Quality variations in the chain log–board–blank

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To achieve a high economic return in the wood industry it is important to control the grading procedures and to know the quality distribution in different steps. Scots pine (*Pinus sylvestris*) timber from Sweden has been compared regarding quality variations in the chain log–board–blank caused by biological properties and subjective grading procedures. This study describes the quality distributions in the treatment of trees from harvesting throughout sawing and to the user’s judgements, the correlation between the grading procedures in various steps, and the yield in all classes based upon the customers’ opinion. The results emphasise that current classification system is very hazardous and seems not to be in concordance with the customers’ demand. The subjective and visual grading procedures are not sufficiently effective to predict the properties. Three main needs must be satisfied in order to reduce the costs for poor quality: knowledge about the biological variations, new equipment for grading and knowledge about the customers’ needs and behaviours.

1 Introduction

The chain from trees via logs, boards and blanks to products contains many different steps of grading. Mostly the judgements are subjective, but the separate classes rely upon grading rules and classification codes that describe the main characteristics for each class. Today these important judgements constitute the basis both for the economic deal between the buyer and the seller and also for further separation procedures.

It is commonly held in quality work nowadays that variations are the root of all evil. Variations are often in focus in the quality process and it is very important to decrease and control variations to attain improvements.

When dealing with variations in the wood industry, we must realise that these “variations” within and between the trees are a part of the law of nature. It is impossible to demand the “manufacturer” of the trees to keep the “variations” within some given specification, if we exclude the possibilities inherent in genetics and silviculture. Instead we must handle these variations by using sophisticated scanning technology and production methods so that each board, blank and end-use product is delivered to the right customer.

To reduce the effects of those large variations, several classification procedures in the chain tree–log–blank are always used. The products are separated according to various characteristics such as knots, rot, sweep, compression wood, spiral grain, shakes etc. The amount of knots, their size and whether they are alive or dead, is by far the most important property for classification of logs or boards into separate quality classes. Also process related factors such as wane, twist etc. affect the quality grading. The different properties give different economic values on the market.

In a competitive economy, continuous quality improvements and cost reductions are necessary for staying in business. As the material cost is the largest cost in all steps in the chain from the tree to the customer it is very important to utilise the raw material in an optimum way. To achieve a high economic yield it is important to control the grading procedures and to know the quality distribution in different steps.

Quality distributions and variations in the treatment of trees from harvesting throughout sawing and to the user’s judgements, the correlation between the grading procedures in various steps, the yield in all classes based upon the customers’ opinion are described in the thesis Grönlund (1992). This paper is a summary of the thesis.

2 Materials and methods

A common way to handle variations in the raw material properties is to split the logs, boards and blanks into separate groups. These procedures are commonly performed by visual judging based upon the manual Guiding Principles for Grading of Swedish Sawn Timber (Anon, 1982) and skilfulness. This manual is translated into English, German, French, Italian, Danish, Spanish and Arabic. In this investigation the classification procedures for approximately 1000 scots pine logs (*Pinus sylvestris*) from Sweden are studied. Figure 1 gives an illustration of the classification procedures.
2.1 Sample plots
There are many factors influencing the growth of trees, e.g. soil, geology, climate, and geographic position. Depending on these factors two separate areas, A and B, representing different circumstances, were chosen for the investigation. In both area A and area B eight sample plots were sampled. In every sample plot a clear-cut harvesting area was chosen. The sample logs were randomly chosen by a crane loader from an unsorted stack on the clear-cut area. Every collection consisted of about 50 scots pine logs (Pinus sylvestris) with a top diameter of 150–180 mm and about 25 pine logs with a top diameter of 230–260 mm. Each log was marked with a unique number, \( I : j \), where \( I \) is the number of the sample plot (\( I = 1 \ldots 75 \)) and \( j \) is a serial number within the sample plot (\( j = 1 \ldots 16 \)).

2.2 Scaling of timber
The logs from area A were scaled by a measurer from the Measurement Society’s district containing area A and the logs from area B by a measurer from the Society’s district containing area B. The following parameters were noted and/or measured: Plot number, individual number, top diameter inside bark, length, classification code (grade IV, V, VI and W, respectively), length and diameter reduction. The last classification code W (waste) was assessed on logs that were judged as unusable for manufacturing of wood products.

By using exterior geometries, appearance, experience, and an “X-ray-eye” the skilled worker judged the interior properties of the log. Each log was in this process categorised into one separate class. Thus, the measurer graded the centre boards (the two boards in the middle of the log) into one class, for instance IV–IV, IV–V or V–V. This means that according to the measurers’ opinion the boards will have this classification after the sawing process.

2.3 Sawing process
The logs were sawn into two dimensions. The small logs were sawn to two 50 × 100 mm centre boards. The large logs were sawn to two 63 × 175 mm centre boards. Each centre board was given an individual, randomised number, consisting of five figures and a letter describing left or right centre board. The board had after this procedure an identity, that did not disclose the geographic area or number of the plot. With these procedures the various skilled workers were able to grade the single board depending on the special characteristics and without influence of geographic identity of the sawn timber. After the sawing procedure the boards were dried to 18% moisture content in a kiln.

2.4 Sawmill grading
The sawn timber was independently graded by two skilled sawmill graders from factories in area A and B. The boards were graded in four categories: unsorted (IV), quinta (V), 6ths (VI), and waste (W). The last class consisted of boards that were graded as unusable for production of wood products. A secretary noted the identity-number, the classification code and an estimated length of each board. The length was given in 3 dm modules, but the cutting procedure was not carried out. The grader was allowed to use the possibility to shorten the board in order to assign a better classification group.

2.5 End-use grading
The 50 × 100 mm boards were graded according to the quality requirements for door frames. The grading procedure was repeated, the first time the grading was done for painted door frames, the second time for stained door frames. The requirements are stricter when pine is used for stained door frames. The 50 × 100 mm boards were independently graded by two skilled workers, from two different door factories situated in area A and area B, respectively. The 63 × 175 mm boards were graded according to the requirements for window casements. The grading was also done independently by two skilled workers, from two different window factories situated in area A and B, respectively. The skilled worker estimated how much of each board it was possible to use for this specific product. He told the secretary the identity-number followed by 100, 75, 50, 25 or 0% on each board.

3 Theory
The data from this investigation are mostly represented in the form of cross-classified tables of counts, commonly referred to as contingency tables. The data are observations of ordered polytomous variables, usually called ordinal data (Fienberg, 1976). Assume that the observed frequencies in the different categories have a multinominal distribution. It is interesting to analyse if the classifications are independent. The null-hypothesis, \( H_0 \), i.e. the groups are sampled from the same population, is tested by the \( \chi^2 \)-test (Pearson, 1904). Test of association is performed by Somers’ \( \Delta \), that is an asymmetrical index of relation between two ordered variables. (Somers 1962; Siegel et al. 1989). The index can attain any value between -1 and 1, and is equal to 1 if and only if there are no disagreements in order and each row has at most one non-zero cell. This index is a measure of the predictability of one of the categorical variables when the value of the other is known.