

# PROYIELD – Sawmill Yield Analysis User’s Manual



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# **PROYIELD SPREADSHEET PROGRAM USER'S MANUAL**

The Projection of Sawmill Yields ("PROYIELD") personal computer spreadsheet program for sawmill yield analysis has existed in various forms and formats since the late 1990s. The initial distributed form of the program was primarily designed for use in extension outreach efforts in the late 1990s. Prior to development of the PROYIELD program, the USFS Best Opening Face (BOF) model was the best freely available and most commonly used public domain programs to generate yield assumptions for such analyses on a log diameter/length product and process assumption based analysis. However, the BOF model was never really designed for such use, and although it was the best available model which would be generally useful in such applications in many respects it was out of its element in the desired use for which the PROYIELD model was created, which was to provide detailed entry level input projection data (on a species by log distribution by product basis and associated residual basis) as an entry mechanism into the SAWFEAS Sawmill Financial Feasibility Analysis model. The problems with using the older DOS based program in this type of application included that much of the desired information (e.g. estimation of residuals) was not part of the program, the typical hard copy output usually would require further compilation and analysis to be usable for that purpose, reruns of the program for different assumptions was time consuming, and much the other desired data transformation was simply not part of the program.

The PROYIELD model has been successfully used for projections of mills of various sizes since the late 1990s. In circumstances where model projections have been compared to sawmill yield studies the model has very closely predicted actual yields (in some cases within 1% of the actual volumes) also the PROYIELD model will very closely parallel the projections of the BOF model on the data projected by the BOF model, where similar assumptions are used in each model and within the diameter range where reasonable performance can be expected (i.e. in a reasonable side-by-side comparison avoiding analysis comparing very large diameter logs for which the BOF setup options are not truly appropriate). Within the initial design and continued development of this program, an underlying objective has always been, to the degree possible, to make the model more robust and detailed in its output. In recent years, changes and additions made to the program have continued to have been for the purposes of improving the program as an analysis tool in addition to data generation for use in other programs.

For someone reasonably experienced with the program and having background in the subject area, the PROYIELD program is fairly easy to use. Unfortunately however, it is not terribly common to find people who are well versed in understanding how various elements of log mix, product and process variables influence sawmill yield, and even where persons in industry might have such background through practical experience, in many circumstances those same people would not necessarily typically also know where to find information regarding data required in analyses. For this reason, training in the use of the model has typically been required and in many (most) circumstances the PROYIELD model has been used by trained extension and other tech-transfer professionals from USFS or State Departments of Natural Resources in a technical assistance basis to industry.

The normal way in which the PROYIELD program is first used is in a preliminary analysis form, to develop a reasonably functional working model of the planned operation usually on a species by species basis. In doing this, required variable inputs may range in quality from being carefully calculated or “known” quantities to very rough guesses. Common sense would dictate (and the model will quickly confirm) that the assumptions regarding the log diameter/length distributions are very important. Consequently, estimated variables that are first entered in to the model will frequently be refined at a later time for some or all species.

In working directly with persons who are interested in using the PROYIELD model; in many cases once a functional working model may be created for one or more species and the user understands the inputs needed, and the importance of various assumptions, and the person who will be using the model is trained in how the model works (and they understand what variables need to be refined) - the model is often in their hands to carry forward in performing more detailed analysis. Alternatively, some users are more comfortable in having someone else (e.g. extension or other tech-transfer person) assist them with using the model. Users have been trained in use of the model through industry and extension short-courses (a number of which have been conducted in the past five years) and based on that experience have an understanding such that they are usually able to then perform initial model set-up on their own. Development of this user’s manual was undertaken with the encouragement and support of the United States Forest Service personnel, and others, to spread the model to a wider audience where someone reasonably well versed in analyses of this type could get beyond the hurdle of being a first time user without training by having access to this basic user’s manual.

The creation of a user’s manual for the SAWFEAS model was a real impetus for the creation of this manual. Where the SAWFEAS model is designed to be a suitable and useful spring-board to carry forward with the business plan’s pro-forma financial statements – where the plan is for an entirely new startup or where new equipment or different log distributions are contemplated for an existing business, assumptions must be made regarding yield factors (e.g. overrun, residual volumes, etc.). It is highly desirable to calculate these numbers and to be able to explain to prospective lenders and others where the calculated data assumptions came from, rather than to use some kind of “industry averages”, or “rules of thumb”, or old company data from different equipment and resource mixes. Important estimates for data entry in the SAWFEAS model regarding lumber and residual yields are typically not readily available from historic operational data where changes in equipment or resource are more the norm rather than the exception. Although use as a teaching tool is not the primary purpose of the PROYIELD model, it performs well in that role in quickly demonstrating the effects of changes in parameters such as lumber oversizing, kerf, etc.

This user’s manual will follow the PROYIELD model, from top to bottom, explaining what entries are required and what is being done in the various parts of the spreadsheet (with some key warnings as needed) – section headings and row labels will be taken exactly as they are on the spreadsheet itself to allow for ease in going between the model and this manual, both in a hard copy format, or the manual may be used in a hard-copy format while following along with the spreadsheet – or just as simply – the manual may be viewed as an active window in your word processing program as you shift back and forth between the manual text and the active spreadsheet. Items taken directly from the model for explanation in this manual *will generally be*

*displayed in the manual in italics format (like this) in the manual*, for clarity that it is directly within the spreadsheet model.

#### SOME BASICS TO BE MENTIONED BEFORE BEGINNING:

The PROYIELD model is typically found in an Excel workbooks format; however, the basic model (as it will be described here) is all contained within a single worksheet in a fully functional form. This form of the spreadsheet is also available in an older version of Excel worksheet format (Version 4) and it is also fully functional within Lotus 1-2-3 Version 4. These spreadsheet “standards” of the mid 1990s which were frequently run under Windows formats as old as Windows Version 3.1 should represent the extreme of older aged of spreadsheet software which might be encountered today.

As within any spreadsheet model of this type, it is advised that the user save the file under its standard name as it is received or down-loaded (to serve as a “master” backup), and then save the file under a different (or slightly modified) name and use that (different named file) as the working copy. The program file will easily fit on standard floppy-disk storage medium as a backup to file storage on the computer’s hard-drive. In first time review and use of the program, it is suggested to first scroll down through the program to get a feel for what will be required and what the outputs will be, then go back to the top of the spreadsheet model and more carefully look at the requirements before making entries.

A number of rows at the top of the PROYIELD model contain basic contact and background information for the user who might not have other background (such as is contained in this manual). These rows of “boilerplate” are unnecessary for in-house use or where the model is going between users that are familiar with it, however, the “identity” may be useful where the model is passed along to others, who may then become aware this manual exists.

Where the PROYIELD model may be used to generate yield data (e.g. overrun assumptions) for use in developing assumptions for pro-forma financials in a final business plan, the initial label rows are typically desirable, and having example runs from the model for lender review is also desirable. Experience has shown that lenders in many circumstances are not well versed in fully understanding where overrun comes from or why it occurs, however, most seems to understand that it is variable. Consequently, many lenders are more comfortable where a “canned” program is being used in those purposes of estimation with those results or more conservative assumptions being entered into the financial models.

Following these “boilerplate” first rows is a row that indicates:

*(note: an "e>>" in column A indicates an entry is required in one or more cells in that row)*

As indicated the “flag” in column A that is shown as "e>>" indicates an entry is required in one or more cells in that row. In some places throughout the model this is a single entry required, however, in many cases entries are needed for multiple columns in the row. In all circumstances where an entry is required in any cell, an example entry has been included in the model for that required cell entry. The idea here is to give the new user an opportunity to examine what the

model does and to get a “feel” for the output by initial inspection of the model with data entered. When doing their own analysis runs, the user need to ensure that data entered reflect the actual circumstances of their analysis.

*e>> SPECIES BEING CONSIDERED IN THIS ANALYSIS IS >> enter >>RED OAK* – this species “tag” will be reflected not only on this opening page of the spreadsheet, but also in key areas of the data summary that would normally be print outputted. The label is entirely the “users choice” normally breakdown is made on a species or group, but more discrete labeling is also an option.

The data entered and displayed in the following section is as follows:

<i>ESTIMATIONS FOR SOME BASIC ASSUMPTIONS</i>							
<i>NOMINAL SIZE</i>		<i>Calculation of “nominal” board feet per lineal foot</i>					
		<i>nominal thickness</i>	<i>common nominal widths</i>				
			<i>4</i>	<i>6</i>	<i>8</i>	<i>10</i>	<i>12</i>
<i>e&gt;&gt;</i>	<i>enter &gt;&gt;</i>	<i>1</i>	<i>0.333</i>	<i>0.500</i>	<i>0.667</i>	<i>0.833</i>	<i>1.000</i>
<i>ACTUAL (green) SIZE INFORMATION</i>							
<i>Used to estimate actual fraction of 144 cubic inch volume per lineal ft</i>							
<i>using assumptions entered for GREEN thickness compared to nominal</i>							
		<i>actual widths of above common nominal widths</i>					
		<i>4.000</i>	<i>6.000</i>	<i>8.000</i>	<i>10.000</i>	<i>12.000</i>	
<i>e&gt;&gt;</i>	<i>enter actual width &gt;&gt;</i>						
<i>e&gt;&gt;</i>	<i>enter thickness &gt;&gt;</i>	<i>1.125</i>	<i>0.375</i>	<i>0.563</i>	<i>0.750</i>	<i>0.938</i>	<i>1.125</i>
							<i>check sum</i>
							<i>below,</i>
							<i>should</i>
		<i>Ratio of actual 144 cubic inch volume to a nominal board foot</i>					
		<i>nominal</i>	<i>4</i>	<i>6</i>	<i>8</i>	<i>10</i>	<i>12</i>
	<i>1</i>	<i>1.125</i>	<i>1.125</i>	<i>1.125</i>	<i>1.125</i>	<i>1.125</i>	<i>1.125</i>
	<i>% in size</i>	<i>20%</i>	<i>30%</i>	<i>30%</i>	<i>15%</i>	<i>5%</i>	<i>100.0%</i>
<i>e&gt;&gt;</i>	<i>contribution</i>	<i>0.225</i>	<i>0.338</i>	<i>0.338</i>	<i>0.169</i>	<i>0.056</i>	
<i>weighted average actual to nominal ratio = 1.125</i>							
<i>simple average actual to nominal ratio = 1.125</i>							

The data entered within the first part of this section simply has the user define the nominal thickness, then for different common nominal widths the board foot volume per lineal foot is calculated. The term “nominal” is used in describing the board foot volume to clearly differentiate this is not necessarily based on a 144 cubic inch volume. Within the next section the user inputs the actual width and actual thickness of the lumber (the example used here is for “standard” green thickness 4/4 hardwood edged to full nominal width) and what is displayed (in decimal fraction format) is the actual fraction of 144 cubic inch volume that is contained in a lineal foot. These data are calculated for use in developing ratios to deal with differences in board foot volume with varying cubic inch volumes (as compared to the commonly assumed 144 cubic inch volume), where such differences occur due to oversizing or undersizing lumber. In terms of example, it might typically be assumed that a 12 inch wide board of 1 inch thickness that is 12 feet long would contain a cubic foot of lumber. However, if the lumber is 4/4 hardwood sawn to 1.125 inches in thickness, and a full 12 inches in width, the board would contain 12.5% more wood, or 1.125 cubic feet of wood, because each lineal foot of the 1 1/8<sup>th</sup> thick by 12 inch wide board actually contains 162 cubic inches of wood as compared to the assumed 144 cubic inches. The opposite occurs in the sawing of lumber that is less than its stated nominal dimensions in the green condition. As an example, 2x6 softwood dimension lumber might be assumed to have 144 cubic inches of wood associated with the one board foot of

volume for each lineal foot of length; however if the lumber is sawn to an actual thickness of 1.7 inches by an actual width of 5.9 inches, there would only be 120.36 cubic inches of wood per lineal foot of lumber, or about 83.6% of the assumed 144 cubic inches of wood per board foot. If lumber is sawn to widths that are the same as the stated nominal width (or an exact percentage difference from the stated nominal width) varying width will not influence the average ratio of actual cubic volume to the assumed 144 cubic inch volume. In the case of lumber sawn to variable widths different from the stated nominal widths, the ratio will change somewhat in relation to differences in actual versus nominal width. Consequently in the next part of the section, the user can specify assumed percentage of board foot volume by width and the program will calculate a weighted average ratio in addition to a simple average ratio. This entire section defines thus far is simply for user shorthand calculations and estimations for desired entry in the following section.

The next section deals with critical entry assumptions that will be used by the model in estimating board foot volume yield.

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          BASIC INPUT ASSUMPTIONS TO BE USED IN MODEL FOR YIELD PROJECTIONS
e>> enter >> 1.125 = assumed ratio of actual cubic volume to "nominal 144 cubic inches" per board foot
e>> enter >> 0.250 = assumed kerf in inches
e>> enter >> 1.125 = assumed average green lumber thickness in inches
e>> enter >> 0.5   = assumed log taper (inches) per 4 feet of length
e>> enter >> 0     = assumed slab & edging deduction "fcn of D" beta constant (= 0.71 typical using International Rule
                                     assumptions)
e>> enter >> 1     = assumed slab & edging equivalent loss from equivalent perimeter loss (= 1.0 inch typical) THIS IS THE
                                     SUGGESTED AND PREFERRED OPTION
          Note r.e. slab and edging deductions above, the user should select to use one or the other convention, not both.

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These various entry assumptions will be discussed one by one. The first entry is for the “= assumed ratio of actual to cubic volume to "nominal 144 cubic inches" per board foot” the entry is simply what was discussed earlier in terms of the ratio. In the case of lumber sawn “fat” as in this assumption, the ratio is slightly greater than 1.0. In contrast, if dimension lumber is being considered, the ratio will likely be a number less than 1.0, such as in the example of the 2x6 above, the ratio would be more along the lines of 0.836.

The next entry “= assumed kerf in inches” is the mill’s saw kerf, or if different machine centers are represented making longitudinal axis cuts with different kerfs, then the assumed (weighted) overall average kerf representing those machine centers. In considering an appropriate kerf to represent a weighted average, more attention should be given to the headrig and resaws including gang resaws, as those kerfs will affect lumber yield, In practical purposes, kerf associated with edgers and trim saw may affect residual makeup by volume and type, but should have little affect on lumber yield.

The next entry “= assumed average green lumber thickness in inches” in this example has the prior “= assumed ratio...” variable being represented as the same value, as would be the case of oversized lumber of (nominal) one inch or 4/4 thickness, because the ratio is simply the actual thickness divided by the number “1”. In other circumstances these number would be quite different. For example, in the case of dimension lumber, the ratio variable might be about 0.85, while the thickness variable might be more along the lines of 1.7 inches.

The next entry “= *assumed log taper (inches) per 4 feet of length*” is self-explanatory. The taper factor will be used both in the estimation of side lumber that can be recovered from tapered logs, and also in more accurate cubic volume estimates to develop greater precision in residual estimates than if a full length log cylinder were considered. The program calculates board foot contents of 4 foot long cylinders starting at the small end and increasing in diameter by an amount equal to the variable entered. This is done for the 8, 12, 16 and 20 foot logs, containing a whole number of 4 foot cylinders. For the 10, 14 and 18 foot logs, board foot volumes are interpolated as being an average between the two appropriate lengths projected yield values.

The next entry is an OPTIONAL variable for dealing with loss due to slab and edging. This variable “= *assumed slab & edging deduction "fcn of D" beta constant (= 0.71 typical using International Rule assumptions)*” should only be used in lieu of the alternate variable where this loss is represented as an equivalent perimeter wastage. This variable has been retained apparently as a primitive artifact where it was a “first form” and only alternative or the model some years ago. There is some utility for this to be retained for some purposes by experienced users, and for classroom use. For example, the setup can be made to exactly mimic the assumptions of the International log rule with its assumed 1/8<sup>th</sup> inch kerf, using 1/8<sup>th</sup> inch kerf, 1 1/16<sup>th</sup> inch lumber thickness, taper of 1/2 inch per 4 feet of length, and the .71 “wastage for square edging”, and the model can generate the projected values for the rule for 8, 12, 16 and 20 foot logs. Then adjusting those values by the .905 adjustment factor to convert from the International to International 1/4 Rule can generate those values, while a side-by-side comparison may be given to the analysis if starting with the 1/4 inch kerf option from the outset. Educators and experienced users should immediately grasp the utility of having this “built into the model”, however, for the typical user, the entry for this variable should be “0” and the following “PREFERRED OPTION” slab/edging variable should be used dealing with equivalent perimeter loss.

This last entry in this section is also an OPTIONAL variable and it is the PREFERRED OPTION for dealing with loss due to slabs and edgings; “= *assumed slab & edging equivalent loss from equivalent perimeter loss (= 1.0 inch typical) THIS IS SUGGESTED AND PREFERRED OPTION*”. What is represented in this variable is to have the analyst estimate loss due to slabs and edgings as an equivalent representation of a being a “rind” beginning on the outer perimeter of each of the 4 foot cylinders. This treatment of the variable has been demonstrated to be intuitively obvious to almost anyone with any sawmill experience - in simply imagining the recovery of lumber represented as the end area of lumber represented in cross section on a log diameter, with the remainder around the perimeter in slabs and edging being largely defined as an equivalent circle. (In contrast the other option for this loss “= *assumed slab & edging deduction "fcn of D" beta constant (= 0.71 typical using International Rule assumptions)*” has been noted to be somewhat confusing to even experienced sawmill personnel if they do not have a sound foundation in development of mathematical log rules. In the case of sawing 1 inch lumber that that is reasonably square edged, a value of about 1 inch is an appropriate, or “reasonable” or “normal” assumption for equivalent perimeter loss. Some simple trial and error will quickly show that the value of about 15/16<sup>th</sup> inch or about .94 to .95 will VERY closely approximate the .71 D variable beta constant for the International (1/8<sup>th</sup> inch kerf) log rule for common log diameters of about 6” to more than 35 inches. In circumstances where significant wane might be allowed on lumber produced, the number should be reduced slightly (an example would be if analysis was made for sawing dimension lumber with maximum allowable wane).

But even where considerable wane may be allowed on one or two edges, it should be remembered that slabs and some edging loss must be considered and represented, so the value should not likely be (normally) pushed below about ½ an inch of perimeter wastage. At the other extreme, appropriate variable entry beyond 1.0 inch should be rare indeed, representing fully square edged with a wider than normal slab.

The next two lines of the model is simply a note-keeping reminder that assumptions regarding planer shavings (accomplished at the very end of the model in its basic “worksheet” form) need to be set if the lumber is considered as being produced in the dry surfaced condition (wholly or in part) and if those data regarding planer shavings as a residual product are desired. The note is in this positioning the spreadsheet simply to serve as a “flag” that the data will be inputted later. In a practical standpoint, the purpose this serves in the analysis actually relates only to the residual value for planer shavings which should represent a demise fraction of total revenues that may be dealt with in later “fine tuning”, consequently the model as it is originally “set-up” assumes the variable is “zeroed” with respect to dollar recover from this residual until the user changes that assumption.

The next section of the program projects the board foot lumber yield for logs of 8 to 20 feet in length, in diameters of 3 to 36 inches on the small end. The example printout below shows a portion of the output for this section for logs up to 24 inches in diameter and 16 feet in length. It should be noted that the yield projections within this section are a function of the user-specified basic input assumptions including kerf, lumber thickness, etc. As these assumptions are changed, the projected yields will change accordingly. A quick and easy way to get a feel for how this works would be to change the assumption r.e. sawkerf from representing a ¼ inch circle saw to a smaller number representing a band saw – as this is done, the projected yields will all increase accordingly. In getting the feel for this, it makes sense to change variable one at a time to examine the effect on yield, however this is not a constraint in using the program – variables can be changed or set as desired by the user.

diameter inches	BF contents 4' cylinder	BF contents		Projected yield for: 8' log	Projected yield for: 10' log	Projected yield for: 12' log	Projected yield for: 14' log	Projected yield for: 16' log
		BF contents 4' cylinder less loss for kerf	4' cylinder less loss for kerf slab & edging					
6	8.4	6.9	3.0	6.9	9.3	11.7	14.5	17.4
7	11.4	9.3	4.8	10.5	13.9	17.4	21.4	25.4
8	14.9	12.2	6.9	14.9	19.6	24.2	29.6	34.9
9	18.8	15.4	9.3	20.0	26.1	32.2	39.1	46.0
10	23.3	19.0	12.2	25.9	33.7	41.4	50.0	58.5
11	28.2	23.0	15.4	32.6	42.1	51.6	62.1	72.6
12	33.5	27.4	19.0	40.0	51.6	63.1	75.7	88.3
13	39.3	32.2	23.0	48.2	61.9	75.6	90.5	105.4
14	45.6	37.3	27.4	57.2	73.3	89.3	106.7	124.0
15	52.4	42.8	32.2	66.9	85.5	104.2	124.2	144.2
16	59.6	48.7	37.3	77.4	98.8	120.2	143.1	165.9
17	67.3	55.0	42.8	88.6	113.0	137.3	163.2	189.2
18	75.4	61.7	48.7	100.6	128.1	155.6	184.8	213.9
19	84.0	68.7	55.0	113.3	144.2	175.0	207.6	240.2
20	93.1	76.2	61.7	126.9	161.2	195.6	231.8	268.0
21	102.6	84.0	68.7	141.1	179.2	217.3	257.3	297.3
22	112.6	92.2	76.2	156.2	198.2	240.1	284.1	328.2
23	123.1	100.7	84.0	172.0	218.1	264.1	312.3	360.5
24	134.0	109.7	92.2	188.5	238.9	289.3	341.8	394.4



This section of the model is really the heart of the program and merits some considerable discussion regarding what is happening within the cell. The user can (of course) click on any desired cell and examine the formula at any time, so the explanations provided are to accompany that investigation. The first major cell calculation made (for each diameter log) is the board foot contents of the 4 foot long cylinder of the stated diameter. Within this section what is described as happening as a calculation within a given cell will be a description for all such cells in that column in this section of the spreadsheet.

The first column labeled "*diameter inches*" simply has log diameters listed that will be used as small end diameters in calculations of yield. These consist of integers for diameter of from 6 to 36 inches. If an EXPERIENCED spreadsheet user wished to expand the model to deal with larger diameters, or perhaps to interpolate to include half-inch diameters for yield projections, a change made within these cells would permit such calculations to be made. In each case, the calculations made within a row in this section are linked to the diameter value which is inserted into the first column. (Note: It would not be prudent to attempt to do changes of such a nature unless it is undertaken by someone who is very familiar with spreadsheets and until that person is very familiar with the PROYIELD model.)

The next column labeled "*BF contents 4' cylinder*" calculates the board foot volume of the (first) 4 foot long cylinder in the log of diameter represented for that particular row. This is accomplished by calculating the cubic volume of the cylinder in cubic inches and then translating that volume in to board feet. This is done using the appropriate cubic inch contents per board foot considering the actual dimensions in relation to the nominal dimensions. As per prior explanation of the variable assumptions entered by the user, in the case of "fat" 4/4 hardwood, a board foot of lumber in the green rough condition will contain more than 144 cubic inches, and softwood dimension lumber will typically contain considerably less than 144 cubic inches per board foot.

The next column labeled "*BF contents 4' cylinder less loss for kerf*" takes the calculated board foot volume of the (first) 4 foot long cylinder in the log of diameter represented for that particular row and reduces the projected yield volume for loss due to kerf. This is accomplished simply by calculating the decimal fraction of loss due to kerf as a fraction of the total set, subtracting that decimal fraction from 1.0 and multiplying the result by the contents of the column labeled "*BF contents 4' cylinder*". This calculation of loss due to kerf is done in a straight-forward fashion, in much the same way a set reduction decimal fraction might be calculated. Readers who are familiar with the mathematical development of the International Log Rule as it was developed and published by Judson Clark will not find the somewhat similar logic being employed here with some differences worth mentioning. This adjustment for loss due to kerf is precisely just that and does not include an adjustment for oversizing (or "loss due to shrinkage"). This is because the oversize (or in the PROYIELD model also undersizing) assumptions regarding their effect of the cubic volume of wood contained in a board foot of lumber sawn are dealt with in the first step. This has a number of advantages including it easily permits dealing with lumber of other than 1 inch nominal thickness, and detaching the oversizing (or undersizing) factor from the kerf loss calculations allows changes in kerf to be dealt with

easily and to more precisely (and accurately) reflect reasonable changes across the full diameter spectrum.

The next column labeled “*BF contents 4' cylinder less loss for kerf slab & edging*” depicts the final adjustment in reducing the projection of product volume, accounting for losses associated with the generation of slabs and in edging two sided flitches. The option that the user specified (i.e. either by specifying a beta coefficient making it a direct function of diameter or specifying perimeter wastage) will be used in this step in calculation of the final projected lumber yield for the four foot cylinder.

The next seven columns headed “*Projected yield for: 8' log*” through “*Projected yield for: 20' log*” provide the projected yields for logs of the stated lengths in all the diameters (6 inches through 36 inches). The user specified taper is used to establish increasing diameters for each consecutive four foot cylinder. In terms of example, assuming the user has specified a taper of 0.5 inches per each 4 feet of log length, for a 12” diameter 20 foot log, the first 4 foot cylinder projected yield will be calculated using a diameter of 12 inches, the second 4 foot cylinder will be calculated using a diameter of 12.5 inches, the next using a diameter of 13 inches, the next using a diameter of 13.5 inches, and the last using a diameter of 14 inches. These calculations are made for logs that are 8, 12, 16 and 20 feet in length, and values for 10, 14 and 18 foot logs are interpolated as representing an average of the bracketing lengths for that diameter (for example, the value for a 10 foot log is an average of the values for the 8 and 12 foot log of the same diameter) the effect of this is to add half the value of the third four foot cylinder as representative of the yield for the incremental half of the third cylinder represented as the additional 2 feet of length.

The next column is simply a copy representation of the first column labeled “*diameter inches*” and as before simply has a listing of the small end diameter. The following three columns provide insight with regard to the nature of losses by type, and how that affects yield. The first of these columns “*volume % loss in first 4' cylinder dia. = D due to kerf loss*” simply indicates an estimation of what fraction of the total cubic volume of the cylinder is lost due to wastage which is saw kerf. This calculation is represented by expressing the difference between two prior columns the first labeled “*BF contents 4' cylinder*” and the second labeled “*BF contents 4' cylinder less loss for kerf*” and having this difference expressed as a percentage fraction of the first column labeled “*BF contents 4' cylinder*”. (It may be noted that this treatment is analogous to an assumption of live sawing and then square edging.) The second of these columns “*volume % loss in first 4' cylinder dia. = D due to slab & edging losses*” similarly projects the percentage of the total volume of the four foot cylinder which is a wastage loss due to slab & edging losses. It should be noted that there is considerable variation in this number relative to diameter, with smaller diameters having considerably more percentage loss due to slabbing and edging losses than in larger diameters. This is something has been well understood for almost a century – perhaps longer – but it is often forgotten by many people. The last of these columns “*volume % in first 4' cylinder dia. = D recovered as green rough lumber*” simply indicates the lumber yield as a percentage of the cubic volume of the input cylinder (or what is left after the kerf, slab and edging wastage are accounted for). The percentage of volume recovered in comparison to the loss due to slab and edging for very small logs again underscores the importance of attention to good slabbing and edging practices.

The next major section of the spreadsheet model has the heading:

*“COMBINED LUMBER AND RESIDUAL YIELDS VIA SIMULATION FROM MATHAMATICAL MODEL - LOG SCALE, CUBIC VOLUME AND LUMBER YIELD SUMMARIES BASED ON DIAMETER CLASSES”*

within this section the projected lumber yield values from the prior section and other information will be used in various calculations to project residual yields for the logs of various diameters and lengths, cubic volumes are calculated and measures of performance including both the Lumber Recovery Factor (LRF) and the overrun (or underrun) based on the users selection of common log rules or user defined log scale. The entry data summary and data entry area of the table begins with the specification of prior entered data, including the user specied species etc., as follows:

*species >> RED OAK*

*1.125 = assumed ratio of actual 144in3 per nominal board foot*

*0.25 = assumed kerf*

*1.125 = assumed thickness*

*1.375 = assumed set*

*0.5 = assumed log taper in inches per 4 feet log length*

All of these above are wholly self explanatory and/or have been explained prior, however, the next entry requires explanation:

*0.00% = assumed % of volume of green lumber to green s.w.e. planer shavings*

This row also represents a value that is not entered at this point, and also has not yet been entered by the user. If desired the user COULD directly make an entry in the cell at this time, but that is not recommended. Casual inspection will show this cell is linked to a cell which is hundreds of rows below in the spreadsheet. The purpose of calculating the planer shavings value is to account for that residual which may be used or sold. Where green lumber might be considered within the analysis the appropriate entry number would of course be “0” (zero) and it must be remembered that the planer shaving residual is a different component than other residuals such as chips, bark and sawdust, with a “different” kind of accounting for volume, in that planer shavings are already included as a component of the green lumber, and their recovery requires the drying and planning of some fraction of that green lumber to generate the incremental residual. Generally the value of planer shavings is not terribly large so it is suggested that it is perhaps best set as “0” in initial phases of the analysis. However, if the user desires, the estimate can be directly entered at this time, or the user can at this time go to the portion of the model where the planer shavings estimations are made. The detailed calculations for inclusion of planer shavings into the analysis is accomplished at the very end of the model, where the user enters a number of assumptions including the dry surfaced thickness, the dry surfaced widths in four-sided planed lumber (e.g. dimension sizes), shrinkage values for the species, the final dry moisture content and an assumption of what percentage of the lumber for the species will be dried and then planed, versus being sold green and rough or dry and rough.

The next part of this section is again familiar:

*slab and edging loss >>> = assumed slab & edging equivalent loss from equivalent perimeter loss (= 1.0 inch typical) THIS IS THE SUGGESTED AND PREFERRED OPTION*

*Note: In the first entry section for assumed loss due to slab and edging, you entered:*

*0 = assumed slab & edging deduction "fcn of D" beta constant*

*1 = assumed slab & edging equivalent loss from equivalent perimeter loss*

This display shows the user’s specification regarding the method to be used in estimating loss due to slabs and edging and also the specific assumption for the method. An additional purpose

of this section is to serve as an “error flag” in the event of basic errors of entry. If the user places entries under both of the slab and edging assumptions, or if the user leaves both of the assumptions as blank, the following would be displayed:

```
slab and edging loss >>>      Warning r.e. slab and edging deductions assumed, the user should select to use either one or the other
convention, but not both.
```

```
    Note: In the first entry section for assumed loss due to slab and edging, you entered:
```

```
    0          = assumed slab & edging deduction "fcn of D" beta constant
```

```
    0          = assumed slab & edging equivalent loss from equivalent perimeter loss
```

In this example the user has neglected to make an entry under either option, so the program provides a “warning note” and quick inspection indicates the problem is the user has not made an entry assumption under either convention. If the user places entries under both of the slab and edging assumptions, the following would be displayed:

```
slab and edging loss >>>      Warning r.e. slab and edging deductions assumed, the user should select to use either one or the other
convention, but not both.
```

```
    Note: In the first entry section for assumed loss due to slab and edging, you entered:
```

```
    0.71      = assumed slab & edging deduction "fcn of D" beta constant
```

```
    1         = assumed slab & edging equivalent loss from equivalent perimeter loss
```

Again there is a problem prompting a “warning note” and quick inspection indicates the problem is the user has made an entry assumption under both conventions. In each circumstance the user is prompted to correct the problem, and when that is accomplished, the label indicating which of the options is used is displayed (versus the “warning note”).

The next four rows of this area involve user entries:

```
enter >>  0.1      = assumed average double bark thickness in inches per inch of diameter inside bark
```

```
enter >>  0.56     = assumed green specific gravity of wood
```

```
enter >>  0.65     = assumed green specific gravity of bark
```

```
enter >>  1        = desired board foot log scale to use in analysis (see below)
```

The first of these entries: “*enter >> 0.1* = assumed average double bark thickness in inches per inch of diameter inside bark” calls for an assumption of the approximate double bark thickness in inches per inch of diameter inside bark. Within this example, the entry of 0.1 (inch) would equate to ½ inch (single) bark thickness in a 10 inch diameter log, and to 1.0 inch (single) bark thickness in a 20 inch diameter log, and to 1½ inch (single) bark thickness in a 30 inch diameter log. This is designed to be a simplified estimate of bark thickness allowing for a preliminary estimate of bark volume. It may be noted that the assumption regarding a direct relationship of bark thickness doubling with a doubling of diameter inside bark (or halving as diameter inside bark is halved) is an oversimplification that is not precisely a measure of reality (i.e. bark thickness may be expected to increase with increasing diameter, but at a slightly lower ratio than a 1 to 1 increase). Consequently for whatever diameter (average, midpoint or median value selected) might be used to approximate a central value for the species in question, the assumption will be somewhat lower than it should be for smaller diameters, and somewhat larger than it should be for larger diameters. Regardless, the assumption should be reasonably close for the purposes for which it is being used, as long as the assumption is reasonable for something near the median or weighted average diameter. The purpose in doing this calculation is to calculate a bark volume in an approximate solid equivalent form (this is of course impossible to precisely do, given the fissured nature of bark, even if the bark thickness was precisely known – this can only provide a rough estimate). This volume is used in a bark volume estimate in calculation of residual values. A technically more precise way of handling this estimate would be to use input of standard linear regression for bark thickness. This was considered but rejected as an alternative in the model development where these data sets tend to be quite old, quite limited in species represented, and difficult to find further given the inherent limitations in such a

calculation, given the fissured nature of most bark, the benefit of what could in some cases be increased precision is not justified by increased difficulty in securing that information for data entry.

The next two of these entries:

*enter >> 0.56 = assumed green specific gravity of wood*  
*enter >> 0.65 = assumed green specific gravity of bark* are each straight-forward data entry from reference. These specific gravity data are available as published data from a wide variety of sources including USFS publications available through the Forest Products Laboratory, including the Wood Handbook and other publications that are downloadable in PDF format. If necessary, the data can also be calculated using samples in basic lab procedures that are explained in virtually any Wood Science or Forest Products text. These data are used to estimate the approximate dry weight of sawmill residuals including pulp chips, planer shavings, sawdust and bark.

The last entry:

*“enter >> 1 = desired board foot log scale to use in analysis (see below)”*

Calls for the user to select a number corresponding to the board foot log scale that the user desires to use in the analysis, in this example, the entry of the number “1” is a selection for the Scribner Decimal C log scale among the choices which follow:

*r.e. selection of board foot log scale above, enter the # corresponding to desired scale*  
 1 = Scribner Decimal C (user select, also default scale)  
 2 = International 1/4  
 3 = Doyle  
 4 = Expanded Scribner  
 5 = User specified alternate (must enter all scale values in column "X" below)

With these user selections and data entries complete the following 15 column table is generated for log of diameters 6 to 36 inches and 8 to 20 foot lengths which is represented as data in more than 200 rows, segregated as all log lengths within a given diameter. To break this into a workable form for this presentation the column headings for log diameter and log length will be shown, along with column headers for each of four to five columns at a time, along with the displayed values for the 10 inch diameter logs ranging in length from 8 feet to 16 feet.

Log		Scribner		Theoretical	
Small	Log	Nominal	Dec C	Yield via	Yield via
End	Length	Log	Log	Math.	Math.
d.i.b."	(feet)	vol ft <sup>3</sup>	Scale	Total BF	Overrun %
10	8	4.82	30	25.9	-13.5%
10	10	6.18	30	33.7	12.2%
10	12	7.60	30	41.4	37.9%
10	14	9.09	40	50.0	24.9%
10	16	10.65	60	58.5	-2.4%

Within this displayed element of the table broken down by log diameter and length is first the calculated log volumes by diameter and length. These calculations are made using the Smalian’s convention in estimation of volume which simply averages the small and large end areas of the log (large end diameter is estimated based on taper assumption provided by the user) and then multiplies the average end area by the length, with the result converted into cubic feet. The

length used is the nominal length in feet, creating a nominal volume where trim is ignored. The log scale is the appropriate scale value for the diameter and length of the board foot log scale that has been selected by the user. (Note: This scale value is selected from the appropriate column to the right of this table for the selected log scale, including Scribner Decimal C (which may be user selected, but is also the “default” scale if no other scale is specified), the International ¼ scale, the Doyle scale, the Expanded Scribner scale (expanded from the original Scribner diameters, but the scale values not rounded to 10 board feet). Also the user may specify any desired alternate scale, entering the scale values with column “X” in the table for the diameters and lengths of all log sizes which will be represented in analysis at a minimum (must enter all scale values in column "X" below). The theoretical yield is the yield data calculated and earlier displayed in a matrix format of diameter and length representing the axis of the table. The overrun (or underrun if negative) is the difference between the calculated theoretical yield which is used to estimate the projected mill tally of lumber, and the log scale, expressed as a percentage of log scale. The example shown using the 10 inch diameters in five log lengths sawing hardwood logs to 4/4 lumber was intentionally selected to illustrate an important aspect of the program, the need for good data assumptions and for careful analysis in studies such as is represented in this model. The wild swings in overrun/underrun by log length within the diameter is a function of the particular log scale being a fairly blunt tool within the example diameter and length class (e.g. where the scale is the same for 8, 10 and 12 foot logs, increasing lumber yield with increasing length is directly represented as increasing overrun). Where this model is often used in estimations for new mill startups the more cautious (and prudent) investors take great pains to do significant sampling to obtain the best data regarding log distributions that are expected for the mill, by species. In some cases with new mill startups of larger mills, literally thousands of logs are sampled in key species and hundreds in minor species, to develop the appropriate distributions. Where the importance of such data may be doubted, it is only necessary to input different diameter and length distributions and to compare the results.

The next five columns of the table estimate the cubic volumes of product and residuals for logs of the different diameters and lengths. Again the 10 inch diameters in lengths of 8 to 16 feet are displayed:

<i>Log Small</i>	<i>Log End d.i.b."</i>	<i>Log Length (feet)</i>	<i>Estimated</i>				
			<i>Estimated cubic feet of green lumber produced</i>	<i>Estimated cubic feet s.w.e. sawdust produced</i>	<i>Estimated cubic feet s.w.e. pulp chips produced</i>	<i>cubic feet (green) plan. shav. produced</i>	<i>Estimated cubic feet s.w.e. bark produced</i>
10		8	2.432	0.721	1.668	0.000	0.96
10		10	3.155	0.927	2.097	0.000	1.21
10		12	3.878	1.133	2.590	0.000	1.47
10		14	4.683	1.357	3.049	0.000	1.74
10		16	5.489	1.581	3.577	0.000	2.01

Within this part of the table the first column of the cubic foot volume of lumber that would be recovered from the log. This is calculated by multiplying the projected board foot yield for each log by the appropriate factor to do the conversion given the assumptions that have been made by the user. (Note: as discussed in detail prior, a board foot of 4/4 hardwood will generally have more than 144 cubic inches of volume due to oversizing, commonly in excess of 160 cubic inches, in excess of 10% greater volume, while in contrast, softwood dimension lumber will typically have less the 144 cubic inches of volume.) The next column estimates the volume of sawdust that would be generated in solid wood equivalent (s.w.e.). For sawdust and all other

residuals, the volume which is being calculated is for that “solid wood equivalent” volume, allowing direct conversion to estimation of dry weight of residuals which can be combined to represent a single number value representing the combined total of all residuals (on the basis of dry weight). The actual cubic volume the sawdust would occupy would be significantly greater, perhaps up to 2 ½ times greater if the sawdust was free sawdust that was not compacted, or somewhat less than the twice the volume to the degree the sawdust might be compacted. Other residuals might occupy even greater volumes in their residue form (in the case of planer shavings) or slightly less (in the case of pulp chips and bark) but in all cases the free residuals would occupy significantly greater space than the solid equivalent from which they were derived. The sawdust volume is estimated by applying the ratio of loss due to kerf as compared to lumber thickness considered against the volume of lumber produced, and a further adjustment (diameter specific) is made to estimate sawdust generated in square edging of the lumber. The cubic volume of pulp chips is estimated as being the remainder of the log volume after the lumber and sawdust volumes have been subtracted. Planer shaving volume is contained with the lumber volume and is calculated as being a (variable) percentage of the lumber volume based on specific calculations of the percentage of the volume of the lumber which is dried, the green dimension of lumber, the dry-surfaced dimension of the lumber, the volumetric shrinkage for the species, the final moisture content after drying and assumptions with regard to the percentage of lumber within various size classes in the case of lumber to be surfaced on four sides. This calculation is accomplished based on data entry in the last section of the spreadsheet. In this example, the lumber is to be shipped in the green condition and no planer shavings are generated. The solid cubic equivalent of bark is estimated based on the user’s assumptions regarding bark thickness. In this example the double bark thickness is assumed to be equal to 0.10 inches per inch of log diameter (small end) inside bark – therefore for the 10 inch logs in the example, bark thickness would be ½ inch (and double bark thickness would be 1.00 inch) in doing the volume calculations. Again the Smalian’s formula is used in calculation, with volume calculated using diameters inside bark being subtracted from volume calculated using diameters outside bark, with the difference representing the solid equivalent of the bark volume.

The last elements of the table provide for some conversion factors, residual recovery and additional lumber recovery factors broken down by the log diameters and lengths.

Log Small End d.i.b."	Log Length (feet)	Board feet	cubic feet		LRF
		of log scale per cubic foot of log	of bark per cubic foot of log	of bark per MBF of log scale	Board feet per cubic foot of log
10	8	6.22	0.199	32.0	5.38
10	10	4.86	0.196	40.5	5.45
10	12	3.95	0.194	49.1	5.44
10	14	4.40	0.191	43.4	5.50
10	16	5.64	0.189	33.5	5.50

Within this part of the table, the first column provides an estimate of the board foot of log scale (in this example according to the user specified Scribner Decimal C scale) by log diameter and length, This is actually a fairly important conversion number to know if there conversions must be made. Many people are familiar with “industry average” numbers commonly used in conversion (usually about 7 board feet of Scribner Decimal C board foot log scale per cubic foot of log input) but these numbers are highly diameter/length dependant. The next two columns

express cubic feet of bark in relationship to cubic and board foot log scale respectively and are simply a tool in that residual volume estimation (again diameter dependant). The last column represents the LRF or Lumber Recovery Factor, which in this case is the projected yield in board feet of lumber to be recovered per cubic foot of log input. This is again a diameter dependant factor where loss due to slab and edging is proportionately greater in small versus larger diameters. As previously mentioned, the columns beyond these last described (i.e. Column T through Column X inclusive) are simply the scale values for the respective board foot log rules for the associated diameters and lengths used within the model. The last of these columns (X) allows for insertion of board foot log rule scale values for any rule beyond the common ones provided.

The next portion of the spreadsheet combines the data for projected values for lumber and residual yield for logs of different diameters and lengths with data assumptions for a sample log distribution consisting of user specified percentage fractions of total number of logs within each diameter and length category. Within this matrix it is possible for the user to directly enter the percentage of the total number of logs in each diameter and length category simply by entering the percentage directly, HOWEVER, it is recommended the user first examine the standard entry method, where within a following section of the spreadsheet the user can directly enter the number of logs in each diameter/length category within a log distribution sample (that can be from an actual sample as is preferred, or a hypothetical sample distribution), where each diameter/length category will be automatically transformed into percentage of the total logs in each diameter/length category.

The first portion of the header of this matrix calls for an entry of the total number of logs assumed within the analysis being done:

*LUMBER & RESIDUAL PRODUCTION ESTIMATES*

*Approximate # of logs in this species  
to the mill for production of lumber*  
e>>    enter # of logs>>                    25,557

The number entered in this example, 25, 557 logs will equate to a certain total number of board feet of logs, based on the percentage (diameter/length) distribution entered by the user. This log scale board foot total (according to the log scale specified prior by the user) is displayed in the next section to the right as follows:

*species >>    RED OAK*

*Approximate MMBF of Logs in this species to the mill  
for production of lumber, given assumption r.e. # of logs*  
2.000 MMBF Logs    Scribner            Dec C

In this example the assumed 25,557 logs would have a total board foot scale value of 2 million board feet given the diameter/length distribution assumed and using the Scribner Decimal C Log Scale (and of course using a different distribution and/or a different log rule would almost



certainly yield a different total scale). In using the program, an assumed total number of logs may be entered to “find” the total scale, or trial and error entries of number of logs could be done until a desired total board foot volume of logs is achieved.

For the assumed number of logs entered by the user, given user specified assumptions regarding the diameter/length distribution, the program calculates a variety of summary information regarding the total number of logs of the species in each element of the diameter/length. The first columns of information showing the data for 12 inch diameter logs from 8 to 16 feet is displayed as follows:

<i>Log Small</i>	<i>Log</i>	<i>% of Logs to Mill in this Diameter</i>	<i># of Logs to Mill in this Diameter</i>	<i>MBF Logs Dec C to Mill in Diameter</i>	<i>Nominal Cubic ft Logs to Mill in Diameter</i>	<i>Nominal Lineal ft Logs to Mill in Diameter</i>	<i>Theoretical Yield via Model in Diameter</i>
<i>End d.i.b."</i>	<i>Length (feet)</i>	<i>&amp; Length Class</i>	<i>&amp; Length Class</i>	<i>&amp; Length Class</i>	<i>&amp; Length Class</i>	<i>&amp; Length Class</i>	<i>&amp; Length Total BF</i>
12	8	3.52%	899.0	36.0	6,139	7,192	35,988
12	10	4.02%	1,027.4	51.4	8,954	10,274	52,964
12	12	4.02%	1,027.4	61.6	10,969	12,329	64,799
12	14	1.01%	256.9	18.0	3,266	3,596	19,434
12	16	0.00%	0.0	0.0	0	0	0

Within the example segment provided, of the total of the 25,557 red oak logs considered in the analysis, it was assumed that 3.52% of the total number of logs (equal to 899 logs and also equal to 36 MBF of logs according to the Scribner Decimal C log scale) would be of 12 inches in diameter and 8 feet in length and would yield a projected 35,988 board feet of lumber when sawn. These logs would total approximately 6,139 cubic feet of wood volume and have a total lineal length of 7,192 feet. (Note: the cubic volume data is important for various calculations including residual volumes, the aggregate lineal footage is important design information for machine use (e.g. debarker capacity in lineal feet per unit time). In contrast, for the 12 inch diameter 14 foot long logs, they comprise only 1.01% of the total log input or the equivalent of about 256.9 logs, less than a third of the number of 8 foot logs of the same diameter, but account for fully half the board foot volume as the 8 foot logs of the same diameter, more than half the cubic volume and more than half the projected board foot yield as the 8 foot logs of the same diameter. As this would imply, diameter distributions to be processed are important considerations in analyses.

The next section of the table deals with cubic volumes of lumber and residuals product, again displayed for the 12 inch diameter class in lengths of from 8 to 16 feet:

<i>Log Small</i>	<i>Log</i>	<i>Estimated cubic feet of green lumber produced</i>	<i>Estimated cubic feet s.w.e. sawdust produced</i>	<i>Estimated cubic feet s.w.e. pulp chips produced</i>	<i>Estimated cubic feet (green) plan. shav. bark produced</i>	<i>Estimated cubic feet s.w.e. produced</i>
12	8	3,374	945	1,820	0	1,233
12	10	4,965	1,382	2,607	0	1,779
12	12	6,075	1,684	3,210	0	2,155
12	14	1,822	502	942	0	634
12	16	0	0	0	0	0

Within the example segment provided, of the total of the 25,557 red oak logs considered in the analysis, the 3.52% of the total number of logs (equal to 899 logs and also equal to 36 MBF of logs according to the Scribner Decimal C log scale) would be of 12 inches in diameter and 8 feet in length and would yield a projected 35,988 board feet of lumber when sawn. This volume of lumber would equate to an estimated 3,374 cubic feet of lumber recovered from the approximately 6,139 cubic feet of wood volume in those logs. About 945 cubic feet (solid wood equivalent) of sawdust would be produced from these logs (given the user specified assumption regarding kerf etc.) and about 1,820 cubic feet of the log (solid wood equivalent) would be recovered as chips. Given user specified assumptions regarding bark thickness (in this example being double bark thickness equal to 0.1 inch double bark thickness per inch of diameter inside bark small end) these 899 logs would also yield about 1,233 cubic feet (solid equivalent) of bark. In the example, where lumber is sold in the green rough condition, planer shavings are not recovered, however, where lumber is dried and surfaced, the model also calculates the volume of planer shavings recovered from the lumber.

Aggregations in all the columns described above are provided in summation of the more than 200 rows representing diameters from 6 to 36 inches and lengths from 8 to 20 feet, totaling percentages in diameter/length (check sum should total 100%), total number of logs, total board foot log scale, total lineal feet of logs, total projected lumber yield, and total cubic volumes of logs, lumber and residuals.

The next section of the model provides an aggregation summary of prior information and some new calculated information as follows:

<i>SUMMARY DATA FOR:</i>		2.000	MMBF of RED OAK
<i>Logs to the mill for production of lumber</i>			
25,557	= # logs to the mill to be sawn		
2,000	= MBF logs to the mill to be sawn		Scribner Dec C
309,952	= cubic feet of logs to the mill to be sawn		
248,121	= lineal feet of logs to the mill (e.g. lineal feet of logs through debarker)		
1,976	= theoretical potential yield in MBF		
-1.2%	= Overrun/(Underrun) overall for this scenario for all logs sawn		
6.38	= LRF overall for this scenario for all logs sawn		
1,052	= bone dry units of bark produced associated with logs sawn (note: bdu = 2,400 lbs dry equivalent weight)		
1,816	= TOTAL bone dry units of wood residue produced in sawing		
715	= bone dry units of sawdust produced		
1,100	= bone dry units of chips produced		
0	= bone dry units of planer shavings produced		
2,867	= TOTAL bone dry units of wood and bark residue produced in sawing		
1.45	= AVERAGE bone dry units of wood and bark residue produced in sawing per MBF LUMBER produced		
1.43	= AVERAGE bone dry units of wood and bark residue produced in sawing per MBF LOGS sawn		

Within this section, the first several rows are simply summary presentation of prior information including total log input on a board foot, number of logs and cubic volume basis and the total lineal feet. An aggregate overrun (or underrun), and the overall Lumber Recovery Factor (board feet of lumber per cubic foot of log input) is calculated based on total projected yields and on the total log volumes, to provide aggregate overall overrun and LRF data. The volume of bark and wood residue in individual types and in aggregate is calculated in bone dry units (bdu) which is equal to 2,400 dry pounds of wood (or bark) equivalent. This calculation is straight-forward, based on the cubic volume (s.w.e.) and the user specified specific gravities for wood and bark. An total (bdu) of the residue generated (wood and bark combined) and an average bdu of

residue per MBF lumber output and per MBF log input is calculated. These averages are particularly useful in financial feasibility analyses in projections, such as the Sawmill Financial Feasibility model.

The next section of the spreadsheet calls for user inputs of costs (for logs and sawing) and values (for lumber and residuals) on a per standard unit basis. The data entry is straight-forward. For all products the user specifies a percentage of the product that is to be sold in estimation of residues to be received. Normally this percentage would be 100%, but in some circumstances it may be desired in analysis to assume some fraction of residuals (or product) is locally used. The user can (of course) assume the product is sold and a cost transfer is made to another arm of the company if that is preferable (and specify 100% sold) or the percentage actually sold can be entered and the percentage that is not sold is removed from consideration in the revenue stream). In the example, it is assumed that 50% of the bark is locally used and revenue from that fraction of bark is ignored in the analysis. This entry section is shown as follows:

*ASSUMPTIONS REGARDING AVERAGE VALUES OF LUMBER AND RESIDUE PRODUCED AND SOLD*

*species >>RED OAK*

<i>e&gt;&gt;</i>	<i>\$600.00</i>	<i>= value f.o.b. mill per MBF for lumber in log fraction sawn</i>	
<i>e&gt;&gt;</i>	<i>100%</i>	<i>= % of this product sold</i>	
<i>e&gt;&gt;</i>	<i>\$6.50</i>	<i>= value f.o.b. mill per BDU bark produced</i>	
<i>e&gt;&gt;</i>	<i>50%</i>	<i>= % of this product sold</i>	
<i>e&gt;&gt;</i>	<i>\$11.00</i>	<i>= value f.o.b. mill per BDU sawdust produced</i>	
<i>e&gt;&gt;</i>	<i>100%</i>	<i>= % of this product sold</i>	
<i>e&gt;&gt;</i>	<i>\$50.00</i>	<i>= value f.o.b. mill per BDU chips produced</i>	
<i>e&gt;&gt;</i>	<i>100%</i>	<i>= % of this product sold</i>	
<i>e&gt;&gt;</i>	<i>\$35.00</i>	<i>= value f.o.b. mill per BDU planer shavings produced</i>	
<i>e&gt;&gt;</i>	<i>100%</i>	<i>= % of this product sold</i>	
<i>e&gt;&gt;</i>	<i>\$400.00</i>	<i>= delivered cost at sawmill per MBF of logs to be sawn</i>	<i>Scribner Dec C</i>
<i>e&gt;&gt;</i>	<i>\$100.00</i>	<i>= sawing cost per MBF of LOG SCALE to be sawn</i>	<i>Scribner Dec C</i>

The next section uses the prices and percentages established, along with prior volumes that were calculated, to aggregate revenues and costs as follows;

*POTENTIAL ANNUAL GROSS REVENUES GIVEN YIELD, SAWING AND SELLING ASSUMPTIONS*

*species >>RED OAK*

<i>\$1,185,627</i>	<i>= TOTAL revenues from lumber</i>
<i>\$3,418</i>	<i>= TOTAL revenues from bark</i>
<i>\$7,868</i>	<i>= TOTAL revenues from sawdust</i>
<i>\$55,018</i>	<i>= TOTAL revenues from chips</i>
<i>\$0</i>	<i>= TOTAL revenues from planer shavings</i>
<i>\$66,303</i>	<i>= TOTAL revenues from residuals</i>
<i>\$1,251,931</i>	<i>= TOTAL GROSS REVENUES FROM ALL LUMBER AND RESIDUALS</i>
<i>\$799,844</i>	<i>= TOTAL LOG COST DELIVERED TO MILL</i>
<i>\$199,961</i>	<i>= TOTAL SAWING COST</i>
<i>\$452,086</i>	<i>= GROSS MARGIN (REVENUES - COST) CONSIDERING LOG COST ONLY</i>
<i>\$252,125</i>	<i>= GROSS MARGIN (REVENUES - COST) CONSIDERING BOTH LOG &amp; SAWING COSTS</i>

This section provides aggregate information regarding revenue by product type and in total, total log and sawing costs, and basic gross margin calculations in total, including on the basis of raw material only, and raw material plus sawing costs. The second part of this section deals with these data expressed on a dollars per unit basis as follows:

\$226.09	=	<i>\$/MBF LOG SCALE GROSS MARGIN (REVENUES - COST) CONSIDERING LOG COST ONLY</i>
\$126.09	=	<i>\$/MBF LOG SCALE GROSS MARGIN (REVENUES - COST) CONSIDERING BOTH LOG &amp; SAWING COSTS</i>
\$228.78	=	<i>\$/MBF LUMBER GROSS MARGIN (REVENUES - COST) CONSIDERING LOG COST ONLY</i>
\$127.59	=	<i>\$/MBF LUMBER GROSS MARGIN (REVENUES - COST) CONSIDERING BOTH LOG &amp; SAWING COSTS</i>
\$23.12	=	<i>Average revenue received in \$ per BDU of all residue GENERATED in production</i>
\$33.55	=	<i>Average revenue received for residuals in \$, per MBF LUMBER produced</i>
\$33.16	=	<i>Average revenue received for residuals in \$, per MBF LOGS sawn</i>

Within this part of the section the summaries on a per unit volume basis become much more meaningful in presenting something that is more readily understood by virtually anyone. The presentation of gross margins as being what is recovered on a per thousand board foot (log scale or lumber scale) after recovery of raw material costs (only) and after recovery of raw material and (variable) sawing costs. The difference being represented as the gross margin is the potential contribution to fixed costs and profits after recovery for the variable costs. This can represent a very useful “pre-screening” of species and the potential to contribute to the operation. The average revenue received per bone dry unit of residuals is again information that will be needed and used in feasibility analyses, such as in the Sawmill Financial Feasibility model.

Although BDUs represent a standard and universal (across residue type) measure of residuals generated, some users may be more familiar with cubic volume estimates. Cubic yards represents a standard cubic volume that can be converted into different units (e.g. a user defined “truckload” or “carload”) if desired. These cubic volume estimates are far from precise, in that they are not represented as a solid equivalent volume, rather the solid wood is converted into the residual form that will have varying bulk densities based on residue type (and also if it is compacted or not compacted) these data are presented as follow by residual type, along with user input options:

*EQUIVALENT VOLUMES AND EQUIVALENT ALTERNATE VALUES  
FOR ALTERNATE METHODS OF TALLYING AND SELLING RESIDUALS*

e>>	85	=	<i>assumed cubic feet of solid wood equivalent per unit (200 ft3) of residue for BARK</i>
e>>	80	=	<i>assumed cubic feet of solid wood equivalent per unit (200 ft3) of residue for SAWDUST</i>
e>>	85	=	<i>assumed cubic feet of solid wood equivalent per unit (200 ft3) of residue for PULP CHIPS</i>
e>>	50	=	<i>assumed cubic feet of solid wood equivalent per unit (200 ft3) of residue for PLANER SHAVINGS</i>
	5,423	=	<i>cubic yards of bark produced associated with logs sawn</i>
	11,134	=	<i>TOTAL cubic yards of wood residue produced in sawing</i>
	4,548	=	<i>cubic yards of sawdust produced</i>
	6,586	=	<i>cubic yards of chips produced</i>
	0	=	<i>cubic yards of planer shavings produced</i>

*EQUIVALENT RESIDUAL PRICES ON A PER CUBIC YARD BASIS*

\$0.63	=	<i>value f.o.b. mill per cubic yard bark produced</i>
100%	=	<i>% of this product sold</i>
\$1.73	=	<i>value f.o.b. mill per cubic yard sawdust produced</i>
100%	=	<i>% of this product sold</i>
\$8.35	=	<i>value f.o.b. mill per cubic yard pulp chips produced</i>
100%	=	<i>% of this product sold</i>
\$0.00	=	<i>value f.o.b. mill per cubic yard planer shavings produced</i>
100%	=	<i>% of this product sold</i>

The first part of the section deals with the assumed solid wood equivalent of the residue per unit (200 gross cubic feet) of residual in that form. The entries provided are standard average conversion ratios for the residues of that type in an uncompacted form. The user can modify these conversion data if they have better information regarding their situation, but the entries provided typically should not need modification. The next section translates the BDU volumes of

residuals (by type) into cubic yard equivalents at the bulk density of the residuals in their form (i.e. an approximation of the actual volume of residuals in their actual form, not in some solid equivalent form – it should be noted that the bulk density of the residuals is now much lower). The final section translates the residual prices expressed in dollars per BDU into the price on a basis of dollars per cubic yard of residuals. If the user desires, the price in dollars per BDU can be adjusted until the dollar per cubic yard price reaches a desired outcome, however, the residual aggregation price on a dollar per BDU basis is still needed for common unit valuation. It may not be obvious, but this cannot really be accomplished “correctly” without extensive manipulation on a dollar per cubic yard basis where expansion/compaction is expected to be markedly different for different residual types.

The next section of the model is an area where data entry of a log sample distribution can be used to provide an appropriate weighted average distribution of logs for the model. This section is labeled as: “*DIAMETER DISTRIBUTION ENTRY AREA (for data from study of delivered resource)*” with a label entry below it that is tied to prior entry showing the species, as in this example “*species >> RED OAK*”. As noted, below this, there are only two entry columns within this section “(note: entries required in this section are in number of logs and assumed ft<sup>3</sup> logs per cord in diameter/length class)”. The first of these entry columns (in column “D”) permits direct entry of the number of logs in the user’s distribution that are within each of the diameter and length classes (i.e. diameter in inches from 6 inches to 36 in one inch class increments and 8 feet to 20 feet in 2 foot increments, for more than 200 diameter and length classes). This diameter distribution entry is essential if the user is intending to make a meaningful projection for a population of logs which should be represented by the log distribution. (Note: Examination of the model projections will quickly underscore that elements such as overrun, LRF, etc. are highly sensitive to the log’s diameter and length distribution.) The direct numerical entry in each diameter and length class is transformed into a percentage of the number of total logs in that class, that is used in the prior part of the model as already mentioned.

Experience has shown this entry section is straight-forward and easy to understand. In this example (dealing with hardwoods) there are no entries for diameters less than 10 inches (as is common in this in areas where 10 inches is typically the minimum diameter for a Grade #3 hardwood log). The model accommodates diameters down to 6 inches as a minimum sawlog diameter that is common for softwoods and the minimum diameter scaled according to common board foot log rules. Nothing would preclude insertion of smaller diameters (than 6 inches) into the model but that would not be recommended as a normal practice. Where part of the model deals with overall overrun/underrun, residual recovery on a board foot log scale basis, etc. the inclusion within the model of those smaller diameters for which there is not corresponding (log) scale data would be problematical for aggregation criteria. Additionally it should be considered that those smaller diameters may be routinely sawed with in some mills, as even within the early 1980s there were some few mills in North America that sawed down to minimum diameters of 4 inches or less. However, the normal circumstance in such operations would be in computer controlled headrigs, positioning for maximum allowable wane, and for recovery of special sizes such as 2x3 inch and 2x2 inch lumber. Where such circumstances may be contemplated it would probably be much more logical to use specific data for those small diameters and consider them separately, or consider them separately and then aggregate the desired data as appropriate, rather than attempting to “force” such small diameters into the model.

Nothing precludes the model from calculating results for very small diameters or for fractional diameters such as 7.5 inches. Within the table early in the program that is titled “*TABLE OF PROJECTED LUMBER YIELDS BY LOG DIAMETER AND LENGTH*” (that is located just below the basic entry assumptions titled “*BASIC INPUT ASSUMPTIONS TO BE USED IN MODEL FOR YIELD PROJECTIONS*”) within column “B” listing log diameters in inches it may be noted these diameters can be changed to reflect a 4 or 5 inch diameter class, or to more specifically specify a fractional diameter such as 8.5 inches. Changing the numbers will result in a changed projected yield for the various log lengths in the table. Some manipulation of this nature might be desired to gain insight – however it must be remembered that other items occurring later in the model will no longer apply (e.g. board foot log scale associated with the diameter class will no longer be appropriate, labels would need to be changed, etc. etc.). It should also be remembered that, although the model works quite well in doing what it is designed to do, going beyond the range where the model was designed to reasonably work, or in attempting to drive to levels of precision beyond the limits of the model will provide answers.

For these reasons explained above, for general use of the model as designed, the user would simply incorporate directly the sample log diameter and length distribution representative of the log population. The cell entries can be made directly as the number of logs in the sample within the specific diameter and length category (and if a sample has already been reduced to percentages, those percentages may be entered as number of logs for a sample of 100, 1,000 or 10,000, depending upon degree of precision. In most circumstances where the model is being used in projections associated with feasibility studies representing significant investments, large samples of the assumed log input distribution will typically be measured on a species by species basis. In some circumstances, literally thousands of logs may be considered for important species where there is some considerable variability of the input population of logs.

The other column for entry in this part of the spreadsheet is in column “F” where the assumed cubic feet of wood in a cord is recoded for each diameter and length class. Generally the cubic volume of wood will decrease with diameter (as both the wood and bark volume combined on a cubic foot basis, and the percentage of wood fraction in the wood and bark combined volume both decrease with diameter within a species). This decrease is due to the fact that bark thickness tends to decrease with decreasing diameter, but not on an exactly proportional basis; also the smaller diameter tends to exacerbate the influence of sweep and crook in the logs. Also as length increases, the volume (wood and bark combined) again tends to decrease as a result of increased effect of sweep and crook. The example numbers provided are a reasonable average representation but this can vary with species. To the degree these assumption do not reflect reality, the main adverse affect will be with regard to cord conversion information, but will not affect the main working of the model projections.

In addition to the input of diameter and length distribution entry into the model, this section of the model provides some by diameter and length class and overall estimates of conversion items. These include the following which should be self-explanatory:

*Estimated sticks per cord in the diameter and length class,*

*Estimated Board Feet of lumber per cord in the diameter and length class,*

*Estimated equivalent total cords sawn in the diameter and length class,*

*Board feet of log scale (in this example, Scribner Dec C scale) per cord in the diameter and length class, and,*

*The number of Cords per MBF log scale (in this example Scribner Dec C scale) in the diameter and length class.*

In addition to the calculations for these values on a diameter and length class basis, the data also are considered in the form of simple averages and weighted averages are calculated for the diameter distribution for the board foot and cubic volume per cord and for the board foot log scale to cord and cord to MBF log scale conversions.

*Weighted average board feet of lumber per cord*  
*(given this diameter/length distribution and ft3 of wood/cord assumptions) >>>* 531.6

*Weighted average cubic feet of logs per cord*  
*(given this diameter/length distribution and ft3 of wood/cord assumptions) >>>* 83.4

*Weighted average board feet*                      *Scribner Dec C log scale per cord*  
*(given this diameter/length distribution and ft3 of wood/cord assumptions) >>>* 537.9

*Weighted average # of cords per MBF log scale*                      *Scribner Dec C*  
*(given this diameter/length distribution and ft3 of wood/cord assumptions) >>>* 1.9

These summary data should also be self-explanatory but are worth briefly mentioning. The first of these “*Weighted average board feet of lumber per cord*” is an estimate of the board foot lumber yield for a cord of logs which represents a weighted average of the log diameters and lengths in the distribution. In a similar vein, based upon the users entries for assumed cubic volumes of woods for cords of various diameters and lengths, the “*Weighted average cubic feet of logs per cord*” provides an overall weighted average of this number, which varies in relation to log diameter, bark thickness, etc.. The next of these “*Weighted average board feet*” for in this case the users specified scale of “*Scribner Dec C log scale per cord*” gives an appropriate weighted average conversion number to convert the board foot log scale to cords, based upon the diameter and length distribution and the users assumption regarding the cubic volume of wood per cord. Rules of thumb for such conversions are typically 450 to 500 board feet log scale Scribner Decimal C per cord (within the Lakes States Region) however the appropriate value can be quite variable ranging from less than 250 board feet per cord for very small diameters to more than 600 board feet per cord for very large diameters, consequently this calculated weighted average value is something very desirable to know. The next item “*Weighted average # of cords per MBF log scale*” for in this case the users specified scale of “*Scribner Dec C*” is really just the “inverse” of the variable that was just calculated, with the value being expressed in cords per thousand board feet log scale as opposed to board feet per cord.

The final section of the model deals with some estimation related to planer shavings. It must be remembered that the volume of planer shavings that can be recovered as a residual are already contained within the volume of lumber that has been estimated within the model. The planer

shavings for the purposes of this analysis represent an additional residual that may be recovered and sold to generate additional residual revenues. In virtually all circumstances (except in the case of surfaced green dimension lumber) the lumber will be dried prior to planing, consequently the model will adjust the (dry shrunken) solid wood equivalent volume to represent a swollen (pre-shrunken) volume so dry weights of all wood residuals can be estimated using the same (green) specific gravity of wood. These estimations proceed as follow:

*ESTIMATION OF WOOD VOLUME IN LUMBER THAT WILL BE RECOVERED AS PLANER SHAVINGS*

*DRY SURFACED INFORMATION*

*Calculation of actual fraction of 144 cubic inches to nominal BF in S-Dry condition per lineal foot*

*Enter the ACTUAL dry surfaced sizes in thickness AND also in width IF surfaced 4 sides  
(enter actual thickness and nominal WIDTH if S2S)*

```
e>>      enter >> (actual size) width > 4      6      8      10      12
e>>      enter >> thickness>0.8125  0.2708  0.4063  0.5417  0.6771  0.8125

e>>      enter >> 13.70%   = Volumetric shrinkage green to ovendry
e>>      enter >> 8.00%    = Average MC after drying (ovendry basis)
```

Within this section the user first enters the dry surfaced widths of the lumber IF the lumber is to be surfaced on all four sides (as would typically be the case with dimension lumber). For example, if the analysis were for (typical) dry surfaced dimension lumber, the number “3.5” would be entered where the number “4” is currently displayed in the first entry row, and the numbers 6, 8, 10 and 12 would be replaced respectively with 5.5, 7.25, 9.25 and 11.25, representing the actual standard widths of the dry surfaced lumber. In the case of lumber being surfaced only in thickness (i.e. S2S) as in this example, the widths should be represented as being the same widths as listed for the nominal sizes. This can be checked for accuracy in that case by examining the nominal sizes represented for the widths in the rows that follow. (Note: Keeping the number actual and nominal width of lumber as the same in the S2S situation simply ignores recovery of planer shavings from the edge of the lumber in the calculation – it does not somehow imply the lumber does not shrink. The next entry row requires an entry of the actual thickness of the lumber after it has been surfaced – in this example to a 13/16 inch size (or if the lumber was to be surfaced to 15/16 inch thickness, the number “.9375” or the program could calculate that number if the formula “=15/16” was entered. If dealing with dry surfaced dimension lumber, the number “1.5” would be the typical thickness entry. The cells in next five columns of the same row following the thickness entry are the calculations of the percentage (expressed as a decimal fraction) of a 144 cubic inch “nominal board foot” that are contained in a lineal foot of the lumber of each of the nominal lengths and widths (these calculated numbers are not of particular interest to the user, rather they are simply foundation numbers in the calculations which follow).

The next two rows require entry of the volumetric shrinkage value and the average final moisture content after drying. Volumetric shrinkage values (total volumetric shrinkage from green (or fiber saturation point) to ovendry condition (i.e. 0% moisture) can be found in a variety of reference texts, including the “Wood Handbook” (Ag Handbook 72) available online at the FPL web site. The published volumetric shrinkage value is what is used, so direct entry is all that is required, the program will convert the value appropriate to the final moisture content. The average final moisture content entered by the user should be expressed on the ovendry basis (where moisture is expressed as a percentage of the weight of ovendry wood).



The following area of the spreadsheet requires no entries by the user, it is simply an area for interim calculation and display of results in the planer shaving calculations as follows:

*Calculation of the swollen equivalent of actual fraction of 144 cubic inches in S-Dry condition*

(nominal size)	width >	4	6	8	10	12
thickness >	1	0.3015	0.4523	0.6031	0.7539	0.9046

*Difference target green size vs swollen equiv. of S-Dry size of 144 cubic inches*

(nominal size)	width >	4	6	8	10	12
thickness >	1	0.0735	0.1102	0.1469	0.1836	0.2204

*% of cubic feet of green lumber produced in green equivalent planer shavings*

(nominal size)	width >	4	6	8	10	12	
thickness >	1	19.59%	19.59%	19.59%	19.59%	19.59%	
	% in size	20%	30%	30%	15%	5%	100%
	contribution	3.92%	5.88%	5.88%	2.94%	0.98%	

*weighted (by width) average % of a cubic foot of lumber to planer shavings = 19.59%*  
*simple average % of a cubic foot of lumber to planer shavings = 19.59%*

The first area takes the data regarding the decimal fraction equivalent of a 144 cubic inch “nominal board foot” that are contained in a lineal foot of the lumber of each of the nominal lengths and widths in the dry and surfaced condition and transforms this into a green (full swollen) equivalent. This permits the next calculation which is to subtract this swollen equivalent of the dry surfaced volume from the green sizes to which the lumber was actually sawn, the difference (which is displayed) is the decimal fraction equivalent of a 144 cubic inch “nominal board foot” that is the solid wood equivalent of green lumber that would be recovered as planer shavings from a lineal foot of the green lumber in the appropriate size. The next area transforms this into a percentage of the cubic volume of the green lumber that is recovered (in solid wood equivalent) as planer shavings (note: this is a solid wood equivalent used in BDU estimation, given the much lower bulk density of planer shavings as compared to lumber, the actual volume of planer shaving in their final form would be approximately four times that amount). In this example, the estimated 19.59% of volume is the same across all lumber widths, this is the case when the lumber is surfaced on two sides (S2S) as is more common with hardwood. In the case of softwood dimension lumber the percentages will typically vary, depending on the relationship of the target size of lumber widths as compared to dry surfaced wide dimensions in the varying sizes. In this circumstance, the user’s estimations with regard to the percentage of lumber in the five size classes can affect the estimates of the weighted average percentage of volume recovered. (Note: This is specified by the user in the initial setup at the beginning of the spreadsheet. In a similar vein this setup regarding planer shavings could be accomplished at the same time, but it is simply saved till last as it is primarily a complicating “fine tuning” of residual estimations.) The next two lines display both a simple average and a weighted average (across the five width dimension classes) of the percentage of lumber volume that could be recovered as planer shavings.

The final lines of the model require two simple entries to be made by the user, as follows:

```
e>>      enter >>  assumed average % of a cubic foot of lumber to planer shavings = 19.59%
e>>      enter >>  assumed % of lumber produced which is (dried and) surfaced = 0.00%
           calculated % of cubic footage of all lumber produced going to planer shavings = 0.00%
```

The first row requires an entry of the assumed average percentage of a cubic foot of lumber to be recovered as planer shavings – this is strictly what would be expected for lumber that would be surfaced (in the case of surfaced green) or dried and then surfaced in the case of surfaced dry. In most cases the user would want to use one or the other of the percentage numbers generated above (i.e. the simple average or the weighted average) or possibly something in between. No complicated adjustment of the percentages is necessary. The next row requires a percentage entry for the percentage of lumber produced that is surfaced (or in most cases, dried and surfaced). In this example of hardwood being shipped in the green condition, the number “0.00%” is the entry, if it was assumed that half of the hardwood lumber was to be dried and surfaced (with the rest shipped green), an entry of “50%” would be appropriate. In the case of softwood dimension where all the lumber would be dried and surfaced, an entry of 100% would be appropriate. The next row simply adjusts the average percentage per cubic foot (of lumber surfaced) on the basis the percentage of the lumber volume that is surfaced, to be represented as an equivalent percentage of green lumber volume recovered (in solid wood equivalent) as planer shavings. To examine how this works, in this example the user simply needs to change the percentage of lumber that is surfaced to some positive number (e.g. assume half the hardwood lumber is dried and surfaced, all other appropriate data are already in the model, so all that would be needed would be to enter “50%” as the assumed percentage of lumber that is dried and surfaced, and a calculated percentage of all lumber produced going to planer shavings will be displayed as “9.8%”. this same assumption entry will be displayed where the “0.00%” had first appeared in the basic inputs, and planer shaving will now come into the overall calculations throughout the model. Generally in most circumstances it makes a good bit of sense to ignore the affect of planer shavings until it becomes time to refine the model inputs (i.e. leave the volume set to an initial “zero” value). The logic behind this is that the planer shavings revenue can only calculated by the model can only add to total revenue in the final aspects of analysis and it tends to be a fairly small fraction of the total revenue. The whole issue of planer shaving tends to be somewhat complicating for many users, as many persons have little real grasp of the actual percentage of green lumber volume that ultimately winds up as planer shavings in average, versus excellent, versus poor practices in the target green sizing of lumber. Consequently, this is set into the model as a final element in fine tuning for most users, while experienced users can just as easily pull good estimates from their experience and fine tune from there at a later time.

One the user has gone through the entire model, it is good to spend some time examining elements of the model and doing various “what-if” trials.

As has been mentioned prior, the model is really designed for the purposes of initial estimates in planning and feasibility studies, principally with a generalized approach in basic mathematical solutions, to provide this in a generalized holistic fashion for both lumber and residuals, and to allow very quick testing and output response. The model is not designed to optimize recovery, project ideal sawline placement in an opening face for maximum volume or value recovery for very precisely measured sizes of logs. This model was not designed to serve as a substitute of any kind for the excellent existing software programs focused on the areas of sawmill control and optimization. However what the model can do quite effectively is to put some analysis tools in the hands of anyone who has access to standard computer spreadsheet software. As a result, the model is readily available without purchasing special software or hardware, the results can be

imported or exported into other applications and easily shared with others. There are some interesting features within the overall model, as an example, the user may wish to test the effects of reducing saw kerf – a quick change of the basic assumption ripples immediately through the model, projecting change on a log by log basis, reflecting the changes in lumber yield, residuals and values, among other things. Consequently, it is suggested that the beginning user having made it through the discussion in this manual may wish to test the model under some “what-if scenarios”.