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EFFECT OF NUMBER OF LOG GRADES ON LOG MAKING ERRORS

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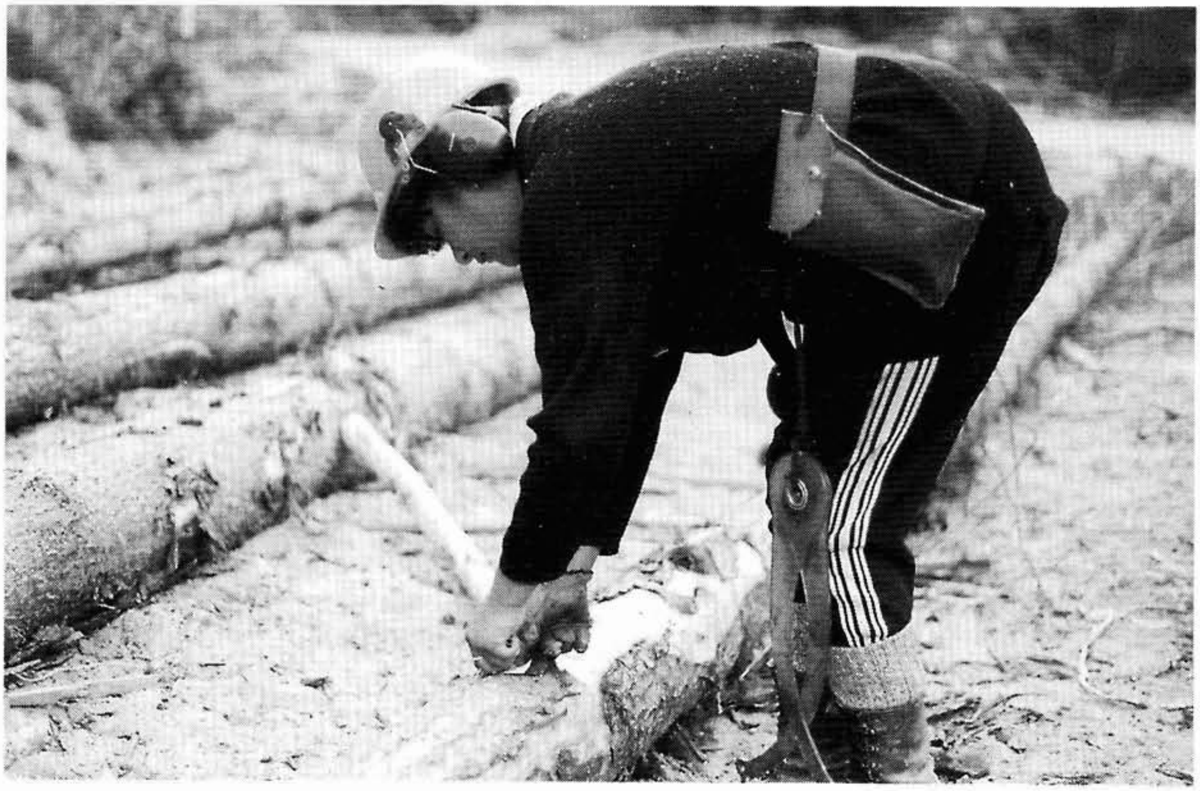

Figure 1 - Log maker assessing stem

ABSTRACT

A study was conducted to determine the effect of the number of log grades on log making errors. In a simulated cold deck operation eight log makers made logs using six, 10, 14 and 19 log grades. Using more than 10 log grades resulted in more log making errors and an increase in the number of out-of-specification logs which needed to be recut.

INTRODUCTION

In New Zealand it is not unusual to have log makers attempting to produce more than 20 log grades at one time. Errors resulting in value loss can occur during log making, and it is important to identify the causes (Strang, 1992; Parker, Cossens and Strang, 1993). In other industries, detection of defects in inspection tasks has been shown to decline as the task becomes more complex (Harris & Chaney, 1969). Log making is a complex inspection task because there are many stem attributes that need to be assessed to make a grade classification. In addition, the classification is not fixed as there is potential to down-grade higher value wood to lower grades. The log maker also needs 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 introduced. This project addresses the question, "What effect does the number of log grades have on the ability of the log maker to identify stem features correctly?"

Several studies have investigated log making ability. The influence of human variability in log making was first established by Landerud, Lier and Oy (1973). Work by Murphy (1987) demonstrated individual variation in log makers' abilities, although only three log makers were used. In a subsequent study specifically designed to investigate human variation in log making, Cossens and Murphy (1988) reported that supervisors were significantly better than experienced skid workers at getting the most value from the stem. Logging experience had no relationship with log making ability but years of formal general education and formal practical logging training were significantly related to better log making ability. The current study measured log making ability in a "cold deck" situation with none of the added pressures of a "hot deck" operation which would be expected to increase the error rate.

In a study of hot deck log making under normal operational pressures, Parker *et al.* (1993) found no relationship between value recovery and log maker heart rate, air temperature, or time of day. They did find a highly significant relationship between the log maker's self-assessment of "boredom" and value recovery ($p<0.005$). Value recovery exhibited a 3% increase for a one unit decrease in boredom (scale: 1 = interested, 7 = bored).

Some of the personal attributes of log makers which influence log making errors and subsequent value recovery have been identified. The influence of the "market driven" requirement for many log grades on value recovery has not been investigated. The objective of this project is to compare error rate of log makers over a varying number of log grades.

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STUDY METHOD

Stems

Four groups of 10 delimbed stems were laid out on landings. The stems were assessed for damage, branch size, sweep, wobble, out-of-round, defects and other quality features for entry to the AVIS (Assessment of Value by Individual Stem) single stem optimisation computer model (Geerts & Twaddle, 1984).

Log Grades

Four cutting strategies were prepared by Tasman Forestry Limited, Bay of Plenty which used six, 10, 14 and 19 log grades respectively. Within some log grades, there were a number of different lengths which could be cut, adding to the effective number of log grades. For operational reasons there were no long logs (more than 6.1 m) in the six log grade option.

Table 1 - Log grades available when cutting 6, 10, 14 or 19 log grades

Priority	Market	6 log grades	10 log grades	14 log grades	19 log grades
High	Export	A4.15	A12.15	A12.15	A12.15
	Export		A8.12	A8.12	A8.12
	Export				J12.15
	Export		TN5.62	TN5.62	TN 5.62
	Export			H8.82	H8.82
	Export				J7.95
	Export				H6.72
	Domestic	Onepu +30	Onepu +30	Onepu +30	Onepu +30
	Domestic	Onepu - 30	Onepu - 30	Onepu - 30	Onepu - 30
	Domestic		TK4.09	TK4.09	TK4.09
	Export				H4.52
	Domestic		TKS4.09	TKS4.09	TKS4.09
	Domestic			RS3.72	RS3.72
	Domestic				House piles
	Domestic			TX	TX
	Domestic			TU	TU
	Pulp	Ground wood	Ground wood	Ground wood	Ground wood
	Pulp	Kraft	Kraft	Kraft	Kraft
Low	Pulp	Over size	Over size	Over size	Over size

Log Makers

Eight experienced log makers were given the cutting instructions on the day before testing. The log grades were those normally used, so that the log makers were familiar with them.

Test Procedure

The log makers were transported to the test landings in groups of four. Each of the four log makers was presented with 10 stems from which to make logs. They used the cutting instructions for either six, 10, 14 or 19 log grades. Pins were used to indicate where the stems should be cut and the log grade written on a card which was attached to the stem. They were given unlimited time to make logs and then were returned to their crews and the second group of four log makers were transported to the test landings. Over a total of four days, each log maker was presented with a different group of 10 stems and a different number of log grades to make. The order of presentation was randomised. For example, on the first day Log Maker 1 used six grades and Log Maker 2 used 19 grades.

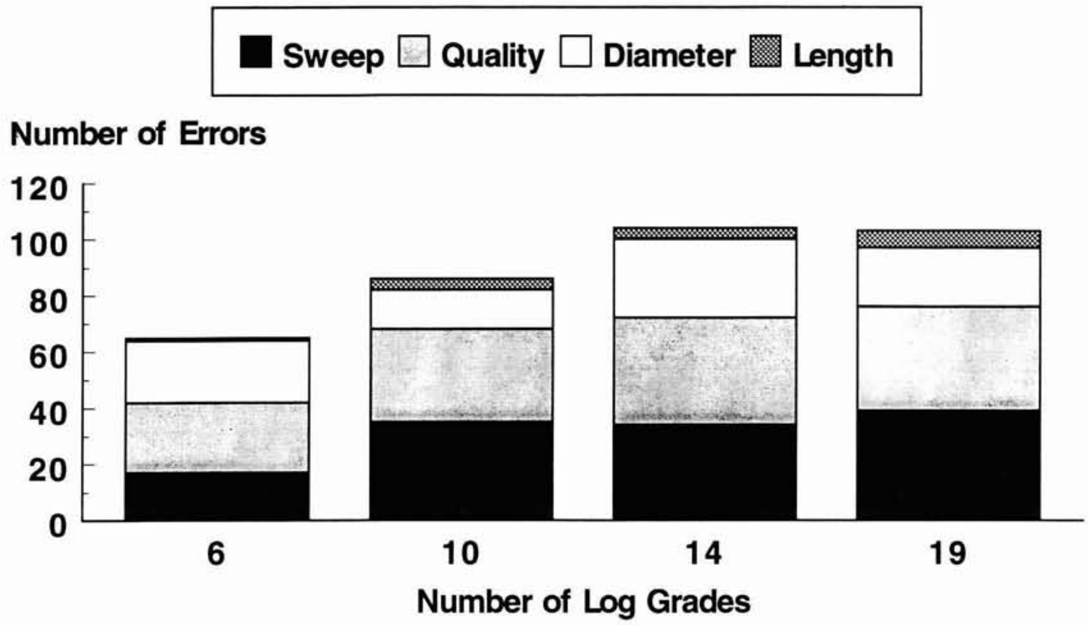
The resulting cutting patterns were compared with the optimal cutting patterns generated by AVIS, and errors in length, diameter, quality and sweep were identified.

RESULTS AND DISCUSSION

Overall, results indicated that the number of log making errors increased with a greater number of log grades. Log making with 14 or 19 grades resulted in the greatest number of errors (Figure 2). Most errors were in the assessment of log quality features and sweep.

Length

Few length errors were made, although there tended to be more errors made with a greater number of log types.



Type of error	6 grades	10 grades	14 grades	19 grades
Length	1	4	4	6
Diameter	22	14	28	21
Quality	25	33	38	37
Sweep	17	35	34	39
Total	**65**	**86**	**104**	**103**

Figure 2 - Total number and types of errors incurred when making logs from 6, 10, 14 or 19 log grades (320 stems; 8 log makers x 40 stems). Total errors for 10 grades are significantly different from 6 and 14 grades ($p<0.05$).

Diameter

Log makers made the least number of diameter errors with 10 log grades ($p<0.05$). The greater number of errors with other grades may be caused by three factors.

Firstly, there were no long (6.1+ m) logs in the six log grade option. Therefore the log maker was measuring more diameters compared with the 10, 14 and 19 grade options.

Secondly, the log maker was confronted with three new log diameters when moving from 10 to 14 grades and only one new diameter (house-piles) when moving from 14 to 19 log grades.

Thirdly, in the six log grade option there are only three log grades with three different small end diameters (SEDs) from which to choose. The SEDs range from 20 cm to 40 cm. In the 10 log grade priority list there are seven log grades with four different SEDs from which to choose. The SEDs range from 20 cm to 32 cm. In the ten log grade priority the log maker has more options from which to choose when the diameter is the only dividing specification between log grades.

Quality

Log quality errors tended to increase with an increasing number of log grades. Quality errors occurred when log makers tried to "push" logs into grades which were higher in priority and failed to identify quality features. With more log grades to deal with there was more opportunity to "push" logs and more opportunity for error.

Sweep

The smallest number of sweep errors occurred with six log grades ($p<0.05$). This is to be expected because there are less long logs in the six log grade option and it is easier to fit short logs into a swept stem.

There were long logs available with the 10, 14 and 19 log grades and there was a trend to more sweep errors with 19 grades.

Moving from 10 to 14 log grades an 8.82 m and 6.1 m log were introduced. These would not have added much complexity to the determination of sweep. In contrast, moving from 14 log grades to 19 log grades introduces a high priority 12.15 m grade and two new grades of 7.95 m and 6.72 m. These provide additional opportunities for sweep error.

Total errors

The total number of errors per log maker was closely related to the number of log making features which had to be considered (Figure 3). The least number of errors occurred with six log grades. In part, this effect was due to a reduction in sweep errors because there were less long options available. However, there was an increase in diameter errors with six grades because of more (short) logs to measure. Errors for 10, 14 and 19 grades can be compared directly and making logs from more than 10 grades certainly results in an increase in errors.

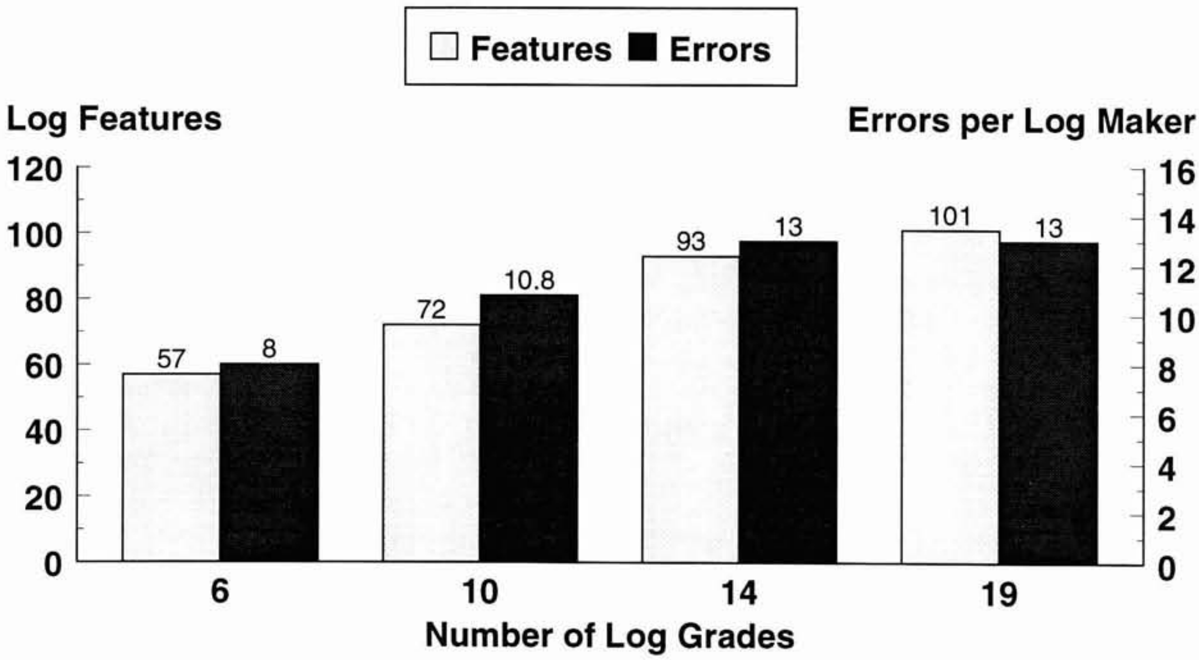


Figure 3 - Comparison of number of log quality features and average number log making errors per log maker

Errors during log making result in additional costs to the contractor and forest company because of:

- time lost in identifying and removing the out-of-specification logs from the stack
- time lost in remeasuring, cutting, sorting and stacking the out-of-specification logs
- a reduction in value recovery because the out-of-specification logs must be recut to (usually) lower value logs
- logs rejected by customers and the associated loss of customer confidence.

Practical Implications

A high number of log grades (14 or 19) increased the number of out-of-specification logs which would need to be recut. Forest companies must become aware of the effects of a high number of log grades when deciding which products to cut from stands.

It is advantageous for the forest company, on a forest wide basis, to cut a greater number of log grades because:

- they then have the flexibility to provide customers with requested log grades
- potentially they can achieve greater value recovery
- reject logs can be recut without a great loss in value.

On a skid by skid basis it is advantageous to the forest company to have fewer grades, so accumulating truck loads faster and rapidly removing the logs from the forest to reduce sapstaining.

For the logging contractor however, it is advantageous to process fewer different log grades because:

- log making becomes a less complex task with less opportunity for error and the costs associated with reject logs
- fleeting is simpler with less opportunity for error
- fewer different stacks are required on the landing which reduces congestion and increases safety.

The results of this study suggest a possible scenario. Twenty or more log grades could come from several contractors, each cutting no more than 10 different grades. In fact, the true optimum may lie somewhere between six and 14 log grades and vary with individual log makers. The 10 grades could comprise (say) five core grades common to all crews and the remaining grades split between crews depending on market requirements. In this way, the company continues to offer a large number of different log grades to its customers but the contractors can operate a simpler and safer system on the landing or road edge.

CONCLUSION

In this study on a simulated cold deck operation there was an increase in the number of log making errors when more than 10 log grades were cut. However, if the total number of log grades are distributed between all crews, companies can continue to offer many log grades and log makers can be given fewer log making decisions so maintaining quality.

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