REPORT

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Log Maker Performance with Electronic Calipers

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Log making with caliper

Summary

Stem feature identification and data entry ability of three log makers using electronic calipers was compared on six stems. For four of the six stems, log makers made similar logs and obtained similar values. However, in two stems there was a large difference in the logs made and total value. Differences were due to log makers entering incorrect information to the caliper, failing to recognise stem features and unfamiliarity with log specifications.

The results clearly show if inaccurate or wrong information is entered into the caliper, a non-optimal combination of logs will result. The electronic caliper is not a substitute for all the skills required for log making but a tool to find the optimum log combination for the stem.

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Introduction

Considerable value loss can occur during log making, making it important to identify causes for losses in revenue (Strang 1992, Parker et al. 1993, Parker et al. 1995). Detection of defects in inspection tasks has been shown to decline with complexity of the task (Harris and Chaney, 1969). Log making is a very complex inspection task compared to other industrial situations, as there are many attributes that need to be assessed in order to make a grade classification. In addition to the task of classification, is the need to select a combination of log grades and lengths that will maximise the total value of the stem. The log making task becomes more complex as more log grades are required to be produced.

To reduce the value lost because of this complexity, electronic calipers have recently been developed in New Zealand. The caliper is preloaded with log grade specifications, allowable quality features of the stem and the current cutting instructions. Starting from the butt, the log maker describes the stem in terms of diameter, quality and sweep. At the head of the stem the optimiser programme is activated and the log maker walks back to the butt marking the solutions (logs). The caliper stores stem descriptions and log stocks inventory that can be later downloaded by the forest owner and used for resource evaluation and the log descriptions which become the start of the forest to mill logistics process.

Background

Several studies have been undertaken in the past to investigate log making. They have indicated factors that influence log making ability. The influence of human variability in log making was first established by Landerud et al. (1973). Work by Murphy (1987) demonstrated individual variation in logmaker's abilities. Subsequently, Cossens & Murphy (1988) reported supervisors were significantly better than experienced skid workers at getting the most value from the stem. The study was carried out in a "cold deck" situation with none of the added pressures of a "hot deck" operation.

In a study of hot deck log making under normal operational pressures, Parker et al. (1993) found no relationship between value recovery and heart rate, temperature, or time of day. They did find a highly significant relationship between the log maker's personal assessment of 'boredom' and value recovery. Value recovery exhibited a 6% decrease for a 2 unit increase in boredom. Further work (Parker et al., 1995) demonstrated that using more than 10 log grades resulted in more log making errors and an increase in out-of-spec logs which needed to be recut.

With the advent of caliper computer decision support technology, the impact of human variability and its impact on value recovery have not been investigated.

Objective

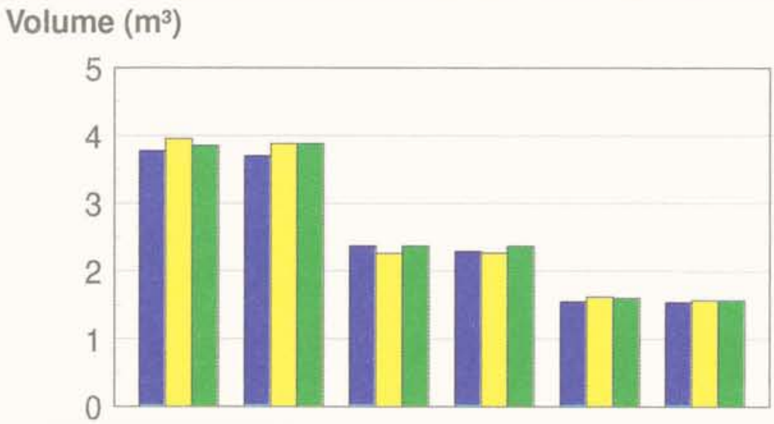
The objective of this project is to compare stem feature identification and data entry ability of log makers using electronic calipers to determine the effect of human variability on caliper outturn.

Method

The study was carried out in a cold deck operation where six stems were laid out on a landing. The stems were selected to represent the range of form and quality that log makers encounter in their normal operations.

Three caliper trained log makers were used. During the test, the log makers worked at normal operational speed to assess each stem. The resulting stem descriptions and cutting patterns for each log maker were compared with optimal cutting patterns generated by the other two log makers.

Results and Discussion



Stem	1	2	3	4	5	6
Log maker 1	3.77	3.70	2.37	2.29	1.55	1.54
Log maker 2	3.95	3.88	2.26	2.27	1.62	1.57
Log maker 3	3.85	3.88	2.37	2.37	1.60	1.57

Figure 1 - Volume of six stems estimated by three log makers using optimising calipers

Variations in volume are due to length and diameter differences. Length discrepancies occur due to the placement of the final diameter; this is related to the operator's method of entering the last diameter. Some log makers will go out to the end of the log and include the split or shatter, whereas other log makers will only enter information up to the start of the split or shatter at the head of the stem. Diameter differences occur because stems are not perfectly round and log makers do not measure diameter at exactly the same place on the stem.

Individual stems

Each stem description entered into the caliper was compared for each log maker. The resulting log grades determined by the caliper optimiser software are also compared between log makers.

Table 1 - Codes used in describing the stem

Code	Feature	Notes
V	veneer log	number indicates knot size in cm
P	saw log	number indicates knot size in cm
B	bark damage	number indicates severity of damage
C	crutch	
I	internode	
M	machine damage	number indicates severity of damage
N	nodal swelling	number indicates severity
Q	pulp	
F	fluting	number indicates severity
R	rot	

Table 2 - Codes used for log grades

Value	Code	Log Type
highest	PP	pruned peeler
	PS	pruned saw
	UPB	unpruned peeler
	IS	internodal saw
	TS	domestic saw
	FA	domestic saw
	KXC	export pulp
	KXB	export pulp
	LC	green pulp
	HDP	kraft pulp
lowest	Waste	waste

Stem One

Stem with little variation between the log makers

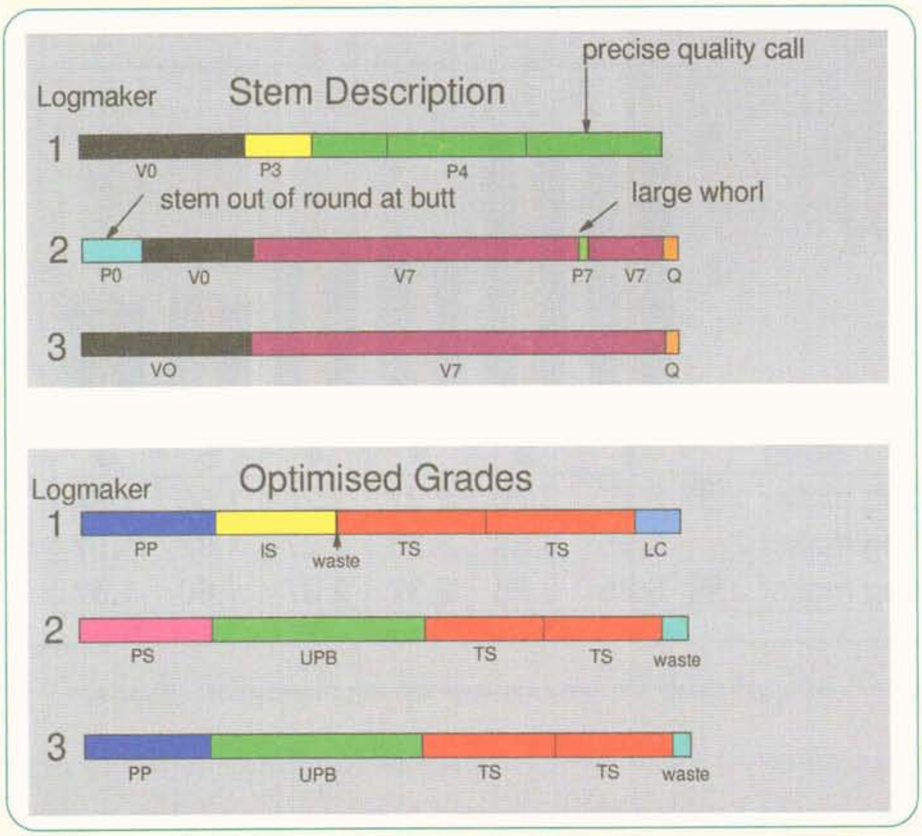


Figure 2 - Stem description by three log makers and optimised grade output from the electronic caliper for stem 1

Comments:

- Log maker 1 failed to make a UPB log in his solution because he entered incorrect quality codes, i.e. "P3" and "P4" because he was not completely familiar with the log specifications.
- Log maker 1 also failed to show that he knew the maximum allowable qualities by using precise quality calls such as, "P3" and "P4", when all he had to identify is where the major changes in branch sizes that had an affect on the output of the caliper occurred.
- Log maker 2 identified a "P0" quality code (out-of-round) at the butt of the log. Log maker 3 did not believe the butt was out-of-round.
- Log makers 2 and 3 on the other hand demonstrated that they did know the log specifications well, as they only entered the limiting qualities of the log grades on their cut plan, i.e. "V0", "V7 " and "Q" rather than "P4".

Stem Three

Stem with much variation between the log makers

Comments:

- Poor placement of the crutch quality "C" by log maker 1 resulted in his optimal solution containing a large section of waste. Had he placed the crutch quality more accurately, the optimiser would have been able to cut two saw logs off the butt, and had a smaller section of waste.
- Log maker 1 also missed the pruned section off the butt, so did not cut an internodal saw log.

- Log maker 2 missed the clearwood section of the butt of the stem because he made a data entry error. He entered the code for 2cm of machine damage and it was recorded by the caliper as 2 m. However, when entering a quantitative quality code such as a 1 or 2 it must be followed by pushing the "enter" key, as the caliper may think that the "2" is the first character of 20 or 200. This feature has been designed to speed data entry. This mistake meant that the optimiser failed to cut an internodal sawlog off the butt, and consequently missed out on some value.
- Log maker 2 showed that he could identify the changes between veneer quality wood and sawlog quality wood by using the "P7" quality code before the crutch. In doing this, the log maker effectively told the optimiser that stem was slightly deformed before the crutch begins, ensuring that no out-of-specification veneer logs were cut in this zone.

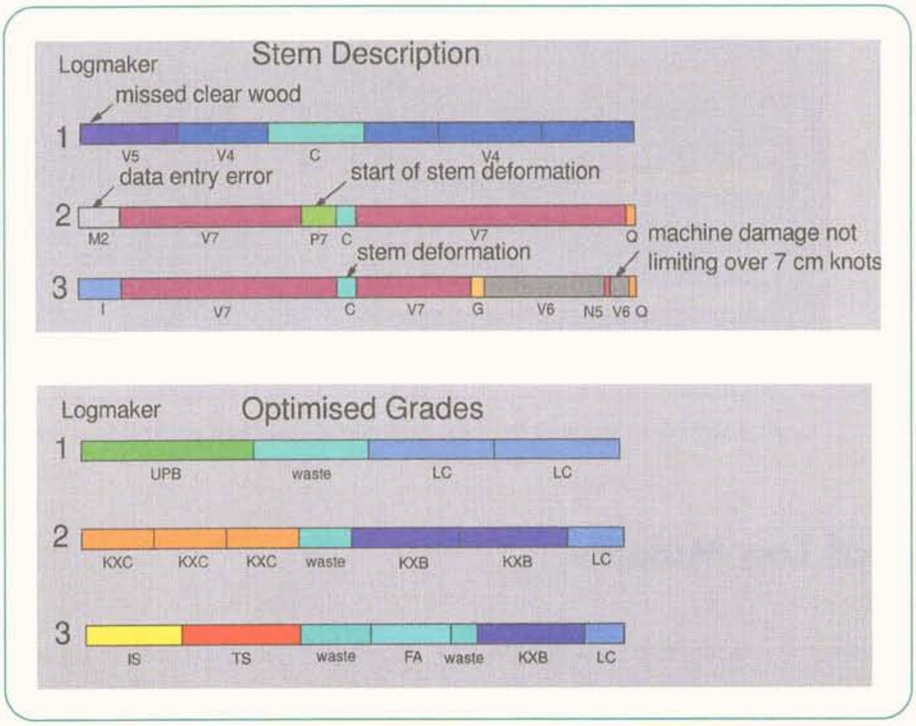


Figure 3 - Stem description by three log makers and optimised grade output from the electronic caliper for stem 3

Stem Four

Stem with much variation between the log makers

Comments:

- The positioning of the quality codes is critical, as can be seen in the stem description by log maker 1. If he had placed the second "Q" (pulp) quality code further towards the small end, the optimiser would have cut a sawlog. This is highlighted when we compare his description with that of log maker 2.
- The volume of waste produced has no relationship with total value of the stem. Log maker 1 only had 0.13 m^3 of waste in his optimal solution, and yet he cut pulp at the head of the stem due to the poor placement of quality codes. Log maker 2 had 0.34 m^3 of waste in his optimal solution. He allowed the optimiser to cut a sawlog at the head of the stem, due to the correct use of quality codes.
- Another example of the importance of identifying correct quality codes can be seen when we compare the stem descriptions of log makers 1 and 2 with the stem description of log maker 3. Log makers 1 and 2 did not enter an internodal section "I" that log maker 3 found and entered into his caliper. This effectively meant that both log makers 1 and 2 missed out on cutting a higher value internodal sawlog.

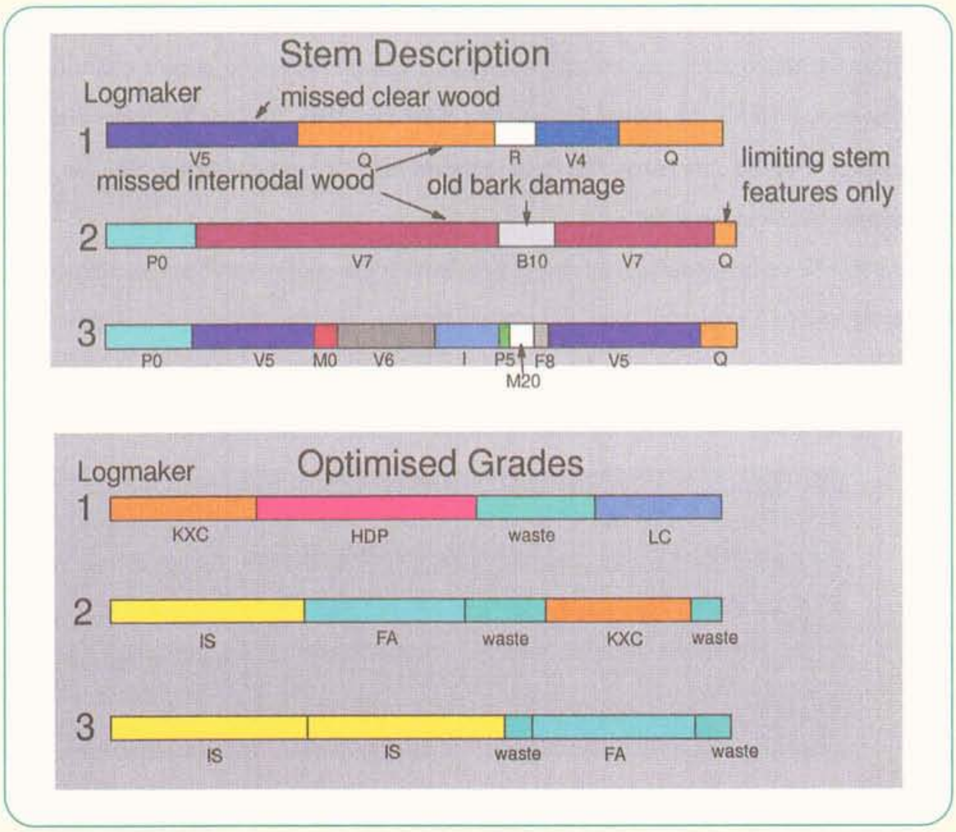


Figure 4 Stem description by three log makers and optimised grade output from the electronic caliper for stem 4

Comparison of Log Makers

Log maker 1 frequently did not use the limiting feature to describe the stem. He had not used the log specifications for very long. This can be seen in his stem descriptions. In most descriptions, he uses a variety of branch sizes instead of just using the limiting branch sizes. He also failed to identify any internodal sections and displayed poor placement of quality codes, which reduced the value outturn of his caliper.

Log maker 2 demonstrated that he knew the log specifications fairly well, but he too missed an internodal section because of a data entry problem, which also hindered the value outturn of his caliper. He did, however, show high skills in distinguishing between veneer and sawlog quality wood.

Log maker 3 performed better than the other log makers in this study because he was more experienced at log making with the log specifications being used. This can easily be seen by the way that he hunted out the internodal sections in the stems, and the use of "V7" quality code frequently because it was a limiting quality code.

Implications

Thoughout the study variability between log makers was evident. This is best seen in Figures 3 and 4 where stem features were not recognised, quality codes for the same feature were not accurately placed on the same part of the stem and non limiting features were used. These differing features for the same stem from different log makers result in a different optimised combination of logs.

A relationship can be seen between the number of limiting qualities entered into the caliper and the quality of logs produced (Figures 3 and 4). This is because the more qualities entered into the caliper, the more factors the optimiser has to work with when finding the optimal solution. It is essential that all caliper operators understand that the better the information put into the caliper, the better the result.

Comprehensive training is the solution to these causes of log making variability. The log makers must be familiar with the log specifications, the limiting features of the grades and the electronic caliper.

Conclusions

This study shows that human variability has a huge impact on caliper outturn. Electronic calipers do not replace the skill of an experienced and well trained log maker. They enhance that skill. Electronic calipers are an optimisation tool which require a correct and detailed description of the stem. Only then can the electronic caliper provide an optimal solution of that stem. It is essential that log makers using electronic calipers are provided with excellent training and resources to allow them to make the best description of the stem, which can then be used by the caliper for the optimisation step.

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