

APPLICATION OF HITMAN[®] ACOUSTIC TECHNOLOGY THE CARTER HOLT HARVEY EXPERIENCE

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fibre-gen, a Carter Holt Harvey business

1 CAPABILITY – RADIATA PINE

1.1 RECOGNITION OF NEED, AND DEVELOPMENT OF HITMAN[®] ACOUSTIC TECHNOLOGY

Stiffness and fibre properties have long been recognised as key product variables in solid wood and pulp and paper processing. End product values are dependent upon the quality of raw material, and method of process. Log raw material is extremely variable in these properties, dependent upon site, genetics, silviculture, and location within the tree from which logs are cut. The need was recognised for a rapid, non-destructive test to be used on logs for these internal wood properties.

Acoustic technology was investigated because it was recognised that acoustic speed provides a direct measure of stiffness in wood, along with wood density. Initial trials evaluated the existing range of acoustic tools available, but all suffered deficiencies and proved non-economic for immediate commercial application.

Carter Holt Harvey contracted IRL to develop an improved acoustic tool to be capable of efficient non-destructive evaluation of wood properties in stems or logs. An intensive collaborative two-year programme resulted in the development of the HITMAN[®] tool, providing an efficient tool which can be used to test and segregate stems, logs, or cants not only for stiffness, but also for commercially important pulp and paper properties.

1.2 STRUCTURAL TIMBER APPLICATIONS

A number of trials have been run to quantify the effectiveness of the technology, and potential value gains from segregation of logs based on acoustic speed. Initial work was done with John Walker and others from University of Canterbury using a Metriguard instrument. More recently the HITMAN[®] tool has been available and trials have been run on radiata pine at Kopu, and Putaruru sawmills, Taylor's Block genetic trial and SFNSW mill in Tumut. Trial results have been fairly consistent, despite some trials being affected by a range of implementation complications.

Typical results are as found in the first HITMAN[®] Kopu trial, where the stiffest 32% of logs yielded 82% of the resulting sawn timber meeting premium structural grades of MGP10 and better, compared against 72% for unsegregated logs.

Kopu HITMAN [®] trial Log Grade	Proportion of sawn out-turn by sawn timber grade					% of logs in class
	Utility	F4	MGP10	MGP12	MGP15	
Red (< 3.25 km/sec)	12%	39%	46%	4%	0%	19
Blue (3.26 – 3.54 km/sec)	4%	24%	56%	16%	0%	49
Green (> 3.55 km/sec)	2%	16%	55%	25%	2%	32
Unsegregated	5%	25%	54%	16%	1%	100

A number of subsequent trials, carried out over three years, have confirmed similar levels of grade out-turn improvement.

1.3 VENEER APPLICATIONS

Several trials have been run to quantify the effectiveness of the HITMAN[®] tool, and potential value gains from segregation of logs for veneer production, based on acoustic speed. Typical results show that for Central North Island logs, segregated into 3 classes (break points being <3.0, 3.0 to 3.3, and >3.3 km/sec), the high stiffness logs result in production of 51.9% premium DT veneer product, compared against unsegregated logs of 24.1%.

Veneer type	DT	DFB	DT +DFB	D
Low speed logs	3.8%	25.9%	29.7%	70.3%
Medium logs	15.3%	34.2%	49.5%	51.5%
Fast logs	51.9%	34.3%	86.2%	13.2%
Unsegregated	24.1%	32.0%	56.1%	43.9%

These results clearly show that segregation using HITMAN[®] results in substantially higher proportions of higher stiffness veneer being produced. Equally, if a higher grade out turn is required for ply veneer production log segregation using HITMAN[®] will result in a value gain.

Some veneer mills are equipped with Metriguard (or similar) acoustic veneer testers, allowing sorting of veneer into stiffness categories. This potentially allows sorting of veneers in the mill, such that an unsegregated log supply may yield sufficient high stiffness veneer for use in manufacture of those grades of ply or LVL demanded by the market. Benefit from a segregated log supply will however still result when an unsegregated supply fails to yield sufficient high stiffness veneer for the ply or LVL products being manufactured.

1.4 PULP AND PAPER APPLICATIONS

Three trials have been run with Carter Holt Harvey Pulp & Paper to quantify the effectiveness of the technology, and potential value gains from segregation of logs for pulp and paper production, based on acoustic speed. The first was run in collaboration with John Walker of University of Canterbury on peeler bolts, typical of corewood, showing the potential to produce pulps with distinctly different average fibre lengths. This trial has subsequently been followed up with two further operational trials using HITMAN[®] to sort logs into three categories according to acoustic speed.

The first full scale continuous digester trial showed for Central North Island logs processed at Kinleith, segregated into 3 classes (break points being <2.8, 2.81 to 3.29, and >3.3 km/sec), that the high speed logs resulted in pulp being produced of average fibre length 2.6 – 2.64 mm compared against 2.4 – 2.45 mm from the medium logs, and 2.23 – 2.35 from the low speed logs. This differentiation provides an opportunity to produce two differentiated, higher value, pulp products; the low speed logs a low coarseness pulp, and the high speed logs a high strength pulp suitable for fibre cement products.

The second operational trial, involving 28,000 tonnes of logs, with break points as for the previous trial except increasing the upper cutoff slightly from 3.3 to 3.4 km/sec, confirmed the ability to produce a low coarseness pulp, but fell marginally short of reaching the same high fibre length as the previous study.

Further a small TMP trial was run with PAPRO at Forest Research to evaluate the potential application of HITMAN[®] segregation to log supply for mechanical pulping. Results from this trial confirmed what was found with chemical pulping, and showed significant correlations between acoustic speed and a range of pulp and paper properties. For a given freeness it was found there were distinct trends between the velocity classes for fibre length measures, tear index and brightness. There were weak trends between the velocity classes for energy input, scattering coefficient and opacity, and no trends between the classes for tensile index and sheet density.

2 CAPABILITY – OTHER SPECIES

Trials have been undertaken to determine how applicable the HITMAN[®] technology might be to other species. It has been confirmed that the technology provides repeatable and reliable velocity measurements on stems and logs, and velocity measures which are correlated with stiffness in the final product.

Typical HITMAN[®] velocity measures on logs from various other species are shown in the table below.

Species	Average velocity km/s	Range km/s
Eucalypts	3.44	2.74 to 4.20
Douglas-fir	4.20	3.62 to 5.15
Other Pine	3.23	2.60 to 3.78
Redwood	2.48	1.91 to 3.02

3 PROCESS DEFINITION

3.1 POINT OF APPLICATION – EFFECTIVENESS AND COSTS

There is an opportunity to apply HITMAN[®] at one or more places in the value chain. Greatest benefit comes from application as far as possible up the value chain, on the stem or log in the forest, at skid/superskid/CPY site.

The big advantage for making the measurement on a stem is that there is no extra handling as stems are laid out for crosscutting anyway. This is also true for logs on the skid as they are sorted and moved individually at this point. This is very important, as the cost of double handling is high. A further advantage of measuring stems is that for one hit you get velocity information for all the potential logs within that stem, so effectively you are measuring 3 to 5 logs at once. Also if the measurement is made on a stem you can include the velocity as part of the optimisation process which determines where the cuts are made. This should allow the capture of maximum value as it is right at the start of the chain, however stem measurement requires calculation of the component log measures, introducing a loss in value due to imperfect estimation. Once logs have been made they can only be shortened if they are subsequently found not to meet certain criteria (therefore a loss of value is incurred). The table below compares segregating by stem or log on the skid.

Areas to consider	Segregating by stem on skid	Segregating by log on skid
Costs	Cheaper as more volume is measured per hit.	4 times more expensive, although cost reduced if stacked in fixed length piles.
Accuracy	r^2 0.71 (correlation stem to log).	No loss of value. More sensitive to typical errors in length.
Value recovery	Full optimisation of log making possible, as velocity can be used as part of optimisation process	Potential loss of value, because logs are already cut to length.
Handling	No extra handling required (done as part of log making/optimising process.	Extra handling may be incurred if sorting is required.
Tool required	Stand alone.	Stand alone.

The conclusion from this analysis is that it is best to carry out the HITMAN[®] testing on logs in situations where cost saving of stem assessment is outweighed by value loss, but on stems where no alternative market exists for target customer log lengths. If applied in an automated processing yard application, costs will be substantially reduced, but options for sale of 'below threshold' logs will still dictate whether to apply on stems or logs.

3.2 ANALYSIS OF POTENTIAL VALUE GAIN

As outlined above, acoustic speed has been demonstrated as having a correlation with sawn timber stiffness and other wood properties. The following analysis uses this measure as an example to analyse the potential value gains resulting from log segregation.

Acoustic speed (km/sec) varies within trees, and between trees within stands. A typical Carter Holt Harvey Northern forest 25 year old stand has a mean acoustic speed of 3.3 km/second, with a standard deviation of 0.3. This distribution of speeds indicates that logs with acoustic speeds from 2.3 to 4.5 km/second will be found within logs harvested from a typical stand with frequencies as outlined in Figure 2.2.1 below:

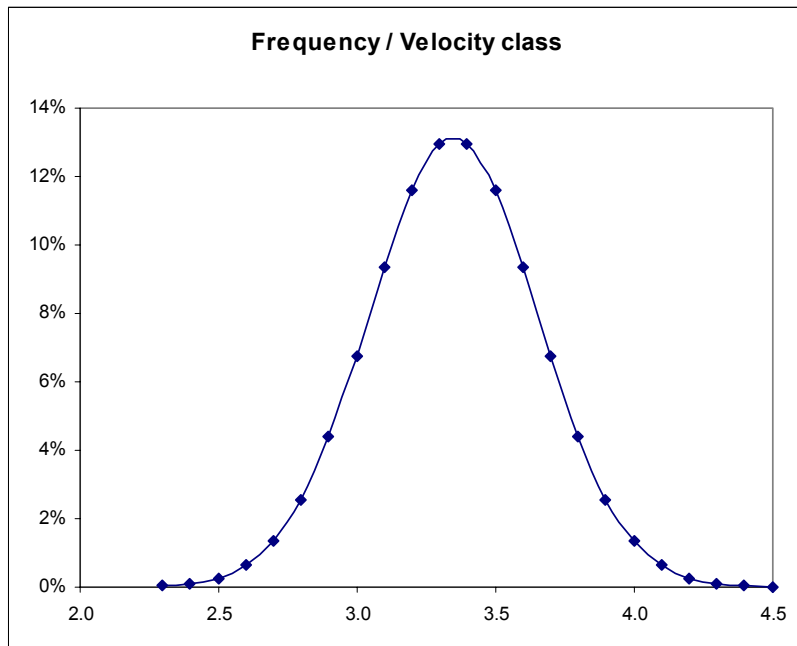


Figure 2.2.1 Log velocity class distribution in Northern forest harvest (mean 3.3km/sec, SD 0.3)

A range of trials with typical results as outlined above show associated value increment, compared against the average of unsegregated logs, varying widely according to process, end use, and market prices. As an example, sawn timber machine stress graded outturn from logs of each category from within the velocity distribution above (with mean 3.3 and standard deviation of 0.3) could show a range of values from around \$25.00 additional value for the highest velocity class, to a loss of equivalent value for the lowest class.

Such estimates of additional value will differ widely between veneer, solid wood and pulp and paper applications, and would need to be based upon actual processing studies undertaken for the purpose. For the example outlined here for illustrative purposes, an average increase

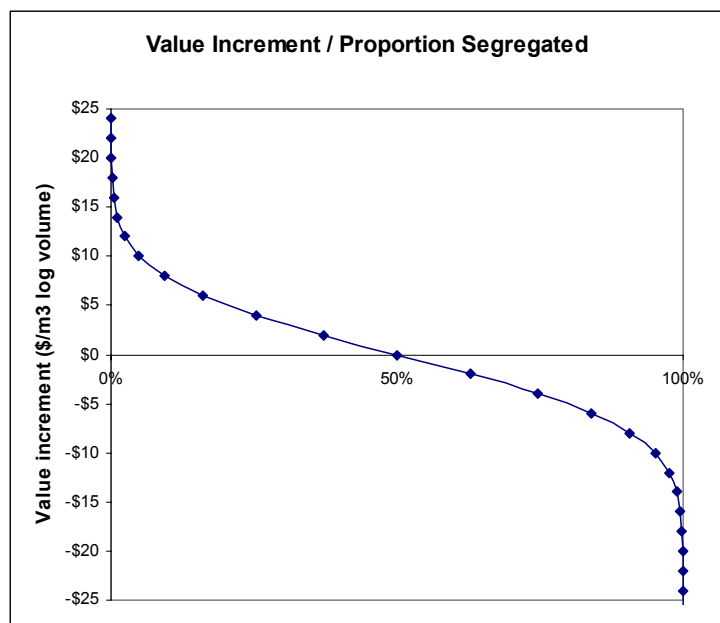


Figure 2.2.2 Value increment for each acoustic speed class

in value of sawn timber outturn of \$2.00 for each 0.1 km/second of acoustic speed is assumed. Value increment by log class is shown in Figure 2.2.2.

Sawing of logs from classes in the top 50%, having an acoustic speed which is higher than the population mean will result in positive value increment due to the sawn timber grade outturn being higher than the average for unsegregated logs. Conversely, those from below the mean will return a negative increment. Hence, for this or any other new segregation trait, to process more than the best 50% of logs segregated on any new criteria will result in a loss of potential value recovered.

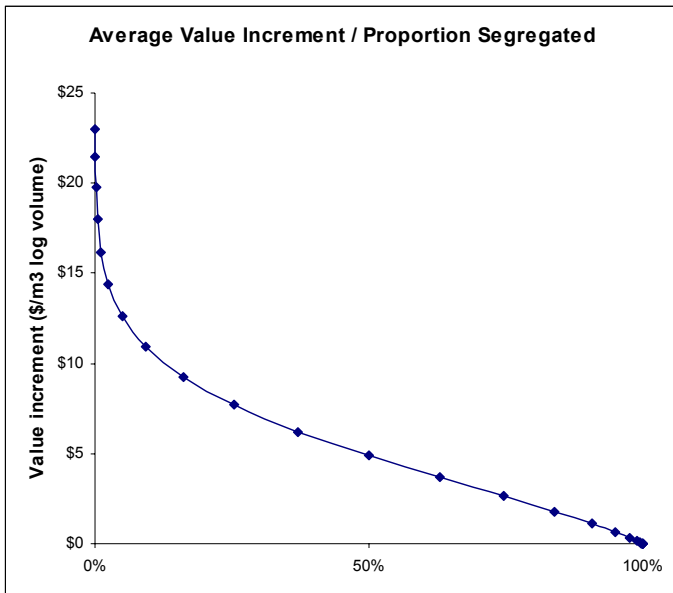


Figure 2.2.3 Cumulative average value increment

This value increment pattern, portrayed as the cumulative mean segregation margin over the equivalent non segregated log volume, progressively from the highest through to the lowest acoustic speed class shows a profile as outlined in Figure 2.2.3.

When applied, for example, to a total sawlog volume of 0.5 million m³ progressively selected from the highest acoustic speed class through to the lowest class, value gain from segregation reaches a maximum of around \$1.2 million. This point is reached at 50% of the volume supplied to customers who are in a position to capture the stiffness related margin.

Supply of segregated logs to such customers beyond 50% of the total log supply results in a progressively increasing reduction of the potential value captured, as lower than average speed logs are processed, with negative margins, and total segregation margin begins to erode as outlined in Figure 2.2.4.

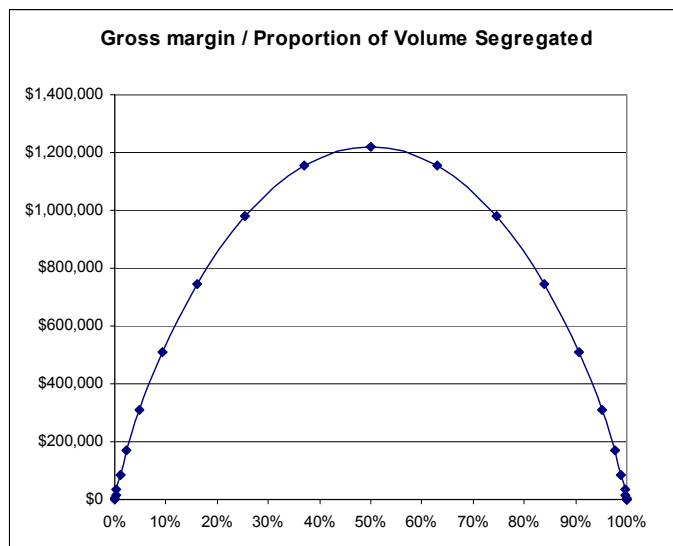


Figure 2.2.4 Cumulative gross margin associated with progressive segregation

In many situations, a typical customer mix will involve less than 50% of total sawlog volume being supplied to a mill with high stiffness requirements. For example, in the structural framing market, many mills are still using visual grading, so would not be expected to capture a significant proportion of the acoustic speed related margin offered from segregation.

Consideration needs also be given to costs of testing and segregation. It should be noted that to identify the component in any log mix which is of higher stiffness, the total log basket has to be tested incurring a fixed direct cost. Hence while costs are fixed, benefit varies with the proportion sent to the target market.

In the situation where markets currently accept unsegregated logs at a given price, the imposition of an acoustic speed threshold will add both the direct cost of testing, as well as any lost revenue from the proportion which is subsequently sold to an alternative market at a lower price.

4 Time study

Activity sampling was performed on a gang operating a superskid in Mahurangi Forest. The results showed that the TimberTech operator spent 9.7% of their time using the HITMAN[®] tool. The log makers spent 2.6% of their time squaring the ends of the logs (this was done to allow HITMAN values to be obtained from either end of the stem). It was observed for this operation on these days that the log making was not on the critical path. The idle time, time not producing work, was 11.9%. For the observed operation, it was the time between stem trucks which was limiting the production level.

5 Implementation issues

Several hardware issues were identified when the tools were operationally deployed. These included the susceptibility of the leather cases to water logging (and subsequent moisture in the tools), optimum cord length being different for stem versus log measurement, battery connectors being susceptible to breakage, sensor head setup could be more ergonomically designed and the tool could benefit from a reset switch. To tackle these issues we are looking at redesigning the tool to be cord free (thus eliminating cord length and damage problems and improving sensor ergonomics) and have a more robust waterproof case. Along with these hardware changes a number of software improvements were identified which will be incorporated into the next upgrade.

Since the HITMAN[®] tool was being used in conjunction with the TimberTech one of the issues was that HITMAN[®] measure could not be incorporated into the log making operation unless the TimberTech was also working. Feedback from the log makers has proven particularly valuable as the tools were used in a real life situation versus trial or one-off applications.

6 Conclusions

Trials have confirmed that HITMAN[®] segregation of logs results in

- **An increase of 10-15 percentage points in machine stress graded sawn timber meeting stiffness specification over that resulting from sawing unsegregated logs.**
- **A doubling from 25% to 50% out-turn of high stiffness veneers for LVL compared against peeling unsegregated logs.**
- **An ability to produce a low coarseness pulp, and potential to produce a premium fibre cement pulp.**

Application to other species, both softwood and hardwood, show that effective results can be obtained.

Whether best applied to stem or log will be dependent upon the range of log products being produced, and flexibility to transfer product between customers and market segments, as well as the costs of application.

Distribution of log acoustic speeds are approximately 'normal', leading to maximum benefit being captured by the segregation and supply of 50% of sawlog volume to 'high stiffness' customers.

Time study has shown that no significant additional time-related cost is incurred by testing stems on forest skid sites. Operational implementation using the portable HITMAN[®] tool has been successful, and a range of useful improvements have been suggested for an enhanced production tool.