Using External Stem Characteristics for Assessing Log Grade Yield. Comparing *Stem Description* and *Stem Coding*[1].

A. D. Gordon and D. W. Baker,
*A*TLAS Technologies, New Zealand Forest Research Institute,
Private Bag 3020, Rotorua, New Zealand.

Background

A key capability of pre-harvest assessment systems is to provide estimates of the volume mix a stand could yield for any set of log grade specifications. To support this capability it is necessary to work back from the log grade specifications to ensure that those quality characteristics on which the specifications are based are measured on the standing stems. For example, if the maximum branch size on a 35cm sawlog is 10cm then branch diameters must be assessed ("cruised") on the standing stems to at least this resolution. Typically the specified characteristics will include diameter, branch size and sweep. The MARVL system (Gordon *et al* 1995) is widely used in Australasia for assessing yield by log grade. This system combines a forest assessment sampling framework with individual stem quality cruising using *stem coding*. MARVL has been superseded by the *A*TLAS Cruiser system (www.atlastech.co.nz) which also supports a new method of quality cruising called *stem description*.

In both systems the assessment data are analysed with an optimising cross-cutting algorithm which cuts logs to specification following a pattern that maximises the value returned from each stem piece. The yield is then aggregated according to the sampling framework to determine the volume and value per hectare by log grade, together with confidence intervals around the estimates.

This paper describes these two methods of external stem quality assessment and presents results from a comparative study designed to measure the improvement in precision resulting from *stem description*.

Assessment using Stem Coding

Stem coding is driven by a quality dictionary; a list of codes and a description of each. For example, Table 1 lists a dictionary which allows for three levels of sweep and three branch size classes plus pruned sections and other qualities.

When cruising, these quality codes are associated with specific sections of each sampled stem (Figure 1). To make this

Code	Description
A	Pruned, sweep < SED/4
V	Pruned, sweep < SED/4, nodal swelling
P	Pruned, sweep < SED/4, fluting
G	Pruned, sweep SED/4 to SED/2
Q	Pruned, sweep SED/4 to SED/2, nodal swelling
U	Pruned, sweep SED/4 to SED/2, fluting
C	Pruned, sweep > SED/2
K	Stem with (0-SED/4) sweep, BS < 7cm
N	Stem with (0-SED/4) sweep, BS 7 - 14cm
B	Stem with (0-SED/4) sweep, BS > 14cm
L	Stem with SED/4 - SED/2 sweep, BS < 7cm
D	Stem with SED/4 - SED/2 sweep, BS 7 - 14cm
H	Stem with SED/4 - SED/2 sweep, BS > 14cm
M	Stem with > SED/2 sweep, BS < 7cm
E	Stem with > SED/2 sweep, BS 7 - 14cm
J	Stem with > SED/2 sweep, BS > 14cm
W	Unmerchantable Wood
Z	Damaged Live Wood

Table 1. Stem Coding Feature Dictionary

[1] Paper presented at the AusTimber 2004 Conference; Albury, Australia. 30 – 31 March, 2004.

association, the field cruiser must identify the heights up the stem at which changes occur in any of the stem characteristics being assessed. For example, the branch size exceeds 7cm at 20.2m. The cruiser must then determine which code applies to the section of the stem with a specific combination of characteristics. At 20.2m the stem is swept, the branch size exceeds 7cm, there is no thinning damage and nodal swelling and fluting are not of interest, so the coding changes from L to D.
Cruising at speed can be quite difficult when there are more than about nine codes. Few people can keep more options than this in their heads at once and often a cruiser will focus on a well-used subset of the defined codes.

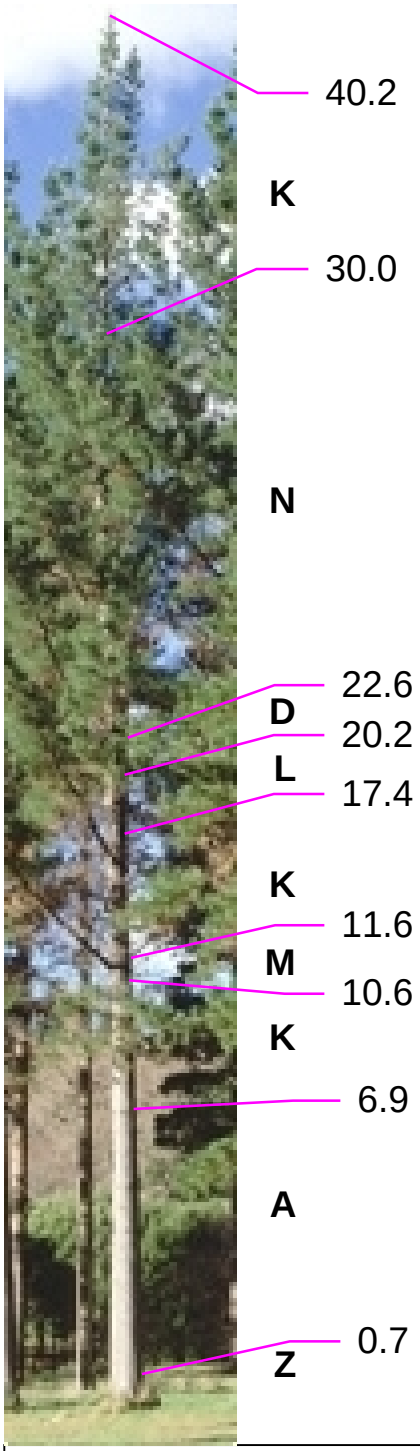

Figure 1. Stem Coding with Quality Dictionary

Assessment using Stem Description

Stem description is a new method of recording stem quality that avoids the use of discrete classes to label combinations of quality characteristics. Cruising is much simpler, as stem qualities can be described without having to be translated into unique codes. The procedure involves independently describing three characteristics: structure, sweep and branching, and then recording any additional quality information as user-defined features.

The example stem shown in Figure 2 is not forked but the description of structure will allow for one or more forks and levels of forking as well as broken tops and merchantable branches. Sweep is described by identifying the shape of any deviation and recording its extent and severity. The size of branches is recorded at a measurable level of granularity that allows for the range of maximum knot sizes used in log grade specifications, in this case <7cm, 7-14cm, >14cm. Other quality information is recorded as features, which are labelled sections of stem with an optional severity measure. The example in Figure 2 shows a section of thinning damage up to 0.7m. Feature sections may overlap.

Comparative Study

To measure the improvement in precision that is obtained using *stem description* rather than *stem coding*, a trial was designed which contrasted the two methods. Two forest assessment crews who were experienced in assessment using stem coding, independently cruised the trial stand twice, once with stem coding and once with stem description. The radiata pine stand was located in Mohaka forest on the east coast of the North Island, New Zealand. At age 23, it was standing at 155 stems/ha, 48m^2/ha basal area, 40m mean top height with a total standing volume of 580m^3/ha under-bark. The majority of stems were pruned above 6 metres. The crews cruised all stems on eleven 0.08ha bounded plots using stem coding. They were then trained over 4 days to accreditation level in the stem description method (Baker *in prep*) and re-cruised all stems in all plots using stem description.

The stem coding measurements were analysed using Marvl V3.5 and the stem description measurements were analysed using *A*TLAS Cruiser V1.4. Estimates of the yield by log grade for all four assessments were generated. The set of log grades and prices used were identical within each system, but differed slightly between systems. The differences in the log grade yield estimates between crews, within stem measurement system, were calculated and the distributions of the differences were compared. The two distributions are shown in Figure 3.

The differences in log grade yield between crews were considerably less variable when quality was measured using stem description. Over half of the log grades from the stem description measurement were within +/- 5 m^3/ha between crews. The variance of stem description differences was significantly smaller than the variance of the stem coding differences (F=11.3, v_1=16, v_2=17).

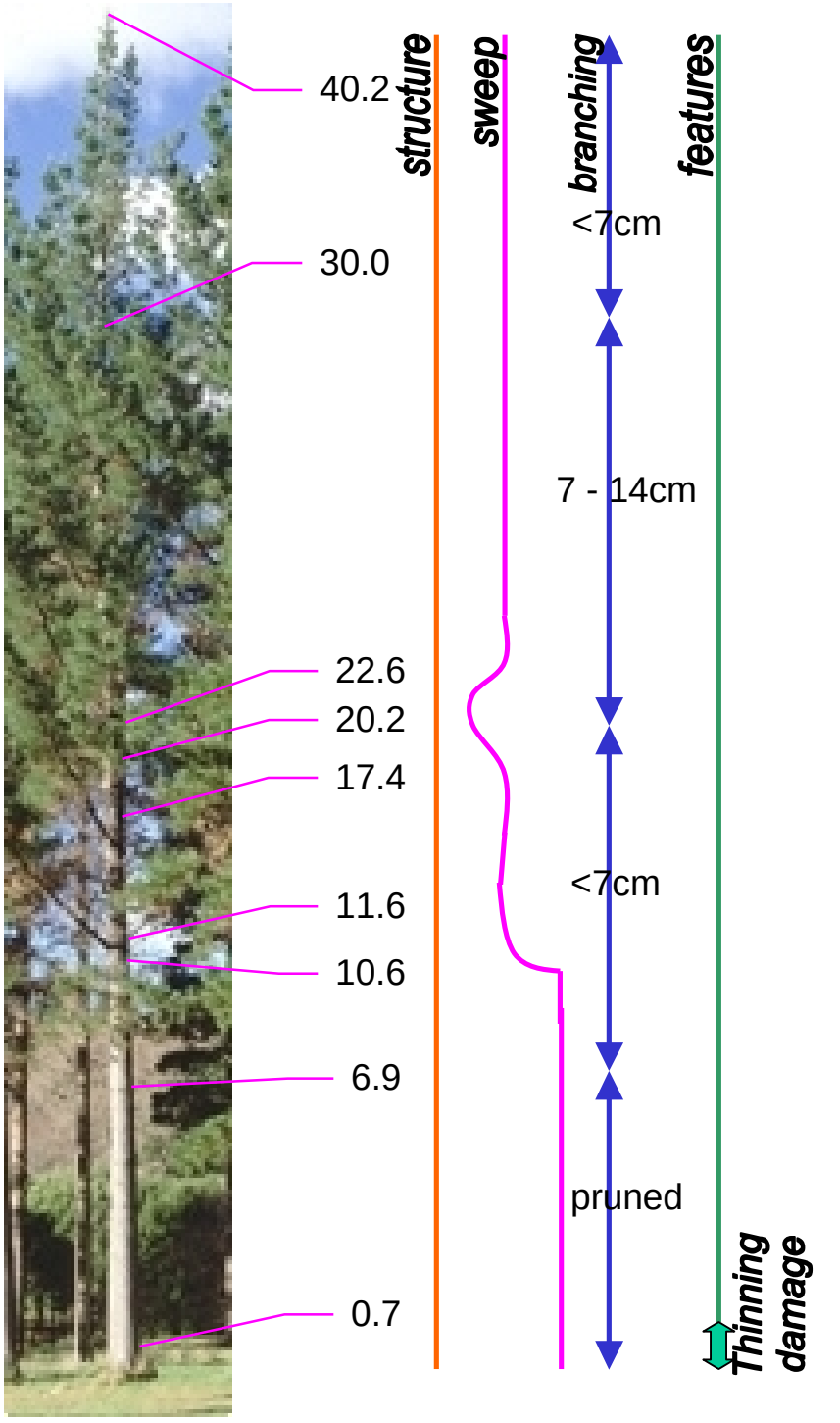

Figure 2. Stem Description

Conclusions

The advantages of using stem description to measure quality are not limited to increased repeatability. A major benefit is seen when estimating log yields, as the assessment data do not limit the range of potential cutting strategies that can be tested. Estimates of the log mix, even for unforeseen log specifications, can be derived from stem description data.

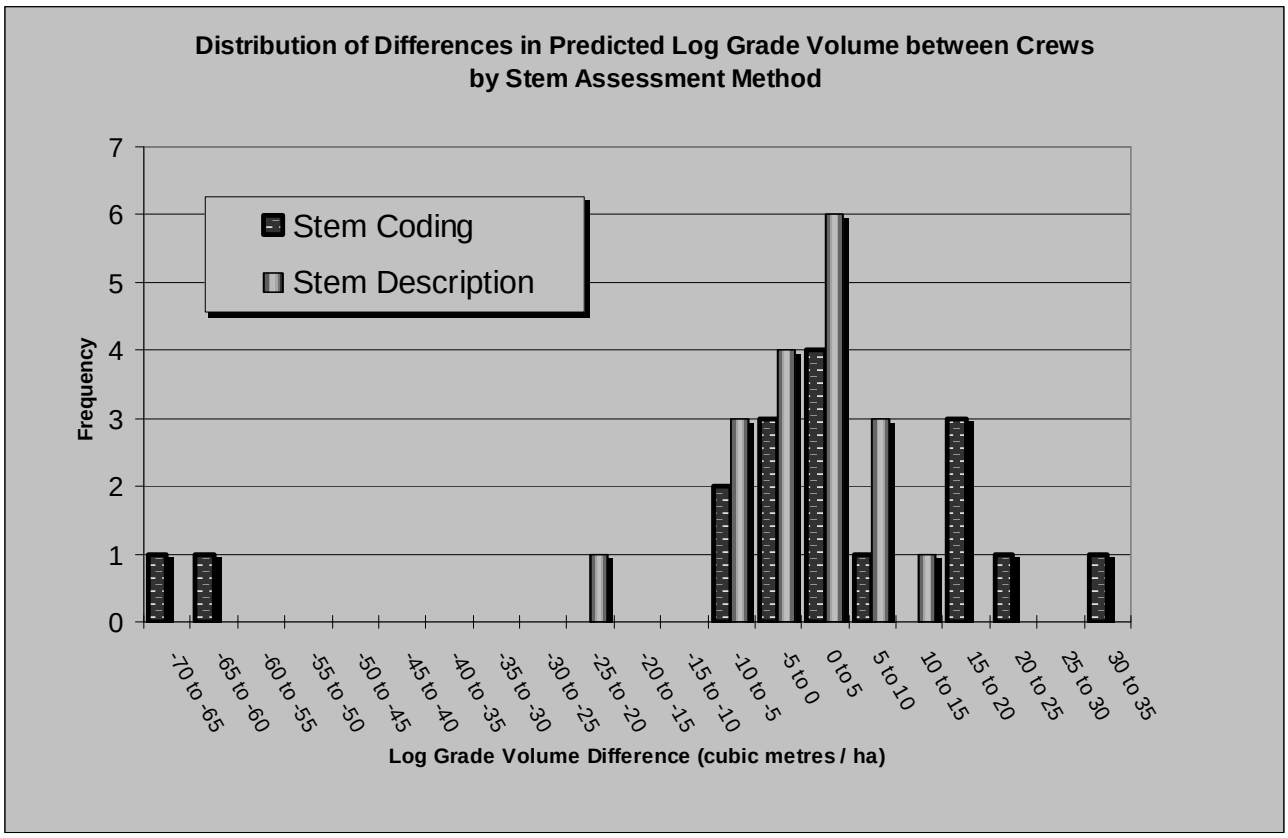

Figure 3. Distribution of Log Grade Volume Differences

Log grade specifications are increasing in detail and becoming more specific, while log prices are being more tightly linked to log quality (Maclaren 2003). Consistent and reliable pre-harvest assessment of potential yield by log grade is key to meeting mill and export demands for volume and quality on time. Using stem description to assess external quality is an important step in improving the assessment of log grade yield.

Acknowledgements

This study was funded by PAN PAC Forest Products Limited, Napier, New Zealand, who have generously granted permission for the publication of these results.

References

Baker, D.W. *in prep*: Course Notes for the New Zealand Qualifications Authority Standard in Inventory Practice. New Zealand Qualifications Authority.

Deadman, M.W. and Goulding, C.J., 1979: A Method for the Assessment of Recoverable Volume by Log-types. New Zealand Journal of Forestry Science 9(1): 225-39.

Gordon, A.D., Lawrence, M.E. and Pont, D. 1995: Assessing the Potential Log Yield of Stands Prior to Harvesting. *In* Proceedings of the Institute of Foresters of Australia 16th Biennial conference "Applications of New Technologies in Forestry." Ballarat, Victoria. 18-21 April 1995.

Maclaren, J. Piers. 2003: What age should you harvest? New Zealand Tree Grower, August 2003.

www.atlastech.co.nz : ATLAS Cruiser, Forest Resource Assessment.