Small Eucalypt Processing Study

Sawing Performance in Western Australian Sawmills.

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This report is part of a program of industrial research and development aimed at establishing techniques and developing equipment to allow processing of small eucalypt regrowth logs in a commercially viable manner, particularly with a view to use in high quality furniture. The research program is funded jointly by the Commonwealth Government under a Public Interest Project, the Department of Conservation and Land Management, and the Western Australian timber industry.

Wood Utilisation Research Centre
Department of Conservation and Land Management

PREFACE

The Department of Conservation and Land Management has a Wood Utilisation Research Centre at Harvey, about 140 km south of Perth, where research programs in both hardwood and softwood are carried out. The major research at present is in regrowth eucalypts, assisted by Commonwealth Government funding under a Public Interest Project.

This report on sawing performance in Western Australian sawmills was commissioned from Dr W.M. McKenzie, a consultant in saw technology, and formerly of C.S.I.R.O. It is part of the program for research and development of techniques and equipment for the commercial utilisation of small regrowth eucalypts.

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MY BRIEF

A letter from P. Shedley of the Department of Conservation and Land Management, W.A. (CALM), July 8, 1987 indicated my brief to be:

" to evaluate and report on our industry sawing efficiency relative to state-of-the-art technology. Your recommendations for change and research could then be considered by industry and our Wood Utilisation Research Centre"

In response, I visited Western Australia in the week of August 9-14, 1987, talked to CALM people, sawmill managers, supervisers and saw doctors, and visited 11 sawmills and saw shops.

MY APPROACH

Hoping to make my suggestions realistic, I have looked beyond "state-of-the-art technology", to factors governing the present level of sawing technology in W.A., in the belief that the decision environment is complex, being influenced by history, geography, and competing objectives, as well as many other factors.

I start by giving my definition of sawing performance, then list some possible motivations for on-going effort to improve it. The four facets of sawing performance as apparent in the mills visited are discussed, and then follow my general comments on sawing in the industry, to be regarded, not so much as recommendations, as suggestions that investigation of certain aspects may well reveal prospects for profitable change.

A list of suggested lines of action appears at the end.

SAWING PERFORMANCE

Sawing has a number of facets, each related to a particular aspect of production, the relative importance of which will depend on the production objectives of the particular

PERFORMANCE FACET	PRODUCTION ASPECT
Feed speed	Production rate
Sawing accuracy	Yield of finished products
	Quality (dimensional accuracy)
Kerf width (actual)	Yield
Surface quality	Quality (appearance)
	Yield (decreased by additional finishing)

sawmill or plant manager. The facets and their connection with production objectives are set out below;

Of course, cost reduction is an over-lying objective, but should in turn be subject to the objective of profit increase, which could justify an increase in initial or subsequent costs of improving sawing performance.

Naturally, a manager would like to optimise all of these facets of sawing performance, but they tend to conflict unless cost is increased. For instance, feed speed can be increased at the expense of the other three, and similarly with sawing accuracy.

MOTIVATIONS FOR INCREASING SAWING PERFORMANCE

Assuming an over-riding goal of middle- or long-term profit, possible motivations for putting money and effort into improving sawing performance, are listed below with no implied priority ordering:

- Higher product quality/value, providing added profit.
- Lower overall sawing and finishing costs.
- Higher yields of finished products from logs diminishing in quality and availability.
- The ability to demonstrate maximum utilisation of a multi-valued forest resource.

COMMENTS ON FACETS OF SAWING PERFORMANCE AS OBSERVED

I emphasise that in visiting several mills per day my observations could only be limited. Thus my comments on an aspect should be regarded as a challenge to look closely at that aspect in a particular mill, to see if it applies.

FEED SPEED

Maintenance of feed speed seemed to be a common first priority, and, with some regard for accuracy (avoidance of snaking), was sought at the expense of other facets. Nevertheless, feed speeds appeared to be generally lower than elsewhere, considering species. Systematic measurement in relation to depth of cut would be required to confirm or deny this assertion, but the later discussion of performance of thin saws in N.S.W. and Queensland should provide basis for comparison.

There should be an inverse relation between depth of cut and feed speed, so that the area of sawn surface is roughly constant. However, commonly, one machine cut a wide range of depths, and feed speed did not seem to vary sufficiently to maintain a constant rate of sawn area output. Of course, the ideal cannot be expected, but I predict that a check of speeds would show a relationship far from ideal.

The key problem is to direct material of a limited range of shape and size to each machine, one which should have greatly influenced the design and equipping of the mill. Flexibility should also have been a feature. Given a suitable lay-out, a continual operating task is to maintain flows to each of the downstream saws, one requiring clear directives from the supervisor to a skilled operative.

Flow can also be smoothed by sorting logs, at least roughly, and feeding the mill with logs one size class at a time.

Another observation was that production rate was depressed by factors other than feed speed. Waiting time was sometimes considerable, due to pauses in material supply to a machine, and delays while clearing material jammed in conveyors. This raises the matter of offcut disposal. Waste offcuts should not pass through a downstream machine, but should be disposed of finally at the machine producing them, by conveyors designed to be less easily fouled by irregular shaped pieces such as spears.

The experience in other regions is that these and other important problems can be greatly alleviated by installing chipper heads to create a flat on the round side of material before it enters saws early in the line. There is already an outlet for karri and pine chips, and jarrah chips may well be successfully promoted for mulch, playground surfaces and animal bedding. Returns from such outlets would add to the reduction in costs of coping with irregular offcuts.

SAWING ACCURACY

Sawing accuracy refers to thickness variations, either top-to-bottom, or longitudinal with a wave-length longer than the feed per saw revolution. They are caused by saw deflection under sawing loads.

The limit on feed speed usually identified by saw doctors was snaking, a relatively gross form of saw deviation to which they are usually alerted by sawyers. Avoiding trouble in the form of snaking is perhaps a major objective of both sawyers and saw doctors. This is natural because the threat of snaking is ever-present and immediate. The daily struggle to meet it tends not to impinge on management unless a major crisis occurs, or a request for equipment is made. Sawyers and saw doctors soon learn managers' tolerance level of inaccuracy, and adopt it as their own.

I did not obtain information on existing procedures for controlling sawing accuracy for construction grades, or the extent to which SAA grades are applied. Possibly there is little market feedback on accuracy of these grades.

I am able to comment on finishing grades only from limited observations on skip in predressed boards. These suggest the need for a closer study of dressing losses, to ensure that losses from sawing inaccuracies add minimally to those incurred due to drying. A regular check on skip would provide a good quality control measure of sawing accuracy.

The need for pre-dressing is of interest, especially as it involves the use of expensive machinery and extra labour for handling and grading. If as stated the purpose is to assist better inspection for quality, I suggest that with accurate sawing and satisfactory drying to avoid surface checks, grading could be carried out before drying, to avoid the cost of processing valueless material. Yield is also likely to be improved.

IMPROVING SAWING ACCURACY

The common reason given for using thick saws was, in essence, the need for maintaining sawing accuracy, but there are other possiblities for controlling accuracy. They start at the log deck, with debarking and washing. Bark and grit can blunt the teeth of a fresh saw in its first cut, so that for the whole of its run the saw is subject to sawing loads and heat generation which threaten its stability. However, it appears that few saws are removed before the usual 4-hour change period, and it seems likely that, in the absence of debarking, most saws operate in poor condition all the time, and good performance is not to be expected. Possibly much existing practice is attributable to this, and little can be done to improve sawing performance before debarking is introduced.

One approach to detecting snaking before it becomes gross is to mount a deflection probe close to the sawblade, to warn the sawyer of excessive deflections, so that he can limit the feed. He can remove the saw if this occurs frequently. Such probes are now being used successfully in the South Australian Woods and Forests mill, Mt Gambier. A further refinement would be automatic stopping of the feed at a certain deflection, which would allow a higher feed speed to be maintained with confidence.

Adequate maintenance of the sawing machine is of first importance in avoiding snaking. Responses to questions about machine maintenance suggest that there is usually no routine schedule of preventive maintenance covering wear loss of adjustment in bearings, wheels, fences, guides, etc. Checking of the machine seems to depend on failure of the sawyer and saw doctor between themselves to cure a problem, possibly after considerable loss of production, quality, or sawshop time. A preventive maintenance schedule can anticipate and avoid major breakdowns. If one is initiated and found to reveal few deficiencies, the frequency can be reduced.

KERF WIDTH (ACTUAL)

I refer to "actual" kerf width initially because the term kerf width is often used for the lateral distance between left and right-hand tooth tips (which I call tooth width), whereas the actual kerf (which I call kerf width) is always wider due to saw deviations.

The thickness of the sawblade obviously contributes to tooth and kerf width, and, worldwide, much effort has been devoted to developing thin saws, with conspicuous success in some contexts. It seems appropriate to compare blade thicknesses used in Western Ausralia with those used in N.S.W. and Queensland mills sawing eucalypts of comparable density, such as blackbutt and ironbark, as well as the abrasive timbers brush box and turpentine, under comparable sawing conditions (bark on, similar log quality and blade size). At feed speeds of 15-80 m per min. and cut depths of up to 150 mm), saws used are commonly at least two gauges thinner than the 8 gauge saws used in Western Australia. The difference is greatest for circular benches, where a 1067 mm blade is commonly 10 or 11 gauge, compared with 8 gauge in W.A..

It is often argued that a thinner kerf does not increase yield significantly because few additional boards are produced. Actually, the savings come from additional thinner, narrower and longer boards at the round, tapered sides of flitches. The volume loss in sawing 19 mm boards, about 10 per cent, is a high price to pay for the savings from using worn down 8 gauge saws rather than 10 gauge saws. It must be justified on other than technical grounds.

Regardless of species, the maximum allowable thickness of a bandsaw blade is set by wheel diameter, in order to limit tension stresses at the outside surface of the band. According to Sandvik (1977), the ratio of wheel diameter to blade thickness should not be less than 1200, for blades thicker than 17 gauge, so that for wheels 6,7,8, and 9 ft diameter, blades should not be thicker than gauge 17,15,14 (2.0 mm) and 14 (2.3 mm) respectively. This could explain why mills visited that were using 13 gauge saws on 8 ft wheels were wrestling with gullet cracking. If, in addition, straining loads greater than recommended are used, yet more gullet cracking can be expected.

If a saw cannot be operated without exceeding the specified limit on band thickness and straining load, the solution should be sought elsewhere.

The concept of the high-strain bandsaw is essentially to use thinner saws for a given wheel diameter, and take advantage of the lower stress from bending to increase the straining load and hence blade stability. However, as the developers point out, the mill, saws, and all aspects of operation and maintenance must be state-of-the-art (Clark, 1968; Porter, 1971). This was all too evident when high-strain bandmills were first introduced into Australia in the 1960's.

Excessive tooth set is another source of kerf loss. In the N.S.W. and Queensland species mentioned, an initial set of 0.64 mm is common, compared with 0.76 or more in W.A.. In mills sawing pine,the higher set may be justified, but for hardwoods, it may be to compensate for rapid blunting due to bark and grit.

SURFACE QUALITY

Quality of sawn surfaces relates to the average and variation in depth of tooth grooving. If variability is great there may be losses in dressing. In general, however, quality of sawn surfaces is not a problem, except perhaps where the sawn surface is a feature in panelling or exposed beams. Tooth height and set should be kept as small as other factors permit, in the interests of surface quality.

One problem encountered was the poor quality of surfaces from splitter saws in moulders. I have encountered this elsewhere, and have suggested trials using conventional carbide-tipped saws with 50 teeth and very low radial clearance angle.

SAWBLADE STABILITY AS A KEY FACTOR

Feed speed, sawing accuracy, kerf loss, and to some extent surface quality all are closely dependent on sawblade stability, the mysteries of which have only recently been dispelled by the work of Mote and his students at the University of California, Berkeley. Stability can now be designed into a saw, and, in the sawshop, can be kept under control with the help of new measuring devices, such as frequency analysers.

Features such as slits, fluid pressure guides, and controlled tension stresses can now be applied scientifically, and under suitable conditions their value could be demonstrated in Western Australia.

GENERAL COMMENTS AND SUGGESTIONS

It will be evident from the foregoing that I believe there is a need and a capacity for improvement of sawing performance in Western Australia. This applies particularly to mills sawing predominantly hardwood, but some of the points also apply to pine sawmills.

1. Debarking

The need for debarking seems to have been accepted by Western Australian sawmillers, but I feel it could not be emphasised too strongly, and the move to debarking should be seen as urgent. The benefits may not have been fully accounted, so the major ones are listed as:

- Greatly reduced tooth damage and wear, the benefits being increased saw stability and feed rate, that is, increased production rate.
- Reduced maintenance of machines, sawblades and teeth, and extension of saw working life, lowering machine and saw maintenance costs.
- Reduced accumulation in the mill of dust and rubbish, and hence reduced accident and fire hazard, lower clean-up costs, and possibly lower insurance premiums. Production losses due to fouling of saws and conveyors would also be reduced.
- Better exposure of log shape and defects, facilitating the sawyer's task.
- Easier handling and sawing of slabs, or chipping of slabs for uses not allowing bark.
- Concentration of the bark for disposal or treatment (e.g. hogging) for utilisation. Rosser heads can be designed to tailored particles. The marketing of bark as a horticultural mulch should be investigated.

I believe that the benefits of debarking will be found to exceed the costs, and further, that major expenditure on new sawing technology is not warranted unless debarking is carried out. A study comparing sawing performance in mills which debark and in mills which do not would be convincing, I'm sure.

2. Material Flow

In some of the mills visited, throughput appeared to be limited by material flow rather than sawing feed rate. A saw costs nearly as much when idling as when cutting, and if it is idling 50 per cent of its time the running cost per unit sawn is double that of continuous sawing. With a carriage or other reciprocating feed system some non-sawing time is inevitable, and it becomes important to have a high return speed. With smaller logs and products it is increasingly important to have machines with continuous through-feed. It is also important to feed them as continuously as possible, with the help of buffered conveyor systems. One reason for flow irregularies is the widely varying size of logs presented to the headsaws at random. It seems worth-while to try sorting of logs into diameter classes, even coarse ones, for feeding into the mill in batches.

I saw cases where highly mechanized saws were far from achieving their potential throughput rate because they were not kept supplied with material or it was unsuitable, that is, too irregular in shape, or with wane on the fence side. Apart from fouling the mechanisms and slowing the feed, this overloads a key operator, presumably experienced, skilled and well-paid, with the added time-wasting task of juggling pieces himself or operating his controls at length, sometimes at speed requiring hasty judgments.

3. Performance In Sawing Boards

Sawing performance is particularly important in sawing and re-sawing dressing lines, since at the dressing stage, material has increased considerably in cost and value through processing. Thus it is in sawing boards that I think profit gains can be made, not only through better practice, but through applying new technology. Some appropriate innovations already being successfully applied are:

- Precision multi-saw machines with fluid pressure guides.
- Scientifically designed thin-rimmed circular saws with slits.
- Controlled-load roll tensioning of circular saws.
- Use of frequency analysers to control tension stresses.
- Swage-shape tungsten carbide or stellite tips formed by precision automatic grinding.

4. Organization Of Saw Maintenance

As elsewhere, saw maintenance and the saw shop seem to have been afterthoughts in sawmill layout. Especially with bandsaws, which are bulky and require careful handling, this can be a costly oversight.

It is time for the saw shop to come out of the dark age. Attention should be given to layout, space, lighting, environment control, noise control, and cleaning requirements. Good conditions are necessary for skilled work, and will be even more necessary when precision mechanical and electronic instruments, including computers, become part of saw shop equipment.

An important organisational question, where a number of mills are within, say, an hour's drive of one another, is the extent to which saw making and maintenance should be centralised. My view, shared generally, is that routine saw maintenance, such as front grinding, swaging, shaping and levelling should be carried out at each mill by qualified people. This is needed for the saw doctor to collaborate closely with the sawyer, and have a sense of direct responsibility. However, since automatic machines for saw making (welding, tooth cutting, stelliting, etc), and for equipment for precise saw maintenace (tensioning, side grinding, etc) are expensive, with high outputs, I favour centralisation of such functions. Apart from economics, skills can be developed better, and new techniques incorporated, in a central shop with a full range of facilities, in the charge of a highly trained and experienced person. Technicians and trainees can be rotated between locations to keep them in touch with all aspects of the work.

A valuable practice, which I found in only one saw shop, is the keeping of saw records. For each saw, dates, current and cumulative run times, resharpenings, benchings and any relevant events, comments on performance, etc, are recorded in a book. These records of each saw's history have proved very useful in deciding how to treat a saw, what can be expected of it, and when to retire it. The value for budgeting and ordering new saws should be appreciated by managers. With the advent of more sophisticated and centralised saw maintenance, where various measurements are involved, full records, including data on material sawn, machine adjustments and operation (e.g. feed speeds) will be essential. Obviously, a computer is required for records of a large number of saws, with the added advantage that such records can be analysed for diagnostic, planning and other purposes. (I am at present analysing records accumulated over 20 years for saws in a Californian mill.)

5. Education In Sawing Technology

Improved sawing performance, especially through new technology, will require a higher level of skill among sawing technicians-millwrights, maintenance fitters, operators and saw doctors. This implies a higher level of training, written and practical, initial and in-service.

I became aware of an acute shortage of saw doctors in W.A., and many of those at present employed have learned their skills on the job, where systematic coverage of the field is not guaranteed, so that the range of skills may be very limited. I was told of moves by some companies to begin in-house apprentice training of saw doctors. While this is a positive step, I favour a broader, industry- or state-sponsored scheme overseen and certificated by T.A.F.E., which could draw on external sources in developing curricula and practical techniques. The South Australian scheme based on the T.A.F.E. college at Mt Gambier is an excellent model, and should be studied closely. Consideration should be given to sending people there for at least part of their training. The Australian Saw Doctors Educational Association (A.S.D.E.A.) was initiated there, and now has members from several states and New Zealand. The next meeting is scheduled for 1988 in northeastern Victoria. The Secretary is Peter Mikelson, South East Community College, 7 Wehl St South, Mt Gambier 5290, Tel. (087) 25 6733.

The title "saw doctor", it seems to me, has an archaic ring, suggesting activities as mysterious of those of a witch doctor. I think it would be beneficial to change the official title to saw technician, implying possession of a systematic body of written knowledge and practical skills. There is a notable absence of (live) women from saw shops, and I suggest that the large untapped resource of female talent should not be overlooked when seeking ways of skilling the saw technology field. Of course, an essential aspect to be considered is the pay scale necessary to attract people into training and retain them in a demanding job.

Another scheme that is needed urgently for advancement of sawing technology is one to educate all supervisors and managers who make decisions in this area in the basics of the subject. The National Core Curriculum Module 9, Sawlog Conversion, is now in draft stage, and a scheme encouraging all managers to become familiar with it would serve the purpose.

Visits by groups of sawmill people to selected mills in the east, particularly N.S.W., Queensland and S.A. would also be very worthwhile.

Another approach to educating both managers and sawing technicians in the demands of each other's worlds would be for each mill to arrange meetings of all people involved when ever a major problem presents itself, for instance a persistent sawing problem, proposed purchase of new sawing or sawshop equipment, etc. Such a habit might help to overcome the observed tendency for each group to be ignorant of the basis for the other group's actions or decisions.

6. Chipping heads

Chipping heads placed on the infeed side of head saws are becoming common elsewhere. Advantages are:

- Very irregular pieces such as spears do not reach roll conveyors, to cause jams and reduce sawing time.
- Straight edges are generated for saws that have fences, which cannot be used against wany edges.
- The number of waste conveyors can be reduced.
- If logs are debarked, the chips can be used for pulp, or if not, there are markets in landscaping and horticulture.

7. Even Flow Of Material To Saws

It is possible that close study would show that, in some mills, production is reduced more by non-sawing time than by slow feeding. Apart from debarking and chippers at headsaws, other steps that might be considered are sorting of logs and establishment of a procedure enabling the headsawyer to monitor flows and vary his cutting and routing to adjust supplies to downstream saws.

8. Dressing Allowance

The factors governing present dressing allowances should be studied closely. As discussed above it appears that valuable timber could be saved by more accurate sawing, and that costs could be saved by grading before drying.

9. Programming

I acknowledge that a comprehensive program to improve sawing performance presents a formidable task, calling for close examination of objectives, detailed planning, considerable investment in equipment such as debarkers, chipping heads, saws, saw maintenance equipment, etc, and education of personnel involved in sawing processes at all levels. It requires faith that profits will result within a reasonable period.

However, given long-term commitment, a plan can allot priorities and be implemented in stages.

SUMMARY OF SUGGESTED INVESTIGATIONS AND ACTIONS.

Subjects which might be investigated by companies or C.A.L.M, individually or in co-operation, are listed below.

1. A vigorous educational program for saw technicians, supervisors and managers, embracing new technology.
2. Debarking
3. Chipping heads
4. Non-sawing time
5. Log sorting
6. Dressing losses
7. Reducing saw deflections, sawing inaccuracies, and kerf losses for given feed speeds and depths of cut
8. New technology in design, manufacture and maintenance of saws.

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