Precision Log-Making to Maximise Value Recovery from Plantation Forests

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Abstract

Poor log-making is the leading cause for value lost. To improve value recovery, Carter Holt Harvey has adopted the IFR Timbertech System. The system is designed to increase value recovery by improving the log manufacturing process by placing a log optimisation tool on the landing. The Timbertech system yields additional value from the stem and log data collected during the process. This data has numerous used including marketing, but its main use is to audit the log-making process for each log-maker on each crew. Introduction

Plantation resources are expanding around the world with afforestation projects in 2000 exceeding 295,000 ha in just three countries, Argentina (130,000 ha), Australia (125,000 ha) and Uruguay (40,000 ha) (Southern Hemisphere Forest Industry Journal, 2001). New Zealand's forest industry has focused on value recovery as a cornerstone in its competitive strategy. A value recovery program is one that emphasises the three elements of the profit equation: price, volume, and costs, instead of focusing on cost reductions as the sole element in the competitive strategy.

Value lost occurs from felling to unloading the logs at the mill. It has been shown that 40% of the value can be lost (Murphy and Twaddle, 1986).

- Stump heights – higher operating costs, loss in value and volume
- Felling Damage – higher operating costs, loss in value and volume
- Extraction Damage – higher operating costs, loss in value and volume
- Log-making – loss in value
- Loading-unloading damage – loss in value and volume

Log making is the largest cause of value lost. In initial studies in New Zealand have shown a value lost of 26% of the total value (Murphy and Twaddle 1986). Results from a mechanised log-making operation in a loblolly pine forest in Florida (USA) showed an enormous value lost of 43% of the total potential value from poor log making (Boston, in review).

The Interpine Calliper System.

Carter Holt Harvey has adopted the IFR Timbertech System to improve value recovery. The system has three components:

- A logger tool attached to a calliper
- A stocks tool
- A database management system

After the one time activity of defining the grades in the database management system, the process begins by creating the cutting instructions; these contain the grades, lengths, and priority values assigned to each crew, usually for a fortnightly period. The cutting instructions are entered into the database and the files are transferred into directories to be downloaded by the crews. Using the stock tools, the cutting instruction are downloaded to the crews and transferred to the logger tools. The logger tool is attached to a calliper and automatically records the diameter and the length from the butt end of the log (figure 1). The log-maker will describe the stem by recording its attributes such as branch size, roundness, pith location, and defects. After the stem has been fully described, the log-maker uses the individual stem log optimisation model that is built into the logger tool. The algorithm uses a linear taper function, the stem description, and the desired grades, length, and relative values from the cutting instruction to maximise the value recovered from each log. It will assume that the markets are unlimited for all grade-length combinations on the cutting instructions.

The logger tool saves both the stem descriptions and the recommended logs that should have been produced from the optimisation algorithm. These are transferred back to the stock tools and this information is uploaded to the database every second day. The full process description is shown in figure 2. A similar version has been developed for mechanised systems.

In the Central North Island operations in New Zealand, Carter Holt Harvey harvests approximately 50 000 tonnes per week of pine and gum produced by approximately 50 harvesting crews. The central North Island serves a number of domestic mills, both Carter Holt Harvey and others companies, and is the main source for export volume for the company. Both ground-based and cable systems logging systems are used with log making occurring at the extraction skids or full stems are hauled to centralised superskids that can receive logs from multiple extraction points. Each type of logging system has restrictions on the number of grade-lengths combinations that can be made due to safety and the ability to complete full loads in a reasonable time, as radiata pine is a perishable product due to sapstaining in summer.

There are three potential points for value loss in this process. They are:

- Not assigning the correct grade-length to the cutting instruction.
- Assigning the incorrect relative value to each grade, too low and the it will result in markets not being satisfied; too high will result in a surplus that will result in additional costs for storing or downgrading the log.
- The manufacturing losses that exists with manual log-making such as failing to properly recognise log attributes, improper use of the tool such with too few measurements or poor calibration.

The tool is not a panacea for log making. It will not replace a well-trained log-maker, but can complement a well trained log-maker, as the cutting instruction increase in complexity by having as many as 25 length-grade combinations (sorts) on a super-skid log-making operation. One of the most valuable aspects of the TimberTech System has been the stem and log data captured from the process. It has numerous uses, including marketing and auditing value recovery. An example, A customer would like to know the impact of changing from an unrestricted to large-end diameter to a maximum large end diameter of 50 cm. Using the What-if analysis capabilities within the Timbertech Database system, one can change the log descriptions and evaluate the strategy based on real data, not just intuitive beliefs. The results from the analysis show that the volume will be reduce by 7% due to the added constraint on log-making (Table 1).

The principle use for the database is to evaluate and monitor the three potential sources of value lost that occur in this system: Incorrect grades, incorrect relative value, and improper log-making practices.

One method to evaluate whether the correct grades has been included in the cutting instruction requires that the cutting instruction be applied to a previous set of stem data, usually two week worth of stem data in the What-if analysis. This is the control for the analysis. The next step adds the new grade-length to cutting instruction and applied to the same stem data. Once this is complete the lowest value grade is dropped from the cutting instruction and it is reapplied to the stem data. If the result is a higher value then the new grade is replaces the dropped grade. These decisions can now be made using objective analysis. There is a problem with this approach in that the operational stem data may be limited by the cutting instruction from which it was gathered. If a cutting instruction did not contain veneer grades, the log-maker may not have recorded the central pith required for those trees; thus it may underestimate the volume produced. Carter Holt Harvey Fibre Solutions working with its Key Supplier, ValueTech Services of Rotorua has developed a mensurational quality stem database that accurately describing the stems in the various croptypes (strata) with current Fibre Solutions Operations. This valuable data set can quickly and accurately evaluate the financial impact of exchanging a grade on a cutting instruction.

The second source of value recovery is the evaluation of the relative value. It is through the relative value that the market considerations are included in the unconstrained log optimisation algorithm. To properly assign relative values to 50 crews that are each cutting between 12 and 20 cuts to satisfy 15 markets is a difficult task that Carter Holt Harvey Fibre Solutions has not mastered. Currently, we can only simulate the impact of changing relative values on the production for key grades. The example in figure 3 shows the production of three grades, two structural and one internode grade, one that must have at least 1.3 meters of clear wood between branch whorls. It clearly shows the impact of increasing relative value on production of the internode, primarily at the expense of the SLM grade, but with the loss of some of the higher value SLS grade (Figure 3).

These analytical tools highlight some of the capabilities of the Timbertech database. The additional power is the reporting power to audit the log manufacturing process. Some reports that have been developed include:

- Evaluation of felling practices and the incidence of slabbing damage.
- Consistence use of log attributes
- Consistence use in log-making
- Comparison of pulp percentages

This report shows stem descriptions collected from an operation. The incidence of slabbing and stump-pull damage codes L and Y, on five stems. It is a .22 metre slabbing defect loss in log 1, 1.25 metre in log 2, a 1.65 metre loss in log 3, and .57 metre loss in log 4, and 1.12 metre loss in log 5. It is important to note that the I and P attributes with size 0 indicate that these losses are occurring on pruned stems. This is damage can result in an enormous loss as the highest value for pruned logs is in a 5.1 metre length. The slabbing damage will eliminate these logs from this market. The TimberTech system has a standard report that shows the use of attributes by the individual crews. During a week, one could expect these numbers to be similar for log makers working on the same landing, but not always. Table 3: Report showing the inconsistency between log-makers on same crew

This report clearly shows that log-maker JB and GH in crew 1 are not using the I attribute, internode with the same frequency for a two week period. The results from Crew 2 show a much more consistent pattern of using the log attributes. This can translate into difference in the volume being produced by each log-maker (Table 4) where log-maker GH is producing a much smaller percentage of internode volume and small-knot structural wood, but a higher percentage of the medium knot size, plus almost 1.5 times the pulp. The log-maker GH was scheduled with the highest priority to receive training to improve his log-making ability.

The ability to track the performance of individual log-makers is important when trying to change the culture of the crews from the simplistic past of maximising production to maximising value. Fibre Solutions can quickly show where value is being lost and with proper training and supervision can work with the logging contractors to improve their performance and our profitability.

The Future

There are a number of modifications to the system that Carter Holt Harvey Fibre Solutions would like to implement with the tool. One would be to have the ability to uses a more complex taper function. The linear taper function causes too many errors in the log-making and we believe as Olsen et al. (1991) showed that a better taper function could improve the value recovered. Rejects or missed opportunities are a result of the difference between the estimated diameter from the taper function and the actual diameter.

The desired future state would be to integrate the log-making tool with other technology to best capture the potential value. Currently we have an operational trial where the log-maker can test the stiffness of a stem using an acoustic-testing machine. The result is to segregate the stiff material for the LVL plant. Stems that do not meet the threshold value will have the veneer grade removed from the cutting instructions (figure 1). This is a manual process with the long-term goal to develop a seamless set of tools.

Carter Holt Harvey still needs to develop the ability to accurately predict the yields by length and grade groups. To accomplish this, we need to develop a forest wide log allocation model that utilises an accurate inventory estimates that can be used to assigns the relative value to each log grade for each crew to maximise the revenue from the forest. We realise that this is a difficult process given the size of our problem, but is necessary as we fully optimise our supply chain.

Literature Review

Boston, K. In review. Value recovery from mechanised log-making operations in the southeastern United States. Southern Journal of Applied Forestry.

Murphy, G., and A. Twaddle. 1986. Techniques for the assessment and control of log value recovery in the New Zealand forest harvesting Industry. In: Improving productivity through forest engineering. Proceedings of the Council on Forest Engineering.

Olsen, E, J. Garland, and J. Sessions. 1989. Value Loss from Measurement Error in the Computer-Aided Bucking at the Stump. American Society of Agricultural Engineers 5:283-285.

Table 1: Results from What-if Analysis showing the impact of a 50 cm LED restriction.

What IF Grade Out-Turn					
		Capped			
GradeID	**Length**	**Volume**	**LED**	**SED**	**Volume%**
SLS					
	3.70	420.98	38.93	35.30	6.20
	4.10	397.03	40.38	35.78	5.85
	4.90	172.84	40.48	35.06	2.55
	5.50	81.81	40.52	35.08	1.21
	6.10	49.05	39.97	34.96	0.72
	Total:	1,121.71	39.76	35.41	16.53
		Uncapped			
SLS					
	3.70	433.13	39.17	35.34	6.38
	4.10	425.71	41.19	35.87	6.27
	4.90	197.99	41.78	35.28	2.92
	5.50	89.63	41.60	35.24	1.32
	6.10	55.48	41.01	34.99	0.82
	Total:	1,201.93	40.43	35.50	17.71

Table 2: A report showing the incidence of felling damage

Record No.	Starting distance from end of log	Ending distance from end of log		Attribute Size
2,880,644	0.00	0.22	L	0.00
2,880,644	0.22	19.07	P	0.00
2,880,644	19.07	21.56	J	0.00
2,880,644	21.56	28.98	P	6.00
2,880,663	0.00	1.25	L	0.00
2,880,663	1.25	6.08	I	0.00
2,880,663	6.08	31.92	P	6.00
2,880,678	0.00	1.65	L	0.00
2,880,678	1.65	7.67	P	6.00
2,880,678	7.67	9.30	C	0.00
2,880,678	9.30	32.52	P	6.00
2,880,679	0.00	0.57	L	0.00
2,880,679	0.57	5.93	I	0.00
2,880,679	5.93	16.20	P	6.00
2,880,679	16.20	19.57	R	0.00
2,880,679	19.57	23.98	P	6.00
2,881,006	0.00	1.12	Y	0.00
2,881,006	1.12	5.56	I	0.00
2,881,006	5.56	24.89	V	6.00
2,881,006	24.89	29.30	P	5.00
2,881,006	29.30	30.08	S	5.00
2,881,006	30.08	33.68	P	6.00

Table 3: Attribute Reports from Weekly Log-Makers Reports

Attribute Codes Report

			A	B	C	D	I
Crew 1							
	GH	2.72		4		17	11
	JB	2.34		1	1	15	25
Crew 2							
	KH	1.21		1		8	9
	RK	1.36				7	7

Table 4: Comparison of volume production by log-maker

GH

Grade	Volume	Count	Percent of Total
SLM	**108.71**	**185**	**14.46**
SLN	**51.59**	**67**	**6.86**
SLS	**26.92**	**30**	**3.58**
UBR	**155.21**	**596**	**20.65**
UHR	**68.10**	**115**	**9.06**
UKB	**18.97**	**138**	**2.52**
Total Pulp			**32.23**

JB

Grade	Volume	Count	Percent of Total
SLM	**77.45**	**132**	**10.76**
SLN	**121.23**	**166**	**16.84**
SLS	**65.31**	**73**	**9.08**
UBR	**83.68**	**299**	**11.63**
UHR	**47.03**	**86**	**6.54**
UKB	**25.99**	**201**	**3.61**
Total Pulp			**21.78**

Figure 1: Picture of Timbertech Tool with HITMAN

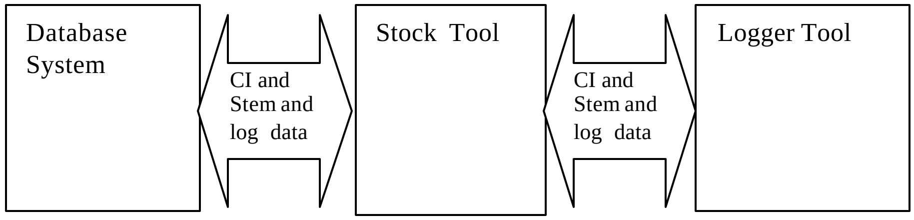

Figure 2: Process Diagram

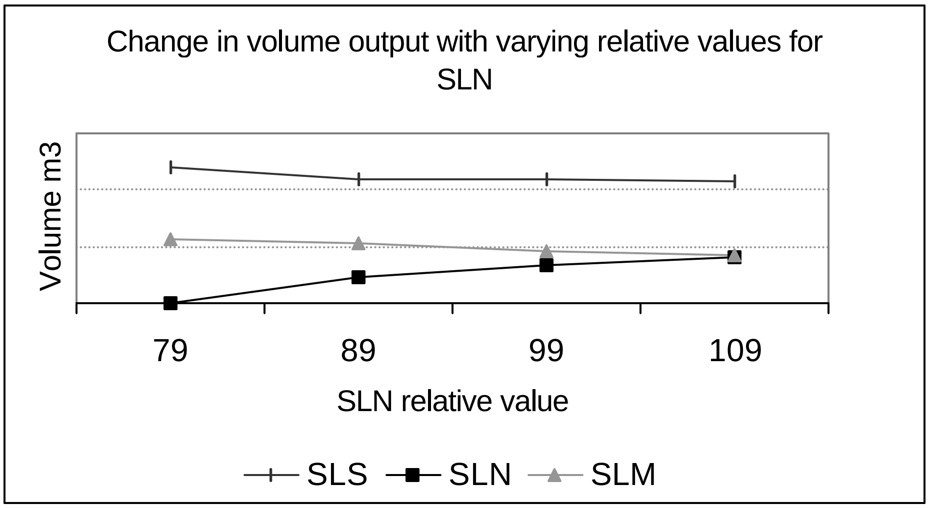

Figure 3: Change in volume output with varying relative values for SLN