A METHOD FOR EVALUATING THE EFFECT OF DIFFERENT DRYING METHODS ON LUMBER QUALITY

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Introduction. The lumber manufacturing industries suffer from enormous inadequacies in terms of ability to measure what is happening. Changes are continually being made to drying procedures, schedules and other processing operations based on someone's opinion rather than any reliable well founded facts. This can in some cases result in significant improvements, but no one can establish the improvements as a fact unless reliable measurements are taken. This paper deals with some of the problems involved in measuring what happens to lumber quality during drying and specifically with a method of comparing the effect of various drying schedules or treatments on the value of the lumber produced.

No one will contest the argument that drying procedures and drying schedules can have a considerable influence on the value of the end product. In all of our drying research, schedule development, etc., the objectives are to dry lumber with the highest quality at the lowest possible cost. Since these two objectives may be mutually exclusive, a more reasonable objective is to dry with the lowest total drying cost, where cost includes direct cost of drying as well as any loss in value due to yield or grade losses during drying. The direct costs of drying by different methods are generally not too difficult to measure and are a unique problem for each mill site. They will not be dealt with in this paper, not because of their lack of importance, but because of the relative ease of determination and the uniqueness of each mill site. The primary concern in this paper will be with a method for measuring yield and grade losses and particularly the comparison of value loss resulting from different schedules.

Background. The tendency in most drying degrade studies has been to attempt to quantify the value lost due to drying as an absolute value. Our analysis of previous experiments some of which are reported here, have led to the conclusion that an absolute measure of kiln degrade is impossible to achieve because of differences in drying characteristics of the raw material from time to time and location to location. We have therefore concentrated on developing a comparative method, whereby two or more schedules, treatments, etc. are compared to determine which one gives the highest value in the lumber produced.

In arriving at this conclusion we have looked at two alternative methods of evaluating drying procedures and identified the shortcomings and problems associated with each one. From these two existing methods a new method was developed which appears to be simpler and more precise than the previous ones. The two older methods will be referred to as I and II. Method I is a degrade evaluation procedure which has been widely used in Weyerhaeuser and elsewhere. Method II involves determination of volume and grade yield on a massive scale.

Procedure for Method I

1. Select 100 boards of each grade in rough green for each test charge and identify.
2. Distribute sample boards through kiln charge.
3. Dry.
4. Obtain moisture content distribution during unstacking.
5. Separate test stock and sort by grade.
6. Surface without end trimming and set aside for grading.
7. Grade boards, pencil trim and assign cause for downgrade.
8. Calculate degrade loss in $/MBF due to seasoning defects and manufacturing defects for each grade.

Procedure for Method II

1. Use normal mill run production lumber.
2. Assign alternate kiln cars to each test charge.
3. Dry.
4. Obtain moisture content distribution during unstacking.

5. Surface - measure volume input to planer and obtain yield by grade and length.
6. Calculate value of surface dry lumber based on volume charged into planer.

Comparison of Methods I and II

To evaluate and compare methods I and II some rather extensive tests were run during which methods I and II were run at the same time in the same kiln charges. Full kiln charges for method II had the relatively small amount of test stock for method I dispersed through the kiln so that lumber employed in both methods experienced the same drying conditions at the same time.

In this study we were comparing 3 drying schedules, which are designated as A, B and C. Since the purpose of this paper is not to compare schedules, but to examine test methods, the specific details of the individual schedules are omitted. The partial results from comparison studies on 2x6 and 2x12 Douglas fir are shown in Tables 1 and 2. Two runs were made which are shown as trial 1 and trial 2. Recall that for method I the result is a degrade figure and with method II a value figure, thus for method I the best schedule is the one with lowest degrade and for method II the best is the one with highest value.

Some very interesting observations can be made by comparing the results in successive trials. For example in Table 1, using method I, schedule A gives $.90/MBF less degrade than schedule C in trial I and $2.14/MBF more than C during trial II. A similar situation occurred in the case of 2x12 as seen in Table 2. The results are quite obviously inconsistent. The accepted procedure in the past has been to run the evaluation once and accept the data as fact. The danger in this is obvious when you examine the results of the replication in these two cases. The first trial alone could have been completely misleading.

A similar situation exists in the case of method II. In looking just at the results of the 2x6 trials, method II appears to be fairly consistent. Both trial 1 and 2 favor schedule C over either B or A. However, the apparent consistency disappeared in subsequent tests on other sizes. This is seen clearly in Table 2 where schedule C was $9.32 higher than B on the first trial and -$8.49 worse on the second trial.

These data are shown for illustration only. From these and additional unreported data we have made some conclusions regarding evaluation of the effect of drying on lumber quality which are as follows:

1. Replication is essential to any test method.
2. Regarding method I
   A. The method is very laborious.
   B. Sample size is too small and atypical.
   C. Boards of a given grade are not equally dryable.
   D. Randomization of boards between schedules to obtain uniform dryability is inadequate.
3. Regarding method II
   A. The method is simple.
   B. There is no knowledge of the starting green population.
   C. The green population was not randomly distributed between schedules.
   D. Boards of a given grade distribution and dryability tend to be clustered in mill output.
4. An absolute measure of drying degrade for a given schedule and item is unattainable.
5. A new, simple, accurate method for comparing schedules should be developed.

Development of a New Method

In devising a new method for comparing the effect of different drying schedules, etc., we attempted to draw on the good points of methods I and II and to ensure that the bad points were eliminated. One of the particularly bad points of both methods was that no attempt was made to ensure that boards distributed among the test procedures had uniform dryability. It is obvious to the experienced kiln operator that boards from a given log or tree tend to behave similarly. The wood in some trees is very easy to dry without checks, splits, warp, etc., whereas the wood in other trees results in lumber which will not dry well no matter how you treat it. In normal production operations the boards which are from the same or similar trees will tend to be clustered in the same unit of lumber. This will be more pronounced with mills cutting large old growth logs, because sizeable percentages of a given unit can be from the same log or tree.

TABLE 1

RESULTS OF TESTS ON 2X6 DOUGLAS FIR

	METHOD I		METHOD II	
SCHEDULE	TRIAL I	TRIAL II	TRIAL I	TRIAL II
A	-$1.98	-$3.57	$51.63	$56.59
B	- 2.45	- 2.66	53.45	56.62
C	- 2.88	- 1.43	54.15	59.47
C - A	- .90	2.14	2.52	2.88
C - B	- .43	1.23	.70	2.85

TABLE II

RESULTS OF TESTS ON 2X12 DOUGLAS FIR

	METHOD I		METHOD II	
SCHEDULE	TRIAL I	TRIAL II	TRIAL I	TRIAL II
A	-$7.46	-$7.57	$69.78	$56.86
B	- 7.99	- 8.23	68.88	68.33
C	- 5.18	- 9.89	78.20	59.84
C - A	2.28	- 2.32	8.42	2.98
C - B	2.81	- 1.66	9.32	- 8.49

As a result, boards of a similar 'dryability' will tend to be clustered into a given test using either method I or II. After much discussion and probing, a decision was made that any comparative method should involve board by board randomization among the drying procedures under test.

The simplicity of method II led us to feel that a direct measurement of grade and volume yield on a production basis would allow us to get adequate information with the greatest ease. At first it may seem that we are losing too much by not having the detailed information as to cause and amount of degrade on a grade by grade basis, but our replications indicated that this type of information was not valid anyway because of the small sample size. Therefore, we were spending a lot of time gathering information which we couldn't use. Another important aspect of this question using method I was defining what degrade was due to drying and what wasn't. For example, skip was defined as a manufacturing defect, not a seasoning defect. However, if you were comparing two schedules and one produced more shrinkage than another, the schedule with more shrinkage would produce more skip. If you have defined skip as a manufacturing defect and not a seasoning defect it won't show up in the seasoning degrade column. Our conclusion is that the advantages of obtaining the degrade data by defect using method I do not justify the added time and effort required to get the information.

This brings us to the new method itself. The details for the method follow.

I. Specify
   A. Process(es) to be compared - i.e., schedules, kilns, etc.
   B. Species and source of lumber.
   C. Type - i.e., clears, commons, boards, etc.
   D. Size and length (preferably only one of each).

II. Procedures
   A. Green lumber input.
      1. Grade and mark rough green mill run stock and assign successive pieces in sequence to each process. Eliminate obvious oversize or undersize pieces from test material.
      2. Obtain a tally by grade of the boards assigned to each process.
      3. For each process accumulate enough units to stack one unit in each kiln car. (e.g. this would require 6 units of 16' stock in a 104' kiln).
      4. Identify each unit concerning process to which assigned and color code ends of units for identification after drying.
   B. Drying
      1. Randomize the sequence of running the different processes, if they cannot all be run at the same time.
      2. Stack one unit of test material in each kiln car, randomizing the height of the test unit in the car.
      3. Dry
   C. Unstacking
      1. Tally by grade any pieces lost at the unstacker due to breakage, etc.
      2. Measure moisture content distribution in the test units (minimum of every 3rd board).
   D. Surfacing and grading
      1. As soon as all process runs are complete, run test lumber through the planner. For each process determine:
         a. Loss by grade and volume ahead of planer.
         b. Number of boards discarded by trimmer.
         c. Tally of all lumber for each test process by grade and length after surfacing and trimming.
      2. Make certain that the same grader is used throughout to eliminate grader to grader variation from test results.
   E. Replicate steps A - D at least once.

III. Analysis
   A. Calculate the projected dry value per MBF based on rough green grades.
   B. Calculate actual dry value per MBF based on surface dry grade and tally and rough green volume.
   C. Value change is the difference between the projected value and the actual dry value.
   D. Compare the value change for each process and determine whether the differences are statistically significant.
   E. If other direct drying costs are different incorporate them into the total cost comparison.

Our experience with this method has been limited to date since it is relatively new and we encountered some kiln problems on our initial trials. We have completed one set of comparative tests in which four different schedules were run in one kiln. The stock used was mill run 2x8 inch Douglas fir commons 14 foot long. A summary of the results of those tests is shown in Table 3.

The effectiveness of the randomizing procedure to establish uniform grade distributions for each process can be seen by comparing the values for the different schedules based on the green grade distributions in the three trials. In trial 1 the spread was only $.85/MBF: in trial 2 $3.11 and trial 3 $.38. The spread for trials 1 and 3 is judged to be excellent, that in trial 2 is rather poor.

The really critical information is the value after drying. If the green grade distributions were all similar and the green values very similar, a direct comparison between surface dry values could be made. The more accurate procedure, however, is to take the difference between the value based on rough green grades and value of the dry finished lumber and compare these differences among the four schedules. These values are shown at the bottom of Table 3.

One of the facts which is most visible and somewhat unexpected is that some increases in value as a result of drying and surfacing are indicated. There are several ways this can happen. Surfacing can result in removal of wane and some surface defects to result in upgrading. End trimming can also result in upgrading. Finally, the grader may view the boards differently from time to time. Unfortunately, we were not able to secure the same grader for grading the surface dry stock who graded the rough green lumber. This may have had a significant effect on the magnitude of the differences, but would not affect the comparisons between schedules.

Since the primary aim in this test method is to compare, not to obtain absolute values, these grader differences will not matter so long as one grader grades all material for one trial on a given day.

The data in Table 3 do not overwhelmingly support the contention that this new test method is more reliable. However, many of the inconsistencies can be directly attributed to moisture content differences and mechanical problems encountered in the course of the three trials. The only trials where something didn't go wrong were schedule A and B in trial II and all schedules in trial III. Thus, the only perfectly valid comparison is between schedule A and B on trials 2 and 3. These data favor schedule A by $6.96 and $5.98 which is very consistent.

A statistical analysis was run on the data as a whole disregarding the problems and the results showed that schedule B has significantly higher degrade than any of the other schedules. The differences among schedules A, C and D were not statistically significant. To determine if those differences are significant an additional trial or trials would have to be run using schedules A, C and D.

Summary

Evaluation of a method for measuring drying degrade and a method for comparing the value of lumber dried by different methods has resulted in a new method for comparing the effect of drying on lumber quality. Key elements of the new method are board by board randomization of mill run lumber among processes being compared, measurement of green grade distribution for each process, determination of value of surface dry product, comparison of the change in value between the processes under consideration, replication and statistical evaluation. Preliminary results indicate that the new method is less laborious and more reproducible than the methods used previously.

TABLE III

COMPARISON OF 4 SCHEDULES USING THE NEW EVALUATION METHOD

Projected dry Value ($/MBF) Based on Rough Green Grades

SCHEDULE	TRIAL I	TRIAL II	TRIAL III	AVERAGE
A	$70.00	$72.34	$76.19	$72.84
B	70.00	73.80	75.81	73.30
C	70.32	75.45	75.96	73.91
D	69.47	73.58	76.02	73.02

Actual Dry Value ($/MBF) Based on Green Volume

A	69.14	68.42	74.65	70.74
B	69.96	62.94	68.29	67.06
C	71.90	73.36	76.34	73.87
D	72.91	66.12	75.82	71.62

Difference Between Actual and Projected Dry Values ($/M)

A	- 0.86	- 3.92	- 1.54	- 2.10
B	- 0.04	-10.86	- 7.52	- 6.14
C	+ 1.58	- 2.09	+ 0.38	- 0.04
D	+ 3.44	- 7.46	- 0.20	- 1.40