GRADEYIELD – Lumber Grade and Yield Studies for Analysis of Sawmill Profit-Potential

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Conducting Hardwood Lumber Grade/Yield Recovery Studies and Use of the GRADEYIELD Spreadsheet Program to Perform Analysis of Data Collected in a Hardwood Lumber Grade/Yield Study

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Introduction and Overview

Operating within an environment where both stumpage and delivered log costs have risen dramatically over the past decade, and where procurement of higher grades logs has become increasingly competitive, more mills are finding it desirable (if not absolutely necessary) to more closely monitor their raw material costs. This is always an important issue for the hardwood sawmill, but it is particularly important for mills which are largely dependant on NIPF landowners as a source of timber supply, where lumber prices rise and fall with market conditions, but stumpage and log prices can tend to be quite "sticky" in the downward direction where many landowners may simply elect not to sell timber in a depressed market.

However, an appropriate strategy in such analyses cannot simply look at a minimization of raw material costs in any reasonable hope to reach appropriate conclusions. Rather it is necessary to consider the combined affects of raw material and manufacturing costs as compared to revenue received from lumber that is produced, to determine which grades and species of logs may be most profitable to saw, and to develop appropriate strategies.

Where this might not be intuitively obvious, it is only necessary to consider a possible circumstance in the comparison low grade versus higher grades of logs with any given species. On a nominal basis of cost per unit of product input (i.e. $/MBF delivered to the mill), the purchase of lower grade logs would yield a lower raw material cost per unit of product input and almost certainly per unit of product output, as compared to higher grades of logs within the same species.

This might lead to the somewhat obvious conclusion that the best way to reduce or minimize raw material costs would be to purchase lower grades of logs at the relatively low prices at which they may be obtained. This kind of decision-making may lead to a logical conclusion, and a correct course of action, based on pure luck. However, this could possibly be a very foolish strategy leading the sawmill manager down a disastrous path.

The problem with this kind of a strategy would be that it considers only costs and entirely ignores revenue. In terms of example, even though lower grades of logs may be purchased at minimal $/MBF log scale costs, it is entirely possible that the value of lumber recovered from those logs may not be sufficient to cover the costs of purchasing and sawing the logs. In contrast, it is possible that higher grades of logs, having commensurately higher costs of purchase in $/MBF log scale, could have associated potential for recovery of much higher value lumber which could cover the higher log costs and still return a significant additional value in contributing to profits.

This example underscores why it is insufficient to look solely at raw material costs ignoring revenue. An apparently opposite but similar mistake may be made when sawmills move in the opposite direction in their purchase decisions and attempt to purchase the highest grades of logs available. This strategy is predicated on the recognition that higher grades of logs have the potential to yield higher grades of lumber. Pursuing this strategy without considering costs and revenues carries with it the latent assumption that the expected recovery of larger proportion of higher-grade lumber may somehow ensure a desirable margin after recovering raw material and sawing costs. That may be true in some circumstances, but in others it may not be.

What is really needed by sawmill managers is an effective and simple way of simultaneously considering both revenues and costs together. The gross margin, that is the difference between revenue and costs - is what is important to examine. In doing this the manager may then identify both those species of logs and grades within species that offer the greatest potential for profitable returns, and also those which pose the greatest “problems” or risk of losses or unacceptably low margin returns. It is entirely possible (and not uncommon) for a sawmill to have a circumstance where the mill is profitable overall, but is essentially making nothing or actually losing money on some grades of logs within some species. Identification and understanding of such problems is always the first step towards solution.

Given differences in log grading, processing strategies and products produced, mill equipment, raw material costs and availability of resources, and market prices received for lumber sawn; these issues regarding revenue from lumber produced and associated costs to determine gross margins must really be considered on an individual mill basis. Lumber grade/yield studies conducted within the unique circumstance of the individual mill are a simple and effective way of obtaining that information. Some types of these studies may be easily conducted by personnel at virtually any sawmill, with minimal direct costs and very little opportunity costs in loss of potential production in the collection of data. Further, these raw data collected may be then be easily transformed into usable information for decision makers using a spreadsheet on a personal computer.

Spreadsheet Analysis

The GRADEYIELD spreadsheet has proven to be a simple and easy to use tool for analysis of data from hardwood lumber grade/yield studies that can run on almost any computer spreadsheet. It can be operated “as-is” by persons with even the most basic spreadsheet experience, however it may be easily modified by more experienced users in tailoring the program to suit their specific needs, desires and circumstances. The following discussions will revolve around hardwood lumber grade yield studies, how to conduct basic hardwood lumber grade/yield studies and analysis and interpretation of data collected from those studies using the GRADEYIELD spreadsheet.

Conducting Hardwood Lumber Grade/Yield Studies

Hardwood lumber grade yield studies provide an indication of potential volume recovery of lumber overall in relation to log scale, and the percentages of lumber within the various lumber grades which could be expected to be obtained from a sample of logs representing the log resource of interest. In almost all cases these studies are conducted using samples of logs of a particular species and typically within a given grade of logs within the species. Assuming grade yield studies were to be conducted for a sawmill, for the resulting data to be reasonably useful, it is obvious that sorting must occur at least at the species group level, such that species may be separated in analyses.

For example, it would only make sense to separate the red oak from the hard maple for purposes of analysis, given differences in values of lumber sawn within grades, etc. It should be obvious that much of the data that would be representative of either of the two species could be expected to be very different from the other. While this example is obvious, the same logic would apply to the mixing of radically different species within a species group, for example the mixing of Northern red oak as compared to Black oak, both of which would yield red oak lumber, but for which very different percentages of lumber recovered in various grades might be expected.

In a similar vein it also appropriate and highly desirable that grade yield studies within a species separately consider the different log grades sawn by the mill within that species, to provide a further level of comparison between grades of logs within the species, as grade recovery will vary significantly within log grades and also overrun can vary considerably as well.

Data collected resulting from typical hardwood grade yield studies would include log volume input (at least on an MBF basis, perhaps also on a cubic basis), and also, at a minimum, the lumber volume output within the various grades of lumber sawn. Data also could be collected regarding residuals produced in the study (such as chips, bark and sawdust), but in many cases, residual values are simply estimated from other information due to the difficulty of collecting this information for a relatively small sample of logs.

From these data the overrun (and LRF) could be calculated, and also by simple mathematical analysis using appropriate log and lumber prices, the gross margin (revenue minus costs) could be calculated for the sample and then calculated on a MBF log input and MBF lumber output basis. The revenue data should consider at least lumber values, and if possible the residual values (which could be directly calculated or estimated). Cost data considered in the analysis should include, at a minimum, the raw material cost of logs, but additional useful information can be derived if other variable manufacturing costs are also considered. Some persons conducting grade yield studies also choose to include a contribution to fixed costs on a per unit basis of production, however, when doing this, caution is advised that the contribution considered be reasonable for the species/grades being considered otherwise results may not be truly representative of reality.

Lumber Grade Yield Study Methods

There are two general methods of conducting hardwood lumber grade yield studies, which are, the batch study, and the individual log study. There are additional variations between these two general types of studies that may be given various labels, however, unless a grade/yield study is truly an individual log study, it is probably best to consider it a batch study of some kind.

Individual vs. Batch Log Study— In an individual log study each board that is produced is traced back to the individual log from which it was sawn, consequently the data may be broken down to the individual log level. This is normally accomplished by assigning a unique identifier code or number to each log. Every board that is sawn from that log is marked with the same code or number for that log. When the lumber is graded, the code or number is then used to tally the lumber produced, by grade, back to the individual log. The alternative to this use of codes or numbers placed on each log and board would be to ensure that only one log is fully processed at a time, and the lumber is then tallied back to that log, with no chance of mixing the lumber sawn from two or more different logs until tally of data is completed. This may be done in a very small mill, but is a difficult proposition in most commercial sawmills. In contrast, within a batch study, a group of logs (or batch), of the same species (and usually the same log grade) is processed all at once, and the lumber produced, by grade, is tracked back to the group of logs in the batch.

There are significant differences within these two study methods, including the level of results obtained. Also there is considerable debate among researchers and forest products specialists as to which of these two study methods is “superior” to the other. Most researchers and forest products specialists who have any significant experience in sawmill grade/yield studies have been involved in both of these types of studies and usually have a “preferred” method. Either method can provide very useful information for sawmill decision-making. Which study method or procedure a mill might choose to use in their grade/yield study testing should in most cases focus on the kind of information which is desired, and the cost/benefit of conducting the mill study. The pros and cons and some qualitative generalized costs of conducting the two types of studies and the benefits that may be derived from the two types of studies are as follows.

Individual Log Study—The individual log study, as previously mentioned, requires that every board produced can be tracked back to the individual log from which it came. The key advantage of this type of study is that log specific data may be derived. In terms of example, it can be determined exactly what the lumber grade and yield was recovered for each individual log, and it is also possible to derive a measure of performance in recovery (e.g. overrun) for each log. These data may be of particular interest on a log-by-log basis, if a log may in some way be unique, or represent some special attribute of interest (e.g. representing a particular type of defect or some other quality which makes it of special interest). This kind of unique circumstance would definitely favor an individual log study, but that is rarely the case for most mills.

There is a significant advantage to being able to look at changes in overall lumber grade/yield and measures of performance (e.g. overrun) as related to log diameter, which is easily derived from results of an individual log study. But it is important to note that the same data can be obtained in batch studies if batches are further reduced to subsets beyond species and grade, into subset batches in diameter groups. So if the effect of different diameters is a primary area of interest to be addressed in the study, it could be accomplished with either method of study, either automatically (in the case of an individual log study), or through design (in a more detailed batch study where subsets of diameter groups could be processed as separate batches).

The benefit of having individual log level data comes at considerable costs, including both direct costs and opportunity costs in conducting that type of study. As mentioned, in an individual log study, it is essential that each board can be tracked back to the individual log from which it came (and implicitly cannot be mixed with or otherwise confused with the lumber from another log). This requires that one of two approaches be used. In most simple form, it would simply require that all lumber from each log is fully processed, graded and tallied before lumber from the next log in the study can enter the stream. This is possible in any mill, but would typically only be practical in a very close coupled small mill, such as a mill consisting perhaps only of a headrig and an edger, and the study could then be accomplished with one or two additional persons to keep track of information from the study. Even in this type of mill, there would likely be significant delays in total time waiting between logs, but such an individual log study could reasonably be conducted without having to mark each board to tie it back to the log.

However, when such a study is conducted in larger mills with additional downstream processing equipment such as resaws, and for mills with multiple headrigs, processing only one log at a time fully through the mill will typically result in an enormous amount of idle time for various machine centers while such a study is conducted, with a significant associated opportunity cost. Given this practical aspect and associated opportunity costs, in such circumstances where individual log studies are conducted at larger mills, it would be most common to mark boards coming off logs as they are processed, using an identifying number such that lumber could ultimately be tracked back to the log from which it came. This requires additional persons involved in the study to mark lumber at all machine centers from which lumber may be sawn from a log or cant.

Depending on mill layout, there may still be some considerable delays at the various machine centers allowing for such marking, so it reduces the opportunity cost of idle machine centers, but it does not typically eliminate that problem. Further, it should be recognized that with such interruption to the process flow, machine operators would not likely be operating under anything approaching normal circumstances that may influence the results of the test. (And also the safety of the persons marking the board should be an element of concern, as the design of some mills makes it very difficult to safely mark lumber coming off some machine centers.)

The tradeoff for reduction in machine center idle time is that an enormous amount of data must then be sorted back to individual logs. Another reality in such marking of boards where more than one log is processed simultaneously is that, despite best efforts to the contrary, some board marks may be easily misread in the lumber tally process, and board numbers may be lost or partially lost in the process at the edger or trim saw.

Consequently, in summary, the individual log study method can provide significant individual information where data may be tracked back to an individual log level, but that benefit comes with some associated costs. The associated costs tend to be minimal and much easier to bear in smaller close-coupled mills which by their nature are virtually limited to processing one log at a time, but in larger mills, particularly with multiple headrigs and resaws, attempting to conduct individual log studies can be quite difficult and very manpower intensive. Regardless of mill size, if board coding or numbering is used, the study will result in an enormous amount of data that must be sorted.

For these reasons, the total numbers of logs that will typically be used in an individual log studies tend to be relatively small, or the time (and costs) associated with conducting the study can be quite high. Where sample size may be relatively small in a study where you may assume there could be significant variation in the population being sampled (as is the case with logs), this can be an element of concern. Consider as an example the potential lumber grade yield for a 12-inch diameter, 8 foot long, #3 sawlog. The potential grade yield from such a sawlog could be quite different at the lower end of the spectrum where no face is better than a #3 face, as compared to the higher end of the spectrum where the log could have two #1 faces and two #3 faces, and then consider the variability in between those extremes, and the concerns that should be associated with small sample sizes should be obvious to even someone who may have no background in statistics.

It should also be remembered that, in the case of individual log studies where the diameter and length mix of logs processed in the study is not reasonably proportional to the diameter and length mix of the population of logs from which the sample is drawn, the aggregate results for the study cannot be directly applied as a representative sample for the population of logs, rather proportional adjustment of the data would be required.

In terms of a very simple example of what this would mean, consider a mill which saws only 8 foot logs ranging from 10 inches to 30 inches dib at the small end, conducting an individual log study consisting of 3 logs in each one-inch diameter class from the smallest to largest diameters sawn. The aggregate data from this study would have a disproportionately large number of very large logs that would not be representative of the expected mix of logs. To correctly apply the results of this study to a normal population of logs, the results for each of the one-inch diameter class would have to be adjusted on a percentage basis to reflect the actual log diameter mix the mill receives.

Batch Log Study—Compared to an individual log study, a batch study is basically an exercise of relative simplicity. To conduct such a study, data is gathered for the sample of logs (batch) to be processed. With regard to the log data collected this would typically include log scale data (such as board foot volume, gross and net), at a minimum, and usually would also include a count of logs in the batch sample broken down according to diameter and length. Individual numbering or marking of logs is not necessary as long as the batch of logs to be processed is kept separate from other logs on the yard, such that logs may not inadvertently be added to or subtracted from the logs in the batch sample.

Prior to starting the sawing run on the sample batch it is necessary to ensure the mill is “cleared out” of other logs and lumber in process at various machine centers (to prevent inadvertent mixing of logs and lumber in the mill). Lumber data collected in such a study in a hardwood mill is typically just at the level of total board foot volume in lumber grade and thickness for the batch of logs being processed (but could include width and length data as well if desired). Generally the level of segregation used in the collection of data should mirror the normal sorts used in marketing of lumber at a minimum. (For example, if hard maple is typically color sorted in higher grades with the “white” sold at a premium relative to the “brown”, then that should logically be done in the study.)

Collection of these data regarding the volume in grades for the lumber recovered may typically be accomplished at either the grading station or in the sorted piles on the green chain (whatever is easier for the mill). If data are collected on the green chain it is essential to ensure that any existing lumber on piles cannot be inadvertently tallied as part of the study.

Also, it is necessary to ensure that once the sample batch of logs are processed (and the mill is shifting back to its normal operation or getting ready to run another batch of logs), the mill floor must be fully cleared out of all lumber and cants in process before any other logs are sawn, and an accurate lumber tally must be completed (or other steps taken) to again ensure that lumber sawn from logs outside the batch is not inadvertently mixed in with lumber in the study. This could require a temporary pause at one or more machine centers, or it could be accomplished with a shift to a different species following the batch, or by other means.

Usually a batch will be limited to logs of a particular log grade and species (e.g. the sawmill’s #2 red oak log grade), with different batches run representing the mill’s different grades for the species being studied, to provide the most useful information to decision makers. If this is done it will allow comparison of data between log grades, including; lumber grade yields, overruns, gross margin calculations etc. for the different log grades within the species.

People involved in such studies have seen numerous circumstances where a mill may be receiving a significant return for logs of a certain grade in a species, but making little or nothing (or in some cases not even covering costs) in sawing logs of a different grade in the same species. Such revelations are typically quite a surprise for the mill and usually prompt immediate action to rectify the situation.

For the results of the batch study to be meaningful in representing the population of logs from which it was drawn in that species and grade, care should be taken that the sample of logs in the batch should be (to the highest degree possible) a reasonably representative sample of the population of logs being proportionately represented in the sample. This would simply mean that the diameters and lengths and general mix of overall quality of logs in the batch should reasonably represent the proportional mix of diameter, length and overall quality of logs, for logs of that species in that grade. If the batch (as compared to the normal mix of logs in the population being studied for that species and log grade) has a disproportionately large or small number of logs representing either relatively large or small diameters, relatively longer or shorter lengths, or relatively higher or lower quality within that log grade for the species, then the batch sample will not be representative of the population of logs from which it is drawn. Results of the batch study where the sample (or batch) may not be representative of the population of logs will be that much less reliable in making inferences with regard to the larger population of logs in that species and grade.

In terms of why this is important, a very good example would be provided in considering a mill doing a batch study of #3 red oak logs scaled according to the Scribner Decimal C log scale, with the sample batch having a disproportionately large percentage of 10 inch diameter logs, relative to what is normal for logs of that grade and species received by the mill. The higher percentage of smaller diameter logs in the sample could easily result in much higher overruns than would be expected for the mill's normal mix of #3 red oak logs, further, if a disproportionately large number of 12 foot logs are included in the 10 inch diameter class, the overrun would be pushed higher still. The disproportionately large number of small diameter logs could also adversely affect the overall grade mix of lumber recovered.

It should also go without saying that if there is a desire that the results of the study may be used to draw implications regarding lumber grade yield for logs of that grade and species overall, then the sawing patterns and mix of lumber recovered should be as close to "normal" sawing of the batch as is possible. Consider that, given this same example, if the large number of the 10-inch diameter logs were more heavily sawn to cants (or ties) than would be normal, the overrun would be pushed higher still. A 10 inch 12 foot log scaled at 30 board feet could easily yield a 6X8 inch cant having 48 board feet of lumber and an associated overrun of 60% just with the cant, and if another 12 board feet of 4/4 side lumber were recovered from the same log which would not be entirely unrealistic, the overall overrun for that log would jump to 100%.

Such numbers might make mill management in a hardwood mill feel quite good, but if the log mix and sawing patterns used to achieve these numbers don't reasonably reflect reality of the mill's operations, in terms of log mix and sawing patterns, then the results of the study would not reasonably reflect what would normally be expected. The reverse would generally apply if the mill might have a disproportionately large number of very large diameter logs in the batch, or forego the sawing of cants and/or ties (if that is normal), as both would tend to depress overrun for the hardwood mill.

The affect of overall log quality would also still apply, as was mentioned within the individual log study. Again consider the example of the potential lumber grade yield for a #3 sawlog. The potential grade yield from such a sawlog could be quite different at the lower end of the spectrum where no face is better than a #3 face, as compared to the higher end of the spectrum where the log could have perhaps two #1 faces and two #3 faces. If the sample of logs used in the study was skewed towards the very best logs in the #3 grade, such as where two opposite faces might be #1 faces, the batch sample would likely yield a much higher than normal yield of high grade lumber. In contrast at the other extreme, if no face were better than a #3 face, then perhaps no lumber better than #2 common might be recovered.

Using the GRADEYIELD Spreadsheet Program to Perform Analysis of Data Collected in a Hardwood Lumber Grade/Yield Study

Using the GRADEYIELD spreadsheet program requires only a bare minimum level of experience in the use of spreadsheets. There are a number of rows of information at the bottom of the spreadsheet regarding data entry in various cells of the spreadsheet, and the location of this information is "flagged" at the introductory page of the spreadsheet. It is suggested that a first time user simply print out these rows of information to have them readily accessible while learning to use the spreadsheet, which is a bit more convenient than scrolling back and forth between the cells where data is entered and the explanations regarding data entry.

Given this information regarding data entry included within the spreadsheet, it is literally in a “stand-alone” format. This is provided the user has some overall background and understanding regarding the conducting of a hardwood sawmill grade/yield study (as discussed above), and interpretation of analysis results as will be discussed later.

The spreadsheet is designed to easily permit modifications by any reasonably experienced spreadsheet user to fit the local circumstances of users and to be compatible with a wide array of spreadsheet programs. In terms of example, the formats in which the spreadsheet is currently provided can be easily converted for use in older versions of the most popular spreadsheets (including the Lotus 1-2-3 Version 4© spreadsheet (with the .wk4 extension), and the Excel Version 4© spreadsheet (with the .xls extension)).

The entire program is presented in a single sheet in both of these programs, versus in a paginated format common in the use of spreadsheet workbooks. This allows for easy translation to other (including older) formats by almost anyone. If a user desires, it is a simple matter to save the spreadsheet into a different format (such as a newer/higher format) and move elements or sections of the spreadsheet into a pagination format.

Spreadsheet macros are intentionally not used as the spreadsheet is designed to be readily accessible over the Internet and may be easily forwarded via email. For this reason, spreadsheet macros were intentionally avoided since many virus-checking programs alert on spreadsheet macros as a possible “virus”. (Note: This is worth keeping in mind if a local user modifies the spreadsheet to include macros and wants to share information with others.)

It is strongly suggested that the first thing a first time user should do with the spreadsheet the first time they pull it up is to save it in its existing format and name (on disk or hard drive), to serve as a master back-up, and then do a “save-as” command, saving the spreadsheet under a different name and in whatever format might be desired and use that file to work from in learning the operation of the spreadsheet.

Data Entry

Data that is entered into the spreadsheet by the user in the section titled “Definition of Log Input Variables” include what the mill’s log grades are named, delivered log price in the grade, sawing cost (in $/MBF log scale or other units such as cords), and input log volume in grade for the study, expressed in board feet for MBF log scale, or other units as appropriate such as cords. The user of the spreadsheet will quickly find that it is essential to input the MBF log scale as the board foot scale rather than the MBF scale of logs in that grade, which will become immediately obvious because if MBF versus board foot scale values are entered, this will result in overrun and gross margin calculation which could be enormous to the point of going off the scale and overflowing the cell space, since the log input is being incorrectly expressed at a thousandth of what it should be.

The spreadsheet is designed to handle four different grades of logs using board foot log scale, and one additional grade using another scale (such as cords or cunits) which the user defines. With this design, the spreadsheet will handle (at one time) four different MBF log grades and another non-board foot scaled grade (such as boltwood purchased on a cord scale), so essentially the spreadsheet should be able to handle any given species in essentially all log grades for that species sawn by almost any hardwood mill. Separate copies of the spreadsheet would then be used for different species. If the user might desire additional log grades within the species, an experienced spreadsheet user could easily modify the spreadsheet by the addition of some rows and columns and judicious copy and paste operations, or an additional spreadsheet could simply be used for the excess.

The input areas for log data are intentionally offset between the MBF log scale entries and the other unit entries, as the units of entry are different. This is designed to limit the likelihood of errors due to an operator not considering that the units according to which data are expressed can be different. In terms of example, sawing cost for logs scaled according to a board foot log scale is in $/MBF log scale, but if boltwood scaled as cords is used as another scale, then sawing costs would need to be expressed in that scale (e.g. $/cord), which should nominally be much lower in that unit of measure (perhaps about half as much, or slightly less than half as much nominally) than would be the cost on a $/MBF log scale basis.

With regard to what costs are included in the “sawing cost” element for data entry; that choice is entirely up to the user. The user could elect to ignore this and enter a value of “zero”, in which case the only cost considered in the calculation of gross margins would be raw material costs. In most cases users find that it is desirable to treat sawing costs as variable costs associated with the sawing of lumber on an average cost per MBF of logs sawn, including production labor, electricity, consumables and the like, associated with the production of lumber to be sold on a rough and green price valuation, assuming that rough and green prices are to be used for lumber values in all grades produced.

This allows a fairly simple and straightforward “apples to apples” comparison among the grades. Assuming higher grades of lumber are dried, and dry prices for those higher grades is used in the analysis, then associated variable costs for drying may also be something which the user may wish to include within the sawing costs, but care should be used in doing this to correctly reflect applicable costs. In terms of very simple example, assuming the mill dried all its #1 Common and better lumber and sold all lower grades in the rough and green condition, if drying costs are to be included as a component of the sawing costs, then the costs should be higher for higher grades of logs producing a larger percentage of high grade lumber, and commensurately lower for low grade logs which yield a proportionately low fraction of high grade lumber.

In a similar fashion, the user may wish to include (or not include) a general contribution to fixed costs as part of the sawing costs. Again logic should prevail. In terms of example, if fixed costs associated with working capital requirements for holding log inventory are included, where the value of logs varies considerably with grade, this should be appropriately reflected for the various grades. If working capital costs for holding lumber inventory for drying are considered, a similar logic should apply regarding both lumber values and how much lumber is held (assuming low grades are shipped rough and green).

Always it is important to remember that the sawing costs are reflected on a $/MBF log scale, so any costs included as part of sawing costs should be translated into those terms. (Note: To convert from costs on a $/MBF lumber basis into a $/MBF log basis, all that is necessary to do that conversion is to take the $/MBF lumber cost and divide by the number “one” plus the overrun expressed as a decimal fraction. (e.g. a cost of $50/MBF lumber produced, assuming a 15% overrun would be converted to a cost on a $/MBF log scale basis as ($50/(1.15)) = $43.48/MBF log scale equivalent.)

Getting Started

In getting started using the spreadsheet, it would probably make the most sense to simply use a reasonable estimate of actual production sawing costs and green lumber prices for an initial run to get a “feel” for the program (as is shown in the example format), recognizing that greater precision in sawing cost estimates can be added later.

Log Data—In the actual entry of data into the spreadsheet in the section titled “Definition of Log Input Variables” the user will simply enter his/her data directly in place of the example information. In terms of example, for the “Log Grade “A”, if the highest grade of log sawn is called something other than the “#1” as appears, simply enter what you call that grade directly in that cell (and in the columns below related to that log grade, what you call that grade will now appear as a heading), and simply do the same with all prices, costs and volume.

Extra grades that are unused can be labeled as “spare” (in the convention) used or something else you might prefer, but remember that cost and price data should be entered as “zero” for any spare grades of logs to prevent confusion. You can do this by entering the word “spare” and the number “0” as appropriate, or copying and pasting the word or number. **However, it is important to not “cut & paste” any entry data between the rows, as these cells will be addressed later**.

(Note: If you are a relatively inexperienced spreadsheet user, it is important to understand the differences in what happens in the spreadsheet when using the “copy” command as opposed to “cut” command. In terms of example, if you call your highest log grade “Premium” and you enter that word in place of the existing “#1”, in headings for columns below, showing data and calculations for that log grade, your new label of “Premium” will now be shown. If your next highest grade is called #1, you could copy and paste that label to a new position without trouble, and then enter the new label of “Premium” in place of the existing label for Log grade “A” with no problem, however, if you “cut and paste” instead of “copy and paste” it will cause significant problems you will want to “undo” if possible or, if not, to simply start over.)

Lumber Data—Data that is entered into the spreadsheet by the user in the section titled “Definition of Lumber Input Variables” include what the mill’s lumber grades are named for the species being sawn, the selling price ($/MBF lumber) in that grade, and the volume in board feet of lumber recovered in that lumber grade for each log grade which is studied. An additional column in which rows are identified as "Lumber Grade A", "Lumber Grade B", etc. allows for some amplifying information, such as special grade sorts for specific customers and the like. As in the "Definition of Log Variables" section, the user can copy and paste elements in this section (such as the "spare" label and "0" entries for values and volumes), but **do not cut and paste**. Given the $/MBF values in grade, and lumber volumes recovered in grade, the spreadsheet calculates total value in lumber grade by log grade, and the lumber in lumber grade as a percentage of both total volume and value for all lumber recovered in that particular log grade.

Mill Residues Data—The next section of the spreadsheet deals with residual values. The user directly enters the value for residuals in the log grade in one of three different ways. These include a total value of residuals in the log grade for the batch of logs run in the grade/yield study (coded as the #1), or an average value of residuals on the basis of value in $/MBF of lumber output (coded as the #2), or an average value of residuals on the basis of $/MBF log scale, or $/cord or other raw material units of measure in other than board foot log scaling (coded as the #3). If a grade is not used the code number is coded as the #0. In grade/yield studies it is often difficult or impractical to directly measure and record values for residuals in the study, consequently, most mills would use average values for entry and these approximate values can be easily estimated for one or the other basis (i.e. average value of residuals in $/MBF lumber or $/unit of raw material input), and most mills are already aware of these values on one or the other of these average measures.

WARNING: The code numbers (0, 1, 2, & 3) are not simply labels, rather they are specific identifiers which should not be changed or re-identified except by experienced spreadsheet users, as these specific code numbers are used by "if statements" in later calculations. If the user wishes to ignore residual values completely in the analysis, then a code number of 1, 2 or 3 may be used with a dollar value assigned as "$0.00" to accomplish this, and that may be done by simply entering the number "0" in the cell related to value of residuals in that log grade. (Note: There is no advantage to entering a "$0.00 residual value versus a reasonable "best guess" if precise calculations cannot be made, as the spreadsheet will calculate gross margins on a basis of both "with" and "without" contribution of residuals.)

If estimates of average values for residuals are used in this part of the analysis (as is normally the case), if the values used are on the basis of $/MBF log scale, it is important to remember that the average value used for the grade where scaling is other than on a board foot scale should logically be different. In terms of example, the value of residuals in $/cord input should probably be about half of the value of residuals on the basis of $/MBF log scale. Given these input data for residual value and the basis on which it is provided (i.e. test, MBF lumber and, MBF log or cord), the spreadsheet will then calculate the value on the two other methods. It is probably worth keeping in mind that volumes and types of residuals generated in the different log grades can be somewhat different to the degree sawing patterns and products produced, etc. might be different, but more importantly to the degree that the mix of diameters in the various grades might be different. On a per MBF of log scale basis, typically a higher volume of bark and a higher percentage of slabs and edgings (recovered as chips) could be expected for smaller diameters, consequently, if lower grades have a significantly greater component of smaller diameters, some adjustment of value might be considered.

Summary of Results

The final section of the spreadsheet is the "Summary of Results". Summary data is provided regarding entries for log costs and sawing costs (on a $/MBF or other unit basis), and log volume inputs and the total lumber volume recovered in the respective log grades. This summary section also calculates the associated overrun (or board feet per cord or other non-MBF log input), and the total log cost, total sawing cost, total lumber value, and average lumber value (in $/MBF lumber) for the batch of logs within each log grade for the test or study.

The next element of the summary table is a calculation of the gross margin associated with the study in each grade, and this is calculated in two major breakdowns, which are; on a basis of considering lumber revenue only, and on a basis of considering both lumber and residual revenue. Within each of these two major breakdowns, the gross margin is calculated three different ways; 1) for the "test" which is for the batch of logs within the grade, 2) on the basis of the gross margin calculated as $/MBF (or $/cord or other raw material input unit) in the log grade, and, 3) on the basis of $/MBF of lumber produced in the log grade.

It is these final data in calculation of gross margins within the "Summary of Results" section which will probably be of greatest interest and importance to decision makers within the mill. In terms of example, in examining the gross margins on a $/MBF log basis in the different log grades, this provides a direct indication of the dollars which remain after covering raw material costs and other costs which are included as part of sawing costs, on a $/MBF log scale basis. The results of this kind of analysis have proven to be "enlightening" for many mill managers the first time they do this, as in some cases they find that for a particular log grade in a given species, they may barely break even in covering costs, while for other grades in that species, the gross margin is acceptable.

Within the example data of an old red oak study, the gross margin in $/MBF log scale for the #2 log grade is slightly less than 50% of the gross margin for the mill's #1 log grade, and only a little more than 70% of the gross margin for the mill's #3 log grade. Prior to conducting this study, this particular mill expected that the #1 log grade would show the highest gross margin, but they had expected the #2 log grade would have a significantly higher gross margin than the #3 log grade, but the opposite was found.

Results of a similar study done at a different mill a few years later (also with red oak) showed the mill's #2 log grade was yielding such a low gross margin, that sawing that grade was basically a "break-even" proposition at best, but that the other log grades in that species had acceptable gross margins. (Note: A number of extension specialists and other researchers have seen exactly this kind of situation, and most frequently it seems to be associated with the #2 (or middle) log grade.)

Armed with this kind of information and knowing that the study indicates there is something to be concerned about, the mill is then in a position to begin digging deeper in looking at the problem and possible solutions. The problem may simply be stated in each case that: the mill delivered log price is too high, relative to the volume of lumber recovered, and the mix of lumber grades the mill is recovering and lumber values in those grades.

One thing that could quickly be looked at using the spreadsheet would be to look at what log price would have to be reduced to in that grade for that grade to yield an acceptable gross margin, which could be easily done on an iterative trial and error basis. If the result would push the mill too far from a nominally "acceptable" market price for logs, another alternative would be to look more carefully at the mill's requirements in the grade as perhaps being "too loose", and if they should possibly be changed. It should go without saying this kind of thing should prompt a serious look at how the log scaler/grader is applying the grading criteria, which is frequently a problem too.

In addition to analysis of the test data, having these results in a spreadsheet allows for some other analysis. In terms of example, the lumber grade yield data which directly results in a percentage lumber recovery in grade could be used with new lumber prices in changing markets to estimate what gross margins might be achieved as a result of price changes for lumber.

Consideration of the results of a lumber grade/yield study can obviously provide some important information to sawmill decision-makers, however, there are other benefits as well. One way in which this can happen is the simple affect of doing such studies can have a positive impact on the workforce.

In terms of example, in doing the grade/yield study for which these sample data were generated that are presented as an example. These data are actual study results, sawn on a two sided mill with band headrigs, and a band linebar resaw, followed by edgers, using the mill's actual recoveries, log prices in their grades, and green lumber prices, the only thing which was slightly changed was the mill's assumed sawing cost in $/MBF. (The boltwood data shown are all estimates as that was not part of the study, it is simply provided as an illustration.) The data can be presented without disguising some important data elements, because this study was conducted some years ago (mid 1990s) in a mill which has since changed ownership and has had major equipment modification and changes in its resource in this species, consequently it is not now reasonably reflective of that changed mill in a radically changed circumstance. By simple observation, it was evident that in doing the study that the crew was really interested in showing management just what they were capable of doing – there was no special reward for this except their pride. As the study was being conducted, it was mentioned by a lumber grader that there was "an awful lot of 4 foot lumber" coming from all the three different grades of MBF scaled logs. The logical response was; "If he (the grader) wasn't used to seeing that much 4 foot lumber all the time, had he considered why not? And where this lumber might normally be going instead? and in what form?" That was an enlightening question to the lumber grader that, needless to say, did not take him too long to figure out. Also, a result of this study, the mill management had an excellent opportunity to see what kind of overruns the crew was capable of achieving with that mill and its resource in an effort to maximize grade and overall volume recovery, and they also got some indication of what might be sacrificed in too much focus on overall volume production.

Some mills never do any kind of grade/yield studies, and until they do such analyses they deny themselves considerable access to information that may be critically important to management decision makers. In most cases these personnel at these mills simply do not know how to conduct such studies or recognize the potential value of the information they could receive. For these mills, the results of a grade/yield study are typically quite an "eye-opening" experience. Some mills rarely do grade/yield studies, so they have some background information, but it is frequently old (and may not reflect current circumstances) and it is often incomplete as well. For these mills a grade/yield study is often made to be a special event of some kind, where the mill's personnel know how to conduct the study, but it is not a routine operation. For these mills, the benefits of grade/yield studies are well understood, but it is not a routine evolution, consequently, the difficulty and costs associated with doing the study are perceived to be excessive.

However, there are also mills that conduct grade/yield studies on a routine basis, such that is it unusual where a week would go by that a study of some sort is not conducted. For these mill's personnel, a grade/yield study is a routine operation, wherein the log grader/scaler knows exactly what is required in developing the batch and tallying his information, equipment operators and all other personnel know the procedures associated with clearing out the mill of other logs, and for lumber tally – in short, personnel in these mills are well drilled in how to conduct a study efficiently and correctly.

Consequently these mills have a logical plan for conducting such studies where the batch of logs is ready for the first part of a run in a shift to a new species, requiring only a minor pause after the batch is run, or it could be the last group of logs sawn. They have developed an idea of what is a comfortable batch size for their mill to run at one time, everyone knows their job in the special evolution, and essentially the grade/yield study becomes a routine operation with minimum disruption to production. Once this kind of training and attitude has been developed, personnel and management within these mills literally cannot even imagine doing it any other way, as they have come to rely on the information and knowledge gained as essential tools of management.

As with anything "new" there is a "learning curve" associated with doing grade/yield studies, and as such studies become routine, mill personnel become quite efficient in such operations. Once sawmill managers come to understand the benefits of information derived from grade/yield studies, this would be the logical model to strive for. It may take a little time and effort to reach that goal, but the results are well worth it in the eyes of mill managers that have.