on wood quality is that New Zealand is now exporting more of its forest products. Rather than being a domestically focused industry responding to domestic performance requirements with the wood competition largely other radiata pine sources or other plantation grown softwoods, the competition is now international. We must produce products that meet international standards of performance, and compete with a wide range of other timbers, hardwoods and softwoods, from natural forests. Performance is often measured against that of wood from 'old-growth' forests.

The comparison in expected performance is illustrated by limits for distortion:

New Zealand:	Permitted Crook	10mm or 0.33%
	Permitted Bow	25mm or 0.83%
Japan:	Permitted Bow and Crook	0.1%

(Basis: 3m 100x50mm)

Differences in fundamental wood quality affect utilisation and value. Radiata pine is being used as a substitute for ponderosa pine in the USA. However, limitations (perceived and real) to radiata pine's performance lower the pricing levels for equivalent grades. See Fig. 2 for a comparison of pricing for radiata pine and ponderosa pine Moulding and Better grade.

One can speculate that a proportion of the significant price difference is due to wood quality and performance

[1] *Wayne Miller is Product Development Engineer at Fletcher Challenge Forests Ltd*

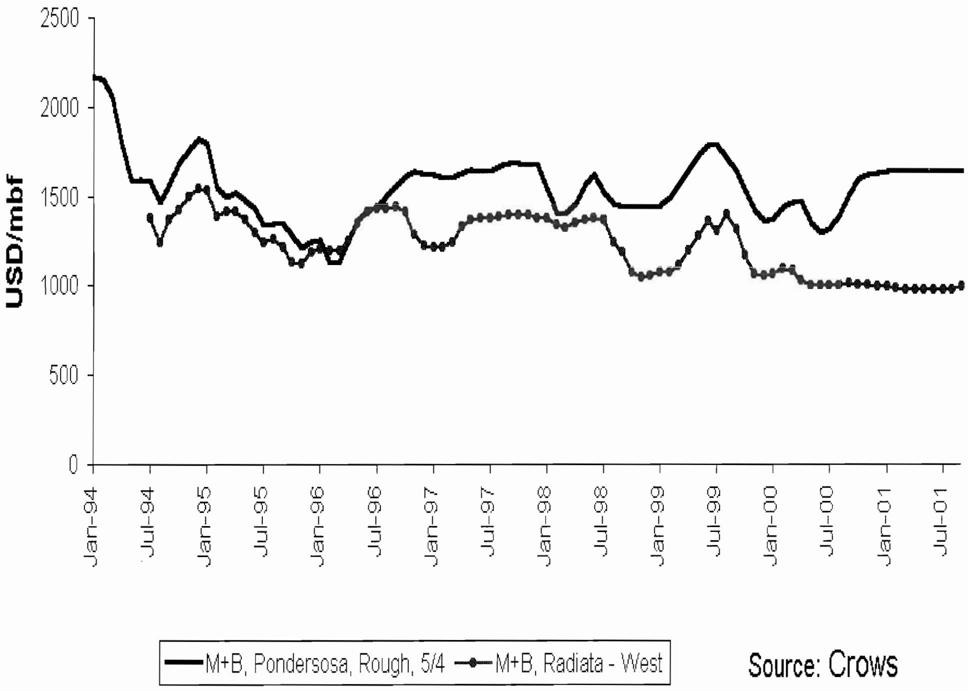


Fig. 2: USA Moulding and Better Prices

differences between the species. Such things as higher intrinsic defects, poorer stability, internal checking and resin pockets, and compression wood, will reduce the yield. Also the potential end uses will be reduced. For example, lower stability limits radiata pine's ability to produce small section mouldings and long length window parts.

Impact of Wood Quality Defects

The Japanese have long been recognised for their attention to 'quality'. One of the key concepts, that my association with the Japanese has taught me, is to continually question 'lack of quality'. Too often, I believe we simply accept poor yield and quality, and fail to make the moves to correct problems.

For example consider a typical the breakdown of rejects of finished solid lineal mouldings:

Manufacturing Defects: Want, Roller Marks, Rubber Marks, Wane, Planer Burn, Taper, Pitch marks, Snipe, Hit and Miss, Blue Stain	50%
Knots	5%
Wood Quality Defects: Crook, Bow, Bark Pockets, Resin Pockets, Resin streaks, Checking	45%

Plant management will focus attention on reducing the manufacturing defects, it is the responsibility of the forest growers to minimise wood quality defects which cause close to half of the reject mouldings. In addition, manufacturing defects such as snipe, planer burn, hit and miss can be increased due to the distortion of the moulding blanks affecting feeding.

While the wood quality defects are normally accepted as part of the 'variability of wood', with knowledge and understanding it should be possible to minimise or eliminate them. This is the challenge.

Variability of Wood Quality

In the past wood quality effects have been lost in the considerable variation in wood being processed. The impact of a 'poor log' has been swamped by the mass of other material. Consequently the demand for improved wood quality has often not been forthcoming from the processors. However, changes to forest practices will have a dramatic impact if wood quality is not addressed.

In the past many logging gangs in different compartments were required to supply a processing plant. The plant therefore received material with much genetic and site variability. The development of 'high velocity' logging, where single large crews working in an individual compartment could supply a plant, has reduced the site variability to the point where poor quality is now apparent. However the inability to accurately monitor and track process efficiency together with delay in processing (storage, kiln drying), mean that when problems occur, the ability to change resource, is lost.

In the future clonal forestry will reduce the genetic variability in our resource, and in combination with 'high velocity' logging, will result in little variation in the material entering the processing plants. The forest industry will either get it very right, or very wrong!

The following illustrates the variability between individual logs in their processing behaviour. The data is from an individual log study where 36 logs from three sites were tracked from log through to production of finished mouldings.

Individual Log Results

Defect	*Range*	*Average*
Surface Checking	0-82%	24% of boards
Distortion in Ripping	0-44%	16% of boards had Severe
Internal Checking	0-23%	4% of moulding length
	0-90%	28% of mouldings

Clearly there were considerable differences in potential yield between the individual logs. Some had a very high propensity for surface checking, internal checking or distortion in ripping. Conversely some logs gave very high yields, with little checking or distortion. The challenge is to understand the behaviour such that less material is produced that will be a problem, and/or that the problem material is sorted and allocated to uses where it will give greater value.

New Approach Required

The previous paradigm for wood is no longer valid. In the past wood with narrow growth rings and straight grain, was considered to be uniform, and the grain angle described grain orientation. Now we are concerned with wood with wide growth rings, significant ring curvature, and properties that vary significantly with radius. Also some product dimensions (e.g. mouldings) are comparable with the growth ring. Intra ring properties are becoming more important; e.g. internal checking, and stability. Hence we must consider earlywood and latewood properties, with the orientation described in polar coordinates: radius and angle.

Value Drivers

It is estimated that, currently, in the order of 10% of finished solid wood products are rejected or downgraded due to wood quality causes. On occasions this can increase to 50% or greater. This loss in value amounts to at least $90 million annually ($450 million at 50% reject/downgrade), representing lost value to both the forest grower, and solid wood producer.

There are also additional costs due to sub-optimal use of material, e.g. high stiffness material being used for packaging uses. The difference in value between different processing routes can amount to $10/m3 log. If this were achieved for 50% of the saw and veneer log harvest of 10 million m3, the annual benefit would be $50 million.

In addition if the performance of wood can be accurately predicted, further market opportunities would be available for radiata pine, e.g. doors and windows, small mouldings, high stability products (Japan), adding to value obtained.

Opportunity for New Zealand to Lead the World (again)

New Zealand is a recognised leader in terms of our forest management practices and our ability to produce wood economically from plantations.

New Zealand has moved through two stages of plantation development[1] :

Stage 1 : Proving that planted forests could be grown economically and produce utility wood. In New Zealand this was the so-called 'old crop'. High-grade wood was still available from natural forests.

Stage 2: Development of more intensive silviculture (pruning, thinning) and improved breeds to produce higher valued 'clearwood' to improve economic returns.

[1] *Bill Dyck, Inwood International 45:37 June-July 2002*

Stage 3 we have yet to reach but, this will result in the production of superior quality wood, which has properties exceeding those of the highest quality wood from natural forests, and which can compete with other materials: plastics, metals, composites in demanding end uses. There is no reason why if the properties are suitable, wood from younger trees can't be used for high value applications. Thus Stage 3 offers the opportunity of shorter rotations in some cases, but with wood quality unaffected.

This solid wood, which doesn't need complex manufacturing, or chemicals and excessive gluing to improve properties, will truly be a 'green product' and a product of the future, limiting the use of energy and outside chemicals in its production.

I am probably too old to see Stage 3 finally achieved, but the building blocks in our knowledge are there already. The Wood Quality Initiative is clearly aimed in this direction. Having lived through Stages 1 and 2, the opportunities are exciting and New Zealand is well placed to be first to achieve them.