USDA United States Department of Agriculture

Forest Service

Northeastern Forest Experiment Station

General Technical Report NE-229

# ROMI-CROSS: ROugh MIII CROSScut-First Simulator

R. Edward Thomas

## Abstract

The ROugh MIll CROSScut-first simulator (ROMI-CROSS) is a computer software package for IBM-compatible personal computers that simulates current industrial practices for crosscut-first lumber processing. This guide shows the user how to set up and examine the results of crosscut-first simulations of current or proposed mill practices. ROMI-CROSS accepts cutting bills with as many as 600 combined solid and/or panel part sizes. Plots of processed boards are easily viewed or printed, as are detailed summaries of processing data (number of crosscuts and rips) and yields for each grade.

## The Author

R. EDWARD THOMAS is a research computer scientist with the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Princeton, West Virginia. He received a B.S. degree in computer science and philosophy from Concord College in 1988 and an M.S. degree in computer science from West Virginia University in 1993. He joined the USDA Forest Service in 1988 and currently is engaged in the research, development and testing of rough-mill computer simulation programs.

Manuscript received for publication 28 August 1996

The computer program described in this publication is available upon request with the understanding that the U.S. Department of Agriculture cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Government-produced computer program.

For an executable copy of the program write to:

USDA FOREST SERVICE
FORESTRY SCIENCES LABORATORY
ATTN: EDWARD THOMAS
241 MERCER SPRINGS ROAD
PRINCETON, WV 24740

Published by:
USDA FOREST SERVICE
5 RADNOR CORP CTR STE 200
PO BOX 6775
RADNOR, PA 19087-8775

For additional copies:
USDA Forest Service
Publications Distribution
359 Main Road
Delaware, OH 43015

January 1997

## Contents

# 1. Introduction

ROMI-CROSS, the ROugh MIll CROSScut-first computer simulator, is the most recent crosscut-first rough-mill simulator from the USDA Forest Service. The ROMI-CROSS install disk contains sample runs, all required programs, the "1997 Data bank for Red Oak Lumber" [1] contains more than 3,000 digitized boards, and sample analysis runs. A digitized board is a real board whose dimensions and defects are expressed in x,y coordinates. A custom datafile creation utility allows you to create board samples corresponding to your lumber supply. ROMI-CROSS processes the board data according to your crosscut-first processing specifications. Outputs, including part counts and yields, graphs, and processing requirements, are available from each run. This guide shows you how to install and run ROMI-CROSS and design simulations for specific scenarios.

ROMI-CROSS was developed to accurately simulate current rough-mill crosscut-first processing practices, and to be compatible with the ROMI-RIP gang-rip-first simulator (Thomas 1995a, b). Meeting these needs allows accurate comparisons between gang-rip-first and crosscut-first processing. ROMI-CROSS allows the user to specify optimization strategies, part qualities, kerf sizes, and much more. It also can process cutting bills with as many as 600 solid and/or panel part sizes. ROMI-CROSS allows 30 primary part lengths and 20 primary part widths as well as random part sizes. If needed, additional lengths and widths can be used for salvage parts.

ROMI-CROSS was developed on IBM-compatible[2] personal computers using the C and assembly programming languages. The minimum computer system requirements to run ROMI-CROSS are:

1. An IBM AT, 386, 486, Pentium, or compatible computer
2. 640K of Random Access Memory (RAM)
3. A hard disk with at least 20 Mb free space
4. MS-DOS 4.0 or later (MS-DOS is a trademark of Microsoft Corp.)
5. A high-density 3.5-inch or 5.25-inch floppy drive
6. An EGA or VGA graphics display
7. A mouse
8. A printer (optional but recommended)

---

[1] Gatchell, Charles J.; Walker, Elizabeth S.; Wiedenbeck,Janice K.; Thomas, R. Edward. **1997 data bank for red oak lumber**.

[2] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

## 2. ROMI-CROSS Processing System

Rough mills process lumber in distinct steps or operations. ROMI-CROSS simulates these processing steps with results flowing from one operation to the next (Fig. 1).

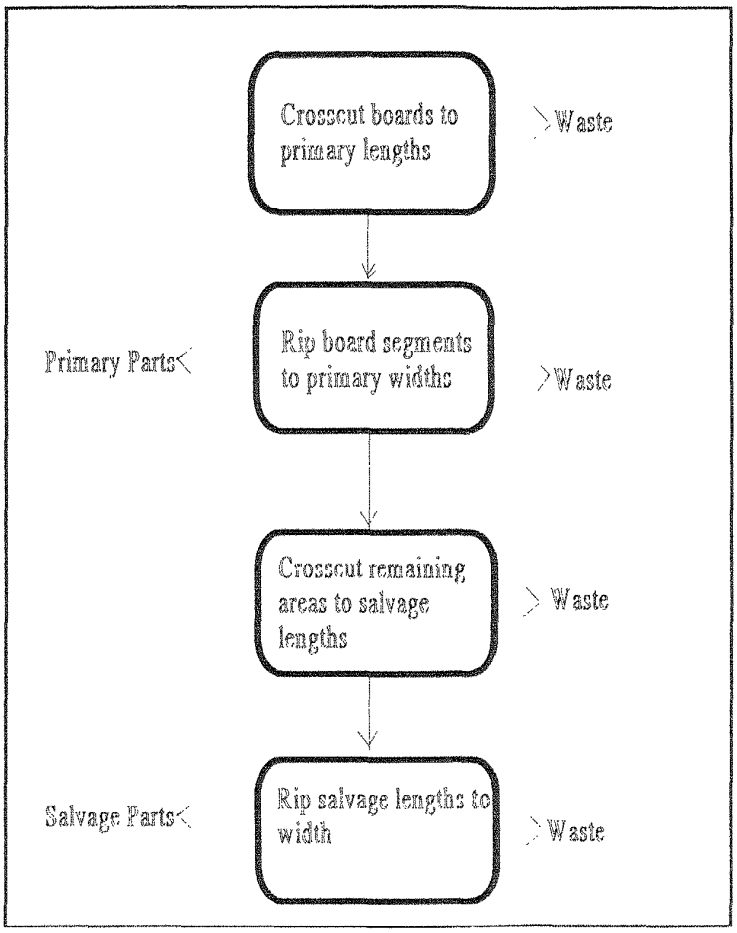



Figure 1. ROMI-CROSS processing/material flow graph.

## 2.1. Primary and Salvage Parts

ROMI-CROSS generates four part types: primary, excess primary, salvage, and excess salvage. A primary part is produced in two cutting stages: crosscutting to length followed by ripping to width. When processing a cutting bill of specified part sizes and quantities, only parts that can be produced in two cutting stages are tallied as primary parts. Parts produced in two stages that are not required by the cutting bill are tallied as excess primary. Salvage parts require at least one additional crosscut operation and may require additional ripping. When processing to a cutting bill, a part required by the cutting bill that is produced with three or more cutting operations is tallied as salvage. A part not required by the cutting bill but requiring three or more cutting stages is tallied as excess salvage. When not processing to meet a cutting bill, all parts are tallied as either primary or salvage.

## 2.2. Area-Based and Cutting Bill-Based Yields

There are two distinct operating modes in ROMI-CROSS. Area-based yields are used when a cutting bill is not used and are dependent only on how well part sizes can fit between defects and the edges of the board. Cutting bill-based yields are used when a cutting bill is being used and are dependent not only on how well your part sizes can be fit to the board but also on the number of parts required for each size. Suppose two cutting bills have identical part sizes but one requires more small parts and the other requires more large ones. Although the cutting bills contain the same part sizes, their yields will differ. Cutting bill yield also is dependent on the part prioritization strategy and scheduling/replacement methods.

## 2.3. Finding Clear Areas

A key to efficient rough-mill processing is finding the best clear areas to process. These could be areas that generate the highest yield or areas that yield more of a highly demanded part size. Often, the human eye can easily spot these areas. However, a computer cannot simply "see" the areas in the board; it must be instructed on how to view the board. This section describes the "vision" algorithms used by ROMI-CROSS.

Earlier Forest Service rough mill simulation programs (Giesse and Danielson 1983; Hoff et al. 1991; Stern and McDonald1978; Thomas 1995b; Wodzinski and Hahm 1966) used a cartesian coordinate system to store board defect information. This system is particularly inefficient for two reasons. First, a large amount of computer memory is needed to represent a board, and each increase in resolution exponentially increases the amount of memory required. For example, an 8-inch by 12-foot board stored in 1/4-inch resolution requires 2,304 bytes. Storing the same board in 1/16-inch resolution would require 36,864 bytes, 147,456 bytes in 1/32-inch resolution.

Second the cartesian system is inefficient to access. Consider the problem of finding a clear scan line on board. A clear scan line is the first step to finding clear area on a board face. Several clear scan lines comprise a clear cutting area. Finding a clear 1/16-inch-wide line running the length of a 12-foot board stored in 1/16-inch resolution requires 2,304 different references to the board stored in computer memory.

The ROMI-CROSS board data representation system uses run-length encoding to store the location and length of clear and defect area lines. Mathematically, these lines are rays. Run-length encoding is a data compression strategy that stores repeating data as a number and the data item. The number is the sum of the times a data item is repeated in a sequence. For example, the character string AAAAAAAAGGGGTTTTTXXXXXXXXX could be run-length encoded as 8A4G5T9X.

In ROMI-CROSS, each ray represents a line 1/16 inch or 1 millimeter wide depending on the resolution mode used. Each ray consists of an x,y coordinate starting point, the ray length, and ray type, i.e., clear, sound knot, etc. This format allows a single ray to store a clear scan line the length of the board, which, in turn, requires only one reference to find a clear scan line the length of any size board. In addition, the ray format scales well. Changing from 1/4-inch to 1/16-inch resolution increases the storage requirements by only a factor of 4.

## 2.4. ROMI-CROSS Vision

The ray format allows efficient processing. Since ROMI-CROSS stores the length of each ray (for clear wood and for each defect), it is simple and fast to go across the board's face and find the longest clear rays. ROMI-CROSS steps across the width of the board face in 1/4-inch increments, finding the longest clear ray for each scan line. A scan line can be composed of many rays. For example, 4 feet of clear area interupted by a 1-foot-long defect area followed by another 3 feet of clear would consist of three rays: 4-feet clear, 1-foot defect, and 3-feet clear.

Starting with the longest ray, ROMI-CROSS first expands it along its width. This is accomplished by first breaking up the ray into segments (Fig. 2.4A). Next, the segments are expanded edgwise until they meet the boards edge or a defect (Fig. 2.4B). More precise solutions can be obtained by decreasing the segment lengths. In ROMI-CROSS, the segment lengths were tuned to obtain the best yield on a range of board grades and cutting bills. Note that the segment sizes shown in the example are much larger than those used in ROMI-CROSS.

After the segments are expanded, the widest segment is determined and marked as BEST (Fig. 2.4.C). Next, BEST is compared to its adjacent segments. If an adjacent segment is the same width as BEST, it is included as part of BEST (Fig. 2.4D). If an adjacent segment if narrower than BEST and the width difference between BEST and the adjacent segment is less than or equal to a specified percent of the BEST segment, it is included as part of BEST and the width of BEST is adjusted to match that of the newly aquired segment (Fig. 2.4E). If the difference between BEST and the adjacent segment is too great, expansion in that direction is halted. When expansion is halted in both directions, a fully bounded acceptable cutting area is described (Fig. 2.4F). The algorithm continues to examine scan lines until the entire board has been examined.

Both sides of the board are examined at the same time. This algorithm can perform clear-one-face (C1F), clear-two-face (C2F), and sound-two-face (S2F) part quality analyses. For C1F and S2F part grades ROMI-CROSS can place face 1 of a part on one board face, and face 1 of another part on the other board face. Once a suitable board area is located, ROMI-CROSS evaluates the area with respect to maximum potential yield (area-based) or potential highest priority part fitting (cutting bill mode). The part area or part priority value, depending on mode, is stored with the section.

After the entire board has been examined, the area with the highest possible area-based yield or cutting bill part priority is crosscut out and ripped to width. The remaining board area is examined repeatedly until there is no usable primary board area.

After primary processing is completed, any areas not occupied by primary parts are examined for salvage. These areas can be remaining board segments too short for primary parts or narrow strips from the primary ripping process. The salvage algorithm operates in the same way as the primary algorithm except that the salvage algorithm uses smaller part sizes and areas. To increase accuracy and salvage yield, the salvage algorithm uses shorter segmentation lengths and examines every other scan line.

The salvage algorthm repeatedly examines every remaining area until no usable salvage part area can be found. In nearly all cases, the salvage algorithm will discover all salvage areas in two additional process steps (one crosscut and one rip step).

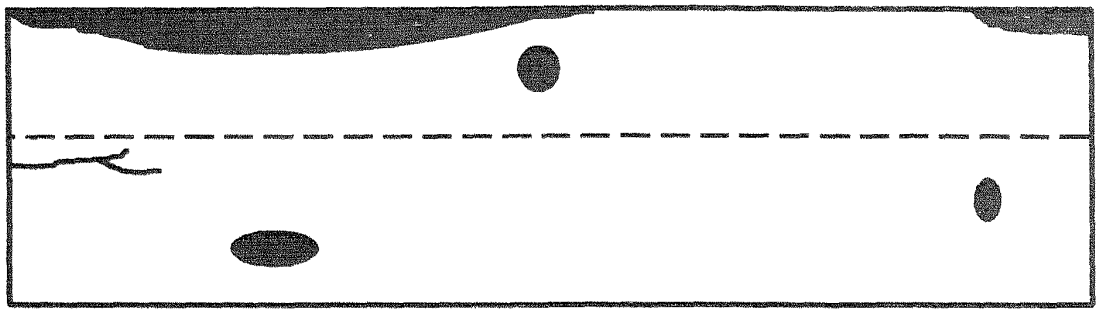


Figure 2.4A. Sample board showing segmented clear vector.

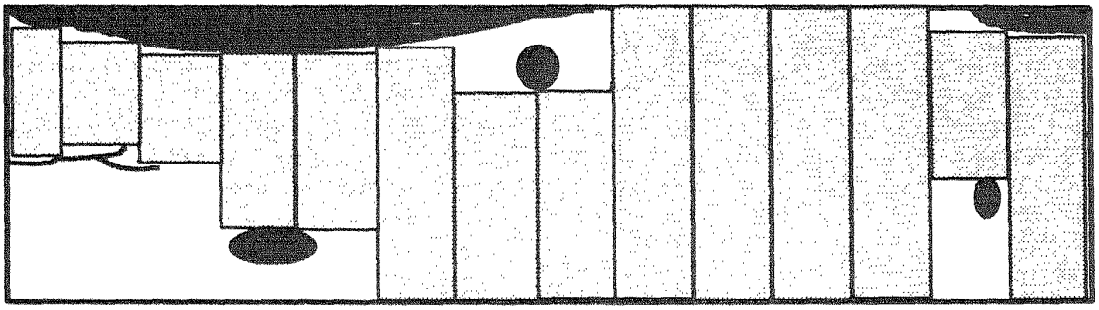


Figure 2.4B. Sample board showing expanded clear areas based on segmented vector.

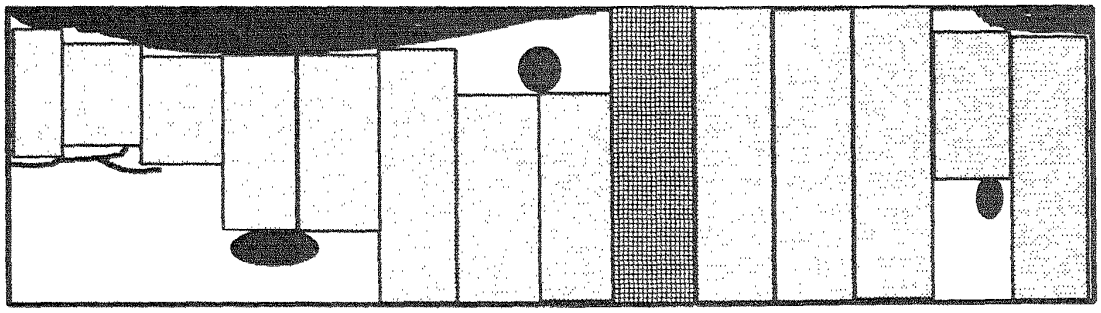


Figure 2.4C. Sample board showing initial BEST segment.

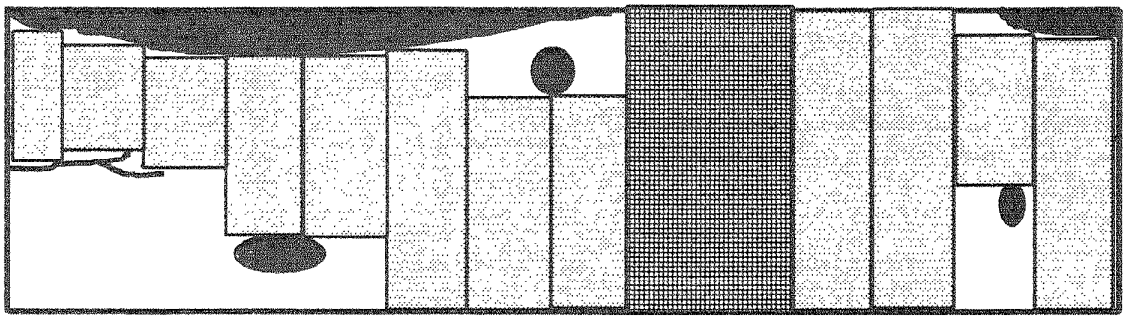


Figure 2.4D. Sample board showing BEST expanded by one segement.

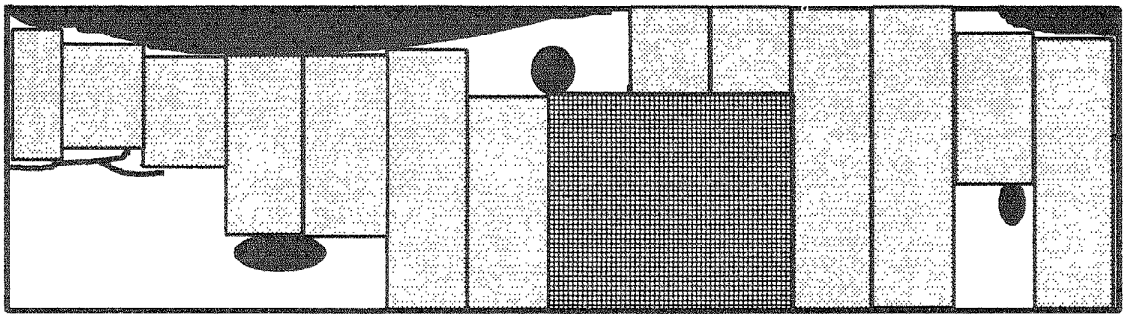


Figure 2.4E. Sample board showing expanded BEST encountering a board defect.

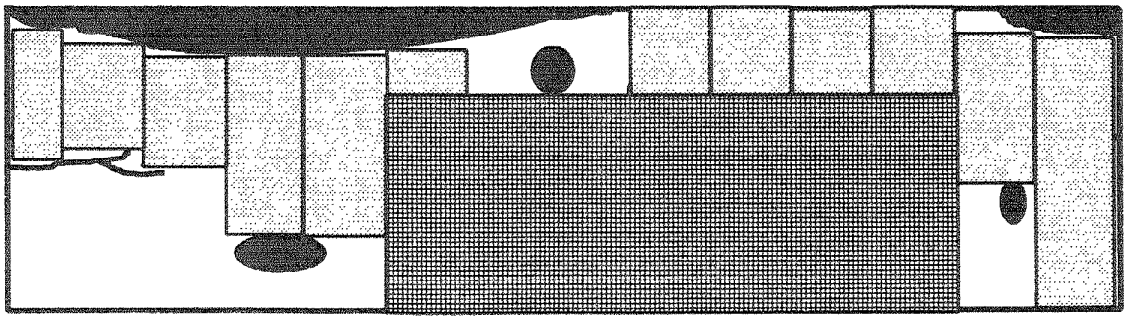


Figure 2.4F. Sample board showing fully described board clear area.

# 3. Installation

The installation program included with ROMI-CROSS installs all programs, support files, samples, and a copy of the "1997 Data Bank for Red Oak Lumber" on your hard disk. The boards in the data bank are graded according to 1994 NHLA Rules (Natl. Hardwood Lumber Assoc. 1994).

## 3.1. Running the Install Program

To install ROMI-CROSS you must be at the DOS prompt. If you are using Windows, you need to exit or start DOS. To begin installation, place the ROMI-CROSS disk one in the floppy disk drive and make it the working drive. For example, if the disk is in drive A: enter:

**A:**

To start the install program, enter:

**INSTALL**

When the program begins, it displays the screen shown in Figure 3.1. Press any key to begin the installation. The program begins by determining the hard drives available on your machine. If the computer has a CD-ROM drive with no disk in it, you may encounter an error such as **CDR-101: Not ready reading drive D:**. If this occurs, press **F** at the **Abort, Retry, Fail** prompt. The installation will then continue normally.

```
                ROMI-CROSS Installation Program
                        USDA Forest Service
            Forestry Sciences Laboratory, Princeton WV


ROMI-CROSS must check your system for valid destination drives.
During this check if a protected network drive or CD-ROM drive is
encountered, you may receive an error message such as:

     CDR101: Not ready reading drive D
     Abort, Retry, or Fail

If this occurs, simply respond F for fail and the install program
will not consider the drive as a possible install destination.


                Press any key to begin installation
```

Figure 3.1. Installation program initial screen.

## 3.2. Confirming Install Destination

Figure 3.2 shows the install destination screen with the default destination of drive **C:** and subdirectory **\RM-CROSS**. If this destination is acceptable, press **C** and proceed to Step 3.4. If you would like to install ROMI-CROSS on a different drive or subdirectory, press **M** and proceed to Step 3.3. Press **A** if you want to stop the installation.

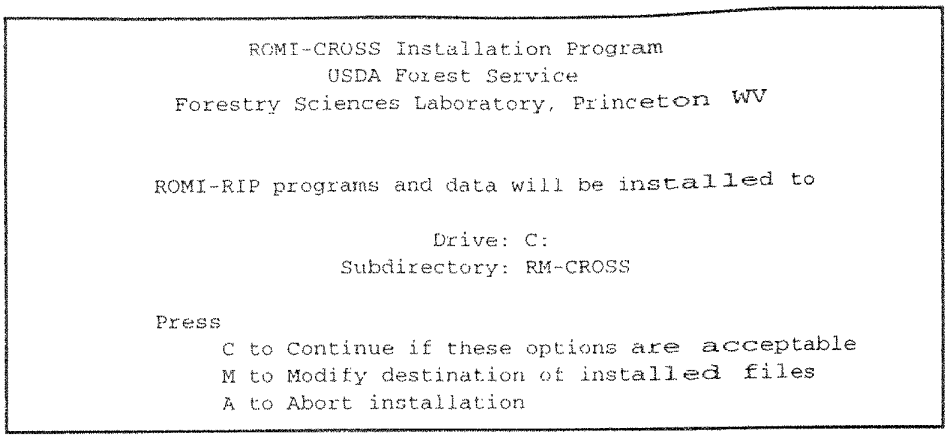



Figure 3.2. Install destination screen.

## 3.3. Modifying Install Destination

This step allows you to customize the install location of ROMI-CROSS. First, choose a new destination drive from the menu. As shown in Figure 3.3, the system check found two hard drives, C: and D:. We will enter **2** to select drive D:.

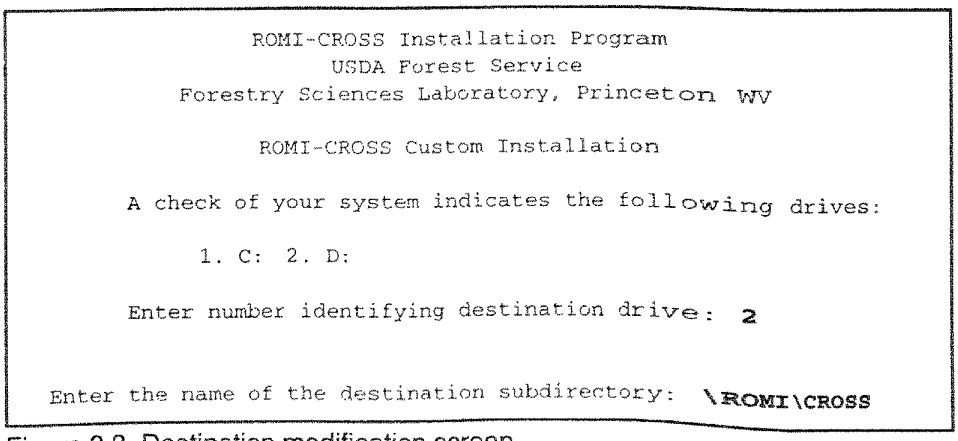



Figure 3.3. Destination modification screen.

After selecting the drive, you are prompted to enter the name of the installation subdirectory. This subdirectory may be a new one or an existing one. When entering the name of the subdirectory, give the complete path of the subdirectory starting with the root directory. For example, to install ROMI-CROSS in the subdirectory \ROMI\CROSS, at the prompt enter:

**\ROMI\CROSS**

Figure 3.3 shows this entry. After you enter the new destination, the computer will show the screen in Figure 3.2 with the new destination drive and subdirectory. Refer to Step 3.2 to continue.

## 3.4. Software Installation Phase

After the install destination is confirmed, the computer checks whether the install subdirectory exists or needs to be created. If the subdirectory exists, you are prompted whether to continue. If you press **N**, the installation will be cancelled. If you press **Y**, ROMI-CROSS will be installed to the directory. As the files are decompressed and copied, the filenames scroll across the screen. The installation may take 15 to 30 minutes to complete on some systems. ROMI-CROSS will seek confirmation before overwriting any existing files. ROMI-CROSS is packaged on three disks. The install program will ask for the next disk to be put in the floppy drive as required. When installation is complete, you will be returned to the DOS prompt.

## 3.5. Configuring Your System

The CONFIG.SYS file, located in the root directory of the C: drive, defines devices and run-time parameters for your computer. After the ROMI-CROSS files have been copied to your computer, check to see that the CONFIG.SYS file includes the following lines:

**FILES = 30**
**BUFFERS = 30**

The sequence, spacing, and location of these lines in the file are not important. It is only important that the values for the FILES and BUFFERS settings are at least 30. If the settings are less than 30, you must edit the CONFIG.SYS file and then reboot the computer before the changes take place.

If you are using a laser or color printer with ROMI-CROSS, see Appendix I for help in configuring the ROMI-CROSS setup files for use with your printer.

# 4. Running ROMI-CROSS

To start ROMI-CROSS, your working drive and subdirectory need to be the ones that contain the ROMI-CROSS files. If you accepted the default installation drive and subdirectory, enter:

**C:**

followed by:

**CD \RM-CROSS**

These two commands will take you to the drive and directory that contain the ROMI-CROSS programs and data.

Now you are ready to run ROMI-CROSS. At the DOS prompt enter:

**RX**

To run ROMI-CROSS with a monochrome monitor, enter:

**RX +M**

When ROMI-CROSS starts running, it first checks for the presence of the setup options file (SETUP.RMX) in the same directory as the other ROMI-CROSS software. This file stores all the options (arbor type, lengths, widths, etc.) that define the ROMI-CROSS simulation. If SETUP.RMX does not exist, (the program has not been run before) a default setup file is used. If the SETUP.RMX exists, it is read and its options are displayed. Figure 4 shows the main menu of using the default setup list. Notice that the main menu is along the top of the screen and the setup options are displayed in the remainder of the window.

For ease of use, ROMI-CROSS uses a point and click environment along with hot keys. To choose an item, move the cursor to the menu item or line you want and press the left mouse button once. If you do not have a mouse, you can press the letter of the item that is designated by a hot key. Hot keys are highlighted numbers or capital letters--for example, R in **R**un and F in **F**iles. Windows with ▲ and ▼ to the right allow you to scroll the window's contents (Fig. 4). Click on the ▲ or press the **Page Up** key to scroll the screen up. Click on ▼ or press the **Page Down** key to scroll the screen down. Some editing windows, such as kerf size modification, use the scroll points, **Page Up**, and **Page Down** keys to increment or decrement the value being modified. To close any window, choose **Cancel** or **eXit**, which are found in the upper right corner (menu windows) or at the bottom left of the screen (list windows). A window's hot keys and click items are valid only within that window. For example, if any other windows are open, the click items of the Main Menu are unavailable.

Several ROMI-CROSS windows will ask you to enter a value or filename. If you find yourself at one of these prompts by mistake, press **Return** and you will be returned to the previous window menu.

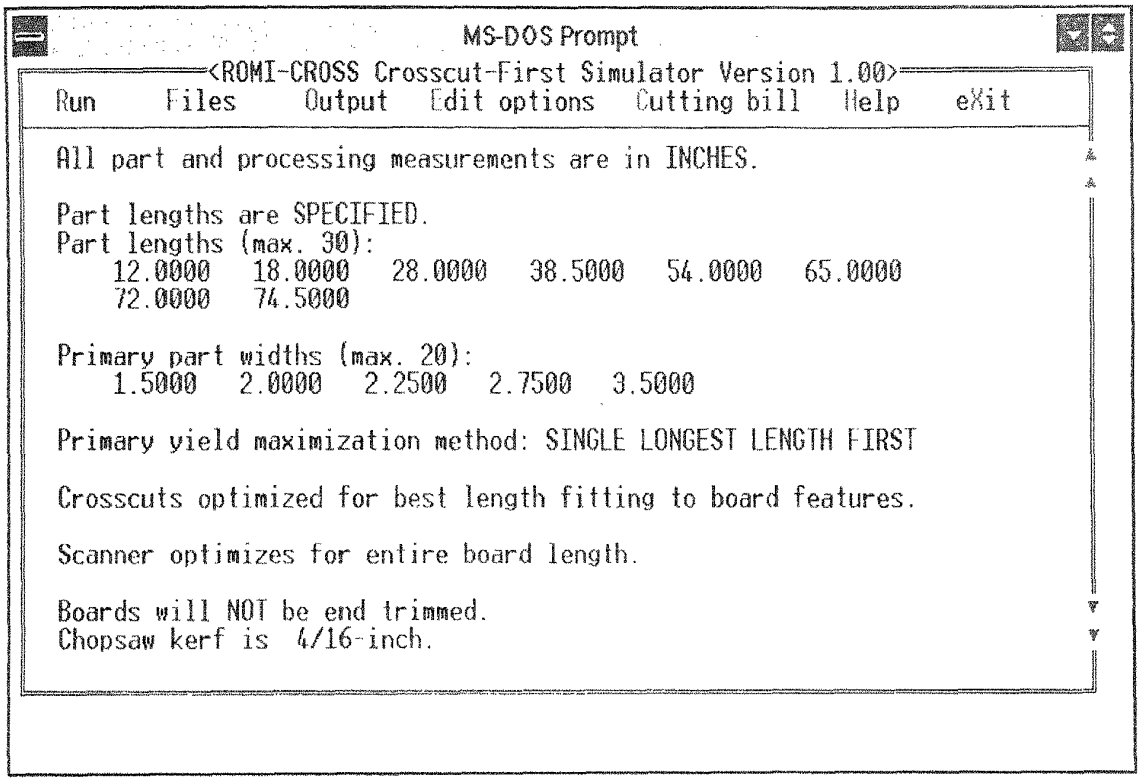


Figure 4. ROMI-CROSS main menu window.

# 5. Editing Processing Options

To edit the setup options, select **Edit options** from the ROMI-CROSS main menu. This will display the EDIT OPTIONS window shown in Figure 5. The EDIT OPTIONS window allows you to change the part and kerf sizes, part qualities, optimization settings, and summary length and width ranges for the ouput summaries.

You may select and modify any option at any time. Different menu choices are presented depending on the options you select. For example, if you are using random lengths, you can modify maximum and minimum part lengths but not the 20 specified part lengths.

## 5.1. Cutting Options

The CUTTING SPECIFICATIONS window (Fig. 5.1), which is displayed by choosing **Process** from the EDIT OPTIONS window, allows you to change the cutting options so that they correspond to the conditions you wish to simulate. You may change part optimization strategies, end-trim specification, kerf sizes, part qualities, and the unit of measure (in inches or millimeters). To modify any item in this window, simply select it and respond to the prompt.

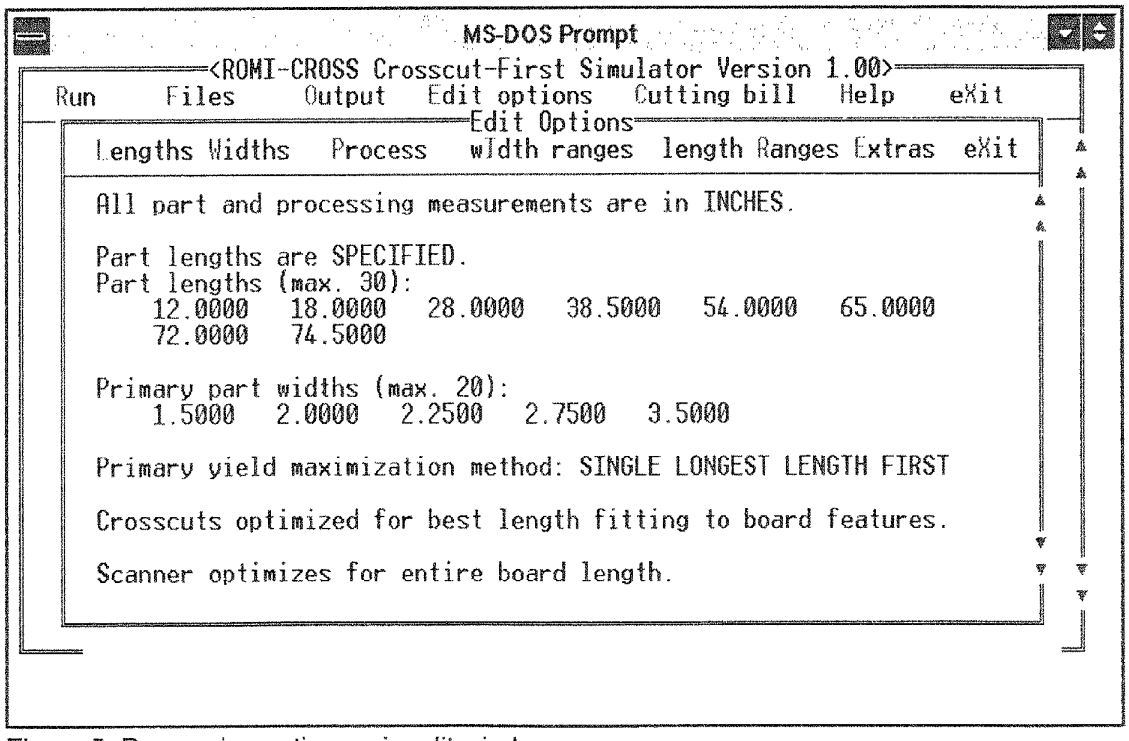


Figure 5. Processing option main edit window.

## 5.1.1. Area-Based Primary Yield Maximization Method

When using area-based yields and specified lengths, you can specify that one, two, or three longest lengths be cut first from each clear area. In the one-longest-length first option, the longest possible length that will fit the clear area is always taken, even if the total yield suffers. For example, if the clear area is 84 inches long and primary-part lengths are 15, 18, 25, 29, 33, 38, 45, 50, and 72 inches, the program will cut a 72-inch length and waste 12 inches. In the three-longest-lengths method, the program searches for that combination of three lengths that will give the same or greater yield than the best combination of two lengths or the longest single length. In this example, the three-length method will yield 50-, 18-, and 15-inch strips (the best two-length yields are 50 and 33 inches). This allows you to emphasize the longer lengths (one-longest length) or the shorter lengths (two- and three-longest lengths first).

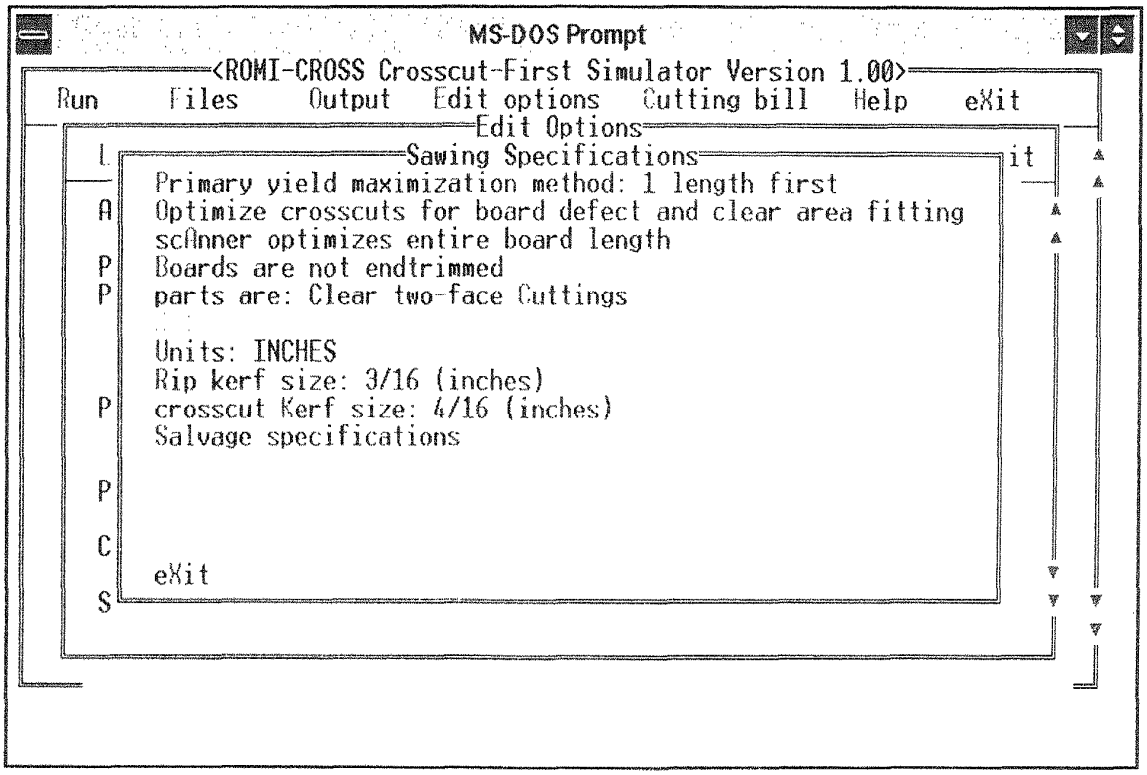


Figure 5.1. Cutting specifications editing window.

To change the primary yield maximization method, select **Primary yield maximization method** (Fig. 5.1). ROMI-CROSS will display the next valid maximization method each time the status line is selected.

## 5.1.2. Crosscut Optimization Strategies

ROMI-CROSS simulates crosscut optimization strategies based on length or clear area. The length strategy optimizes the fit of part lengths into the board length. This strategy does not consider the influence of defects on part yields. This strategy simulates the practice of optimizing only for part lengths on automatic chopsaws when board defects are not being marked. A preference for longer or shorter lengths is controlled by setting the primary yield maximization method.

The clear area strategy optimizes the placement of cuttings with consideration of board defects. Section 2 discusses how clear areas are resolved for this strategy. This method simulates a fully automatic board scanning and saw control system or the operator of a manual crosscut saw who is kept informed of needed part lengths by a backgauge. Defects may be left in a primary board segment only if the defects can be ripped out with minimal waste. As before, a preference for longer or shorter lengths is controlled by setting the primary yield maximization method.

To change the crosscut optimization strategy, select **Optimize crosscuts...** from the CUTTING SPECIFICATIONS window (Fig. 5.1). Selecting this item allows you to toggle between the length and clear area strategies.

## 5.1.3. Scanner Optimization Length

This feature simulates systems in which only a portion of the board length is reviewed/examined at a time by the scanner or operator. This optimization length can be set to 0 to optimize on the entire board, regardless of length, or to examine specific lengths in feet or meters. Select **Scanner optimizes...** (Fig. 5.1) to change the optimization length. ROMI-CROSS will display a modification window that will allow you to select any valid optimization length setting.

## 5.1.4. Specifying End-Trim Amount

ROMI-CROSS allows you to specify end-trim amounts as small as 1/16-inch or 1 mm, or as large as 6.25 inches (1/16 inch * 100) or 100 mm. To specify an end-trim amount, select **Boards are end-trimmed** (Fig. 5.1) and enter a new end- trim amount. By making several runs using different end-trim amounts, you can quantify the effects of end-trim requirements on yield.

## 5.1.5. Primary and Salvage Part Qualities

ROMI-CROSS allows different part qualities to be specified for primary and salvage parts. Specification for primary and salvage part qualities is identical. To modify part qualities, select **Salvage specifications** for salvage parts and **parts are: ...** for primary parts. ROMI-CROSS will toggle through the available part qualities each time **parts are: ...** is selected. The valid qualities for primary and salvage parts are clear-two-face, clear-one-face, and sound-two-face. If you specify clear-one-face or sound-two-face part qualities, you must specify one or more acceptable defects (Fig. 5.1.5). These defects can be of different types and sizes. To specify acceptable defect types, select **Defect options**. Note that this item is displayed only when clear-one-face, or sound-two-face parts are selected. If you do not specify any defect types when using clear-one-face or sound-two-face part qualities, the simulation will generate clear-two-face parts.

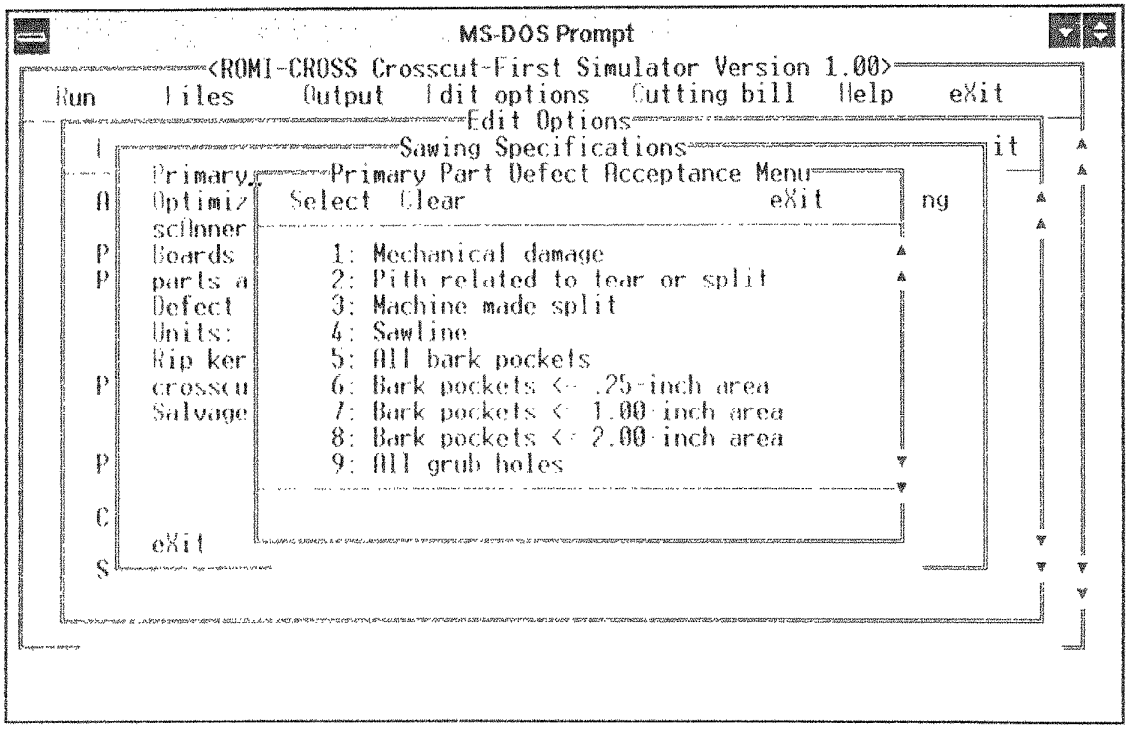


Figure 5.1.5. Defect size and type selection window.

Selecting a defect size/type will cause a checkmark to be placed beside the defect. Selecting the same defect size/type item a second time will turn off the selection of the defect and remove the checkmark. To see more defects, click on the scroll points or use the **Page Up** and **Page Down** keys.

### 5.1.6. Cutting Units

ROMI-CROSS processes either metric or English part sizes. All part sizes must be specified using one system only. ROMI-CROSS processes metric measurements by converting the board and defects to millimeter resolution. Although there is a slight loss of accuracy in representing board characteristics, all measurements are accurate to the nearest millimeter. If you are using metric units, you may specify that all results be reported in English or metric units (see Section 8.2 for information about this option). Selecting **Units** (Fig. 5.1) allows you to toggle between the two systems. Note that when changing from one unit of measure to another, no conversion is made for your part sizes for the other unit measure.

### 5.1.7. Kerf Sizes

Both the rip and crosscut saw kerfs can be adjusted to match any metric or English industrial kerf size. Note that the ripsaw and crosscut saw can be set to use different kerf sizes. To change a kerf select **crosscut Kerf size** or **Rip kerf size** from the CUTTING SPECIFICATIONS window (Fig, 5.1). This will cause the KERF MODIFICATION window to appear. allowing you to choose any valid kerf size.

## 5.2. Modifying Part Lengths and Widths

The LENGTH MODIFICATION and WIDTH MODIFICATION windows (Figs. 5.2A and B) allow you to change any primary or salvage part size setting. From the EDIT OPTIONS window (Fig. 5), Select **Lengths** or **Widths** to modify part lengths widths, respectively. Since both the length and width modification windows operate in the same way, only length modification is discussed here. Although you may edit part lengths or widths in inches or millimeters, all examples shown use inches as the unit of measure. You do not need to modify lengths in any order, nor order them according to size. ROMI-CROSS will sort the part lengths in ascending order and check for and remove duplicate lengths.

To switch from specified to random lengths or vice versa, select **Z** from the LENGTH MODIFICATION window. Figure 5.2A shows the specified length modification window. The modification window for random lengths is shown in Figure 5.2B. Note, all length and widths s are rounded to the nearest 1/16 inch or millimeter depending on the measure being used.

To modify any length, select it with the mouse or associated hot key. A window for the length will appear and prompt you to enter a new value. For example, to change the specified length from 74.5 to 74.125 inches, first select **8**. The modification window for the 74.5 length will appear.

lect the **salVage lengths** from the LENGTH MODIFICATION window to modify salvage
ıgths (Figs. 5.2A and 5.2B). ROMI-CROSS offers three ways to specify salvage lengths. One
ıthod allows you to use primary lengths for salvage. The second allows you to specify as
ıny as 15 lengths (some or all of which may differ from primary). The third allows you to
ecify a minimum and maximum acceptable length for random lengths. Selecting the salvage
ıgth item toggles among the three methods. Salvage lengths are modified in the same way as
mary lengths: select the length to modify and enter the new value at the pop-up edit window's
ɔmpt.

## 5.3. Modifying Width and Length Ranges

For purposes of data presentation, it is necessary to specify width ranges and, in the case of random length processing, length ranges. If you are using specified part lengths and try to

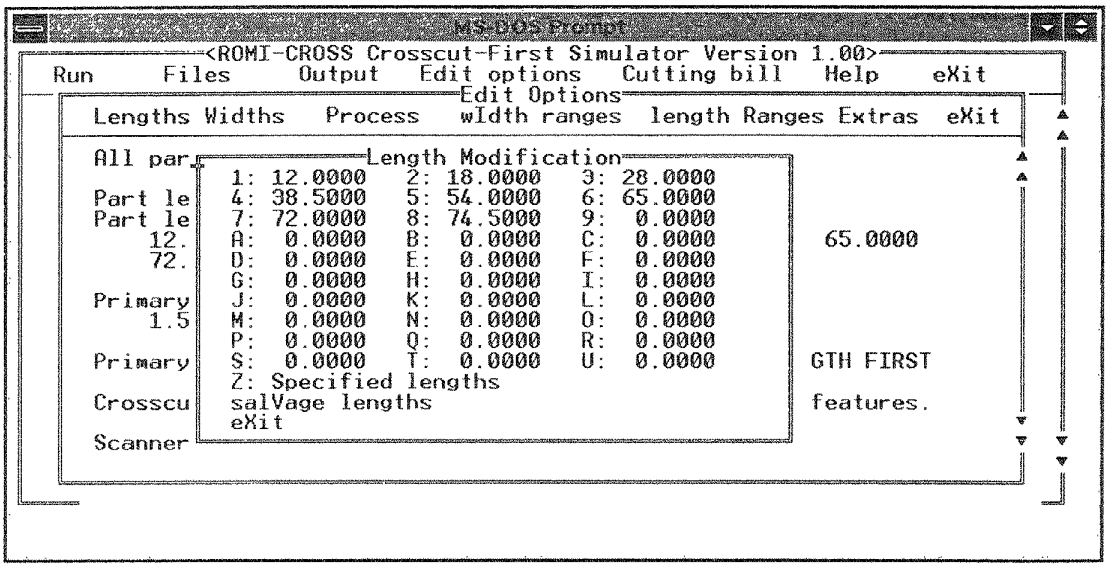



Figure 5.2A. Primary specified length modification window.

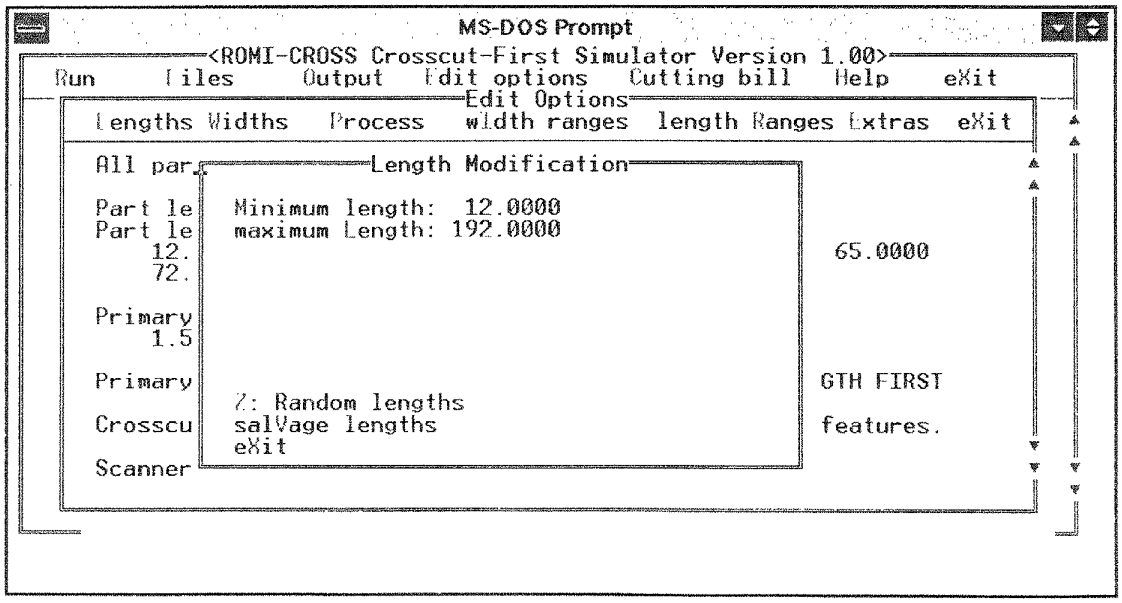



Figure 5.2B. Primary random length modification window.

specify length ranges, you will be advised of the error. The examples in this section are concerned with width ranges, but the steps involved are the same for length ranges. Select **Width ranges** or **length Ranges** from the EDIT OPTIONS window (Fig. 5.1) to modify width or length ranges. The edit window for width or length ranges is shown in Figure 5.3A.

Fifteen primary width and 10 random-length ranges allow yield information to be grouped and subtotaled according to your interest. Do not use the specified widths to begin or end a width range. This may cause inaccurate subtotals due to the rounding procedures of some computers. For example, to specify a width range that includes widths of 1.5 and 2.0 inches, specify a lower range value of 1.45 and an upper value of 2.05.

Random length ranges allow you to group random length results. The LENGTH RANGES window includes "Activate" and "deActivate" toggle items. Selecting one of these items will turn on or off the length range option. If length ranges are deactivated, a subtotal will be created for each different part length produced. For even medium-size runs, this can create **large** tables. If there are too many different lengths, the summary program will not be able to process them all, and will report an error. Select any range to modify it; this will bring up its edit window (Fig. 5.3B). From this window you can modify the upper, lower, or both range values.

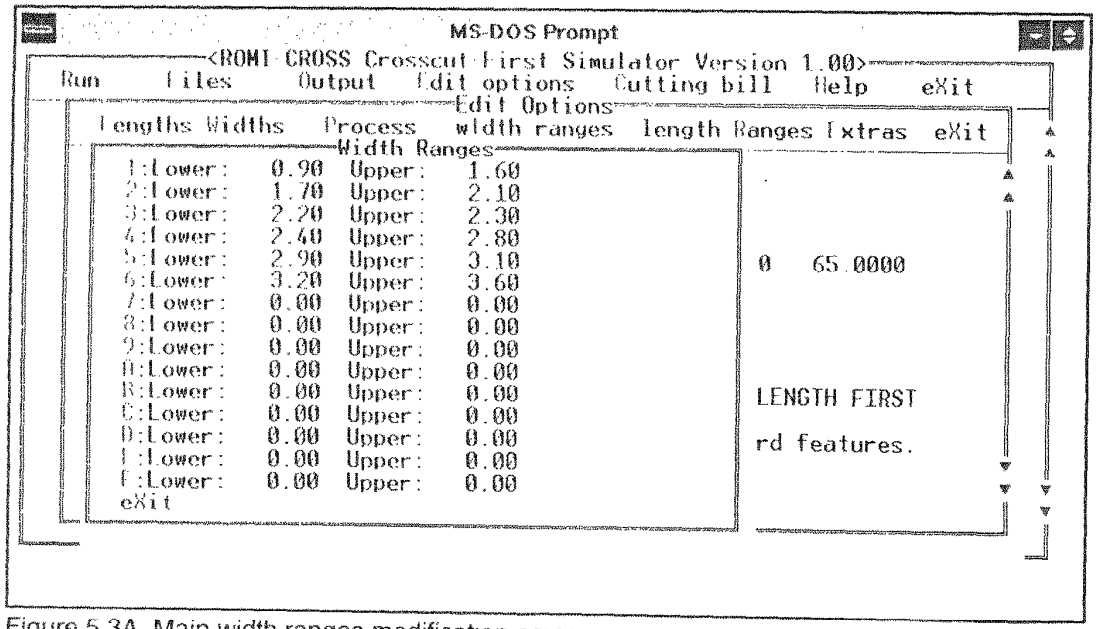


Figure 5.3A. Main width ranges modification screen.

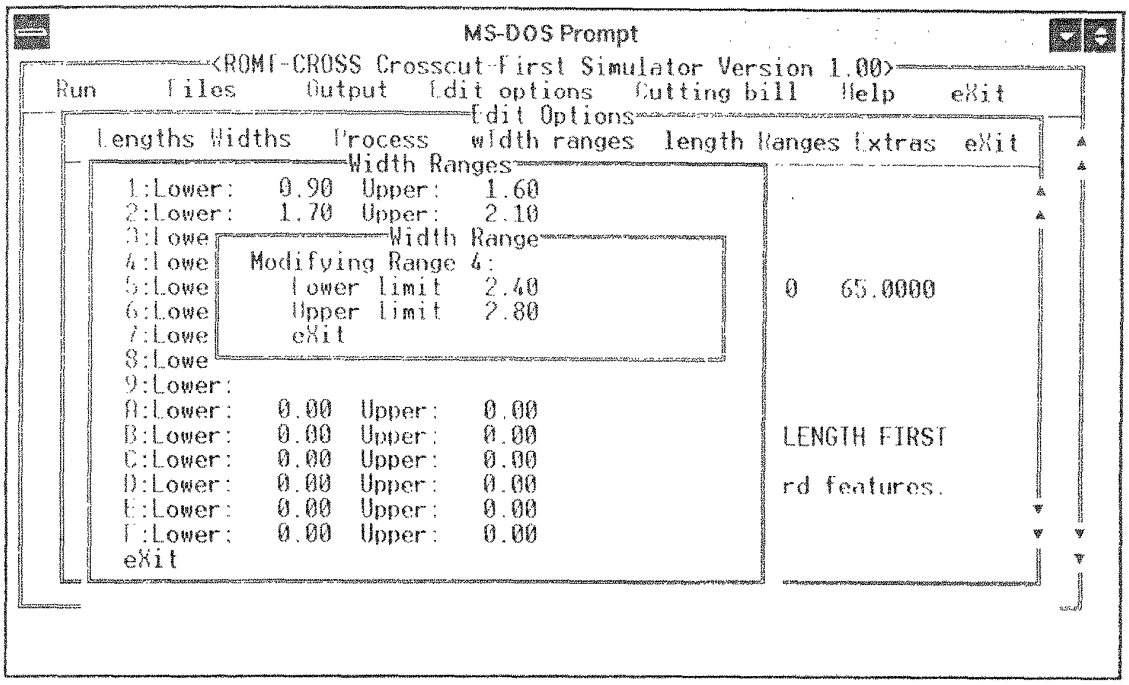


Figure 5.3B. Individual width ranges modification window.

You need to ensure that the ranges do not exclude any specifed particular length or width. ROMI-CROSS looks for this error and will tell you which sizes you have excluded. You also must watch for overlapping ranges. This error, also detected by ROMI-CROSS, occurs when the same length or width can be placed in two or more different ranges. Error detection and an ascending sort for width and length ranges occur when you attempt to exit the WIDTH or LENGTH RANGES window. If the respective ranges overlap, a small pop-up window will notify you of the error and return you to the range editor.

## 5.4. Extras

If you encounter a problem with your current processing options list and cannot determine what the problem is, the EXTRA FUNCTIONALITY window will help it (Fig. 5.4). Selecting **Print processing options** prints all the part sizes and sawing specifications that you have enabled on the printer attached to your first printer port. Studying this printout should help you determine the root of your simulation problems.

If you determine that the problem is connected with several items in your processing specifications, you may want to reset the items to the programs default options, or to your own defaults stored in another processing specification file.

To reset your processing options to the ROMI-CROSS defaults, select **Reset to standard defaults** from the EXTRA FUNCTIONALITY window. A pop-up window will ask you to confirm the reset to default options. If you have another file that you would rather use as defaults, such as the processing options of a cutting bill, selecting **reLoad defaults from file options** will bring up a menu that lists all available processing options files. Selecting any file will bring up a confirmation window asking you to confirm this action. Once you revert to the default options, you can cancel the change to default options by ***not saving*** your options list when you exit the EDIT OPTIONS window.

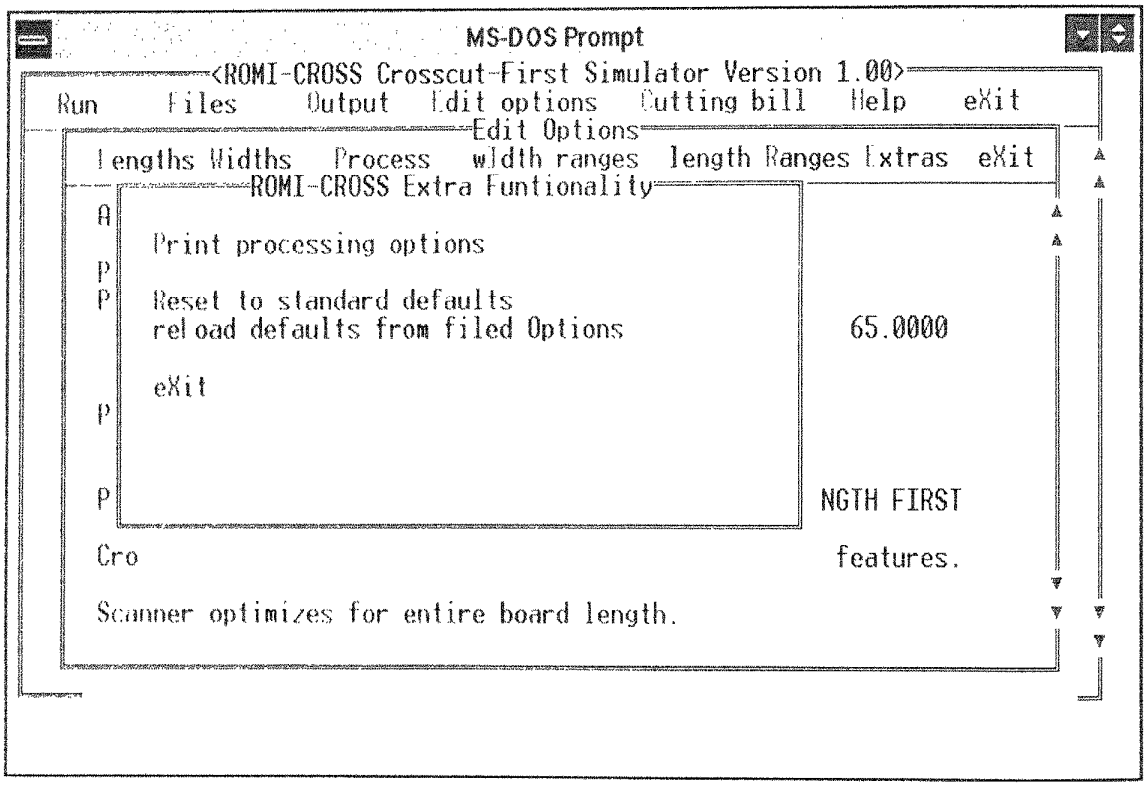


Figure 5.4. Extra functionality window.

# 6. Cutting Bill Setup

A cutting bill is a list of solid and panel part sizes with associated quantities and priorities. ROMI-CROSS allows the user to select one of several part prioritization strategies and scheduling and replacement methods. The installation package includes three sample cutting bills (Frame, Squire, and Sample). You may want to modify these to do your first simulations.

To open, create, or modify a cutting bill, select **Cutting bill** from the main menu (Fig. 4). If no cutting bill is currently open, the only valid choices are to open or create a cutting bill or exit the CUTTING BILL DEFINITION window (Fig. 6A). If a cutting bill is open, you will instead be shown the entire menu. The CUTTING BILL DEFINITION window for the Frame cutting bill is shown in Figure 6B.

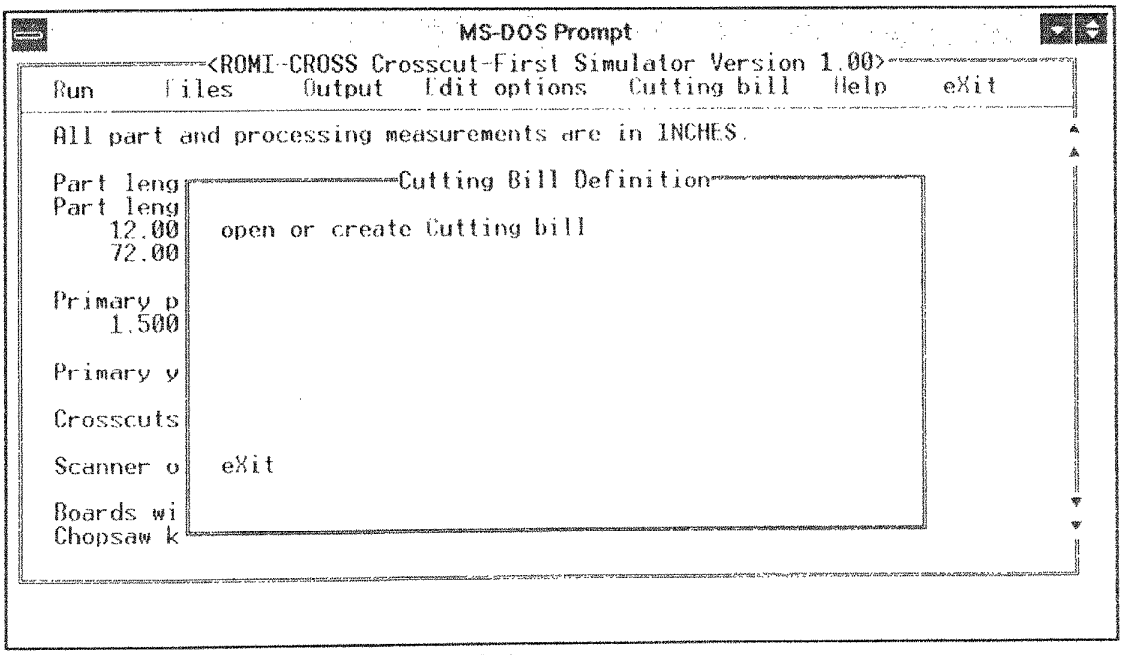


Figure 6A. Partial cutting bill definition window.

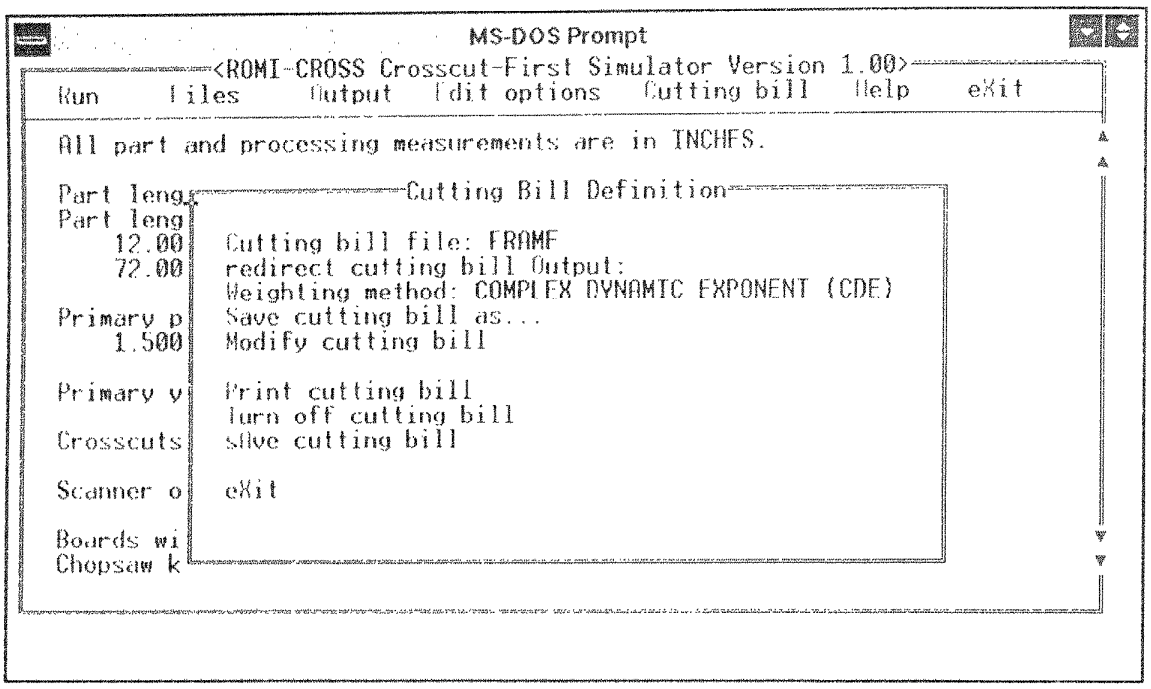


Figure 6B. Complete cutting bill definition window.

## 6.1. Opening and Creating Cutting Bills

To open a cutting bill, select **open or create Cutting bill** from the CUTTING BILL DEFINITION window (Figs. 6A and 6B). You can select from a list of currently defined cutting bills or create a new one (Fig. 6.1). You can click on the name of the cutting bill or choose **Select file** and enter the number of the cutting bill you wish to use.

To create a new cutting bill, select **New file** and enter a name for your cutting bill. If the file exists, it will be opened normally. Otherwise, ROMI-CROSS will confirm the creation of the new cutting bill file. Next, you are presented with the option of using the part sizes defined in the setup or specifying new part sizes in the cutting bill. If the former is choosen, ROMI-CROSS will generate one cutting bill entry for each primary width and length combination. All of these parts are assumed to be solid (no glue-up) and their required quantity is set to zero. The program alerts you if a problem is encountered during the creation of the cutting bill.

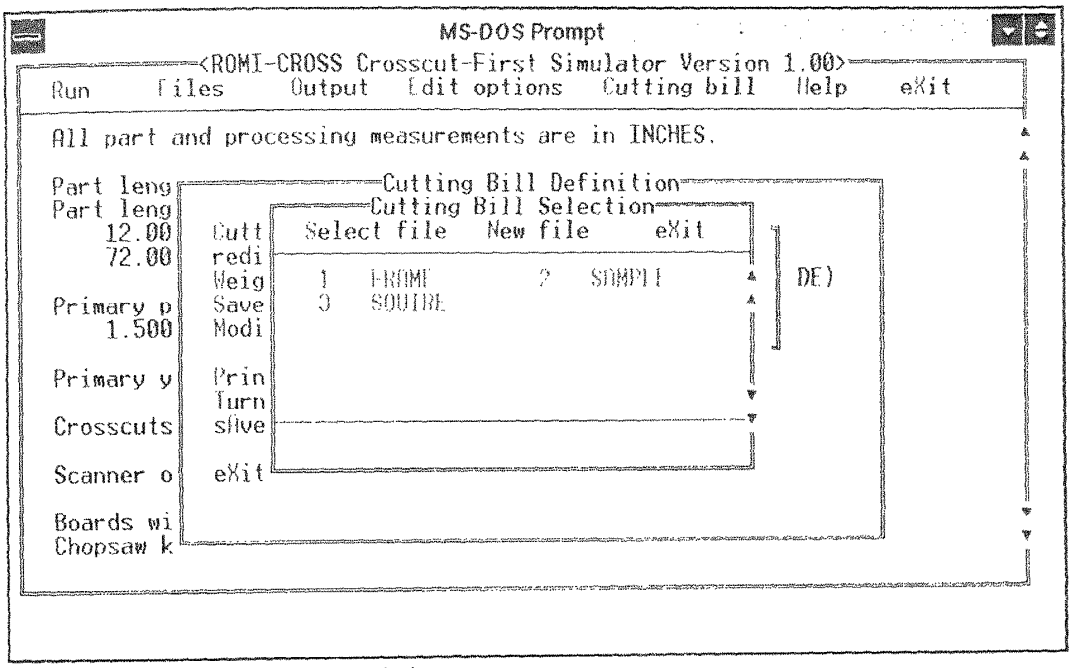



Figure 6.1. Cutting bill selection window.

## 6.2. Part Prioritization and Scheduling

Part prioritization and scheduling have an important impact on rough-mill processing and yield. ROMI-CROSS provides several methods of prioritizing and scheduling parts. It is easy to switch between methods and examine the potential benefits of each.

### 6.2.1. Part Prioritization Methods

ROMI-CROSS provides several ways to prioritize the parts in a cutting bill. To change the way parts are prioritized, select **Weighting method:...** from the CUTTING BILL DEFINITION window (Fig. 6B). ROMI-CROSS will display all available prioritization methods (Fig. 6.2.1). When you select any method, a checkmark is displayed beside that method. Note that if one of the value-based methods is being used, part values also must be defined; this is discussed in Section 6.3. For prioritization methods other than value, you can specify how valuable glue-up parts are. For example, you can specify that the value glue-up parts are 30 percent of the value of solid parts.

There are many different ways to prioritize parts. Some methods work better than others depending on the interactions among grade mix, equipment, and cutting bill difficulty. The dynamic strategies, Simple Dynamic Exponent (SDE) and Complex Dynamic Exponent (CDE) were designed to perform well for most cutting bills and lumber grade mixes (Thomas 1996).

These dynamic strategies prioritize parts based on size and required quantity. Large parts, (length and/or width) and parts with high quantity requirements have initial preference. As parts for these sizes are cut, preference will begin to shift to other part sizes.

The CDE and SDE strategies operate by generating exponential weighting factors from the required quantity of the part. The SDE strategy generates a single weighting factor and applies it to both the length and width of the part. The CDE strategy generates separate weighting factors for width and length, allowing preference to be shifted by the user from length to width and vice versa. The user also can configure the prioritization function for certain conditions. When processing lower grade lumber and more difficult cutting bills, better performance is obtained by increasing the values of the exponential weighting factor(s). In ROMI-CROSS, this is done by increasing the value of the weighting factors. To edit the weighting factors, select **edit weighting Factor**.

A requirement of the dynamic priorities is that part counts for various sizes be tracked continually. If continual tracking does not accurately represent your operation, you can specify that part counts be updated each time a specified amount of lumber is processed. See Section 6.5 for information on configuring part-count operations. This information is used to determine part priorities and for scheduling and replacement operations. ROMI-CROSS seeks to produce these cuttings that maximize the prioritized value of parts in each board.

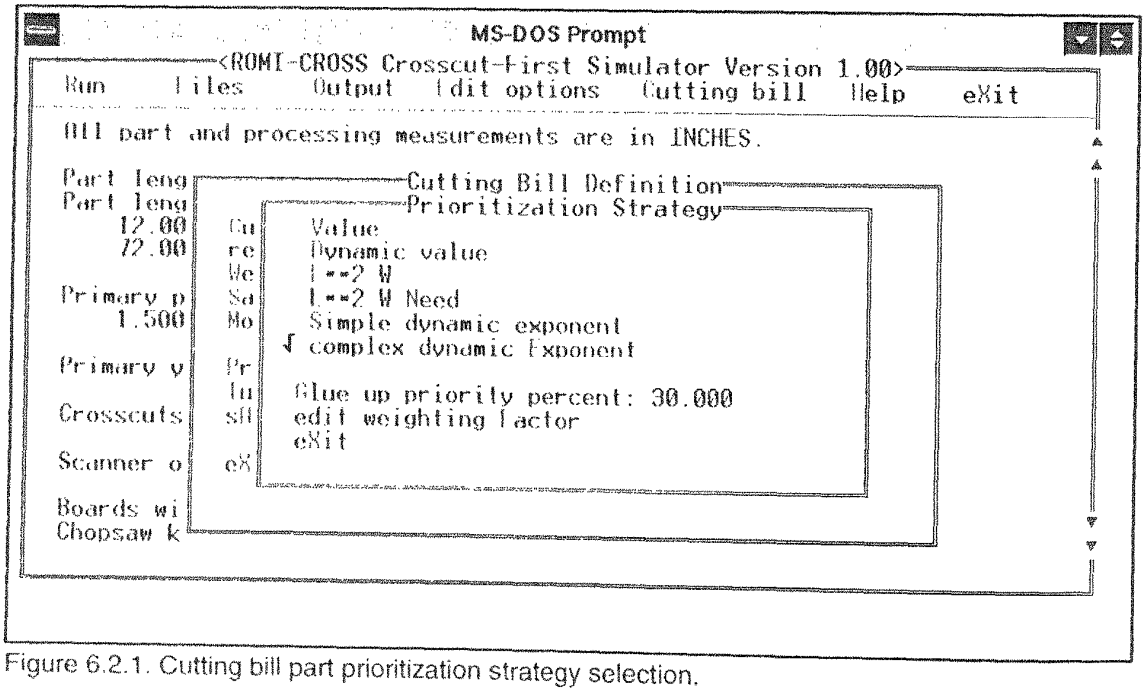


Figure 6.2.1. Cutting bill part prioritization strategy selection.

ROMI-CROSS also allow parts to be prioritized using one of two strategies for longest-length first. The first uses the formula Length$^2$*Width to emphasize long-length cutting areas. The second strategy uses the formula Length$^2$*Width*Quantity, where quantity is the current required quantity of the part size. This formula has the same emphasis on long lengths but is sensitive to changing part requirements. In general, the second method performs better than the first by requiring less lumber to meet the requirements of most cutting bills.

## 6.2.2. Part Scheduling

When the number of part lengths exceeds the capactity of the sorting system, it is necessary to group parts. Part scheduling determines which part sizes are to be grouped together. For example, if you have 30 part sizes in a cutting bill and a sorting capacity of 20 sizes, you need to determine which 20 parts to start processing together and how you are going to replace parts whose requirements are met. This is the rough-mill part-scheduling problem.

Most rough mills try to group part sizes that cover the broadest range of sizes, while not having two or more similarly sized parts in the cutting schedule at the same time. The goal of this strategy is to maximize the fitting potential of parts in each board, thereby improving yield. As the requirements for a part in the cutting schedule is met, the next closest size part is selected and inserted into the cutting schedule.

ROMI-CROSS uses the Schedule ID variable (Fig. 6.3B) to control the scheduling level of each part size. Parts given a schedule ID of 1 are cut first. The number of parts in the first level dictate how many part sizes can be cut at a time--the sorting capacity. Parts whose requirements have been met are removed from the cutting schedule and selected parts from the replacement levels are moved to the first level. Parts given a schedule ID of 2 are selected from as the first-level parts are obtained. When there are no remaining level 2 parts for replacement, level 3 parts are selected. This operation continues until no replacement parts reside in any level.

A problem arises in scheduling when the SDE and CDE strategies are used. Since SDE and CDE are based on quantity, scheduling in a replacement part will cause emphasis to shift to that part size since most other parts in the cutting schedule will have lower quantities. To solve this problem, the priority of the replacement part is adjusted so that it is compatible with the other parts in the cutting schedule. This adjustment considers both the schedule ID of the part and the priorities of the other parts.

## 6.3. Modifying Cutting Bill Parameters

To modify the part sizes, values, quantities, and scheduling priorities, or to indicate if a part is solid or glue-up, select **Modify cutting bill** from the CUTTING BILL DEFINITION window (Fig. 6). In the MODIFY CUTTING BILL window (Fig. 6.3A) click on the scroll points or use the **Page Up** and **Page Down** keys to scroll through the remaining part list. By default, cutting bill parts are shown sorted by width. To see your parts ordered by length, select **L-Sort** from the bottom of the window; select **W-Sort** to reorder the parts by width. If you are creating a new cutting bill and did not opt to generate a cutting bill from the lengths and widths in the processing options, this window will not show any parts. To add a new size to the cutting bill, select **Append**. To modify an existing part size, select the part with the mouse or use **Select**. The modify and append operations use the PART REQUIREMENT EDITOR window shown in Figure 6.3B.

The PART REQUIREMENT MODIFICATION window displays and allows you to edit all of the specifications associated with a particular part, including size, quantity, value, scheduling, and whether the part can be obtained from glue-up. Glue-up parts are obtained from fixed and random-width parts not required in any solid cutting bill requirements. Glue-up part widths are accumulated for a specified length of panel. The quantity requirement for a panel is met when the total accumulated width is equal to the part quantity multiplied by its width. To change any item, select it and you will be prompted to enter the corrected information.

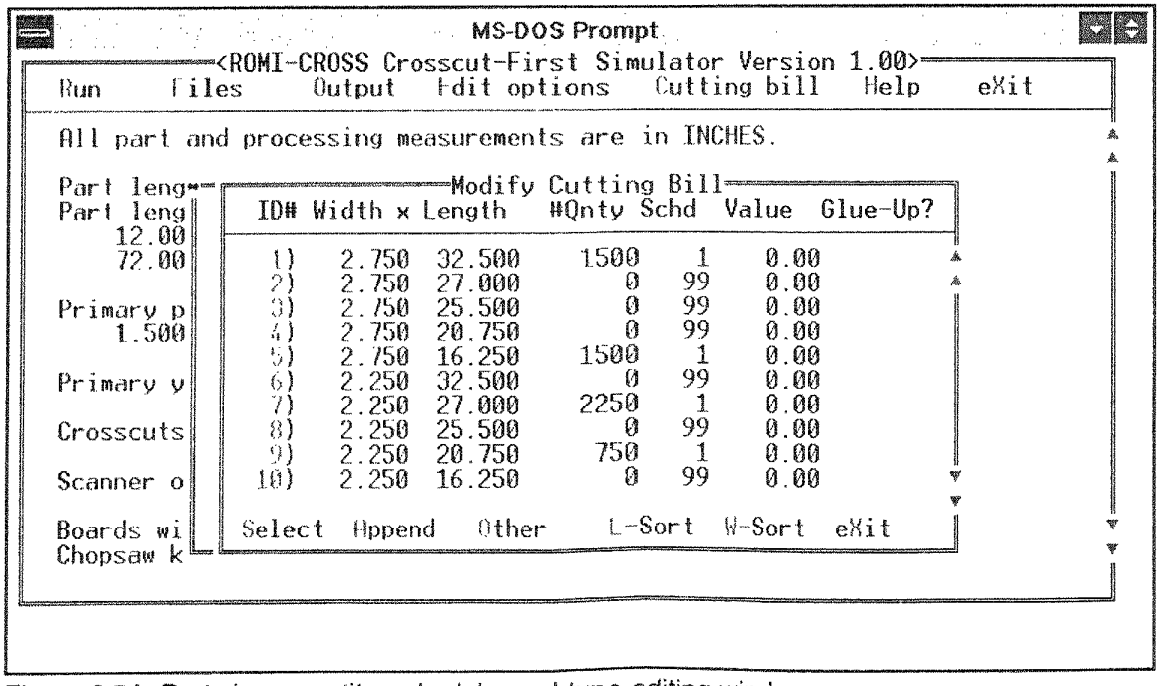


Figure 6.3A. Part size, quantity, schedule, and type editing window.

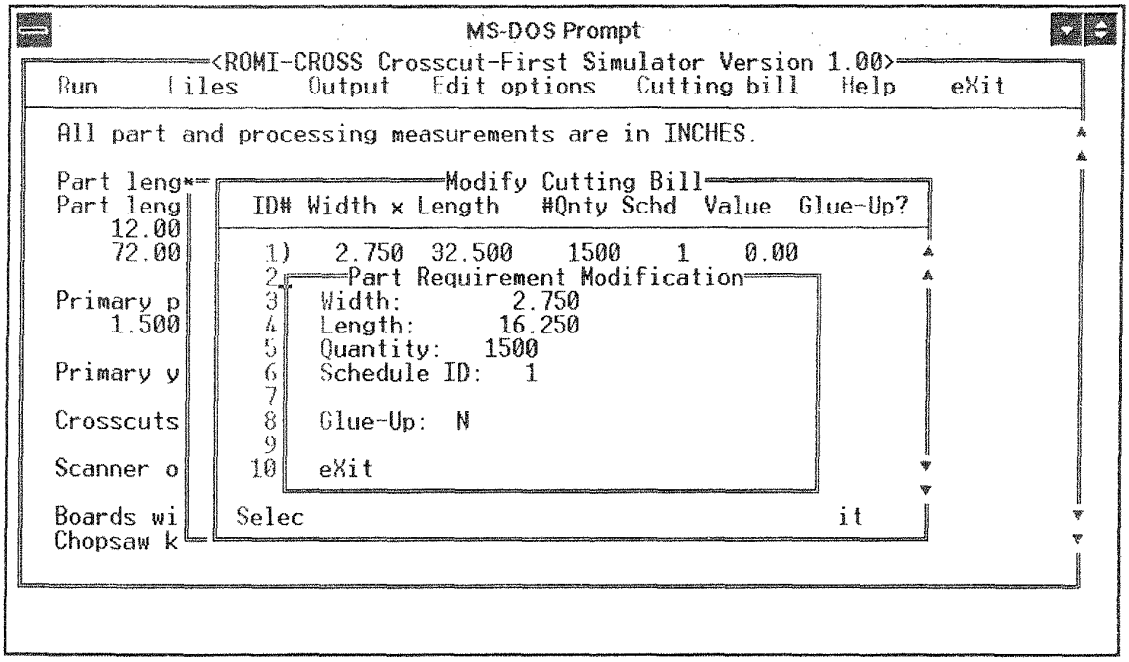


Figure 6.3B. Part requirement editor window.

Once the cutting bill part sizes, quantities, and cutting schedule are defined, you will need to check the random-width glue-up and salvage options to make sure the settings are what you want. To check or modify these settings, select **Other** from the bottom of the MODIFY CUTTING BILL window (Fig. 6.3A). ROMI-CROSS will then display a RANDOM WIDTH MODIFICATION window (Fig. 6.3C).

If your cutting bill includes glue-up (panel) requirements, you may want ROMI-CROSS to use random-width parts to make the panels when no fixed-width parts can be fitted into the board. Alternatively, selecting **Drop back to random...** turns this option on and off. If you want to drop back to random widths when feasible, you must set the minimum and maximum allowable widths acceptable for a panel. To do this, select **miNimum random width** and **Maximum random width** and specify the random-width part specifications for your panels.

If you are using a cutting bill, you can modify part sizes only with the cutting bill editor. The same is true for modifying salvage part sizes. To modify salvage part sizes, select **salvage Widths** or **salvage Lengths** (Fig. 6.3C). The modification of salvage sizes is the same as that discussed in Section 5.2.

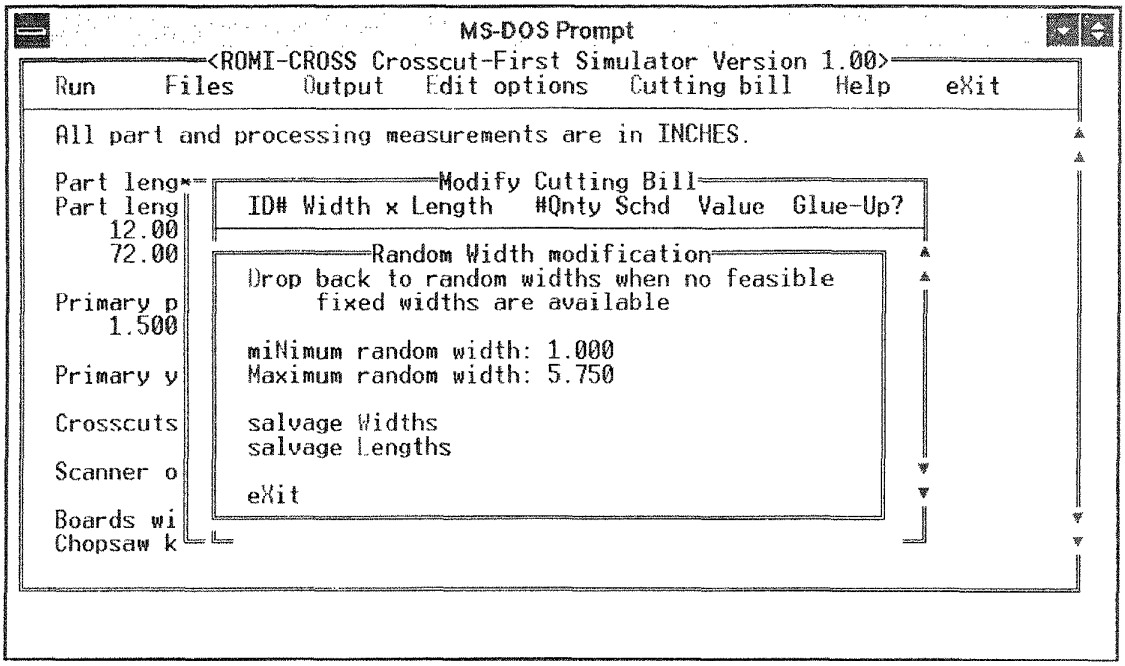


Figure 6.3C. Random-width glue-up and salvage modification window.

## 6.4. Exiting and Saving Cutting Bills

After editing, the easiest way to save the cutting bill changes is to select **Save cutting bill** from the CUTTING BILL DEFINITION window (Fig. 6). If you do not save the cutting bill when you exit the window, all of your changes will be lost. ROMI-CROSS will ask if you want to save your cutting bill when you exit from the CUTTING BILL DEFINITION window. You also can save your changes to a new or existing cutting bill file by selecting **Save cutting bill as....** When using this option, ROMI-CROSS will prompt you to enter a new name for your cutting bill. If that name already exists, it warns that you will overwrite and destroy the current contents of the cutting bill. At this point you are given the choice of canceling the save request or overwriting the contents of the file.

## 6.5. Cutting Bill Processing Options

Additional processing options are made available when a cutting bill is being used. To modify these options you must leave the CUTTING BILL DEFINITION window (Fig. 6B) and enter the CUTTING SPECIFICATIONS window (Fig. 5.1) by selecting **Process** from the EDIT OPTIONS window shown in Figure 6.5. Because we are now processing to a cutting bill and not producing area-based yields, three additional options are available: **back Gauge priorities constantly updated**, **primary operations aVoid orphan parts**, and **saLvage cuts to cutting bill requirements**.

The **back Guage priorities...** option allows you to choose how often you want the part counts tallied and the priorities associated with the parts to be adjusted. Selecting this item will bring up a small editing window. From this window you can specify whether the part counts are constantly updated, updated each time a specified amount of lumber has been processed, or not updated at all. The most efficient method is to have part counts constantly updated. However, if this does not accurately reflect your operation, I recommend the periodic adjustment with an interval set that approximates the average time between updates.

Selecting **primary operations aVoid orphan parts** causes ROMI-CROSS to cut only needed primary parts. This option is especially useful when used with the **saLvage cuts to cutting bill requirements** option. When both of these options are chosen, a larger clear area is reserved for cutting back to shorter required primary part sizes. If no required primary part size can fit into the available clear area, standard salvage operations are used. Selecting either of these options toggles it on and off.

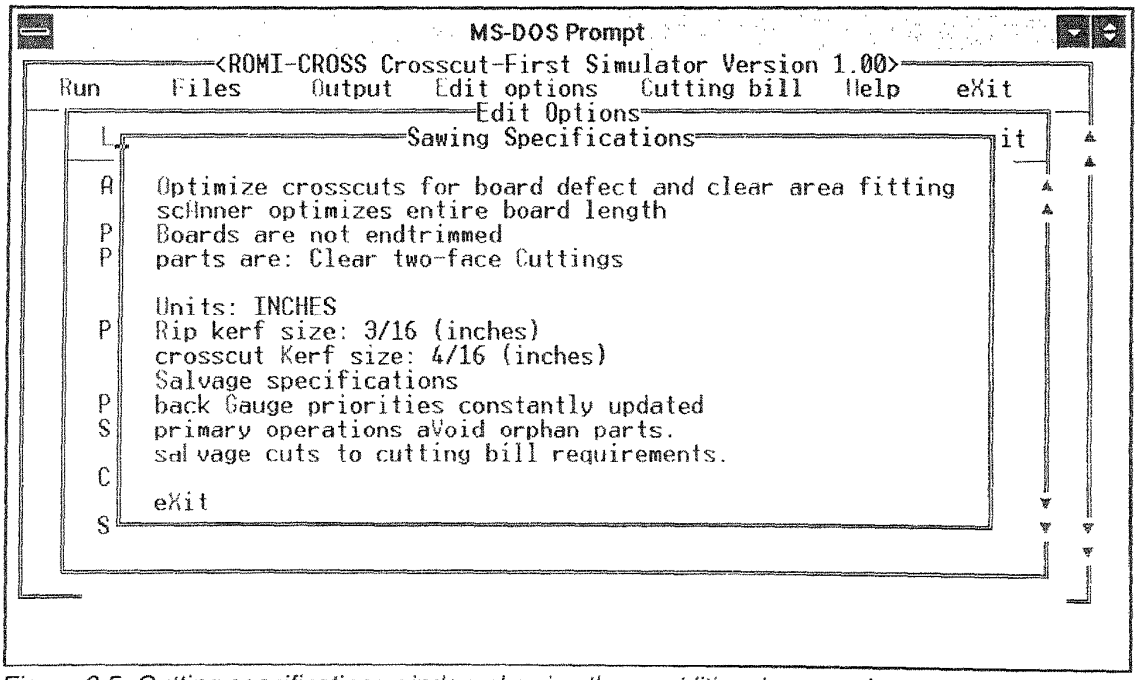


Figure 6.5. Cutting specifications window showing three additional processing options.

# 7. Datafile Selection

A datafile consists of one or more digitized boards. Recall that a digitized board is a real board whose dimensions and defects are expressed in x,y coordinates. To select a datafile or create your own custom datafiles, select **Files** from the main menu (Fig. 4). This will display the DATAFILE SELECTION window (Fig. 7). ROMI-CROSS allows you to create custom datafiles that contain either selected boards or a specified grade and size mix.

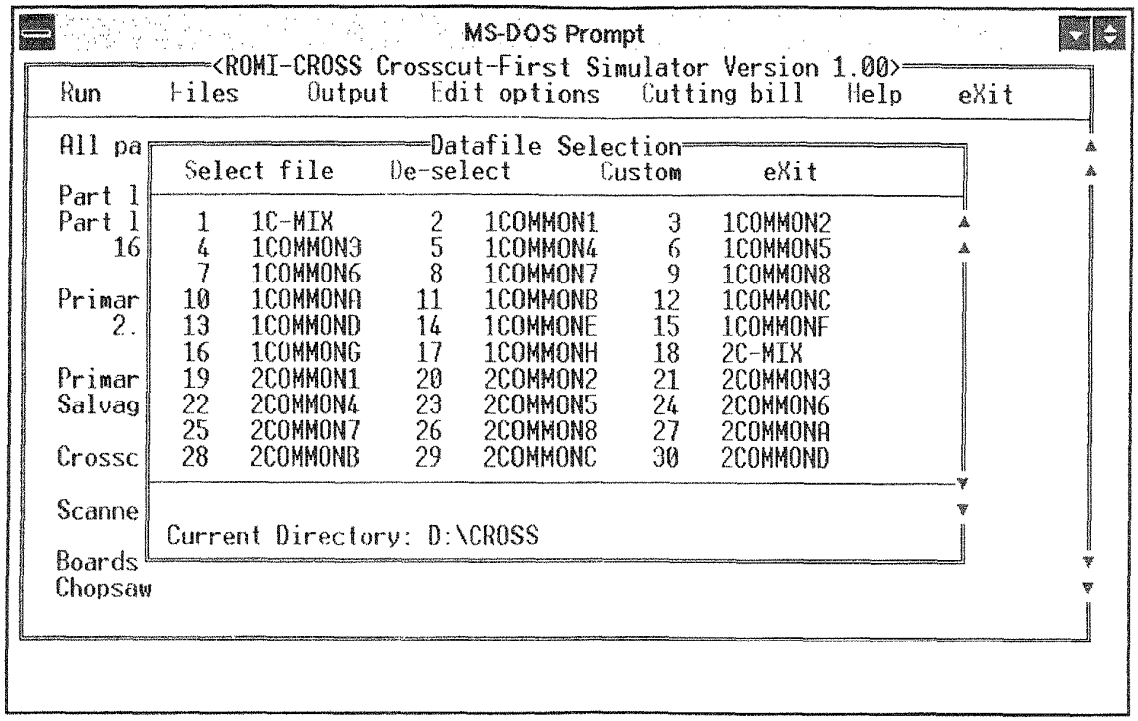


Figure 7. Datafile selection window.

## 7.1. Creating Custom Grade Mix and Specified Files

The ROMI-CROSS simulation package includes the MAKEFILE custom grade mix and specified lumber datafile generation program. The use of this program is discussed in detail in the "1997 Databank for Red Oak Lumber" publication included in the ROMI-CROSS package. To run the MAKEFILE program from ROMI-CROSS, select **Custom** from the DATAFILE SELECTION window (Fig. 7).

## 7.2. File Selection

The DATAFILE SELECTION window shows all the datafiles in the ROMI-CROSS working directory (Appendix III describes the individual board files). To scroll through the list, click on the arrows at the right of the window or use the **Page Up** and **Page Down** keys. To select datafiles, you can click on the desired file or choose **Select file** and specify the number of the file to use. For example, if you wanted to use the datafile 2C-MIX, you would enter **18**. You may repeatedly select as many as 10 datafiles to be processed together. Datafiles are highlighted as they are selected. If you decide that you do not want to use a particular datafile, you can click on a highlighted datafile or choose **De-select** and specify the number of the datafile. For example, you would enter **18** to de-select the 2C-MIX file chosen above.

## 7.3. Removing Old Lumber Datafiles

At some point you probably will want to remove datafiles that you no longer find useful. There are several ways to delete old datafiles. Be warned that it is easy to delete the wrong datafile. Note that ***all*** ROMI-CROSS datafiles have the three letter extenstion .VBD.

The most common way to delete datafiles uses DOS. To access DOS, simply exit ROMI-CROSS or open the DOS window if you are using Windows. Next, make the subdirectory that contains the data files your working directory. If you accepted the default installation directory for ROMI-CROSS, you would enter:

**CD \RM-CROSS**

For example, if we want to delete the file named 251C752C.VBD, we would enter at the DOS prompt:

**DEL 251C752C.VBD**

This method should be followed for each datafile you want to delete.

An easier method is provided for Windows users. To delete files using Windows, first open the file manager and choose the subdirectory that contains the datafiles you wish to remove. Following the above example, click on the \RM-CROSS subdirectory name. The window at right will display all of the files in the \RM-CROSS subdirectory. Search for the file you wish to delete, click once to highlight that file, and press **Delete**. Windows will ask if you really want to delete the file; press **Enter** or click on **Yes** to complete the deletion.

# 8. Output Options

ROMI-CROSS provides several different output types for other applications, such as least-cost-grade-mix programs, and flow simulation. The OUTPUT OPTIONS window (Fig. 8) allows you to select the output types you want, rename output destination files, and delete old output (Fig. 8). Select **Output** from the main menu (Fig. 4) to display the OUTPUT OPTIONS window.

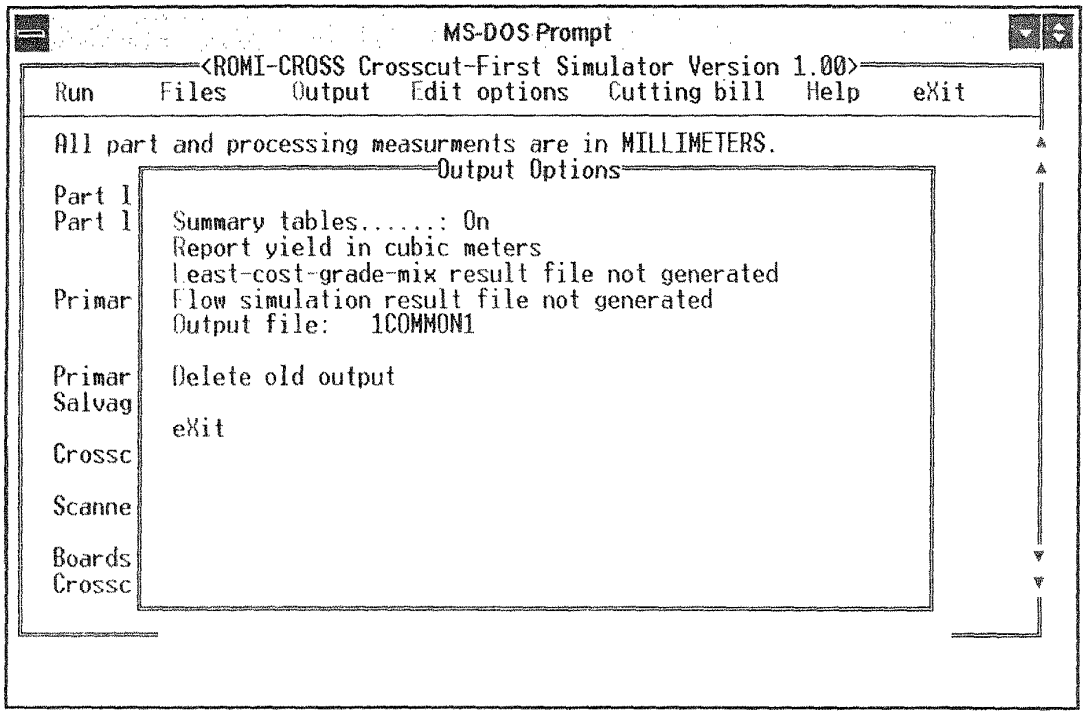


Figure 8. Output options window.

## 8.1. Summary Tables

Summary tables contain part counts, surface areas, and yields for primary and salvage in user-defined size (width and length) categories. These tables are especially useful when cutting to random sizes or when not processing a cutting bill (area-based yields). Selecting **Summary tables..:** turns on and off the summary tables option (it is on by default). Section 11.1 describes and provides examples of summary tables.

## 8.2. Reporting Unit Selection

If you are processing in metric units, ROMI-CROSS can generate result totals in cubic meters or in board feet. Selecting **Report yield in ...** from the OUTPUT OPTIONS window toggles between results in cubic meter and board feet (Fig. 8).

## 8.3. Least-Cost-Grade-Mix Output

When the least-cost-grade-mix option is turned on, ROMI-CROSS produces output that can be used by the ROMI-GRAM least-cost-grade-mix solver.[3] The output file will have the same name as other output files with an .LP extension. The information contained in the file includes the number of parts required and obtained for each part size as well as the total amount of board feet processed and the number of crosscuts and rips. Note that this option is off by default and must be turned on for each run.

## 8.4. Flow Simulation Output

ROMI-CROSS can generate step-by-step processing information for each board, including the number of primary crosscuts and rips, salvage crosscuts and rips, primary and salvage parts, and crosscut section counts and sizes (Stiess 1995). Such information can be used as an input for complete rough-mill flow simulation. Selecting **Flow simulation...** (Fig. 8) turns on and off the generation of the flow simulation result file (it is off by default).

## 8.5. Renaming Output Files

By default, output files have the same name as the first datafile processed. For example, if you are processing the data files 1COMMON3 and 2COMMON4 together, the default output file set will be named 1COMMON3. To rename the output file, select **Output file:...** (Fig. 8) to see all of your current output file sets displayed. You can select from these or select **New** to specify a new file name (Fig. 8.5). If there are no output file sets, the only valid option is to specify a new file set name. Should you select a currently existing file, you will be warned that the contents of these files will be overwritten and destroyed.

[3] Hoff, Kristen G. **Mathematical model for determining optimal lumber grade mix in a gang-rip-first system**. In preparation.

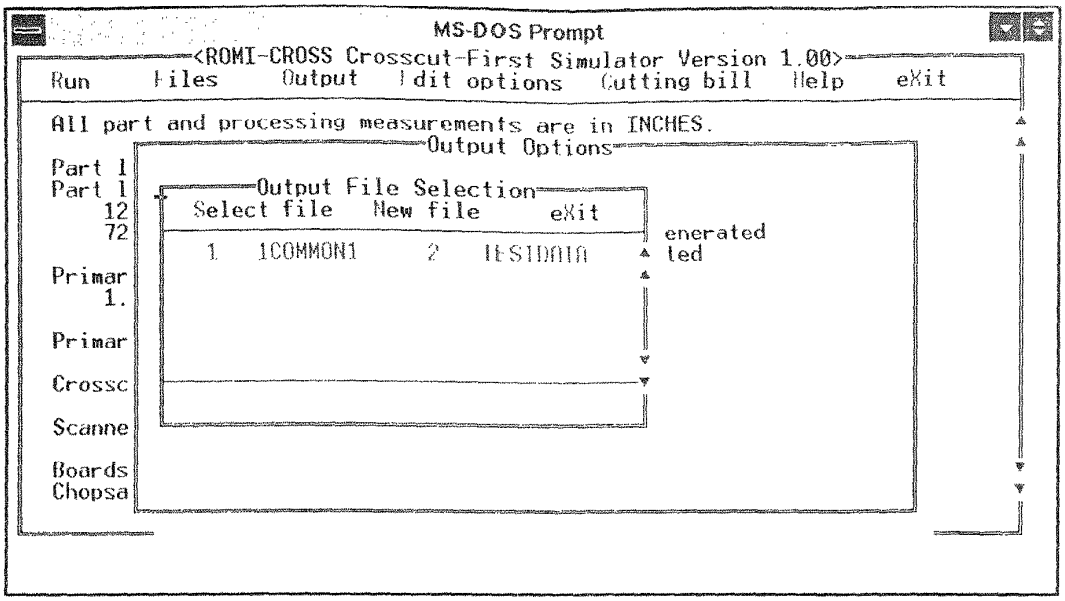


Figure 8.5. Output file selection window.

## 8.6. Deleting Old Output Files

After using ROMI-CROSS several times, you will find a number of old results in your working directory. It is not uncommon for a output set to contain more than 1 million bytes (MB). If you find yourself getting lost in all of the result files or low on hard disk space, it probably is time to delete the old result files.

There are two ways to delete old output files. The first deletes all of the existing result files, including cutting bill results, plot, and yield results. To use this method, select **Run** from the main menu (Fig. 4). Then select **DOS shell** from the RUN window (Fig. 9.1) to get the DOS prompt. The CLEANUP.BAT batch file automatically deletes ***any and all*** exisiting result files. To run the CLEANUP batch file, at the DOS prompt enter:

**CLEANUP**

When the batch file is finished, type **EXIT** to return to the program.

The second delete option allows you to choose which result files you wish to delete. To use this method, select **Delete old output** from the OUTPUT OPTIONS window (Fig. 8). ROMI-CROSS will ask whether you want to delete cutting bill results or summary and plot files. When the type of output to delete has been selected, an output deletion window will appear (Fig. 8.5). To delete an output file, click on the desired filename or choose **Select file**. Once a file is selected, ROMI-CROSS will ask you to confirm its deletion. Answer **Yes** to continue or **No** to stop the deletion action.

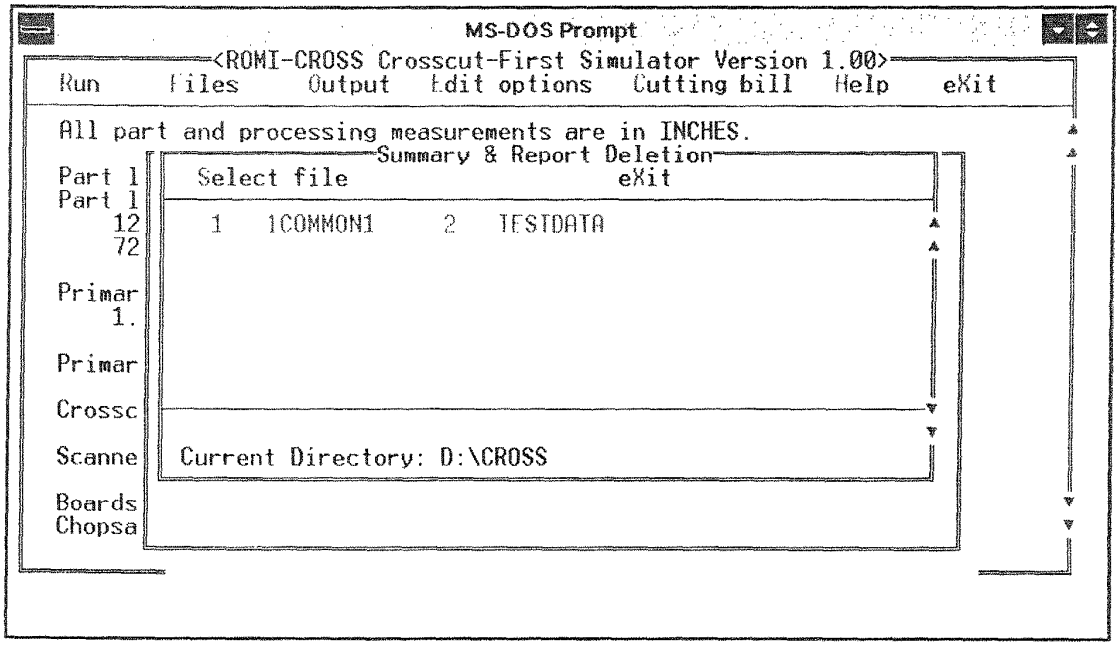


Figure 8.5. Summary and report deletion window.

## 9. Beginning the Simulation

To begin the simulation, select **Run** from the main menu (Fig. 4). This will display the RUN menu shown in Figure 9A. Next, select start **ROMI-CROSS** to begin the ROMI-CROSS analysis. If you failed to select any input datafiles, ROMI-CROSS will report an error and ask you to select an input datafile. If everything is set up correctly, the processing window shown in Figure 9B will indicate the datafile name and board number currently being processed. Selecting **Cancel** stops the run and retains all settings except datafile selection.

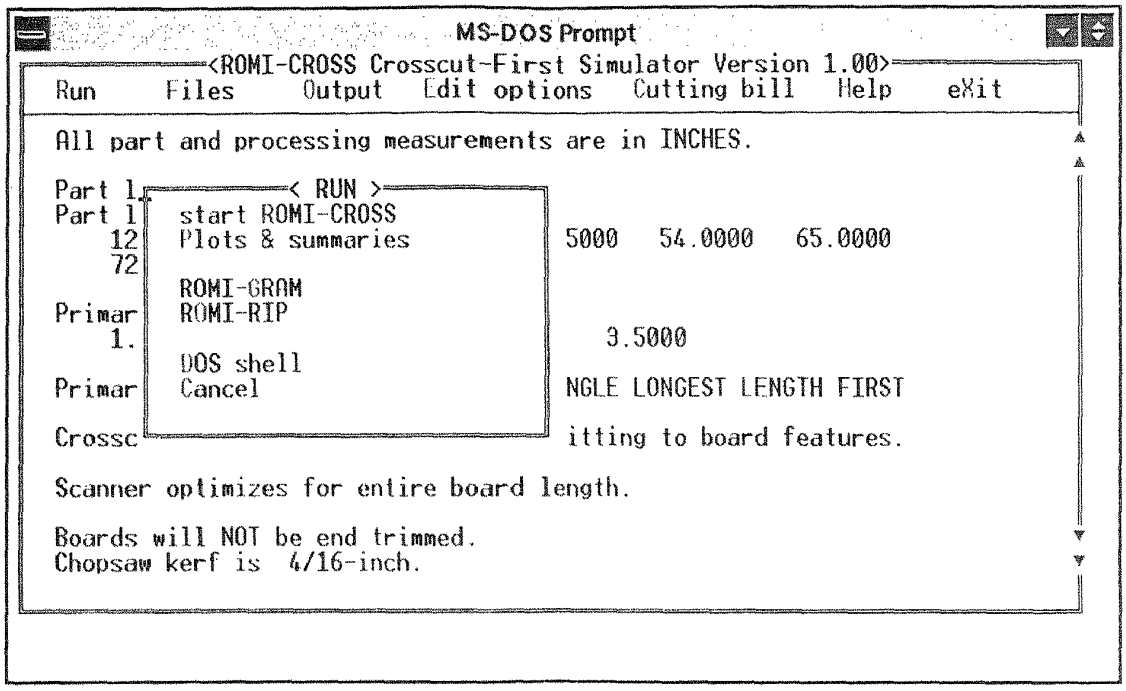


Figure 9A. ROMI-CROSS run window.

If you are using a cutting bill and all of the part requirements for the bill have been met, ROMI-CROSS will stop processing and ask you whether you want to continue (Fig. 9C). If you answer **No**, processing will stop and you will be returned to the window (Fig. 9A). If you answer **Yes**, ROMI-CROSS will continue until all the boards in the input datafile(s) have been processed.

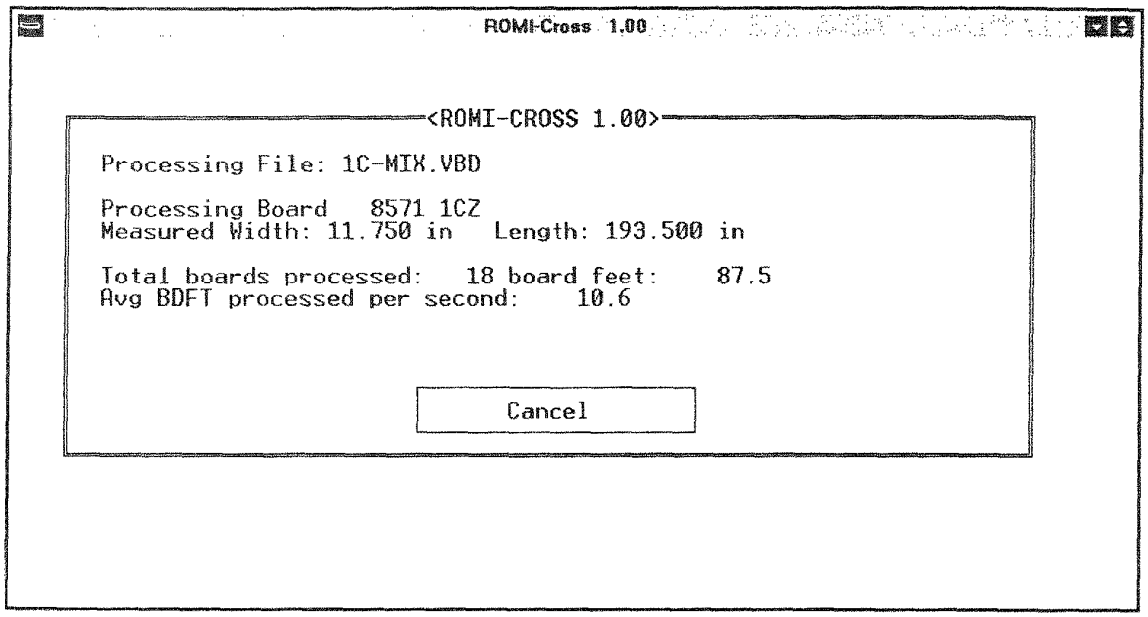



Figure 9B. ROMI-CROSS processing window.

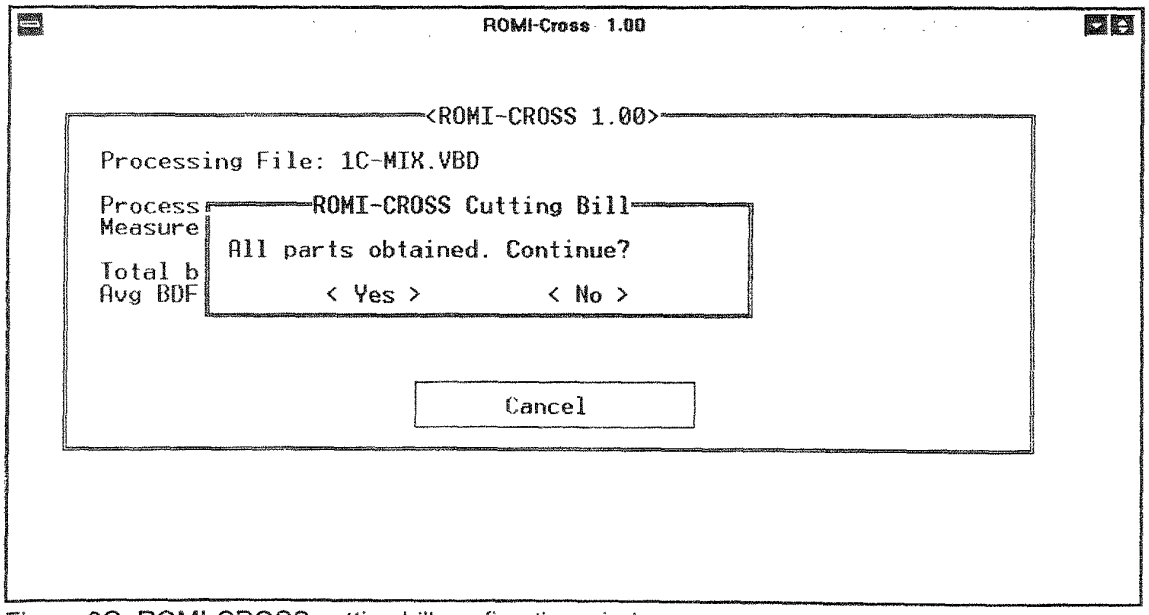



Figure 9C. ROMI-CROSS cutting bill confimation window.

# 10. Running ROMI-CROSS in Batch Mode

ROMI-CROSS has extensive batch-run capabilities. This is useful if you have several large simulations you would like to run overnight. To run ROMI-CROSS in batch mode, you need to have access to a DOS text editor such as EDIT, which is included with MS-DOS versions 5.0 and later.

Before batch mode can be used, all cutting bills and options lists must be previously defined. If you are not running cutting bills, the options list used will be one currently defined by the RX program. Instead of running RX.EXE, you will run the simulation program ROMI-X.EXE directly. In fact, the RX program does nothing more than assemble your options together and submit them to the ROMI-X.EXE program. In batch mode, you do this yourself. Figure 10 shows the program options available for batch runs. To see these options on your computer, at the DOS prompt enter:

**ROMI-X**

```
RRR   OO   M     M  III     CC  RRR   OO   SSS  SSS
R  R O  O  MM   MM   I     C    R  R O  O S    S
RRR  O  O  M M M M   I === C    RRR  O  O  SS   SS
R R  O  O  M  M  M   I     C    R R  O  O    S    S
R  R  OO   M     M  III     CC  R  R  OO  SSS  SSS

Command line error: Too few arguments

Usage:

        ROMI-X in1[,in2,...inN] out1[,out2,...outN] [arguments]

Where arguments consist of a list of one or more of the following options.
        B  Batch mode           G  Generate ROMI-GRAM .LP output file
        S  Summary tables       U  Yield units are metric
        M  Monochrome display   Lcutbillfile    Cutting Bill
        O  Cutting Bill Output filename
        F  Generate Flow Simulation report files
```

Figure 10. ROMI-CROSS command line display.

Immediately following ROMI-X on the command line are the input datafile name(s). You can specify up to 10 datafile names separated by commas and no spaces. Following the datafile names is the output file name. Each output type will still have its own file and a different file extension as with non-batch operations. Option arguments follow the input and output file names.

ROMI-CROSS does not create the summary tables directly. Rather it produces a .SAS file that is processed by another program, ASAS-X.EXE, to generate the tables. ASAS-X must be run once for each output file. Running ASAS-X is easy: enter ASAS-X followed by the output file name. The following examples show how to run ROMI-X and ASAS-X:

**ROMI-X 1COMMON1 1COM +B**
**ASAS-X 1COM**

This example processes the 1COMMON1 data file and stores the output set under the name 1COM.*. The +B option tells ROMI-X that this run will be in batch mode. ASAS-X 1COM processes the 1COM.SAS file to produce the summary table file 1COM.SUM.

**ROMI-X 1COMMON1,2COMMON1 1C-2C +B**
**ASAS-X 1C-2C**

This example processes the 1COMMON1 and 2COMMON1 datafiles and stores the output file set under the name 1C-2C.*. Note that in batch mode, ROMI-X does not check to see if a previous output file set exists under the specified output name. If there is a previous output file set with the same name, the old set will be deleted and replaced by a new file set with the same name.

By default, ROMI-X generates summary table information, part reports, and comma-delimited report files. To turn an option off, precede its key letter with a minus sign. Similarly, to turn an option on, precede its key letter with a plus sign. For example:

**ROMI-X 1C-MIX 1C-MIX +B -S**

batch processes the 1C-MIX data file. This run does not produce a summary table .SAS file, and stores all the output in a file set named 1C-MIX. Since the SAS file was not generated, the ASAS2 program is not run.

To process a cutting bill, use the L and O options. Use L to specify the name of the cutting bill and O to optionally specify the name of the cutting bill output file. If you do not specify a cutting bill output file name, the cutting bill results will be stored in a file with the same name as the cutting bill but with an .OUT extension. When ROMI-X processes a cutting bill, it uses the options list associated with the cutting bill, not the default list currently defined by the RIP program. To process a cutting bill named SQUIRE using the 2C-MIX datafile, enter:

**ROMI-X 2C-MIX 2CSQUIRE +B +LSQUIRE +O2CSQUIRE**
**ASAS-X 2C-SQUIRE**

This would process the 2C-MIX datafile storing the output in a file set named 2CSQUIRE. The cutting bill SQUIRE and its associated options list would be used to process the 2C-MIX datafile and the cutting bill output would be stored in the file 2CSQUIRE.OUT. You can give the cutting bill and the processing results the same name as each uses a different file extension.

Many analyses can be processed sequentially within each batch file. For example, you can process two cutting bills on two lumber grades. The batch file would look like this:

```
ROMI-X 2C-MIX 2CSQUIRE +B +LSQUIRE +O2CSQUIRE
ASAS-X 2CSQUIRE
ROMI-X 1C-MIX 1CSQUIRE +B +LSQUIRE +O1CSQUIRE
ASAS-X 1CSQUIRE
ROMI-X 2C-MIX 2CFRAMES +B +LFRAMES +O2CFRAMES
ASAS-X 2CFRAMES
ROMI-X 1C-MIX 1CFRAMES +B +LFRAMES +O1CFRAMES
ASAS-X 1CFRAMES
```

# 11. ROMI-CROSS Results

ROMI-CROSS provides the user with many result types for each simulation. These include summary tables, yields and processing requirements, cutting bill reports, board plots, and data on least-cost grade mix and flow simulation. The last two data types are intended to be used only by other applications. The other report types are intended to be printed out or viewed using the report viewing program RX-VIEW included with ROMI-CROSS.

There are two ways to run the RX-VIEW report program. The easiest way is to select **Run** from the main menu (Figure 4) and then select **Plots and summaries** (Fig. 9.1). The second method runs the review program from the DOS prompt. To do this you must first make your working directory the ROMI-CROSS subdirectory. If you used the default installation directory, you would enter:

**CD \RM-CROSS**

To run the review program, you would enter:

**RX-VIEW**

When the plots and summaries program begins, it asks which output report to open (Fig. 11A). From this window select the output file set that you wish to view. This will bring up the report program main menu (Fig. 11B).

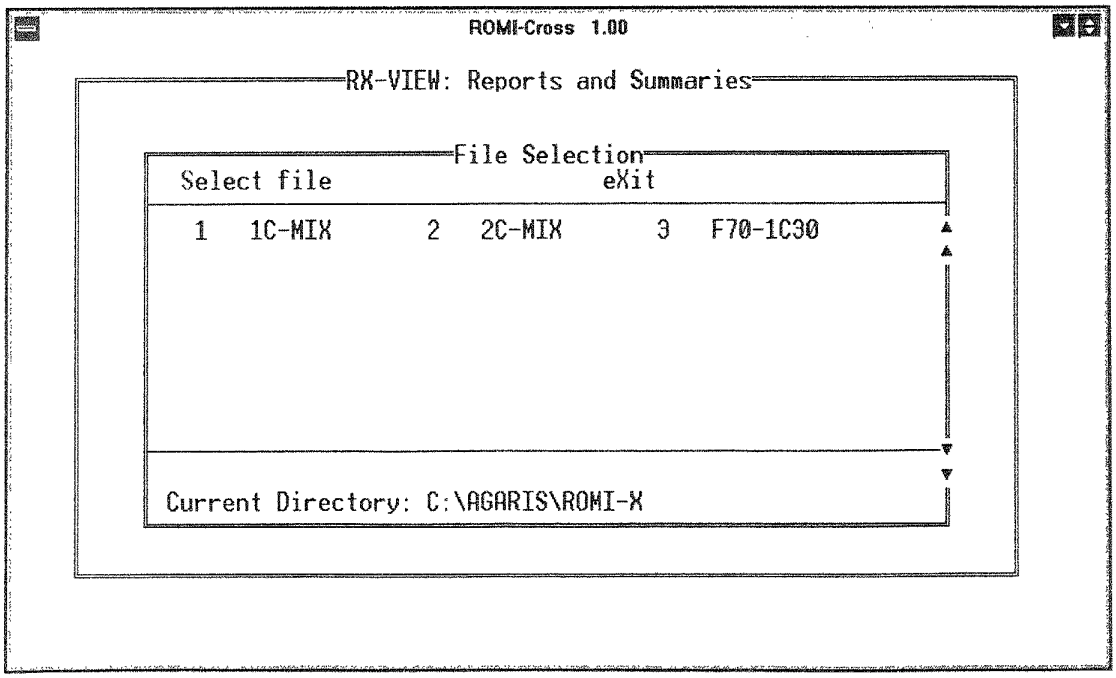



Figure 11A. RX-VIEW opening screen for choosing output file set.

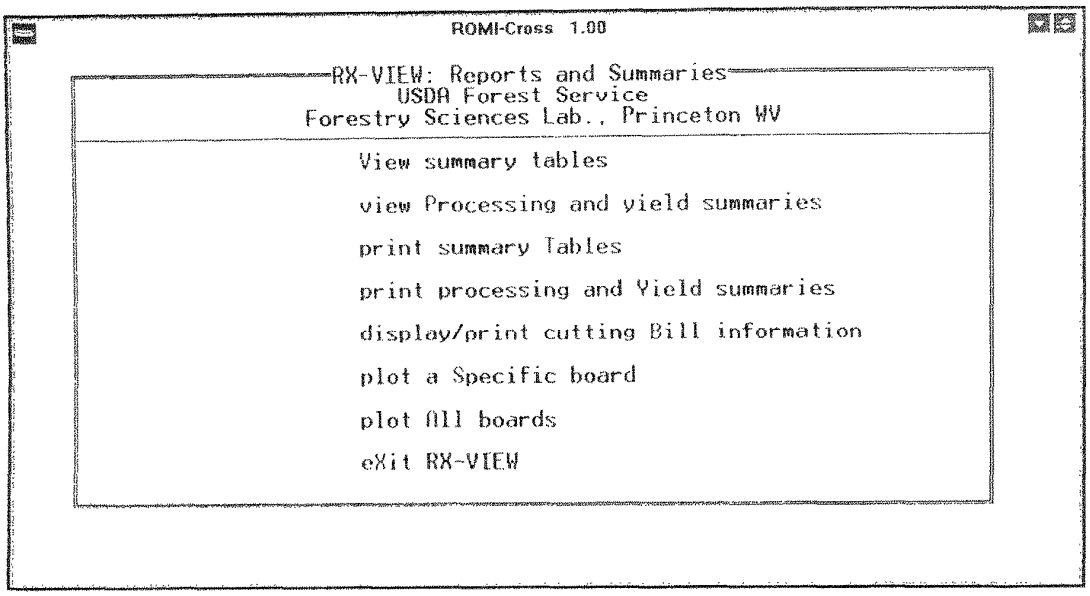


Figure 11B. RX-VIEW main menu window.

## 11.1. Summary Table and Yield Results

Summary tables provide detailed information on parts and yield. They list the number of parts generated, surface area, and percentage of parts by user-defined width and length groupings. Yield results include the yield and processing requirements (number of sections, parts, rips, and crosscuts) in primary, excess primary, salvage, and excess salvage categories for each grade processed and in total. Select **View summary tables** or **view Processing and yield summaries** from the RX-VIEW main menu (Fig. 11B) to examine tables or results. When viewing summary tables, use the **Page Up** and **Page Down** keys to scroll the display. You also can use the cursor keys to pan the screen left, right, down, or up. Select **Help** for descriptions of all the options available when viewing summary tables. Select **eXit** to leave the summary table viewer.

Because summary tables can be large, you may want to print them for easier examination. Select **print summary Tables** or **print processing and Yield summaries** from the RX-VIEW main menu for a printout. All summary tables for an input file are placed in a single output file with the extension .SUM. The processing and yield summaries for an input file are placed in an output file with the extension .YLD.

The summary table file contains the setup options and the yield and processing summaries for each grade and accumulated yields and totals for all grades (Figs. 11.1A, B). The options summary describes the options that were used in that ROMI-CROSS run. The yields and processing summaries follow the options summary and list the number of boards and the total board area processed, and the number of crosscut sections and parts produced as well as the number of crosscuts and rips required to produce the sections and parts. The processing and yield summaries contain only the options and the yield and processing summary pages.

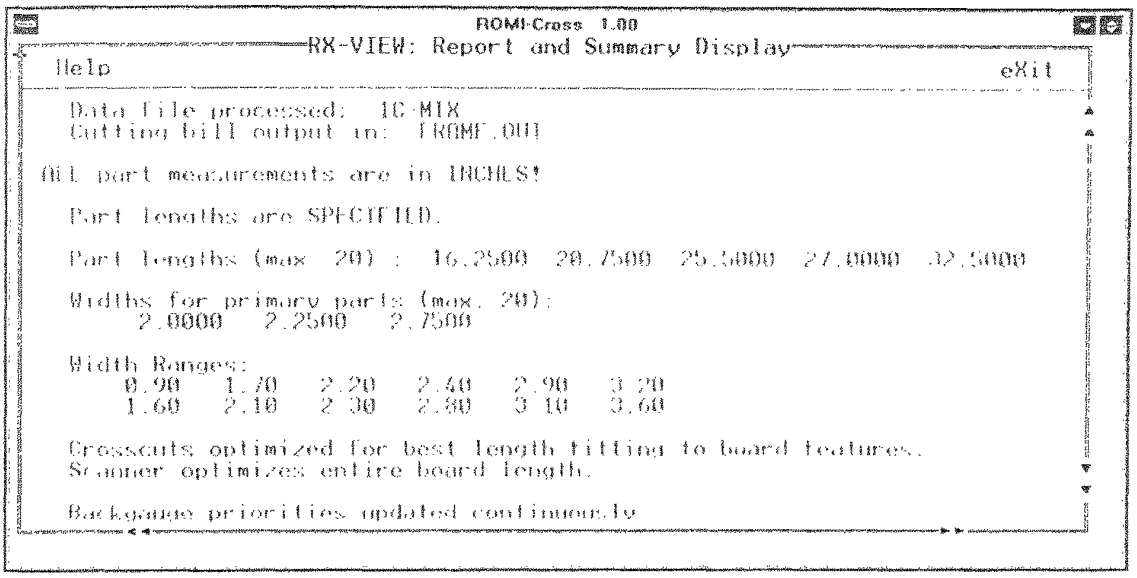



Figure 11.1A. Processing options summary page.

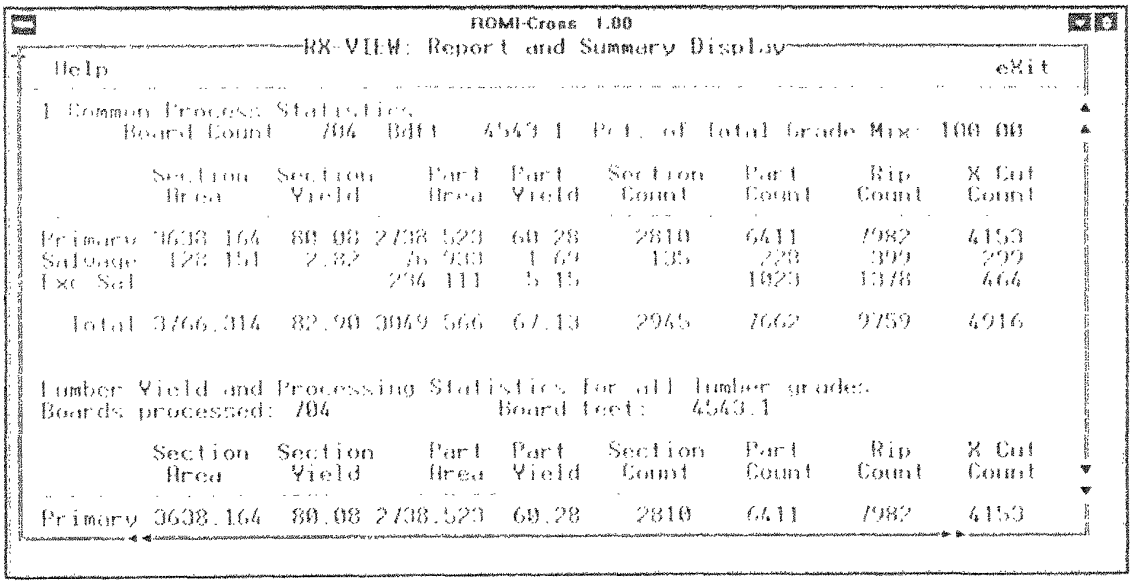



Figure 11.1B. Yield and processing requirements summary.

There are six summary tables that describe the yield distributions. A sample of one of these tables is shown in Figure 11.1C. The first three tables give the yield distributions based on surface area. In each length-width cell, the upper number is the board feet of surface area and the lower number is the yield percentage. The percentages in each column add to 100. The first table is the distribution of total yield. The second and third tables contain the surface-area distributions for the primary and salvage cuttings. The last three tables are based on the number of parts produced. These tables are organized in the same manner as the first three tables. In each length-width cell, the upper number is the part quantity and the lower number is the percentage of total part quantity.

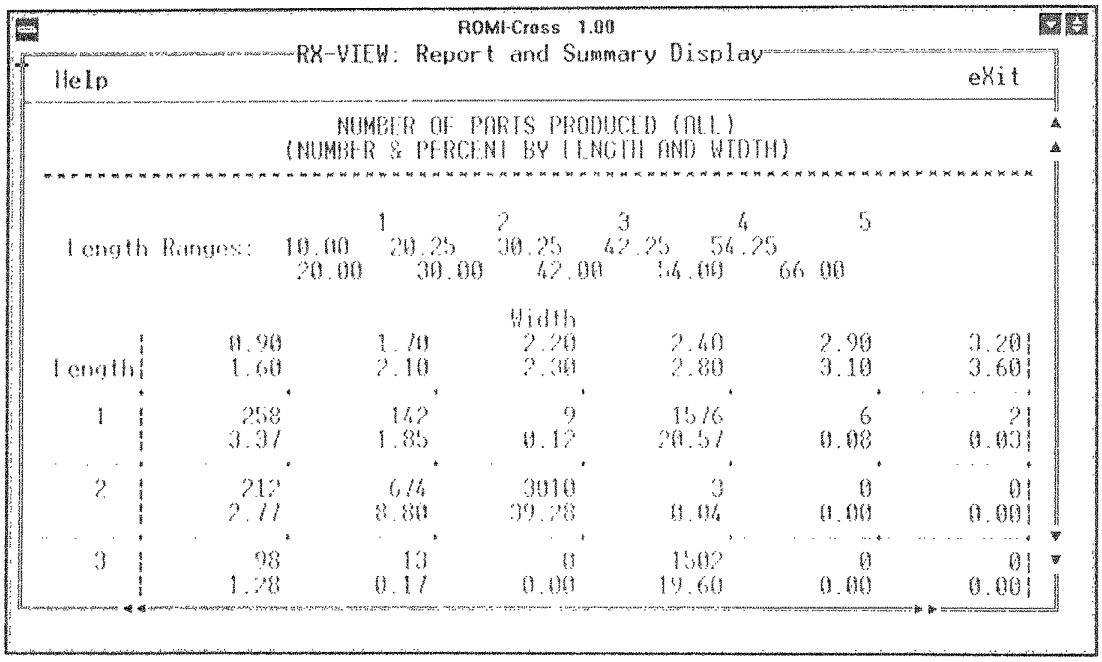


Figure 11.1C. Sample summary table.

## 11.2. Cutting Bill Results

The information generated by ROMI-CROSS when processing lumber to meet a cutting bill allows you to analyze the lumber volume and the processing required to meet the bill. The output for a cutting bill is stored in a file with an .OUT extension. By default, the output file has the same name as the cutting bill processed. For example, if you process a cutting bill named FRAME, the output is stored in FRAME.OUT (the FRAME cutting bill as well as other sample bills are included on the ROMI-CROSS install diskette).

To view or print cutting bill results, select **display/print cutting Bill information** from the RX-VIEW main menu (Fig. 11B). Next, you will be asked to select the cutting bill output you want (Fig. 11.2A). Use the mouse or **Select file** to select a cutting bill output file.

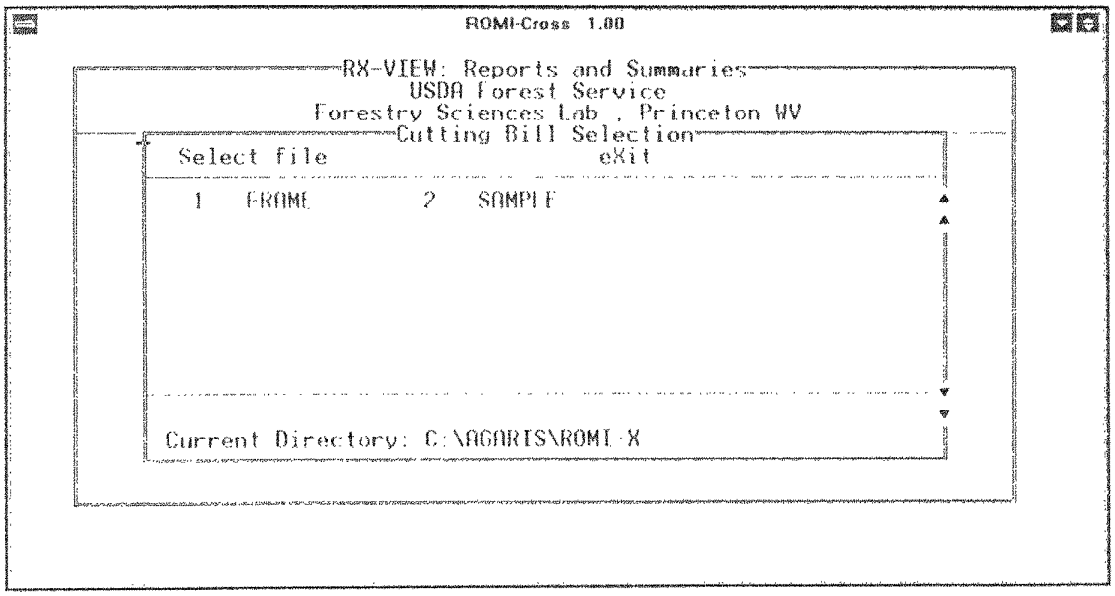
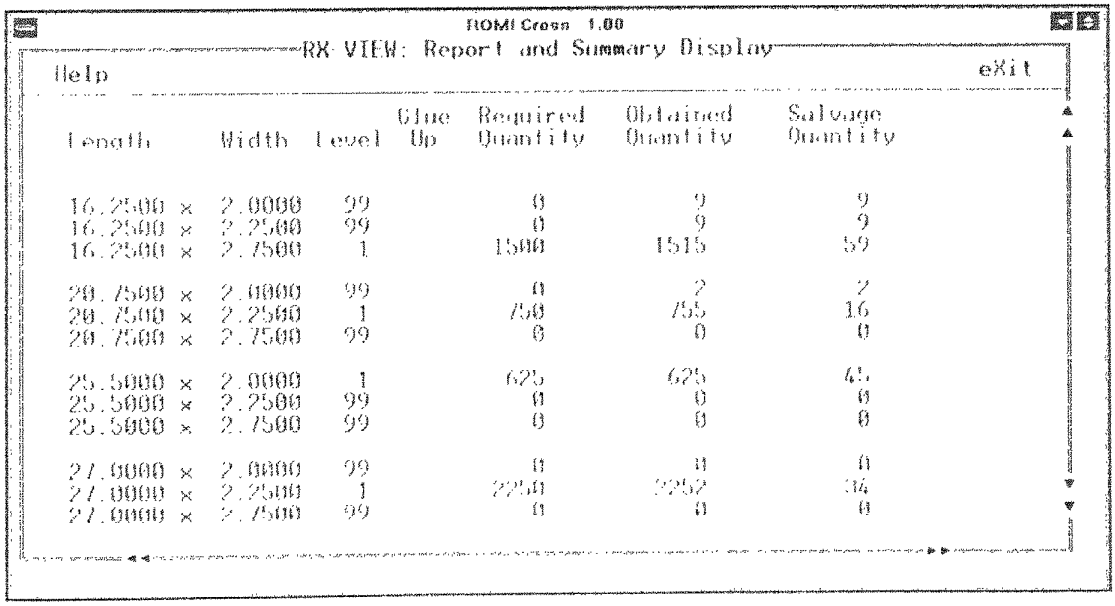



Figure 11.2A. Cutting bill selection window.




| Length | Width | Level | Glue Up | Required Quantity | Obtained Quantity | Salvage Quantity |
|---|---|---|---|---|---|---|
| 16.2500 x | 2.0000 | 99 | | 0 | 9 | 9 |
| 16.2500 x | 2.2500 | 99 | | 0 | 9 | 9 |
| 16.2500 x | 2.7500 | 1 | | 1500 | 1515 | 59 |
| 20.7500 x | 2.0000 | 99 | | 0 | 2 | 2 |
| 20.7500 x | 2.2500 | 1 | | 750 | 755 | 16 |
| 20.7500 x | 2.7500 | 99 | | 0 | 0 | 0 |
| 25.5000 x | 2.0000 | 1 | | 625 | 625 | 45 |
| 25.5000 x | 2.2500 | 99 | | 0 | 0 | 0 |
| 25.5000 x | 2.7500 | 99 | | 0 | 0 | 0 |
| 27.0000 x | 2.0000 | 99 | | 0 | 0 | 0 |
| 27.0000 x | 2.2500 | 1 | | 2250 | 2252 | 34 |
| 27.0000 x | 2.7500 | 99 | | 0 | 0 | 0 |

Figure 11.2B. Sample cutting bill report.

RX-VIEW will then ask if you want to print or display the cutting bill output. If you select **Print**, it is printed on the printer connected to your computer's LPT1 port. If you select **Display**, the report is shown on the screen. Like summary tables, the cutting bill report also includes a header describing all of the processing options used as well as the yield and processing tables.

Figure 11.2B shows a portion of the sample cutting bill report for the FRAME cutting bill. The length and width of each part is shown at left. The "Level" column indicates the scheduling and replacement level number for that part. A "Y" in the "Glue Up" column indicates that the part size is a panel. "Required Quantity" shows the total number of parts required for each part size. "Obtained Quantity" is the total number of parts that meet that size requirement. The parts included in obtained quantity can be primary, excess primary, salvage, or excess salvage. "Salvage Quantity" counts the total number of parts obtained from salvage and excess salvage operations. If a part's required cuttings were not met, the message "*****UNMET*****" is displayed to the right of its part counts.

## 11.3. Board Plots

ROMI-CROSS allows you to view or print plots of individual boards along with their parts, defects, and kerfs. The information used to generate board plots is kept in output files with the extension .PLT. You can view board plots for an entire run or for a specific board. To view all of the boards processed, select **plot All boards** from the RX-VIEW main menu (Fig. 11B). Select **plot a Specific board** from the RX-VIEW main menu to view a selected board. When plotting specific boards, a Board Plot Selection window allows you to choose which board to view (Fig. 11.3A). To select a board, click on it or use **Select a board**. If you use the latter, you will be prompted to enter the ID number and grade of the board. The boards shown in Figure 11.3A are from the 1C-MIX.DAT datafile.

By default, boards are displayed in their entirety with all parts, defects, and kerfs (Fig. 11.3B). The board is displayed as if it were transparent, with defects from both sides visible at once. The defects are color coded, each color representing a different defect classification. Select **Defects** from the bottom of the board plot screen for a legend explaining the different defect types. The width ruler is in inches or millimeters depending on the processing units used. The length ruler has minor ticks every 6 inches, with a major tick every foot, or minor ticks every half meter and major ticks every meter. Select **Print** to print the board plot. Selecting **Cuttings** turns on and off the display of primary and salvage parts.

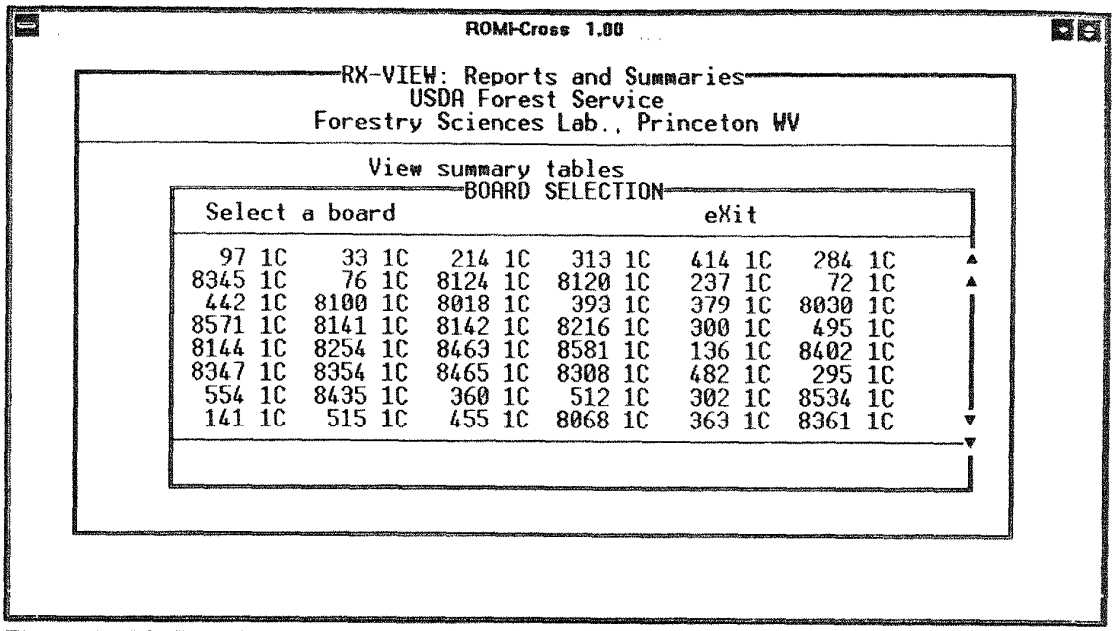



Figure 11.3A. Board plot selection window.

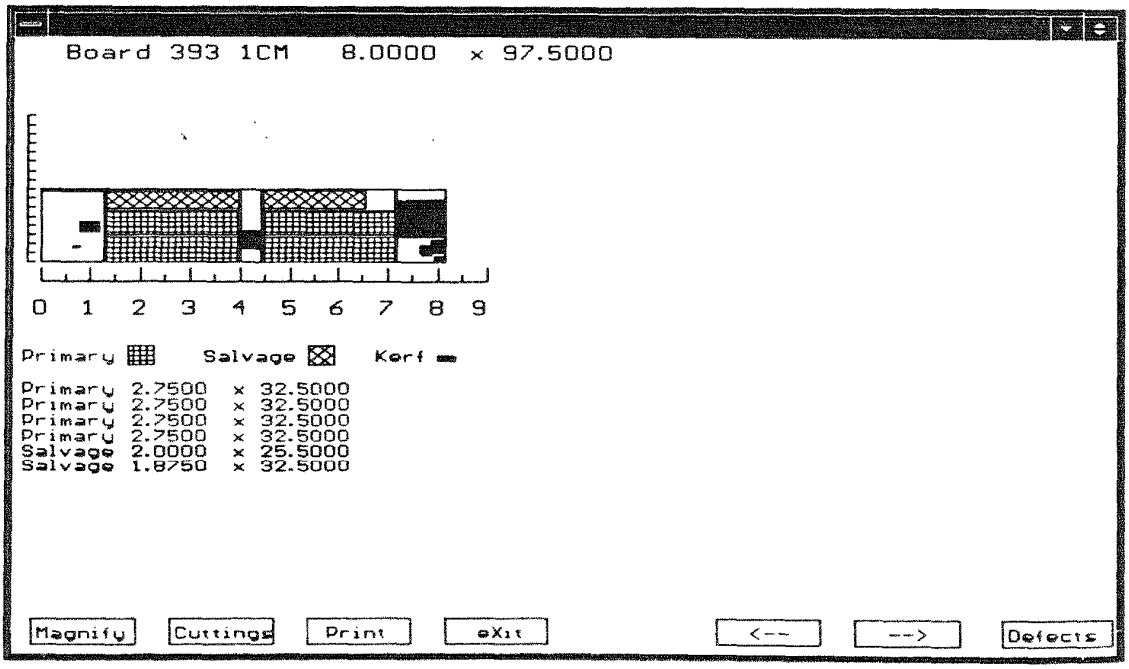



Figure 11.3B. Sample board plot window showing default board display.

Plots can be enlarged to view boards in detail by selecting **Magnify**. To view the remaining board surface, use the left and right arrow keys to pan the display along the length of the board. Select **Shrink** to reduce the board plot to its original size.

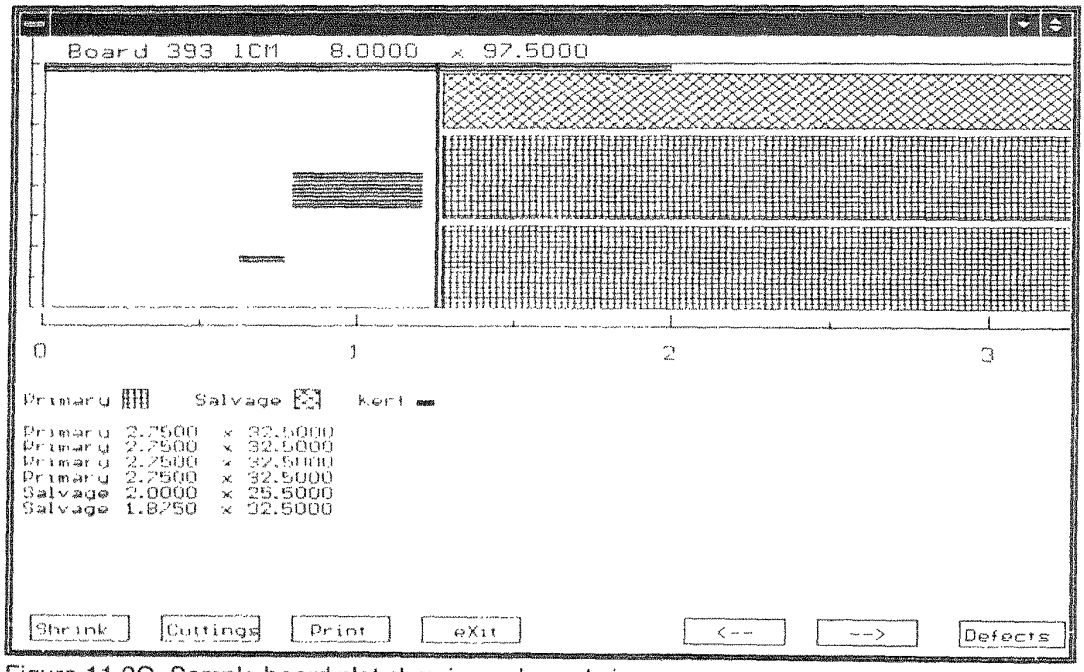



Figure 11.3C. Sample board plot showing enlarged view.

## Literature Cited


Giese, P.J.; Danielson, J.D. 1983. **CROMAX: A crosscut-first computer simulation program** Gen. Tech. Rep. FPJ-38. Madison, WI: U.S. Department of Agriculture, Fo Service, Forest Products Laboratory. 39 p.

Hoff, Kristen G.; Adams, Edward L.; Walker, Elizabeth S. 1991. **GR-1ST: PC program for evaluating gang-rip-first board cut-up procedures**. Gen. Tech. Rep. NE-150. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 16 p.

National Hardwood Lumber Association. 1994. **Rules for the measurement and inspection hardwood and cypress lumber**. Memphis, TN: National Hardwood Lumber Associat

Stern, Abigail R.; McDonald, Kent A. 1978. **Computer optimization of cutting yield from multiple ripped boards**. Res. Pap. FPL-318. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 39 p.

Stiess, Timothy S. 1995. **Simulation in the wood products industry**. Wood & Wood Products. September 1995, pp 133-135.

Thomas, R. Edward. 1995a. **ROMI-RIP: ROugh MIII RIP-first simulator user's guide.** Gen Tech. Rep. NE-202. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 72 p.

Thomas, R. Edward. 1995b. **ROMI-RIP: ROugh MIII RIP-first simulator**. Gen. Tech. Rep. NE-206. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 28 p.

Thomas, R. Edward. 1996. **Prioritizing parts from cutting bills when gang-ripping first**. Forest Products Journal., 46(10): 61-66.

Wodzinski, C.; Hahm, E. 1966. **A computer program to determine yields of lumber**. Gen. Tech. Rep. FPJ-66-009. Madison, WI: U.S. Department of Agriculture, Forest Servic Forest Products Laboratory. 34 p.

## Appendix I. Laser Printer Configuration

Beginning with MS-DOS version 5, Microsoft Corporation began supporting the printing of graphic screens to laser printers. To use the laser printer successfully with ROMI-CROSS, you must do the following:

1. Determine the type of the laser printer and current emulation settings.

2. Refer to the GRAPHICS command in your MS-DOS version 5.0 reference guide or on-line help in MS-DOS version 6.0 and later. Read the documentation for the GRAPHICS command and determine the correct printer driver for your printer type.

3. After you have determined the printer type, you must use a text editor to edit the RUN-DRAW.BAT batch file to allow plotting to a laser or color printer. For the following example we change the batch file to allow plotting to a standard HP Laserjet II printer or a laser printer capable of emulating a HP Laserjet II. Using the EDIT text editor supplied with MS-DOS versions 5 and 6, perform the following steps to make the necessary changes:

   i) Make the working directory the directory that contains the ROMI-CROSS programs and data. To do this; type at the MS-DOS prompt: (assuming a default installation)

   **C:**
   **CD \ROMI-X**

   ii) Edit the RUN-DRAW.BAT file by entering:

   **EDIT RUN-DRAW.BAT**

   iii) Move the cursor to the end of the line that reads:

   **GRAPHICS**

   Specify the correct laser printer type at the end of this line. To specify the HP Laserjet II, edit the GRAPHICS line so that it reads:

   **GRAPHICS LASERJETII**

   iv) Exit the Editor and save the edited RUN-DRAW.BAT file. To do this using the MS-DOS EDIT editor, hold down the ALT key and press F, press the X key, press Y to answer "YES, save this file".

You now are able to print graphics screens to the laser printer.

## Appendix II. System Limitations

These are the current specifications and limitations of the ROMI-CROSS system:

| | |
|---|---|
| Board width: | 48 inches (1.219 meters) |
| Board length: | Unlimited |
| Cutting bill maximum individual part quantity: | 32000 |
| Cutting bill maximum individual part value: | 32000 |
| Cutting bill maximum number of part sizes: | 400 |
| Input files processed at once: | 10 |
| Length ranges: | 10 |
| Lengths, primary: | 30 or Random |
| Lengths, salvage: | 15 or Random |
| Width ranges: | 15 |
| Widths, primary: | 20 or Random |
| Widths, salvage: | 15 or Random |

## Appendix III. Board Data Bank Description

This appendix describes the contents of the individual datafiles included with ROMI-CROSS. All datafiles have an eight letter primary file name followed by a .VBD extension. All of the boards in each datafile are one of six grades. The grade of lumber in a particular datafile is determined by looking at the file name.

| If the file name begins with | the grade is: |
|---|---|
| FAS, | FAS (Formerly Firsts and Seconds) |
| F1F, | FAS one Face |
| SELECTS, | Selects |
| 1COMMON, | No. 1 Common |
| 2COMMON, | No. 2A Common |
| 3COMMON, | No. 3A Common |

The boards supplied with ROMI-CROSS are found in 1997 Data Bank for Red Oak Lumber." The following tables show the total number of boards in each of the six grades. The boards in each grade are randomly sorted into subsets containing approximately the same number of boards. Datafiles ending with a letter contain boards that are mirror images of their corresponding files with number endings. For example, 1COMMONA contains boards that are mirror images of the boards in 1COMMON1, 2COMMONC mirrors boards in 2COMMON3, and so on. MIX files contain all boards, both normal and mirrored for the grade.

| Lumber Grade | Total Boards | Total Board Footage | Number of Subsets |
|---|---|---|---|
| FAS | 659 | 5134 | 10 |
| FAS one Face | 348 | 2552 | 5 |
| Selects | 279 | 1052 | 2 |
| No. 1 Common | 1039 | 5887 | 11 |
| No . 2A Common | 922 | 4737 | 9 |
| No. 3A Common | 240 | 1012 | 2 |

## Appendix IV. Definition of Terms

Board Segment: A full-width section of a board produced by crosscutting the board to a part length. Board segments are ripped to produce one or more primary parts.

Cutting Bill: A specified list of part sizes and quantities. For ROMI-CROSS, the cutting bill m include part prioritization methods based on dollar values or other methods. See als Dynamic Prioritization Methods and Static Prioritization Methods.

Cutting Stage: A single ripping or crosscut operation. Crosscutting a board into primary part length board sections is a single cutting stage. The production of primary parts requi two stages, crosscutting and ripping.

Dynamic Prioritization Method: A method of prioritizing parts required in a cutting bill so that the part priorities change as parts are produced. Dynamic methods generally require less board footage than static methods to meet a given cutting bill. See also: Cutting and Static Prioritization Methods.

Excess Part: See Orphan Part.

Excess Primary Part : Part produced in two cutting stages for which there is no requirement i the cutting bill, but whose width and length, in combination are found in the cutting bil

Excess Salvage Part: Part produced in three or more cutting stages for which there is no requirement in the cutting bill. The first stage is always the initial crosscut.

Minimum Primary Width: The minimum primary width that is specified when processing rand width part sizes.

Orphan Part: A primary part that is cut but is not needed; that is, the cutting needs for a particular part size have been met already. An "extra" piece.

Panel: A panel is made up of two or more edge-glued pieces of specified length and width.

Primary: Parts produced by ripping board sections to primary part widths.

Primary Part Widths: The part widths used when ripping board segments to specified part si: Any part width listed in a cutting bill is a primary part width.

Primary Part Lengths: Any length specified in a cutting bill is specified as a primary part leng The primary part lengths are the lengths that are crosscut from the board.

Run-Length Encoding: A data compression strategy that stores repeating data as a number the data item.

Salvage: Parts that are obtained by at least one additional cutting operation. The additional work makes these parts more expensive to produce and, therefore, less desirable. Unlike excess salvage, salvage parts are required by the cutting bill.

Segment: See Board Segment.

Static Prioritization Method: A method of prioritizing cutting bill parts. The priority assigned to a part at the start of processing is the same priority used at the end of processing. Number or dollar values are good examples of a static-prioritization strategy. Static prioritization generally is less efficient than dynamic strategies. See also: Cutting Bill and Dynamic Prioritization Methods.

## Appendix V. ROMI-CROSS Software Trouble Report

If you encounter **ANY** problems with the ROMI-CROSS programs, please fill out the following form and mail or fax it to:

**Edward Thomas**
**USDA Forestry Sciences Laboratory**
**241 Mercer Springs Road**
**Princeton, WV 24740**

**FAX: (304) 431-2772**
**Phone: (304) 431-2703**

Please include your phone number as you may be contacted for additional information.

Thank you.

---

Name:_____
Company:_____
Address:_____
City:_____ State:_____ Zip:_____
Phone: ( ) _____ FAX: ( ) _____

Operating system (check all that apply):

- ❍ DOS, Which version: _____
- ❍ Windows, Which version: _____
- ❍ Other, _____
- ❍ Windows 95

Total random access memory (RAM) installed (e.g. 4 MB): _____

Processor type, check one:
( ) 80386 ( ) 80486 ( ) Pentium ( ) 686 ( ) PowerPC ( ) Other _____

Are you using a math coprocessor? ( ) Yes ( ) No ( ) Don't know

Are you running ROMI-CROSS on a Local Area Network (LAN)? ( ) Yes ( ) No

On a separate sheet of paper describe the problem(s) you have encountered.