

RIP-Xcut User's Manual

Comparing
Crosscut-
and Rip-
First Yields
and Costs

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RIP-Xcut

A PROGRAM TO DETERMINE AND COMPARE CROSSCUT-FIRST AND RIP-FIRST ROUGH MILL YIELDS AND COSTS

User's Manual

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Disclaimer

RIP-X is believed to provide an accurate simulation and results of rough mill performance. However, the authors are not responsible for user-generated program results.

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RIP - Xcut

User's Manual

1. Introduction

This manual describes how to use the computer program RIP-Xcut (RIP-X). RIP-X is intended for rough mill managers and owners who are interested in determining the yield and cost differences between the crosscut-first and rip-first systems. RIP-X will also determine the least-cost grade mix of lumber for both the crosscut-first and rip-first systems.

RIP-X simulates lumber cutup for a user-specified cutting order followed by a comparison between the resulting yields of the crosscut-first and rip-first systems. This comparison can be made either statistically or by observation of the means. Linear programming techniques determine the least-cost grade mix for both the crosscut-first and rip-first systems. The parts yield of the least-cost grade mix is also determined.

RIP-X was developed to analyze the cutup of hardwood lumber in a rough mill. Specifically, the program analyzes the cutup of red oak lumber. However, there should be little yield difference by grade for any species graded by the National Hardwood Lumber Association's (NHLA) grading rules. The program can, therefore, help analyze the rough mill cutup of any hardwood lumber species graded by the NHLA rules.

RIP-X contains a database of 1,242 digitally described red oak boards from which sample boards are randomly selected for processing by the rough mill simu-

lator. The lumber database was obtained by randomly selecting boards of each grade from four furniture rough mills and two lumber suppliers in Mississippi. The digital board data of the database was developed by digitizing the board periphery and the periphery of all defects on the board on a large digitizing tablet. Defects were described as rectangles in the digital data. Current computer grading software does not allow grading of boards with more than 1/4" of crook. To insure that lumber with greater than 1/4" of crook was accurately graded, an actual size image of each digitally described board was graded by an NHLA inspector. The crook for each board was also digitized and accounted for during the grading process. Table 1 gives the total board feet, the mean board length, and the mean board width by lumber grade for the lumber contained in the database.

The RIP-X rough mill simulation is performed by the CORY software which was developed by Brunner et al. (2). Permission to use and distribute CORY in RIP-X has been provided by the Department of Forest Products, Oregon State University. The RIP-X authors gratefully acknowledge this permission. RIP-X incorporates commercially available linear programming software, LPS-867 (1), to determine the least-cost lumber grade mix solution.

Grade	Board feet	Mean length (ft.)	Mean width (in.)
FAS	977	11	8
F1F	1017	11	8
SEL	363	9	5
1C	2284	12	7
2AC	2551	11	8
3AC	1514	11	7

Table 1. Board feet, mean length, and mean width for each grade of the digitized lumber database.

2. System Requirements

The minimum system requirements needed to run RIP-X are:

- IBM® compatible PC
- Windows® 95/98/2000/NT*
- Monochrome, color, or VGA adapter
- One 3.5" floppy drive and a hard disk drive

RIP-X was written with Microsoft BASIC Professional Development System®, version 7.0 (5).

***Note:** For the Windows NT operating system, RIP-X may not run in full-screen mode. If this situation occurs, run RIP-X through a window on your desktop.

3. Installing RIP-X

To install RIP-X on your computer, follow these steps:

1. Begin at the Windows desktop.
2. Insert **RIP-X DISK 1** into your floppy drive.
3. Click the **Start** button on the taskbar and choose **Run...**
4. Type **A:\SETUP** in the line labeled **Open**. (If your floppy drive is designated by a letter other than **A**, substitute that letter for **A**.)
5. Click the **Ok** button and follow the on-screen instructions to install RIP-X.

4. RIP-X data Worksheet

Prior to entering data in RIP-X, it may be convenient to summarize all required input data on the Advance Data Worksheet shown in Appendix A. This will help insure that all necessary data are available before running the program. The Advance Data Worksheet is also stored as a Microsoft Word for Windows® document (**Worksheet.doc**) in the RIP-X directory on your hard drive.

5. Running RIP-X

To run RIP-X, follow these steps:

1. Begin at the Windows desktop.
2. Click the **Start** button and then point to **Programs**.
3. Click the **RIP-X** menu item to start the program.

Note: When the program begins, it may appear as a window on your desktop. To switch to the full-screen mode, press and hold the **Alt** key and then press the **Enter** key.

RIP-Xcut

A PROGRAM TO DETERMINE AND COMPARE ROUGH
MILL CROSSCUT-FIRST AND RIP-FIRST SYSTEM
YIELDS AND COSTS

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2001

PRESS ANY KEY TO CONTINUE

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PRESS ANY KEY TO CONTINUE

Figure 1. TITLE screen

Figure 2. ACKNOWLEDGEMENTS screen

6. Tutorial

This section provides a tutorial for executing RIP-X and performing an analysis for a hypothetical facility with example input data. The input data provided for the tutorial analysis are used to provide an example and are not intended to indicate the technical and economic data for an actual facility.

Begin the RIP-X program as described in Section 5. When RIP-X begins, the TITLE screen (Figure 1) will appear. To continue, press any key. The ACKNOWLEDGEMENTS screen (Figure 2) will then appear. Press any key and RIP-X will advance to the MAIN MENU screen.

6.1 MAIN MENU. The MAIN MENU screen (Figure 3) is used to enter the mill/run identification, create and run a new analysis, load a previous analysis from disk, or exit the RIP-X system. To select a menu option, press the highlighted letter associated with that option.

6.2 MILL/RUN IDENTIFICATION. The first option in the MAIN MENU screen is *Mill/Run identification*. If this option is chosen, a pop-up window will appear that prompts you to enter the name of your mill

and run identification information. Type the information at the prompt and press the **Enter** key. It is not necessary to give a mill/run name, but it is recommended that a name be given to ensure proper identification of the printout results.

After entering the mill/run name, you may choose the *New analysis* option or the *Load a previous analysis* option. For each of these options, data-input and query screens will be invoked. All data-input screens are full-screen editors, allowing free movement between fields using the arrow keys. Movement between data-input screens is accomplished by using the **PgDn** and **PgUp** keys. The **Esc** key will return you to the MAIN MENU. The **BACKSPACE** key can be used to erase characters immediately behind the cursor. Help is available by pressing the **F1** key. Figure 4 gives an example of one of the help screens.

For the tutorial, choose the *New analysis* option from the MAIN MENU screen (Figure 3). This will advance RIP-X to the SIMULATION OPTIONS screen.

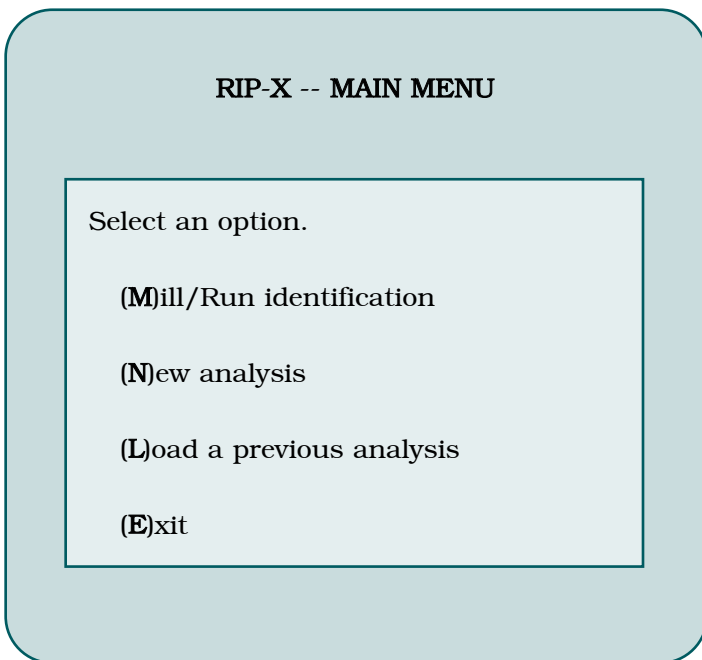


Figure 3. MAIN MENU

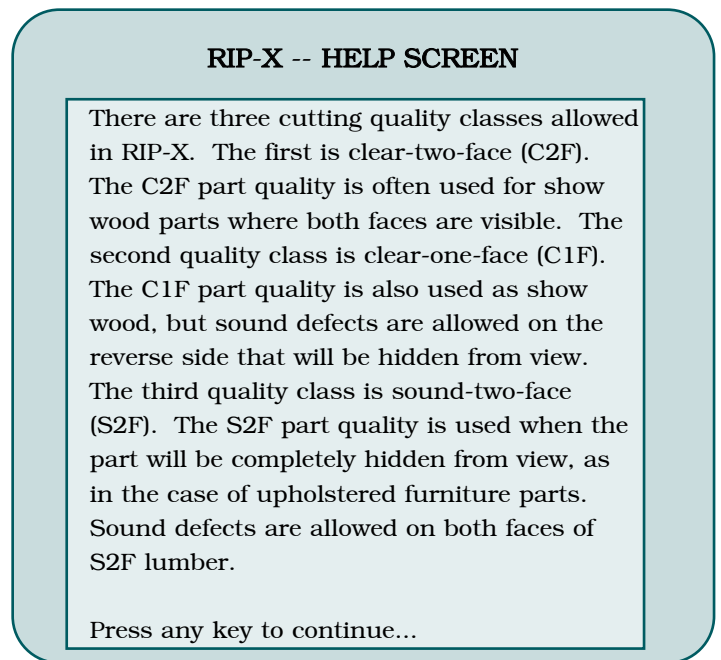


Figure 4. HELP SCREEN Example

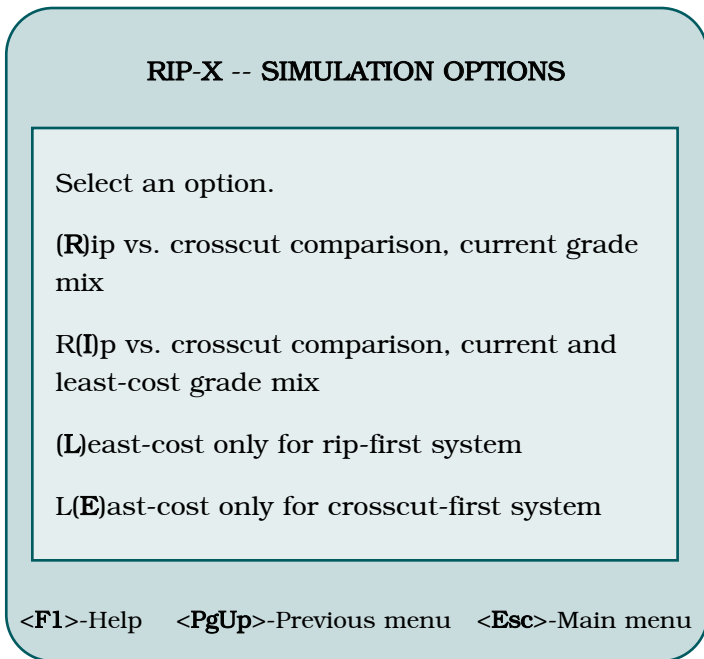


Figure 5. SIMULATION OPTIONS screen

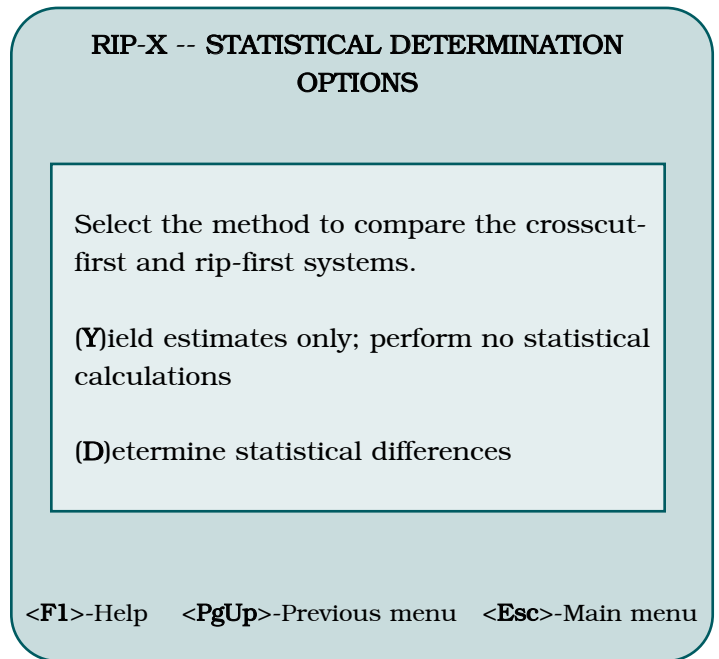


Figure 6. STATISTICAL DETERMINATION OPTIONS screen

6.3 SIMULATION OPTIONS. The SIMULATION OPTIONS screen (Figure 5) consists of four options that allow you to select the simulation option that you want RIP-X to run. If the first option, *Rip vs. crosscut comparison, current grade mix*, is chosen, RIP-X will compare rip-first to crosscut-first system yields for the current grade mix. The least-cost grade mix will not be determined if this option is chosen. If the second option, *Rip vs. crosscut comparison, current and least-cost grade mix*, is chosen, RIP-X will determine both the current grade mix yields and the least-cost grade mix for both the rip-first and crosscut-first systems. The cost of the current grade mix and the cost of the least-cost grade mix will also be compared. If the third option, *Least-cost only for rip-first system*, is chosen, RIP-X will only determine the least-cost grade mix for the rip-first system. If the fourth option, *Least-cost only for crosscut-first system*, is chosen, RIP-X will only determine the least-cost grade mix for the crosscut-first system. To select an option, press the highlighted character associated with that option. For the tutorial, press **I** for the *Rip vs. crosscut comparison, current and least-cost grade mix* option. The RIP-X least-cost linear programming solution follows the method described by Harding et al. (4) and Hanover et al.(3).

6.4 STATISTICAL DETERMINATION OPTIONS. The STATISTICAL DETERMINATION OPTIONS screen (Figure 6) allows choice of one of two options to specify whether or not you want RIP-X to per-

form statistical tests that will compare the yields of the crosscut-first and rip-first systems.

If the first option, *Yield estimates only; perform no statistical calculations*, is chosen, RIP-X will compute the yields for the crosscut-first and rip-first systems and no statistical tests will be performed. If the second option, *Determine statistical differences*, is chosen, RIP-X will compute the yield for each system and will determine if there is a statistical difference between the yields.

For the tutorial, press **D** to determine if there is a statistical difference between the yields of the two systems.

6.5 PARTS DESCRIPTION. Information about the parts in the cutting order must be entered in the PARTS DESCRIPTION screen (Figure 7).

The first line of the PARTS DESCRIPTION screen prompts you to specify the lumber thickness of the cutting order. The valid range for the lumber thickness is between 3/4 and 10/4 inches. The lumber thickness must be specified in integer values. For example, to specify 3/4 lumber thickness, enter 3; to specify 4/4 lumber thickness, enter 4; and so on. For this tutorial, 4/4 lumber thickness will be used, so enter **4** on the first line.

The second line of the PARTS DESCRIPTION screen allows you to specify the cutting quality class. The cutting quality class represents the quality of both faces of the final parts. There are three cutting quality classes considered by RIP-X: clear-two-face (C2F),

clear-one-face (C1F), and sound-two-face (S2F). Clear-two-face requires that all parts be free of defects on both sides. Clear-one-face requires that one side of the parts be free of defects and the reverse side free of unsound defects. Sound-two-face allows sound defects on both sides of the parts. The cutting quality class for this tutorial is clear-one-face, so enter **C1F** on the second line.

RIP-X also allows you to specify any defects that are allowed in the rough parts regardless of the specified part quality class. The third line of the PARTS DESCRIPTION screen prompts you to specify whether any defects will be allowed in the parts. If defects will be allowed, enter **Y** on the third line. Otherwise, enter **N**. For the tutorial, sound knots not exceeding 0.5 inch will be allowed in the parts, so enter **Y**. To continue the program, press the **PgDn** key.

6.6 ALLOWABLE DEFECTS. There are thirteen defect types categorized in RIP-X:

bark pocket	check	decay
grubhole	hole	mineral streak
pith	sound knot	stain
unsound knot	wane	wormhole
split		

If any of these defects are allowed in the rough parts, you must specify those defects and, when applicable, the maximum allowable size of each. The ALLOWABLE DEFECTS screen is given in Figure 8.

To select a particular defect to be allowed in both faces of the parts, use the arrow keys to move the highlighted bar over the defect name and press the **Enter** key. The defect name will then be highlighted indicating

that this defect will be allowed in the parts. Pressing the **Enter** key works as a toggle to select and deselect defects to be allowed in the parts. To deselect any defect type which has been previously selected, move the highlighted bar over the highlighted defect name and press the **Enter** key. The highlighted defect name will return to its normal brightness and the defect will not be allowed in the parts.

For certain defect types allowed in the parts, you must enter a size constraint. These defects include bark pockets, holes, unsound knots, wane, grubholes, sound knots, and wormholes. If any of these defects are selected to be allowed in the parts, RIP-X will prompt you to enter the maximum size allowed for that defect.

For some defects, no size constraint is possible. These defects are stain, checks, split, decay, and pith. If any of these defects are allowed in the parts, all occurrences of that particular defect will be allowed. For example, if stain is allowed in the parts, all stain defects will be included and you will not be permitted to specify a maximum size of stain allowed in the parts.

Mineral streak is not considered a defect by the National Hardwood Lumber Association grading rules. For this reason, all occurrences of mineral streak are allowed in the parts and the mineral streak defect name will initially be highlighted. If, however, you wish to exclude mineral streak from the parts, turn off the highlighted defect name for mineral streak by using the **Enter** key as a toggle as previously described.

For this tutorial, sound knots not exceeding 0.5 inch in diameter will be allowed in the parts. Therefore, select sound knots from the ALLOWABLE DEFECTS screen. When RIP-X prompts you for the maximum size of sound knot allowed, enter 0.5. Press the **PgDn**

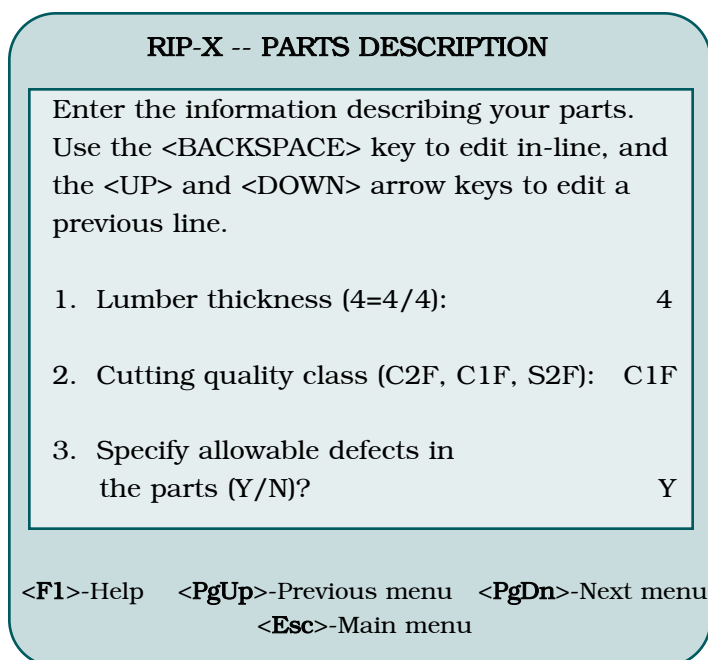


Figure 7. PARTS DESCRIPTION screen

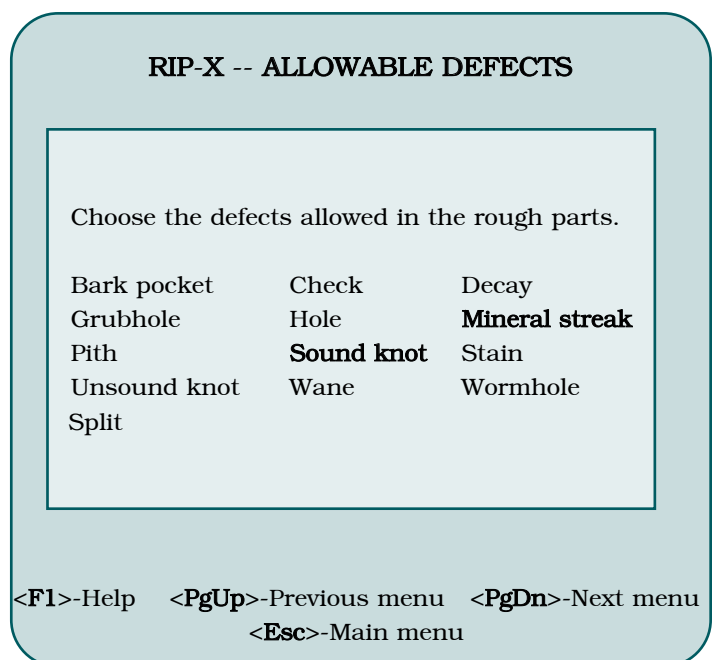


Figure 8. ALLOWABLE DEFECTS screen

RIP-X -- FIXED WIDTH CUTTING ORDER EDITOR						
	Length	Width	Panel?	Salvage?	No.	Editor Keys
1.	12.5	1.00	N	Y	2000	F1 - Help
2.	15.75	1.25	N	Y	1540	F2 - Next
3.	24.75	3.50	N	Y	1250	editor page
4.	35.5	2.75	N	Y	1000	Del - Clear
5.	48.75	3.00	N	Y	900	entire line
6.	85.0	3.75	N	Y	600	↓ ↑ → ← -
7.						Move bet-
8.						ween fields
9.						PgUp - Pre-
10.						vious menu
11.						PgDn - Next
12.						menu
13.						Esc - Main
14.						menu

Figure 9. FIXED WIDTH CUTTING ORDER EDITOR screen

RIP-X -- SALVAGE WIDTH SPECIFICATION

Enter the minimum and maximum widths for the salvage pieces.

Minimum salvage width: 1

Maximum salvage width: 3.75

<F1>-Help <PgUp>-Previous menu <PgDn>-Next menu
 <Esc>-Main menu

Figure 10. SALVAGE WIDTH SPECIFICATION screen

size of sound knot allowed, enter 0.5. Press the **PgDn** key to continue.

6.7 FIXED WIDTH CUTTING ORDER EDITOR.

The FIXED WIDTH CUTTING ORDER EDITOR screen (Figure 9) allows you to enter cutting order part information. Thirty rows are available to enter the information for a maximum of 30 parts. The information which must be entered on each row for a part is: the part length in inches (not to exceed 120 inches), the part width in inches (must be less than 7 inches for those parts which are not panel parts; there is no width limitation for panel parts), whether or not random width panel parts will be cut, whether or not random width salvage parts will be salvaged, and the number of parts needed. If panel parts will be cut to make a particular part, enter **Y** under the "Panel" column. Otherwise, enter **N**. If you want random widths of a particular part length to be salvaged for later use in fixed length panels, enter **Y** under the "Salvage" column. Otherwise, enter **N**.

To specify the cutting order information for the tutorial, enter the data shown in Figure 9. As you enter the data, notice that the cursor moves automatically to the next entry column. If you make an entry error in an earlier column, you can move between the columns using the arrow keys and retype the data. Special keys to control editing are listed on the right-hand side of the editor screen. After all entries for the cutting bill are complete, press the **PgDn** key to continue.

6.8 SALVAGE WIDTH SPECIFICATION. After entering the data for the cutting order, the SALVAGE WIDTH SPECIFICATION screen (Figure 10) will appear if you specified in the FIXED WIDTH CUTTING ORDER EDITOR screen (Figure 9) that salvage pieces are to be cut for at least one part length. This screen will prompt you to enter the minimum and maximum widths allowed for salvage pieces. For the tutorial, enter the values shown in Figure 10. Press the **PgDn** key to continue.

6.9 CURRENT GRADE MIX PERCENTAGES.

The CURRENT GRADE MIX PERCENTAGES screen (Figure 11) allows you to specify the percentage volume of each grade comprising the current grade mix. The sum of the entered percentages must total to 100%. For the tutorial, enter **40%** for FAS lumber, **30%** for F1F lumber, and **30%** for 1C lumber. Press the **PgDn** key to continue.

6.10 LUMBER GRADE MIX SORTING METHOD.

The LUMBER GRADE MIX SORTING METHOD screen (Figure 12) is used to specify the sorting method for the lumber of the current grade mix. The lumber can be processed by either of two sorting methods. The first method, *Sorted lumber grades*, selects boards of the higher grades to be processed first. This method allows the larger parts to be cut from the higher grades. For the second sorting method, *Lumber grades mixed*, RIP-X selects a random mix of lumber from your

RIP-X -- CURRENT GRADE MIX PERCENTAGES

Enter the percentage of each grade in the current grade mix for this cutting order. If a grade is not used, leave a blank line.

FAS:	40	F1 - Help
F1F:	30	↓ ↑ - Move between fields
Selects:		PgUp -Previous menu
No. 1 Common:	30	PgDn - Next menu
No. 2A Common:		Esc - Main menu
No. 3A Common:		

Figure 11. CURRENT GRADE MIX PERCENTAGES screen

RIP-X -- LUMBER GRADE MIX SORTING METHOD

Select your lumber grade mix sorting method.

(S)orted lumber grades; larger parts from the higher grades

(L)umber grades mixed

<F1>-Help <PgUp>-Previous menu <Esc>-Main menu

Figure 12. LUMBER GRADE MIX SORTING METHOD screen

specified lumber grades.

Choose your sorting method by pressing the highlighted character corresponding to that method. For the tutorial, choose the *Sorted lumber grades* option by pressing **S**.

6.11 LEAST-COST LUMBER GRADE AVAILABILITY. The LEAST-COST LUMBER GRADE AVAILABILITY screen (Figure 13) allows specification of any possible constraints on the availability of lumber grades for the least-cost determination process. You may select any combination of the six lumber grades for consideration in the least-cost grade mix. The lumber grades that may be specified are First and Seconds (FAS), First and Seconds One Face (F1F), Selects (SEL), Number 1 Common (1C), Number 2A Common (2AC), and Number 3A Common (3AC).

Choosing a lumber grade in the LEAST-COST LUMBER GRADE AVAILABILITY screen does not necessarily mean that the grade will be present in the least-cost grade mix. RIP-X considers all lumber grades that are chosen from the LEAST-COST LUMBER GRADE AVAILABILITY screen. Lumber grades are chosen for consideration by entering a **U** for an unlimited volume or by entering the available lumber volume in board feet for the grades you wish to consider. If you do not want RIP-X to consider a grade, a zero should be entered for that grade's volume. At least one lumber grade must be cho-

sen before RIP-X will leave the LEAST-COST LUMBER GRADE AVAILABILITY screen.

When the LEAST-COST LUMBER GRADE AVAILABILITY screen is initially invoked, a **U** will already be present on the screen for each lumber grade indicating that each of the six grades will be available in an unlimited volume. To change the volume amount of any grade, use the up and down arrow keys to move the cursor to that grade and enter the new value.

For determination of the true least-cost grade mix, a **U** should be entered for all available lumber grades. Specifying an unlimited volume for a grade means that this grade will be used to produce parts as long as it is cost effective to do so. Constraints placed on the availability of a grade will probably result in a sub-optimal solution. In the southern U.S. the SEL lumber grade is seldom available. Therefore, for this tutorial, allow all grades except SEL to be available in an unlimited volume by specifying a **U** for their volume. The SEL lumber grade will not be available for this tutorial run, so enter **0** for this grade's volume. When all values have been entered, press the **PgDn** key to continue.

6.12 SYSTEM COST DIFFERENCES. The SYSTEM COST DIFFERENCES screen (Figure 14) consists of two options. The first option, *No difference in cost between the two systems*, should be chosen if you do not want to enter different costs for the crosscut-first and rip-first systems. If this option is chosen, the PRODUCTION AND OVERHEAD COSTS screen (Figure 15) will appear, allowing you to enter the associated costs. The second option, *Enter different costs for the two systems*, should be chosen if you want to enter separate costs for the two systems. If this option is chosen, the PRODUCTION AND OVERHEAD COSTS screen (Figure 15) will appear once for the crosscut-first system and once for the rip-first system, allowing you to enter separate costs for each.

For the tutorial, enter **N** for *No difference in cost between the two systems*.

6.13 PRODUCTION AND OVERHEAD COSTS. The PRODUCTION AND OVERHEAD COSTS screen (Figure 15) will prompt you to enter the total lumber cost for each lumber grade that you specified in the LEAST-COST LUMBER GRADE AVAILABILITY screen (Figure 13). The lumber costs must be specified in per MBF terms, where MBF denotes 1,000 board feet. The lumber costs consist of the production and overhead costs which might affect the manufacturing costs of producing

the parts. Production costs might include, but are not restricted to, the labor, capital, and overhead costs required to produce the finished rough parts. Other costs could be storage and handling or any other cost which is believed to influence the cost of producing the parts. Typically, the higher grades of lumber can be processed at lower labor and capital cost than the lower grades because of decreased handling time required to cut the parts. The magnitude of these costs for each grade will have considerable influence on the least-cost grade mix results. For this reason an effort should be made to get a reasonably accurate estimate of by-grade production costs. Simply using the lumber costs as total costs will bias the least-cost results toward the lower lumber grades because these lower grades take substantially more time to process. This increased processing time translates into higher labor, capital, and overhead costs.

At the appropriate highlighted prompt enter the total production cost in dollars per MBF for each of the specified grades. For the tutorial, enter the costs given in Figure 15. RIP-X will not allow you to leave this screen until a cost has been entered for each lumber grade previously specified as available in the LEAST-COST LUMBER GRADE AVAILABILITY screen (Figure 13). Press **PgDn** when all of the costs have been entered.

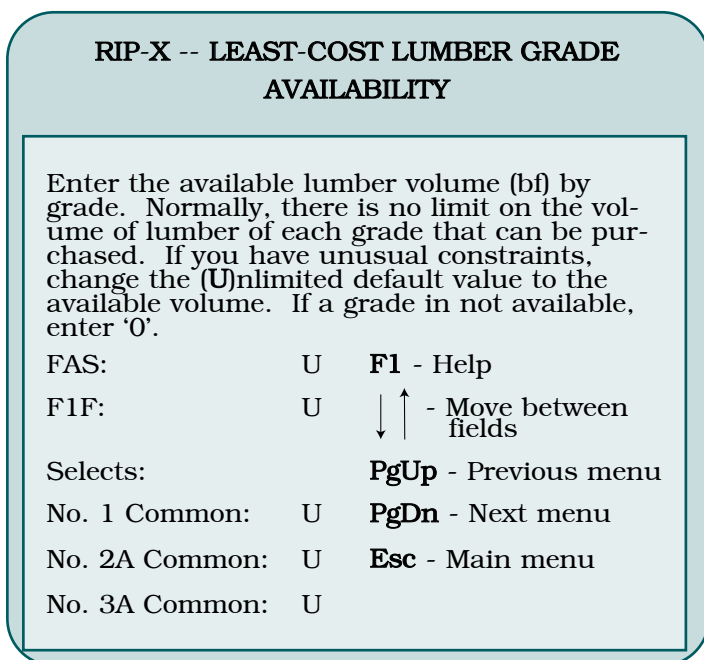


Figure 13. LEAST-COST LUMBER GRADE AVAILABILITY screen

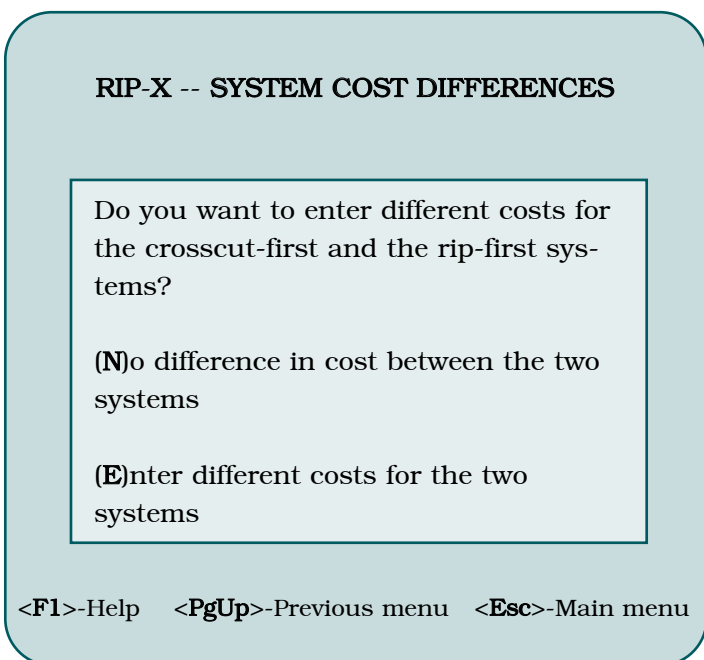


Figure 14. SYSTEM COST DIFFERENCES screen

RIP-X -- PRODUCTION AND OVERHEAD COSTS

Enter the cost per MBF for each lumber grade below. Production costs typically include labor, capital, and overhead costs.

FAS	1355	F1 - Help
F1F	1255	↓ ↑ - Move between fields
No. 1 Common:	885	PgUp - Previous menu
No. 2A Common:	635	PgDn - Next menu
No. 3A Common:	555	Esc - Main menu

Figure 15. PRODUCTION AND OVERHEAD COSTS screen

RIP-X -- SAVE DATA

This is the end of the data entry screens.

PgDn - Continue without saving input data

PgUp - Return to previous menu

S - Save input data

Figure 16. SAVE DATA screen

6.14 SAVE DATA. The SAVE DATA screen (Figure 16) consists of three options: *Continue without saving input data*, *Return to previous menu*, and *Save input data*.

Saving the input data will allow the cutting order information which you have entered to be retrieved and used rather than requiring you to re-enter this information when making a subsequent RIP-X run that requires similar information. To save the input data press **S** and enter a file name at the prompt. The file name must be 1 to 8 characters in length. Enter only the file name and not the extension. The file name is the portion of the name appearing before the period (.). The extension, which is the portion appearing after the period, will be added by RIP-X.

If you want to continue without saving the input data, press the **<PgDn>** key. You will be asked to confirm that you do not want to save the input data.

For the tutorial, save the data by pressing **S** and enter a file name. It is recommended to use a file name that is unique to the current cutting order. For example, if the cutting order is for a specific type of chair, you may want to use the model number of the chair as the file name.

6.15 SAVE LEAST-COST INFORMATION. An option to save the least-cost information from the least-cost grade mix run is available in the SAVE LEAST-COST INFORMATION screen (Figure 17). By saving the least-cost information, you will be able to retrieve this data for a subsequent RIP-X run. The least-cost information can be used for the new run if you only want to change the lumber costs. You cannot enter new lumber grades in a new run based on the saved data because the yields for the new grade have not been determined. If you want to save the least-cost information, press **Y** at the prompt. If you do not want to save the information, press **N**. This option is only available if you saved the input data in the SAVE DATA screen (Figure 16). For the tutorial, press **Y**.

6.16 TERMINATE OR CONTINUE. The TERMINATE OR CONTINUE screen (Figure 18) consists of two options: *Return to the main menu* and *Begin lumber cut-up process*. You can return to the MAIN MENU screen by pressing the **<Esc>** key if for some reason you have decided to discontinue the current run. If you return to the MAIN MENU screen, however, all data previously entered will be lost unless they were saved earlier in the SAVE DATA screen (Figure 16). You can begin the lumber cut-up process by pressing the **PgDn** key. For the tutorial, press the **PgDn** key.

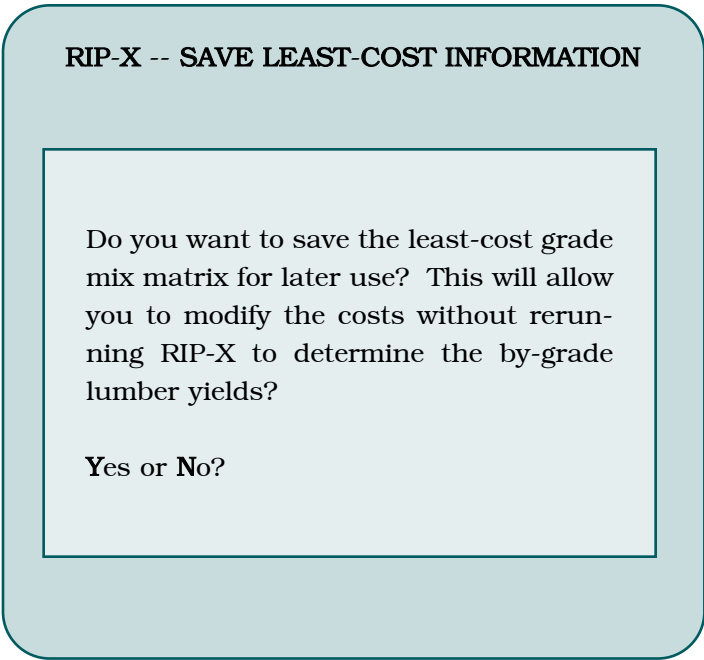


Figure 17. SAVE LEAST-COST INFORMATION screen

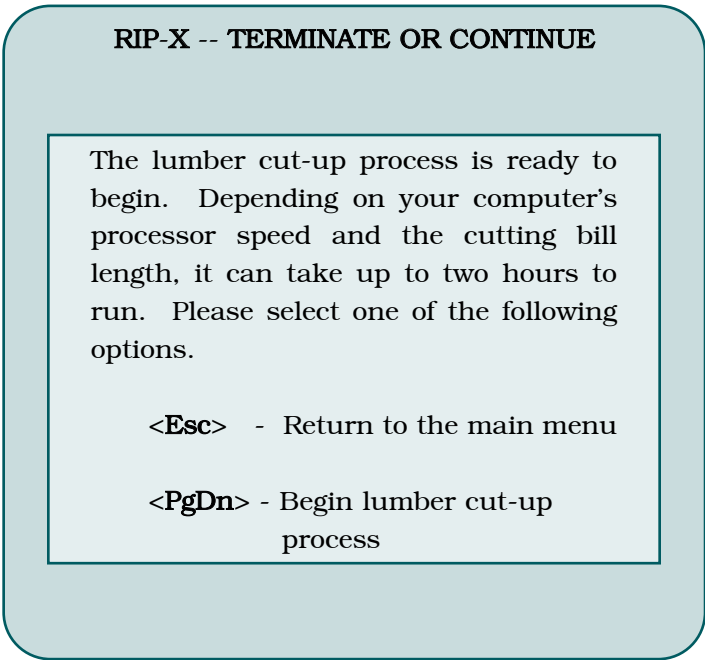


Figure 18. TERMINATE OR CONTINUE screen

6.17 CURRENT GRADE MIX SIMULATION. If the *Rip vs. crosscut comparison, current grade mix* option or the *Rip vs. crosscut comparison, current and least-cost grade mix* option was chosen in the SIMULATION OPTIONS screen (Figure 5), RIP-X will determine the yield for each lumber grade of the current grade mix for both the crosscut-first and rip-first systems. When this simulation has finished, the CURRENT GRADE MIX

RESULTS screen (Figure 19) will appear. This screen gives the yield of each lumber grade in the current grade mix as well as the overall yield for the current grade mix for both the crosscut-first and rip-first systems. If you chose the *Determine statistical differences* option in the STATISTICAL DETERMINATION OPTIONS screen (Figure 6), RIP-X will print a line at the bottom of the CURRENT GRADE MIX RESULTS screen indicating

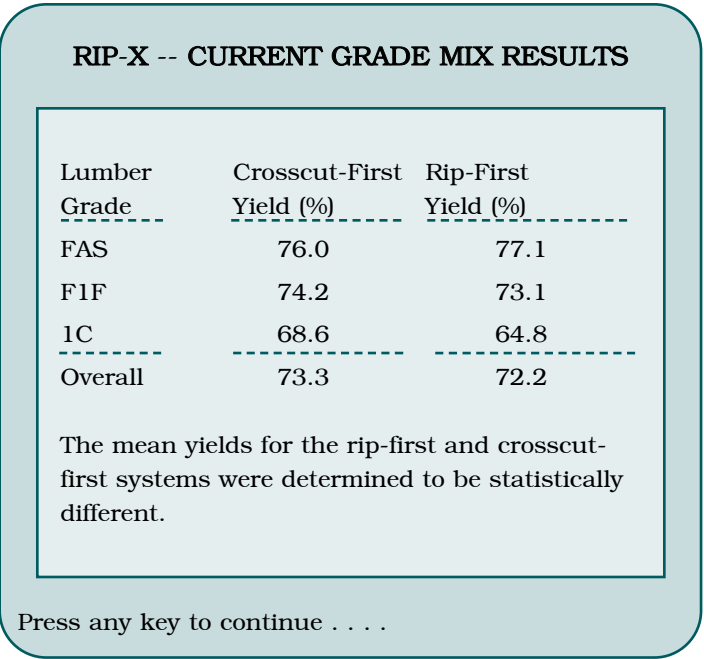


Figure 19. CURRENT GRADE MIX RESULTS screen

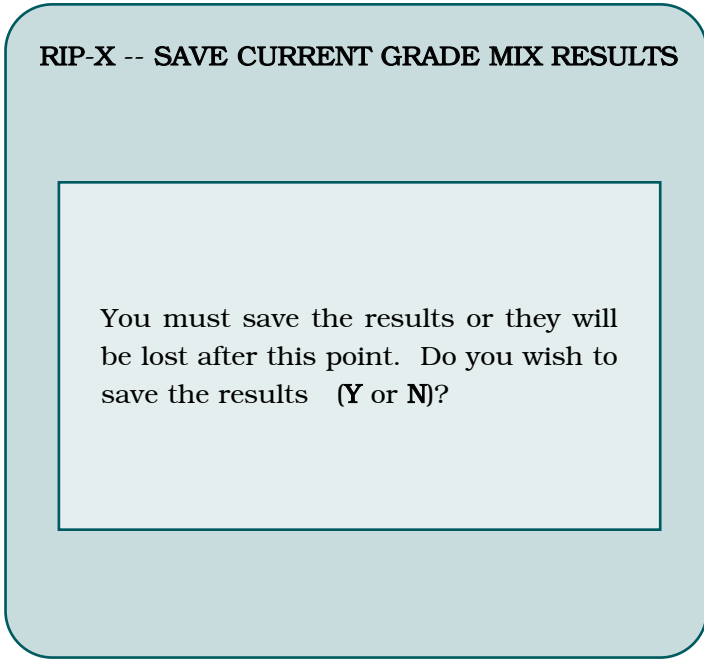


Figure 20. SAVE CURRENT GRADE MIX RESULTS screen

whether or not the overall yields between the two systems differed statistically.

Note that the digitally described boards used for the current grade mix simulation are chosen randomly from the board database. Therefore, the yields obtained for the current grade mix simulation will vary slightly for each individual RIP-X run.

After you have examined the results, press any key and RIP-X will advance to the SAVE CURRENT GRADE MIX RESULTS screen (Figure 20). This screen allows you to save the current grade mix results to an external file. If you want to save the results, press **Y** at the given prompt. RIP-X will then prompt you to enter a file name. If you do not want to save the results, press **N** at the prompt. If a key is not pressed within 10 minutes while in the CURRENT GRADE MIX RESULTS screen, RIP-X will automatically save the current grade mix results to the external file **CURRENT.TMP**. This feature provides automatic storage of the output file.

6.18 LEAST-COST GRADE MIX DETERMINATION. After RIP-X has completed the current grade mix simulation and you have responded to the subsequent prompts, RIP-X will begin the least-cost grade mix determination process for the crosscut-first system, provided the least-cost grade mix option was chosen in the SIMULATION OPTIONS screen (Figure 5). During this process, RIP-X will determine the yields of each lumber

grade specified for the least-cost grade mix. The linear programming model will then determine the least-cost grade mix.

After the least-cost grade mix determination process has completed for the crosscut-first system, several output screens will be sent to the monitor. These output screens give the least-cost grade mix solution for the crosscut-first system. Examples of these screens are given in Figures 21, 22, and 23. After you have examined the contents of a particular output screen, press any key to proceed to the next output screen.

After you have viewed all output screens, RIP-X will prompt you to save the least-cost results. Respond appropriately to this prompt as discussed in the above section.

If no key is pressed within 10 minutes from the first output screen, RIP-X will automatically save the least-cost results to the external file **LCXCUT.TMP**. RIP-X will then begin the least-cost determination process for the rip-first system.

The steps involved in the least-cost determination process for the rip-first system are the same as those for the crosscut-first system. After the rip-first system portion of the run has completed, several output screens will be sent to the monitor. If no key is pressed from the first output screen within 10 minutes, RIP-X will automatically save the least-cost results to the external file **LCRIP.TMP**.

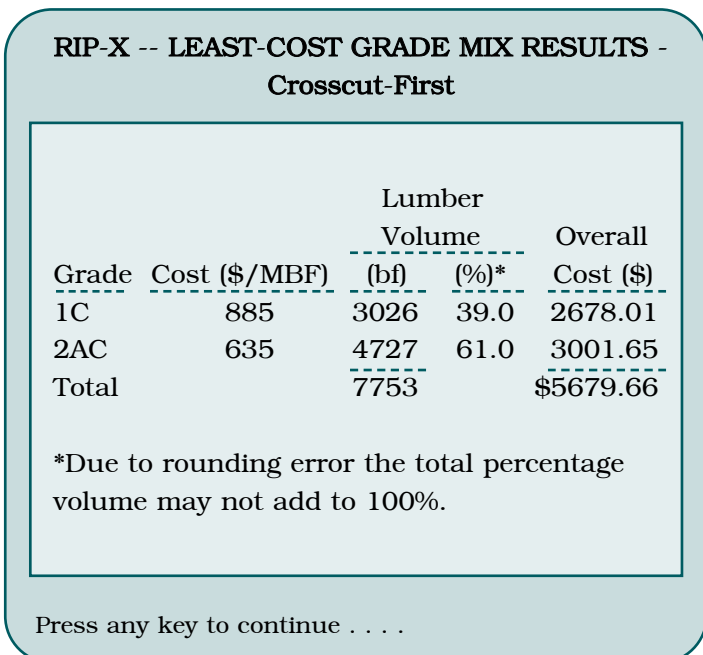


Figure 21. LEAST-COST GRADE MIX RESULTS screen

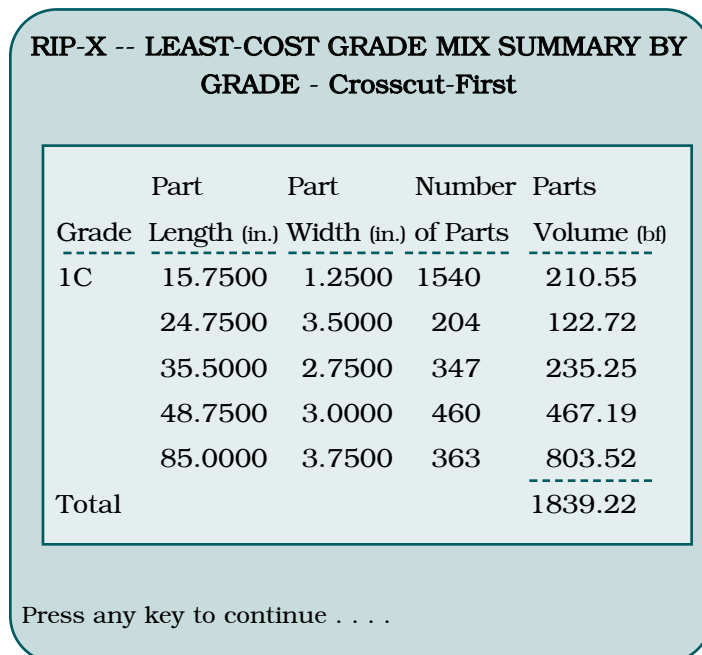


Figure 22. LEAST-COST GRADE MIX SUMMARY BY GRADE for 1C lumber

RIP-X -- LEAST-COST GRADE MIX SUMMARY BY GRADE - Crosscut-First

Grade	Part Length (in.)	Part Width (in.)	Number of Parts	Parts Volume (bf)
2AC	12.5000	1.0000	2000	173.61
	24.7500	3.5000	1046	629.23
	35.5000	2.7500	653	442.70
	48.7500	3.0000	440	446.88
	85.0000	3.7500	237	524.61
Total				2217.03

Press any key to continue

Figure 23. LEAST-COST GRADE MIX SUMMARY BY GRADE for 2AC lumber

RIP-X -- LOAD PREVIOUS ANALYSIS OPTIONS

Select the load option you wish to use.

(O)pen a saved data file

(A)adjust the least-cost lumber costs

<F1>-Help <PgUp>-Previous menu <Esc>-Main menu

Figure 24. LOAD PREVIOUS ANALYSIS OPTIONS screen

6.19 SAMPLE OUTPUT RESULTS. Appendix B contains a sample printout of the results obtained by RIP-X for the tutorial run. The first page describes the cutting order and the available lumber grades and their associated costs for the least-cost grade mix determination. The second and third pages give the current grade mix yield results for the crosscut-first and rip-first systems. The fourth page gives a table which summarizes the yield results for both systems. The remaining pages give the least-cost grade mix results for both the crosscut-first and rip-first systems. For each system they consist of one page summarizing, for each lumber grade in the least-cost grade mix, the lumber volumes, production costs, and percentage yields along with a sensitivity analysis cost-range table; two pages describing the total number and volume of parts cut by lumber grade; and one page which compares the cost of producing the current grade mix to that of the least-cost grade mix.

The sensitivity analysis cost-range table which is printed in the output results allows you to determine when the least-cost results are no longer valid. If the costs are within the specified ranges, the indicated least-cost grade mix is valid. If future costs fall outside one of the specified ranges for any grade, a new least-cost grade mix should be determined. This can be accomplished by rerunning the simulation or by choosing the *Adjust the least-cost lumber costs* option described in Section 7.

It is also a good practice to examine the range of sensitivity values for each lumber grade before making

actual grade-mix decisions. If a grade would leave or enter the solution as a result of a very minor cost change, the decision to either include or exclude this grade should be examined closely. A large difference between the current lumber cost and the minimum and maximum costs indicates that the recommendation for that grade is valid for wide fluctuations in total lumber production cost.

7. RUNNING A PREVIOUS ANALYSIS

The *Load a previous analysis* option in the MAIN MENU screen (Figure 3) allows you to load, modify and run an analysis that you have previously created and saved to disk, or modify a least-cost grade mix that has been saved to disk. If this option is chosen, RIP-X will advance to the *Load Previous Analysis Options* screen.

The *Load Previous Analysis Options* screen (Figure 24) consists of two options: *Open a saved data file* and *Adjust the least-cost lumber costs*.

7.1 OPEN A SAVED DATA FILE. When the *Open a saved data file* option is chosen, RIP-X checks the RIP-X directory for previously saved input data files. A listing of all such files will be printed to the screen, and you may select the desired file. After you have selected an input data file, RIP-X will move through the same series of screens which were described in Section 6 for the *New analysis* option.

7.2 ADJUST THE LEAST-COST LUMBER

COST. When the *Adjust the least-cost lumber costs* option is chosen, RIP-X will advance to the PREVIOUS LEAST-COST RUN OPTIONS screen (Figure 25). This screen will prompt you to specify either the rip-first or crosscut-first system, for which the previously saved least-cost run will be made. If the rip-first system is chosen, RIP-X will check the RIP-X directory for previously saved rip-first least-cost grade mix files. If the crosscut-first system is chosen, RIP-X will check the RIP-X directory for previously saved crosscut-first least-cost grade mix files. A listing of all appropriate files will then be printed on the screen allowing you to select the desired file. After you have selected a least-cost grade mix file, RIP-X will advance to the PRODUCTION AND OVERHEAD COSTS screen (Figure 15). This screen will allow you to change the cost per MBF for each available lumber grade.

To determine the new least-cost grade mix, press the **PgDn** key from the PRODUCTION AND

OVERHEAD COSTS screen. The results for the new least-cost grade mix will appear on the monitor. The screens which give these results will be similar to Figures 21, 22, and 23. RIP-X will also allow you to save the new least-cost grade mix results.

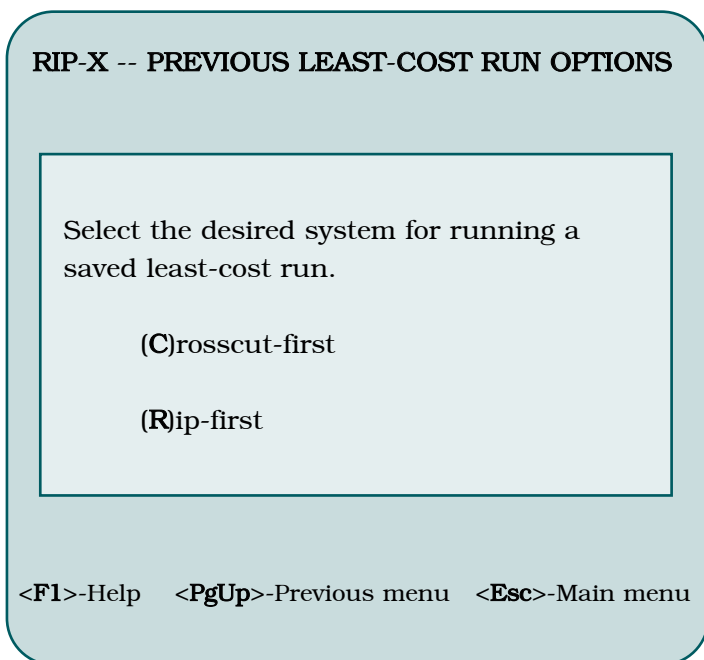


Figure 25. PREVIOUS LEAST-COST RUN OPTIONS screen

Literature Cited

1. Applied Automated Engineering Services. 1990. LPS-867 User's Guide. 54 p. Pennington, NJ.
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3. Hanover, S. J., A. G. Mullin, W. L. Hatley, and R.K. Perrin. 1973. Linear programming and sensitivity analysis for hardwood dimension production. *Forest Products Journal* 23(11):47-50.
4. Harding, O. V., and P. H. Steele. 1997. RIP-X: Decision software to compare crosscut-first and rip-first rough mill software. *Wood Science and Technology* 31(5):367-381.
5. Microsoft Corp. 1989. Microsoft BASIC Professional Development System, Version 7.0. Redmond, WA.

Appendix A

Advance Data Worksheet

Cutting Bill Information

Lumber thickness : _____

Cutting quality class (C2F, C1F, S2F) : _____

Allowable defects in parts (y/n) ? : _____

Current grade mix sorting method (sorted/mixed) : _____

Allowable Defects Specification

_____ Bark pocket	Maximum length : _____
_____ Grub hole	Maximum diameter : _____
_____ Pith	
_____ Unsound knot	Maximum diameter : _____
_____ Split	
_____ Check	
_____ Hole	Maximum diameter : _____
_____ Sound knot	Maximum diameter : _____
_____ Wane	Maximum width : _____
_____ Decay	
_____ Stain	
_____ Worm hole	Maximum diameter : _____

Appendix B

Tutorial Results

Input Summary for Tutorial

Cutting order:

Lumber Thickness: 4/4

Date: 08-04-2000

Cutting Quality: CIF

Current Grade Mix Sorting Method: lumber grades sorted

Current Grade Mix Percentages: FAS: 40.0%
 F1F: 30.0%
 1C: 30.0%

Minimum Salvage Width: 1.00 in.

Maximum Salvage Width: 3.75 in.

Length (in)	Width (in)	Panel	Salvage	Number of Parts	Parts Volume (bf)
12.5000	1.0000	N	Y	2000	173.61
15.7500	1.2500	N	Y	1540	210.55
24.7500	3.5000	N	Y	1250	751.95
35.5000	2.7500	N	Y	1000	677.95
48.7500	3.0000	N	Y	900	914.06
85.0000	3.7500	N	Y	600	1328.13
				----- 7290	----- 4056.25

Available Lumber Grades for Least-Cost Grade Mix Determination:

Grade	Cost (\$/MBF)	Volume Constraints
FAS	1355	None
F1F	1255	None
1 Common	885	None
2A Common	635	None
3A Common	555	None

Allowable Defects:

Mineral Streak : all mineral streak defects allowed.

Sound Knot : maximum diameter of sound knot allowed - .5 in.

Current Grade Mix Results for Tutorial
Crosscut-First

Fixed parts:

Grade	Lumber Volume		Parts Volume (bf)	Percent Yield (%)
	(bf)	(%)*		
FAS	2481	40.1	1878.44	75.7
F1F	1889	30.5	1236.86	65.5
1C	1814	29.3	940.95	51.9
Total	6184		4056.25	

Overall yield without salvage: 65.6%

* Due to rounding error the total percentage volume may not add to 100%.

Salvage parts:

Grade	Parts Volume (bf)
FAS	6.73
F1F	163.85
1C	303.65
Total	474.22

Combined fixed and salvage parts:

Grade	Lumber Volume (bf)	Parts Volume (bf)	Percent Yield (%)
	FAS	2481	1885.17
F1F	1889	1400.71	74.2
1C	1814	1244.60	68.6
Total	6183	4530.48	

Overall yield with salvage: 73.3%

Current Grade Mix Results for Tutorial
Rip-First

Fixed parts:

Grade	Lumber Volume		Parts Volume (bf)	Percent Yield (%)
	(bf)	(%)*		
FAS	2471	39.8	1898.26	76.8
F1F	1882	30.3	1222.32	65.0
1C	1860	29.9	935.67	50.3
Total	6213		4056.25	

Overall yield without salvage: 65.3%

* Due to rounding error the total percentage volume may not add to 100%.

Salvage parts:

Grade	Parts Volume (bf)
FAS	7.41
F1F	153.07
1C	269.67
Total	430.14

Combined fixed and salvage parts:

Grade	Lumber Volume (bf)	Parts Volume (bf)	Percent Yield (%)
FAS	2471	1905.67	77.1
F1F	1882	1375.39	73.1
1C	1860	1205.34	64.8
Total	6213	4486.40	

Overall yield with salvage: 72.2%

RIP-Xcut Analysis for Tutorial

The following table summarizes the percentage yields by lumber grade of the crosscut-first and rip-first systems for the current grade mix.

Lumber Grade	Crosscut-First Yield(%)	Rip-First Yield (%)
FAS	76.2	77.1
F1F	74.2	73.1
1C	68.6	64.8
Overall	73.3	72.2

The mean yields for the rip-first and crosscut-first systems were determined to be statistically different.

**Least-Cost Grade Mix for Tutorial
Crosscut-First**

Grade	Cost (\$/MBF)	Lumber Volume		Parts Volume (bf)	Production Costs (\$/MBF)	Percent Yield
		(bf)	(%)*			
FAS	1355.00	0	0.0	0.00	0.00	0.00
F1F	1255.00	0	0.0	0.00	0.00	0.00
1C	885.00	3026	39.0	1839.22	2678.01	60.8
2AC	635.00	4727	61.0	2217.03	3001.65	46.9
3AC	555.00	0	0.0	0.00	0.00	0.00
Total		7753		4056.25	\$5679.66	

*Due to rounding error the total percentage volume may not add to 100%.

Overall yield: 52.3%

**Sensitivity Analysis
Crosscut-First**

The least-cost grade mix estimates provided have been tested by a sensitivity analysis to determine the price ranges for which they remain valid. These price ranges are as follows:

Grade	Cost (\$/MBF)	
FAS	Maximum	+Infinity
	Current	1355.00
	Minimum	1128.34
F1F	Maximum	+Infinity
	Current	1255.00
	Minimum	995.47
1C	Maximum	997.04
	Current	885.00
	Minimum	790.12
2AC	Maximum	679.51
	Current	635.00
	Minimum	417.58
3AC	Maximum	+Infinity
	Current	555.00
	Minimum	515.80

**Least-Cost Grade Mix
Summary by Grade
Crosscut-First
Page: 1**

<u>Grade</u>	<u>Lumber Volume (bf)</u>	<u>Part Length (in.)</u>	<u>Part Width (in.)</u>	<u>Number of Parts</u>	<u>Parts Volume (bf)</u>
1C	3026				
		15.7500	1.2500	1540	210.55
		24.7500	3.5000	204	122.72
		35.5000	2.7500	347	235.25
		48.7500	3.0000	460	467.19
		85.0000	3.7500	363	803.52
Total					<u>1839.22</u>

**Least-Cost Grade Mix
Summary by Grade
Crosscut-First
Page: 2**

<u>Grade</u>	<u>Lumber Volume (bf)</u>	<u>Part Length (in.)</u>	<u>Part Width (in.)</u>	<u>Number of Parts</u>	<u>Parts Volume (bf)</u>
2AC	4727				
		12.5000	1.0000	2000	173.61
		24.7500	3.5000	1046	629.63
		35.5000	2.7500	653	442.70
		48.7500	3.0000	440	446.88
		85.0000	3.7500	237	524.61
Total					<u>2217.03</u>

**Least-Cost Grade Mix Results
Compared to Current Grade Mix Results
Crosscut-First**

Grade	Cost (\$/MBF)	Current Grade Mix		Least-Cost Grade Mix	
		Lumber Volume (bf)	Production Cost (\$)	Lumber Volume (bf)	Production Cost (\$)
FAS	1355	2481	3362	0	0
F1F	1255	1889	2371	0	0
1C	885	1814	1605	3026	2678
2AC	635	0	0	4727	3002
3AC	555	0	0	0	0
Total		6184	\$7338	7753	\$5680

Least-cost reduction in lumber costs: \$1658

Percentage cost reduction: 22.6%

**Least-Cost Grade Mix for Tutorial
Rip-First**

<u>Grade</u>	<u>Cost (\$/MBF)</u>	<u>Lumber Volume</u>		<u>Parts Volume (bf)</u>	<u>Production Costs (\$/MBF)</u>	<u>Percent Yield</u>
		<u>(bf)</u>	<u>(%)*</u>			
FAS	1355.00	0	0.0	0.00	0.00	0.00
F1F	1255.00	0	0.0	0.00	0.00	0.00
1C	885.00	2769	34.8	1488.18	2450.56	53.7
2AC	635.00	5187	65.2	2568.07	3293.74	49.5
<u>3AC</u>	<u>555.00</u>	<u>0</u>	<u>0.0</u>	<u>0.00</u>	<u>0.00</u>	<u>0.00</u>
Total		7956		4056.25	\$5744.31	

*Due to rounding error the total percentage volume may not add to 100%.

Overall yield: 51.0%

**Sensitivity Analysis
Rip-First**

The least-cost grade mix estimates provided have been tested by a sensitivity analysis to determine the price ranges for which they remain valid. These price ranges are as follows:

<u>Grade</u>	<u>Cost (\$/MBF)</u>	
FAS	Maximum	+ Infinity
	Current	1355.00
	Minimum	1137.74
F1F	Maximum	+Infinity
	Current	1255.00
	Minimum	990.86
1C	Maximum	998.62
	Current	885.00
	Minimum	809.75
2AC	Maximum	685.47
	Current	635.00
	Minimum	387.41
3AC	Maximum	+Infinity
	Current	555.00
	Minimum	509.22

**Least-Cost Grade Mix
Summary by Grade
Rip-First
Page: 1**

<u>Grade</u>	<u>Lumber Volume (bf)</u>	<u>Part Length (in)</u>	<u>Part Width (in)</u>	<u>Number of Parts</u>	<u>Parts Volume (bf)</u>
1C	2769	24.7500	3.5000	160	96.25
		35.5000	2.7500	327	221.69
		48.7500	3.0000	433	439.77
		85.0000	3.7500	330	730.47
Total					1488.18

**Least-Cost Grade Mix
Summary by Grade
Rip-First
Page: 2**

<u>Grade</u>	<u>Lumber Volume (bf)</u>	<u>Part Length (in)</u>	<u>Part Width (in)</u>	<u>Number of Parts</u>	<u>Parts Volume (bf)</u>
2AC	5187				
		12.5000	1.0000	2000	173.61
		15.7500	1.2500	1540	210.55
		24.7500	3.5000	1090	655.70
		35.5000	2.7500	673	456.26
		48.7500	3.0000	467	474.30
		85.0000	3.7500	270	597.66
Total					<u>2568.07</u>

**Least-Cost Grade Mix Results
Compared to Current Grade Mix Results
Rip-First**

Grade	Cost (\$/MBF)	Current Grade Mix		Least-Cost Grade Mix	
		Lumber Volume (bf)	Production Cost (\$)	Lumber Volume (bf)	Production Cost (\$)
FAS	1355	2471	3348	0	0
F1F	1255	1882	2362	0	0
1C	885	1860	1646	2769	2451
2AC	635	0	0	5187	3294
3AC	555	0	0	0	0
Total		6213	\$7356	7956	\$5745

Least-cost reduction in lumber costs: \$1611

Percentage cost reduction: 21.9%



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