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User's Guide to UGRS: The Ultimate Grading and Remanufacturing System (Version 5.0)

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Abstract

The Ultimate Grading and Remanufacturing System (UGRS) is the latest generation of advanced computer programs for lumber grading. It is designed to be a training and research tool that allows grading of lumber according to 1998 NHLA rules and remanufacturing for maximum dollar value. A 32-bit application that runs under all Microsoft Windows operating systems, UGRS provides a sophisticated graphical user interface that shows the board and includes all defects and cuttings, grading information, the remanufactured board, and final results. Potential applications include online evaluation of lumber grades, research on the effects of grading rules on lumber grades and dollar value, training of graders, and studies of yield optimization and the potential value of lumber due to the remanufacturing operation.

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Getting Started

As an advanced tool for the grading and remanufacturing of lumber, the UGRS computer program (Moody et al. 1998) includes the following:

- Simple to use, mouse-based graphical interface.
- High-resolution color graphics that allow color encoding of 11 defect types.
- Four algorithms for remanufacturing of lumber.
- Storage of program parameters in files to allow flexibility without requiring changes in programming.
- A board editor that allows a board to be created graphically.

1.1. Hardware and Software Requirements

UGRS runs on the IBM PC family of computers and all true compatibles. Because the UGRS program and utilities are 32-bit programs, they require at least an 80386-based computer that runs Microsoft Windows 3.0 or newer with at least 2 megabytes of free hard disk space. Although UGRS also runs on less powerful systems, an 80486 computer with at least 8 megabytes of RAM and a mouse is recommended for prompt and reasonable processing times.

1.2. Installing UGRS under Windows

The following steps outline the installation procedure for UGRS using Windows 3.x versions:

1) Insert "UGRS Disk 1" into the floppy drive of your computer.

2) Start Microsoft Windows.

3) From the opening window, choose **File** in the upper left corner.

4) Select **Run** from the main screen.

5) A window will appear with a box labeled **Command Line**. Type the letter of your floppy drive followed by **setup.exe**, for example, **a:setup.exe**

6) Press **Return** or click on the **OK** button.

7) The installation program will begin running by placing a window on the screen prompting you for the directory in which UGRS will be copied. It will offer you a default choice of **c:\ugrs**. If you agree with this choice, choose **OK**. If not, you may type a new directory for UGRS in the window provided.

8) The installation program automatically will install all UGRS files and create a program group with icons for the UGRS program.

Users of the Windows 3.x versions also must load the WIN32S Windows extensions located on UGRS Disks 2 and 3 to run the program. This is not necessary if your system is running Windows 95 or Windows NT. To install WIN32S, you must:

1) Insert the **UGRS Disk 2** (the first WIN32S disk) into the floppy drive.

2) Start Microsoft Windows if you have not already.

3) Choose **Run** from the main screen.

4) A window will appear with the **Command Line** box. Type the letter of your floppy drive followed by **setup.exe**.

5) Press **Return** or choose **OK**.

6) Follow the directions on the screen.

To run UGRS, double-click on the icon labeled **UGRS**. To run the Board Creation/Modification program (see Section 6), double-click on the icon labeled **UGRS BMOD**. Similarly, double-click the **Review** icon to run that program (see Section 6).

To install UGRS under Windows 95 and newer versions, you must:

1) Insert the **UGRS Disk 1** into the floppy drive.

2) From the opening window, select **Start**.

3) Select **Run** above **Shutdown** on the Start Menu.

4) A window will appear with a box labeled **Open**. Type the letter of your floppy drive followed by **setup.exe**.

5) Press Return or click on the **OK** button.

6) Choose the directory in which UGRS will be copied. You will be offered a default choice of **c:\URGS**. If you agree with this choice, click on the **OK** button. If not, you may type a new directory for UGRS in the window provided and click on the **OK** button.

7) Once the **OK** button is clicked, the program will automatically install all of the UGRS files and create a program group with icons for the UGRS program.

UGRS Overview

The UGRS program consists of two modules: a grading module that provides flexible computer grading of lumber and a remanufacturing module that attempts to remanufacture lumber for maximum dollar value. The first module grades lumber based on 1998 NHLA rules. The user can override key grading decisions to investigate the effects of various rules on the grade of a board. The remanufacturing module provides four different algorithms for automatic remanufacture of lumber for maximum dollar value. The user also can remanufacture lumber manually.

UGRS stores all required parameters in files (prices of lumber, remanufacturing costs, rules). This allows different sets of parameters to be stored and used without changes in the program code. The program also creates log files for each board file that include general information about each board, grading and remanufacturing information, and final results.

2.1. Grading Module

When grading a board, UGRS considers both board faces and provides one of seven grades: FAS, F1F, Selects, #1 Common, #2A Common, #3A Common, and Below Grade. UGRS uses 10 defect types and interprets them according to NHLA rules: stain, checks, sound knots, unsound knots, wane, splits, pith, holes, decay, and bark pockets. A special "defect" outside the board—void—is required for grading boards with taper or slight crook (see Section 5.1). When grading lumber with UGRS, the user must clearly understand the handling of "stepped defects" as well as the handling of defects in the first foot or end foot of Selects and better boards.

2.1.1. Stepped Defects

Internally, UGRS considers all defects as rectangles with sides parallel to the sides of the board. For small or round defects, this does not introduce significant errors; however, for some defects, special consideration is required. For example, if a split is encoded as a rectangle enclosing the entire split, the area of the encoded defect can greatly exceed the area of the split. This can limit the placement of grading cuttings (see Fig. 2.1.1.).

An obvious solution to this problem is to encode a defect as a series of smaller rectangles (known as "stepping the defect"). With most types of large defects, this works well. However, when considering some defects (e.g., splits, knots, holes), the length and/or width of the entire defect is required for grading (i.e., split length or knot diameter). When a defect is stepped, only the length/width of each individual defect is available. UGRS overcomes this limitation by allowing you to step defects and still obtain the true length and width of the original defect by calculating the total length/width of all touching defects of the same type. This was not available in earlier grading programs using rectangular coordinates (Gatchell et al. 1992a; Klinkhachorn et al. 1992, 1994a, b).

2.1.2. First Foot Areas

When examining the first or end foot of either end of a Selects or better board, Paragraph 59 of the NHLA manual (1998) states:

> "59. Within one lineal foot from the ends of the boards of standard lengths there must be 50% clear wood, and not less than 25% of sound wood in the aggregate."

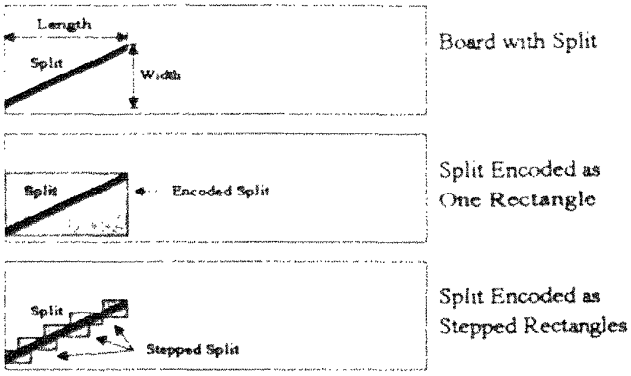

Figure 2.1.1.—Stepping of split defects.

UGRS adds the areas of all defects that prevent a clear face cutting (rot, pith, shake, wane, unsound knots, bark pockets, splits) and ensures that the total does not exceed 50 percent of the first foot area. It then looks to see that at least 25 percent of the remaining area is sound. If the total area of unsound defects is 25 percent or less, the first foot requirements for areas are considered to be met.

2.1.3. Grading Sequence

The UGRS grading module begins grading by verifying that there are no data errors. It then optimizes the placement of any overlength (the portion of the board length that is greater than the nearest standard length) to maximize the grade the board will receive. If necessary, it will divide the overlength between the two ends in a manner that optimizes grade. Next, the better and worse grading faces are determined. These are found by first grading each face of the board independently. Once the grade of each face is determined, the face receiving the higher grade becomes the better face while the face receiving the lower grade becomes the worse face. If both faces receive the same grade, the face containing the greater amount of cutting units becomes the better face.

UGRS then analyzes the board to determine whether any grading rules have been violated by board length, board width, or size and placement of defects. If violations are found and the associated override is enabled (see Section 3.2.1.), the user can override the violation and UGRS will ignore it when grading. If the override is not enabled or the user chooses not to override the violation, grading continues normally. UGRS then attempts to find the required number of cutting units for the grade under consideration. It considers normal cases, extra cuttings, and the 97% Rule.

This algorithm can search for the first solution that satisfies the cutting unit requirements for a given grade or for the solution that provides the maximum number of cutting units in the maximum number of cuttings allowed by the rules. The accuracy of the search is controlled by setting the Area Accuracy option, and the search for the maximum number of cutting units is controlled by setting the Maximum Area option (see Section 3.2.2.) to the desired values. Once the required number of cutting units is found, the user is informed of the grade that the board receives and the value of the board based on the prices listed in the prices file.

2.2. Remanufacturing Module

UGRS provides automatic remanufacturing of a board to a higher total dollar value using one of four algorithms. The first of these is **Edging and Trimming**, which provides quick results but is limited. It attempts to create a board of higher value by removing portions of the edges and/or ends to remove defects (such as wane) and thus produce a board of higher grade. The second algorithm, **Division Based**, attempts to divide the original board into as many as four smaller boards which together have a higher total dollar value than the original board. The third algorithm, a **combination** of the first two, divides the board into as many as four smaller boards and edges and trims each resulting board. This combination algorithm operates more

slowly than the first two but provides excellent results. The fourth algorithm, **Exhaustive,** searches the entire board, dividing it into as many as four smaller boards, edging and trimming each and grading each resulting board. The size and placement of each board is then changed slightly and the boards are regraded. This method produces optimal results for UGRS but operates much more slowly than the other algorithms. For situations in which dollar values are the same, the solution with the largest percentage of the original board area is retained. UGRS can require that at least one of the new boards be of a higher grade than the original.

Before remanufacturing a board, UGRS determines the highest possible grade of the board and its associated dollar value. If the board grades as FAS, no additional remanufacturing is performed because the value of the board cannot be increased. If the board does not grade FAS solely due to its width or length, further division of the board would yield only boards of lower grades and processing is stopped. Such a board would be Selects or No. 1 Common. In all other situations, an attempt is made to obtain a remanufacturing solution that produces lumber with a total higher dollar value.

With Edging and Trimming, an attempt is made to rip or crosscut an edge(s) and/or end(s) of the piece. The Division Based algorithm is effective when grade-reducing defects are located toward the center of the board. UGRS does this by using two division-based remanufacturing methods: width first and then lengthwise (WL) scan and length first and then widthwise (LW) scan. The numbers in Figure 2.2.1. indicate the order in which sawcuts are made.

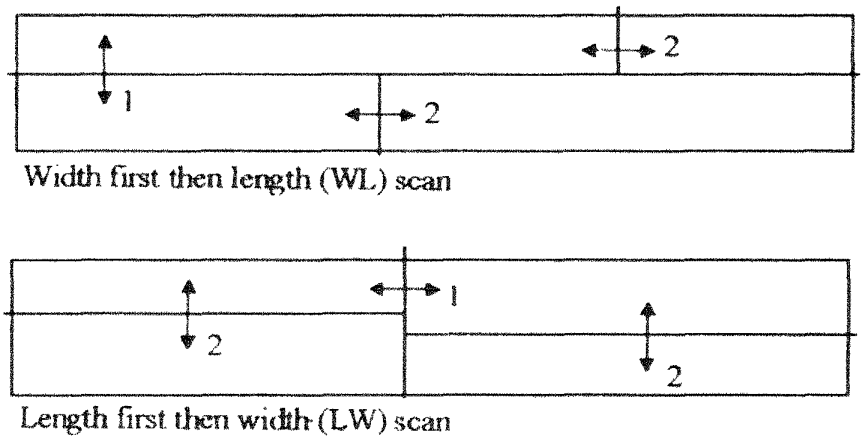

Figure 2.2.1.—WL and LW division methods; the numbers indicate the order in which sawcuts are made.

The WL remanufacturing strategy is attempted first. The board is examined to determine whether two narrower, full-length boards would have more value and, if so, identify the widths that result in the maximum value. Then each of the new, narrower boards is examined to determine whether a single crosscut can produce two shorter boards of greater total value than the newly generated narrow board. With the LW strategy the board is examined to determine whether it can be crosscut into two shorter boards of greater total value. If so, each shorter piece is evaluated to determine whether it can be ripped once into two narrower boards of greater total value. Once both methods have been attempted, the solution that provides the highest value is retained and displayed.

As an example of the remanufacturing process, Figure 2.2.2. shows both faces of a board that can be remanufactured to a higher dollar value. Initially, the board grades as 13 board feet (BF) of #1 Common. We will assume that the prices of lumber (as stored in the Prices file) are as follows:

$1,110/MBF for FAS

$1,100/MBF for F1F

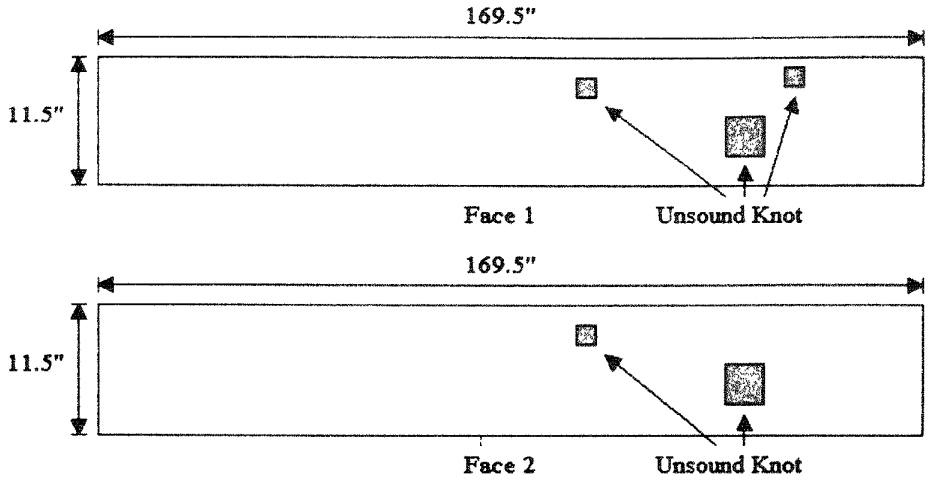

Figure 2.2.2.—Sample board for remanufacturing.

$1,090/MBF for Selects
$700/MBF for #1 Common
$400/MBF for #2A Common
$335/MBF for #3A Common
$50/MBF for Below Grade

The initial market value of this board is $9.10.

If **Edging and Trimming** is chosen, the remanufactured board would appear as shown in Figure 2.2.3. Forty inches have been crosscut from the right end of the board, resulting in a grade of 10 BF of FAS. The board now has a value of $11.10, an increase of $2 (ignoring remanufacturing costs). If Division Based is selected, a new remanufacturing solution can be found (Fig. 2.2.4.). The value of this board will be the sum of the values of the three smaller boards. This results in 5 BF of FAS valued at $5.55, 2 BF of #1 Common ($1.40), and 6 BF of Selects ($6.54), a total value of $13.49. If the combination algorithm is selected, the final solution will be calculated using the **Division Based** method as this results in a higher overall value. If no improvement can be gained over the **Edging and Trimming** result, the latter will be retained and the Division Based result will be discarded.

If the results of the attempted automatic remanufacture are acceptable, the user is given the new value of the board that includes the value of each new board and the new pieces are displayed. If desired, the user may remanufacture the board manually by selecting areas of the original board that will be considered and graded individually. The new value of the board is then given along with the old value for comparison. When the remanufacturing process has been completed, processing of the current board ends and UGRS proceeds to the next one.

2.3 Parameter Files

UGRS stores many of the parameters associated with program operation in files. This allows the values to be updated and changed easily. In addition, the effects of various changes on the final value of the board can be investigated. The three parameter files used by UGRS are:

1. Price file: contains the price per thousand board feet (MBF) for each grade. This is used to determine the final value of the board and to determine whether a remanufactured solution will yield a higher value than that of the original board.
2. Cost file: contains the cost associated with remanufacturing a board. The cost is divided into a fixed cost per board and costs per lineal foot of rip and crosscuts.
3. Rule File: contains a description of the rules applied to the boards.

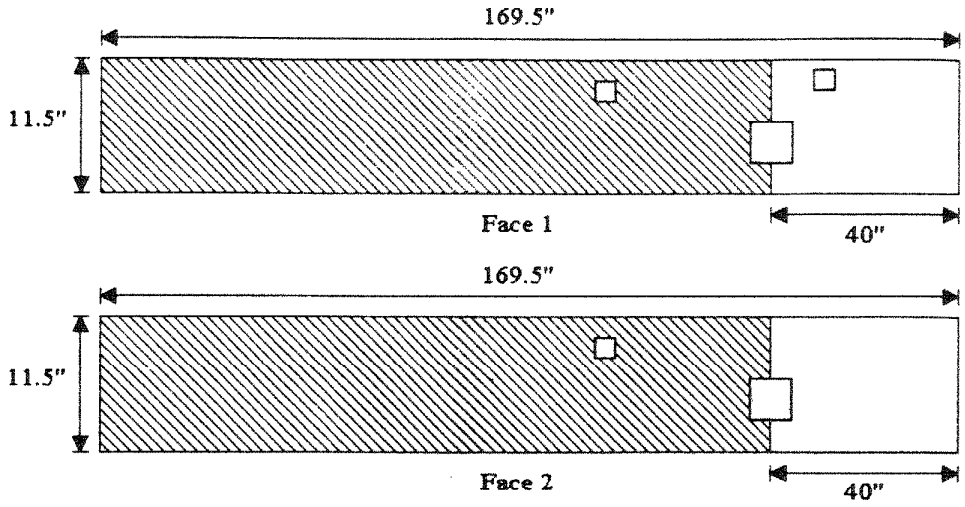

Figure 2.2.3.—**Edging and Trimming** remanufacturing solution.

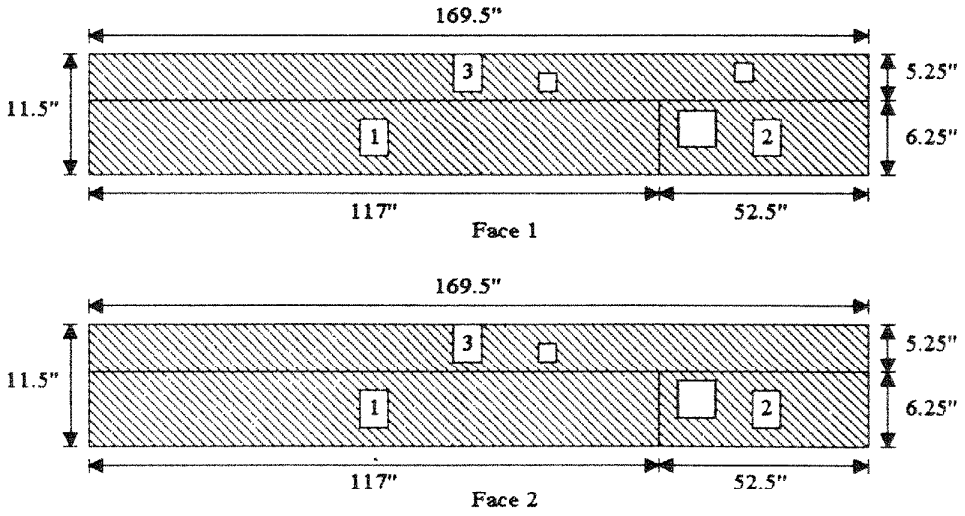

Figure 2.2.4.—**Division Based** remanufacturing solution.

The Price and Cost files are created within the UGRS program. The Rule file is much more complex and must be modified with a text editor, which is not included with UGRS (i.e. the Notepad application provided as part of Windows 3.1 in the Accessories folder). See Appendix A for the format of the Rule file.

2.4. Storing Results

For every board file processed, UGRS can create several types of files for storing results:

Log file: contains grading and remanufacturing information along with the final grade and value of the board.

Catalog file: contains grading information in a compact format (one line of data per board).

Review file: a binary file that is read only by the Review file utility (see Section 6). The utility allows you to print processed boards and split remanufactured boards into sub-boards.

The Log file contains information about each board including grade, number of cuttings and cutting units found, method used to locate the cutting units required (normal, extra cutting, 97%

Rule), value of the board, and remanufactured value of the board. Also, UGRS includes the values of all options. Figure 2.4.1. shows a portion of a log file.

The Catalog file is an abbreviated version of the Log file and generally resembles the data format presented in "1992 Data Bank for Red Oak Lumber" (Gatchell et al. 1992b). This file contains only information associated with the grading of a board (no remanufacturing information or value information) with one line of data per board. A portion of this file is shown in Figure 2.4.2. Each column in the file contains the following:

ID—the board identification associated with each board.

MW—the measured width of the board.

L— the length of the board.

%SM—the percentage of the total surface measure used by the cuttings found.

#Cuttings—number of grading cuttings used to find the required number of cutting units.

Grade—the grade the board receives.

SM—the surface measure of the board.

An asterisk following SM denotes a value that was rounded up or down depending on the options set (see Section 3.2.2.).

```
ULTIMATE GRADING AND REMANUFACTURING SYSTEM LOG FILE.
Beginning processing on 1/28/97 at 16:46:40.
Invoking Remanufacturing module only.

        Rule file : SYSTEM.RUL
        Price file: SYSTEM.PRI
        Cost file : SYSTEM.COS
        Board file: C:\UGRS\TESTDATA.DAT

Remanufacturing Method: Edging/Trimming and Division
Require Higher Grade Board When Remanufacturing: No
Half-way Surface Measure: Rounded Down
Scant Boards: Not Accepted
Area Accuracy: Exhaustive
Maximum Cutting Area: Yes
Rule Set: 1998
Optimize Overlength: Yes

**********************************************************
Board ID: 2413
        Grading Results
           Grade: #2A Common
           Surface Measure: 8
           Better Face: 2
           Number of Cuttings: 4
           Total cutting units: 66.64
           No extra cuttings or 97% rule used.
        Manufacturing Results
                  Grade              Value    Remanufactured Board Coordinates
                  -----              -----    --------------------------------
           Original          #2A Common  2.80
           Reman.                                3.80 (Cost will be 0.05)
           Piece 1           #2A Common  1.40   ( 0.00, 0.00)-( 98.00, 5.75)
           Piece 2           Selects     2.40   ( 98.00, 0.00)-(193.50, 5.75)
```

Figure 2.4.1.—Sample Log file.

ULTIMATE GRADING AND REMANUFACTURING SYSTEM CATALOG FILE.
Beginning processing on 1/28/97 at 16:54:13.
Invoking Grading module only.

Rule file : SYSTEM.RUL
Board file: C:\UGRS\TESTDATA.DAT

Remanufacturing Method: Edging/Trimming and Division
Require Higher Grade Board When Remanufacturing: No
Half-way Surface Measure: Rounded Down
Scant Boards: Not Accepted
Area Accuracy: Exhaustive

Maximum Cutting Area: Yes
Rule Set: 1998
Optimize Overlength: Yes
Surface Measure followed by * indicates half-way value.

ID	MW	L	%SM-#Cuttings	Grade	SM
47	6.00	145.00	93-2	FAS	6
826	5.00	72.75	119-1	Selects	2*
2413	5.75	193.50	69-4	#2A Common	8
2435	6.00	74.25	59-1	#2A Common	3
2941	5.50	73.00	61-2	#3A Common	3

Figure 2.4 2.—Sample Catalog file

3. UGRS Main Menu

The main menu of UGRS, accessed from the opening screen (Fig. 3.1.), consists of the File, Defaults, and Process options.

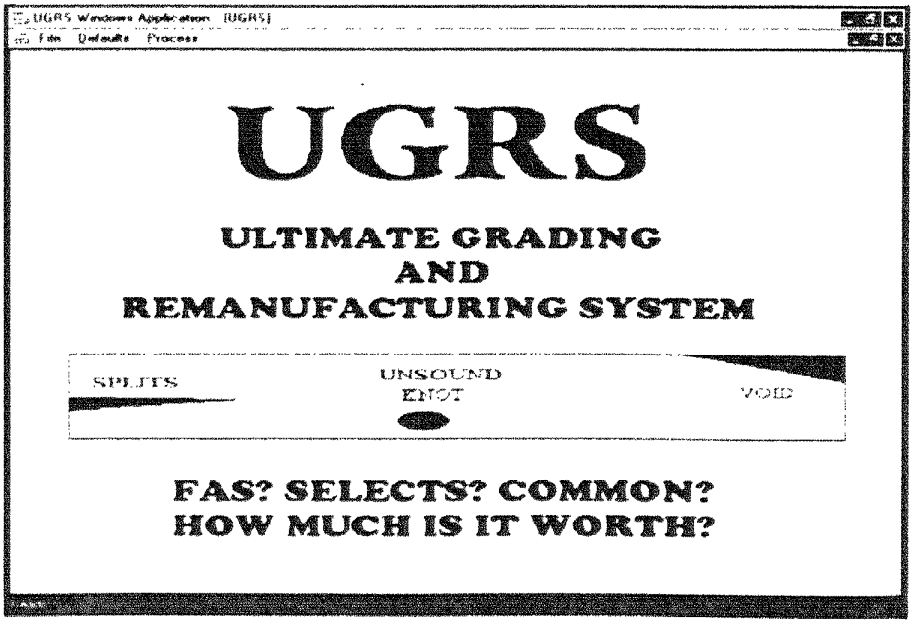

Figure 3.1 —Opening screen and main menu.

3.1. File

The options under File include:

Price: modifies the prices for grades of lumber.

Cost: modifies the cost of remanufacturing boards.

Rule: selects the Rule file used for grading boards.

About: displays program information.

Exit: terminates UGRS program.

3.1.1. Price

The Price file contains the current price of lumber for each grade used in calculating the value of the board. When this file is selected, a window is displayed that allows the user to enter prices for each grade of lumber (see Figure 3.1.1.). This window shows the current prices used by UGRS and the name of the file in which they are stored. To change the price for a grade of lumber, type the new price in the box beside the desired lumber grade and click OK.

If you want to load a different file (initially, the only price file available is the one installed with UGRS), select Browse to display a file selection window. If you want to create a new file, type the name and location of the file. When you return to the Price window, the prices displayed will reflect those in the selected price file. You can then edit the prices as described previously. When all prices have been entered, choose OK to save the new prices in the file listed in the Current Price File box. UGRS uses the new prices in all subsequent calculations of board values. If you do not want to save the new prices and have UGRS use them, select Cancel to abort all changes.

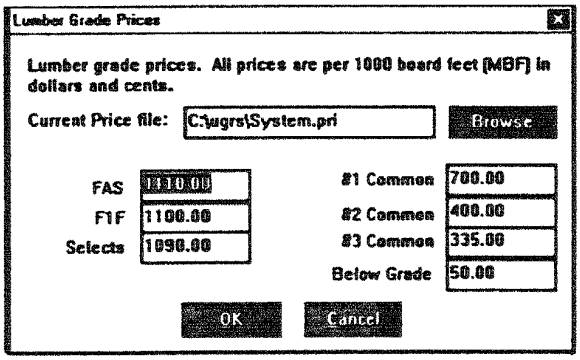

Figure 3.1.1.—Price window.

3.1.2. Cost

When Cost is selected, a new window is displayed that allows you to enter costs associated with remanufacturing a board (see Fig. 3.1.2.). This window shows the current costs used by UGRS when remanufacturing a board. These costs are stored in the file indicated in the Current Cost File box. To change a remanufacturing cost, choose the desired parameter, type in the new value, click OK. If you want to load a different Cost file, follow the procedure for loading a different Price file.

3.1.3. Rule

When Rule is selected, a screen is displayed (Fig. 3.1.3.) that allows the user to change the Rule file UGRS uses when grading boards (initially, the only Rule file available is the one installed with UGRS). For some specialized applications, you might need to create a custom Rule file when grading/remanufacturing lumber (see Appendix B for the Rule file format).

When changing the rule file, you can type the name and location of the file in the space provided or choose Browse to display a file selection window that allows you to choose a file. UGRS uses the selected file as the default Rule file until you change it again. Select Cancel to abort all

changes. **Note: Do not change the default rule file unless you are sure that a change i needed as this can lead to misgraded lumber and/or fatal program errors.**

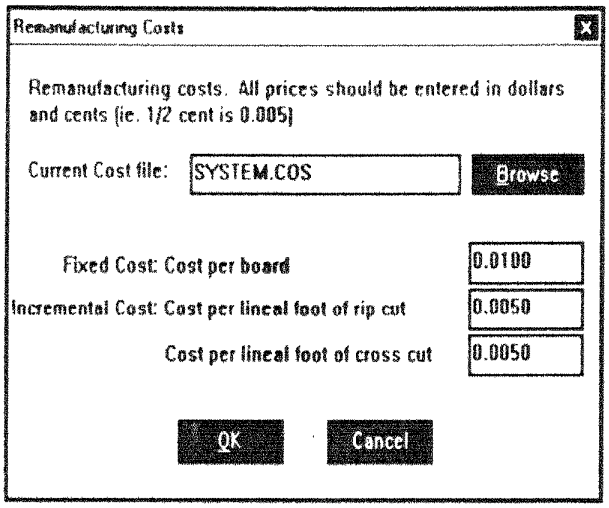

Figure 3.1.2.—Remanufacturing cost window.

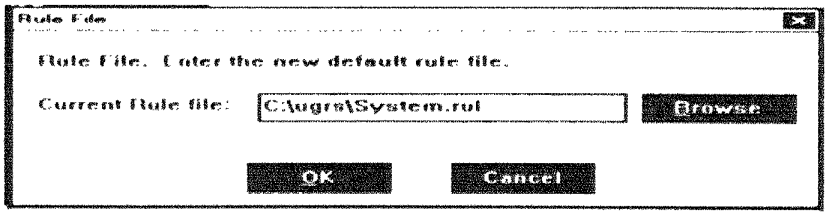

Figure 3.1.3.—Rule window.

3.2. Defaults

The choices located under Defaults include:

Overrides: specifies allowable overrides during processing.

Options: sets various options for UGRS.

3.2.1. Overrides

Overrides allow the user to selectively override rule violations during the grading process a investigate the effect of various grading decisions. For example, what would the effect of reversing the good and poor faces be for a selected board? The types of overrides allowed during the grading of a board are controlled by choosing the Overrides Selection option (Fi 3.2.1).

The user can enable/disable violation overrides for each grade individually by clicking on th box adjacent to the desired grade. An X shows that the override is now in effect (enabled). Clicking again removes the X and the override is disabled. The user can enable/disable all overrides for all grades.

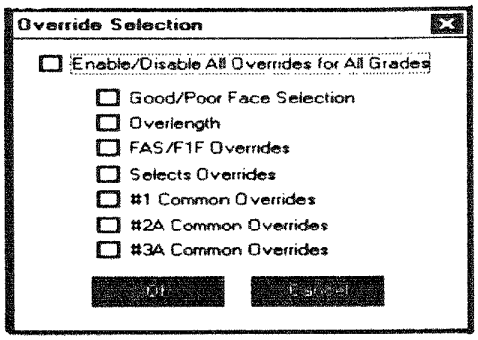

Figure 3.2.1.—Overrides window.

3.2.2. Options

The Options choice is used to set most of the options that control board processing by UGRS (Fig. 3.2.2.). The available options are divided into three groups: Processing Options, Grading Options, and Remanufacturing Options.

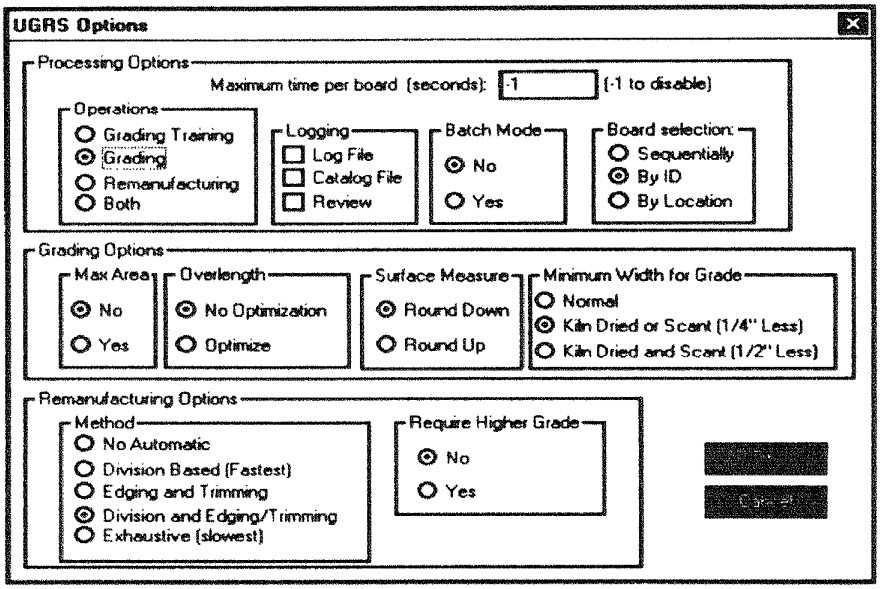

Figure 3.2.2.—Options window.

Processing Options

Maximum Time Per Board (seconds). The number entered in the box indicates the maximum amount of time UGRS can use when processing a board (up to 30,000 seconds). Entering -1 disables the time limit for board processing, though this can lead to extremely long processing times for complex boards. Some 3A Common boards can exceed 30,000 seconds depending on the options chosen. If the displayed time is exceeded, UGRS indicates that the maximum amount of time has been exceeded and proceeds to the next board.

Operations. UGRS can be instructed to grade (only), remanufacture (only), or grade and remanufacture a board. The Grading Training option takes the user through the grading process until the final grade is determined. During the grading process, you are required to answer questions and, if desired, draw grading cuttings on the board. When the Grading option is chosen, the final grade is displayed as are the steps leading to it. When the Remanufacturing option is selected, UGRS grades and remanufactures a board before pausing. When Both is

selected, the board is graded, UGRS pauses, and the board is remanufactured. In either case, if UGRS attempts to remanufacture a board, the user is given the opportunity to remanufacture the board manually after UGRS completes the operation.

Logging. Results can be logged using the Log file, the Catalog File, or both (see Section 2.4). Review is for use by the Review File Utility (see Section 6). When Batch Mode is selected, at least one type of logging must be selected.

Batch Mode. In batch mode. UGRS automatically processes all boards in a file. The Board Selection option will be set to Sequential automatically.

Board Selection. When a board file has been chosen, UGRS can select boards in one of three ways. When Sequentially is chosen, each board in the file is processed in the order in which it appears in the file. When ID is selected, a window is displayed that allows the board to be chosen according to the identification assigned to each board within the file. When Location is selected, the user can choose the board to be processed based on the location in the file by typing the number associated with its position in the file (e.g., 1 for first, 2 for second, 3 for third). When By ID or By Location is selected, you can change grading options and overrides from the window for choosing the desired board.

Grading Options

Maximum Area. When grading a board, UGRS can stop at the first solution that fulfills the cutting unit requirements for a given grade or it can search for the solution that provides the maximum number of cutting units for the same grade. If this option is selected, processing time will be slightly longer but the maximal cutting unit solution will be found. Note that this has no effect on the grade that the board receives or on the selection of better and worse faces. However, this option provides a more precise predictor of utilization potential.

Overlength. When determining the placement of overlength, UGRS can optimize overlength distribution between the ends to maximize the grade or place it on the end with the most defective area (No Optimum). Choosing Optimum increases the grade of the board if possible, though the grading time can be greatly increased.

Surface Measure. For situations in which the board's surface measure is exactly halfway between 2 whole feet, the surface measure can be rounded up or down.

Minimum Width for Grade. UGRS grades boards based on one of three board widths. When Normal is selected, boards must meet the minimum nominal width for a grade to be considered for that grade. When Kiln Dried or Scant is selected, boards that are up to 1/4-inch narrower than the nominal minimum width will be considered for a grade. When Kiln Dried and Scant is selected, boards that are up to ½-inch narrower than the minimum width (1/4-inch for the scant rule plus 1/4-inch for the kiln-dried rule) will be considered for a grade.

Remanufacturing Options

Method. The user can select Edging and Trimming, Division Based, Division and Edging/ Trimming, or Exhaustive to remanufacture a board (see Section 2.2.). You can remanufacture a board manually by selecting No Automatic

Require Higher Grade. When remanufacturing a board, UGRS occasionally may find a solution that has an overall higher value than the original board even though the solution contains no sub-board with a higher grade than the original board. This is generally caused by the rounding associated with calculating the board surface measure. When No is selected, UGRS considers these type of solutions as valid. When Yes is selected, UGRS does not consider this solution valid even though it has a higher value than the original board. However, the user is warned that a solution of this type was found and discarded.

3.3 Process

When Process is selected, the option Begin Processing is displayed. Board processing begins when this option is chosen.

4 Grading and Remanufacturing Boards

To grade and remanufacture boards with UGRS, start the program, select Defaults, and set your processing options as shown in Figure 3.2.2. Choose OK and select Defaults again. Then, select Overrides to see the options available but do not select one. Exit this screen and select Process and then Begin Process. Click on the file named **testdata.dat** and select board 2413 (scroll down until that board number appears and double click on it).

Note that three views of the displayed board are available: Wide View, Expand View, and Scale View. When the board is displayed in Wide View, it is not to scale. Because boards are so much longer than they are wide, a to-scale portrayal can make the board image difficult to examine. With Wide View, the board and its defects are much easier to inspect but they are slightly distorted. For example, square defects are shown as vertically elongated rectangles. With Expand View, the board is to scale but only a portion of it is displayed. The remainder can be viewed by scrolling horizontally. Scale View shows the entire board to scale on one screen. Although this can be convenient, it may be difficult to inspect long, narrow boards (i.e., small defects) in this mode. A portion of board 2413 displayed using the Expand View is shown in Figure 4.1.3.

4.1. Explanation and Board Windows

After processing board 2413, UGRS displays a grading screen (Fig. 4.1.1.) that is divided into the Explanation Window and Board Window. Explanation provides information associated with processing and allows the user to determine how the board is processed and displayed. The Board Window shows a picture of the current board and provides information associated with the board and defects. The identification associated with the board currently being processed and the position of the board in the file are displayed at the bottom of the screen.

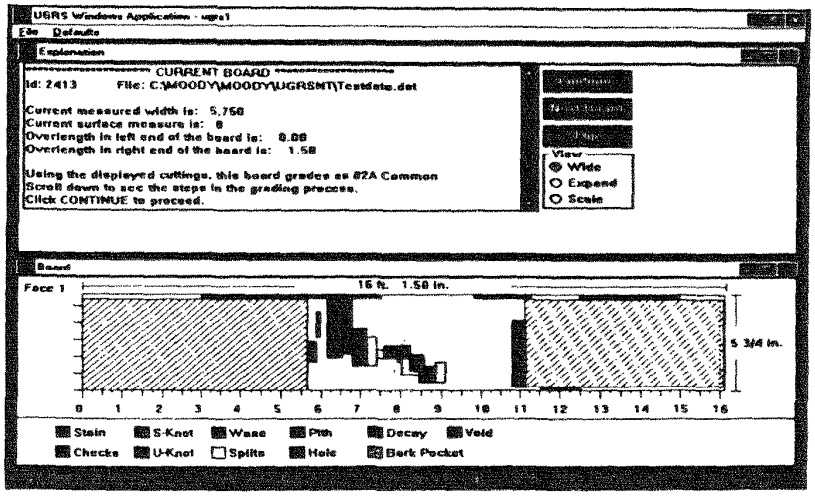

Figure 4.1.1.—Opening grading screen.

Both the Explanation and Board Windows can be individually resized and repositioned to suit your preferences. Figure 4.1.2. shows an alternative setup. Note that the Board Window has been made narrower, bringing the Wide View closer to scale.

In the Explanation Window, all information about the board remains in the window until the current board is processed. Use the scroll bar to see information that is not currently visible. This information subwindow also includes Continue, Next Board, and Flip options. Continue is used to advance through the results for a board. At certain points during the grading of a board, UGRS will pause and print instructions in the information window indicating that Continue should be selected to proceed. Next Board can be selected at any time during board review to advance to the next board in the board file. Choosing Next Board terminates review of

the current board. Flip also can be selected at any time during board review to view the other side of the board.

The Board Window displays a picture of the board and allows the user to obtain additional information about it. Along the edges of the board are rulers that indicate the width of the boar in inches and the length of the board in feet. Below the board is a key that indicates the color associated with each defect type (not displayed in Expand View). S-knot is a sound knot and U knot is an unsound knot. When Flip is selected, the text changes to correspond to the side of the board currently being displayed.

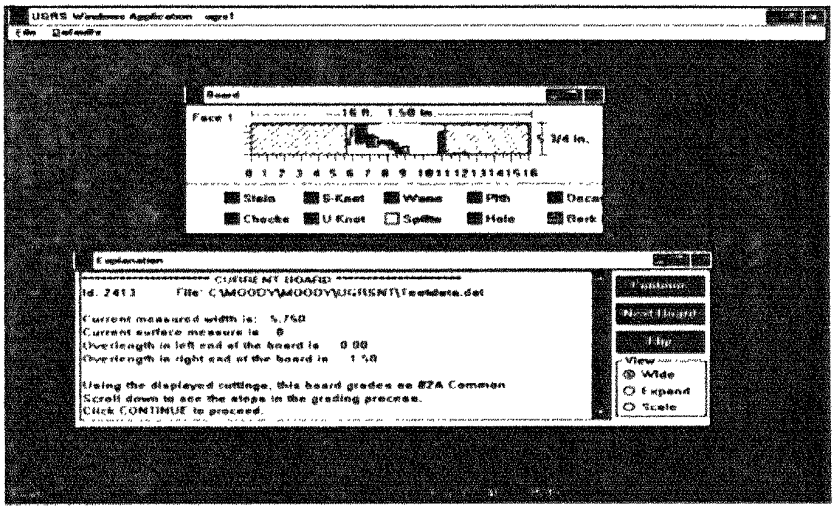

Figure 4.1.2.—Alternate window setup.

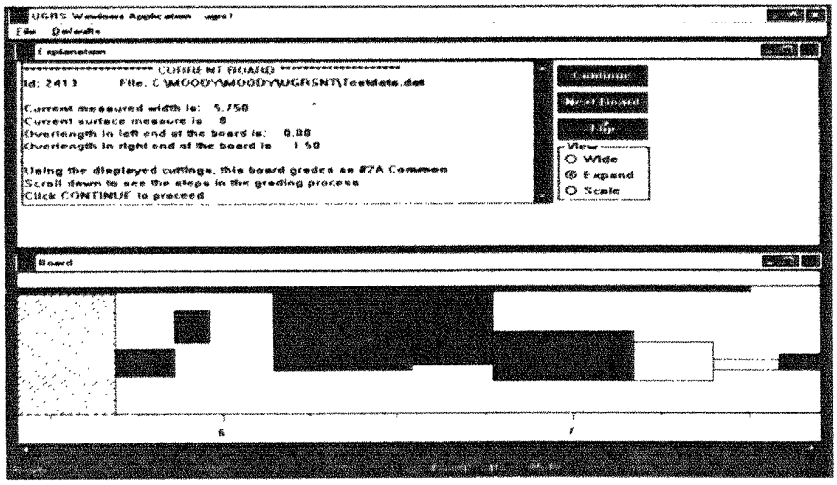

Figure 4.1 3.—Expanded view of board.

Use the right mouse button to open a window that provides information about the defect, including its location and area (Fig. 4.1.4.). You also can use this button to click anywhere in tl clear board area in order to obtain information about the board itself.

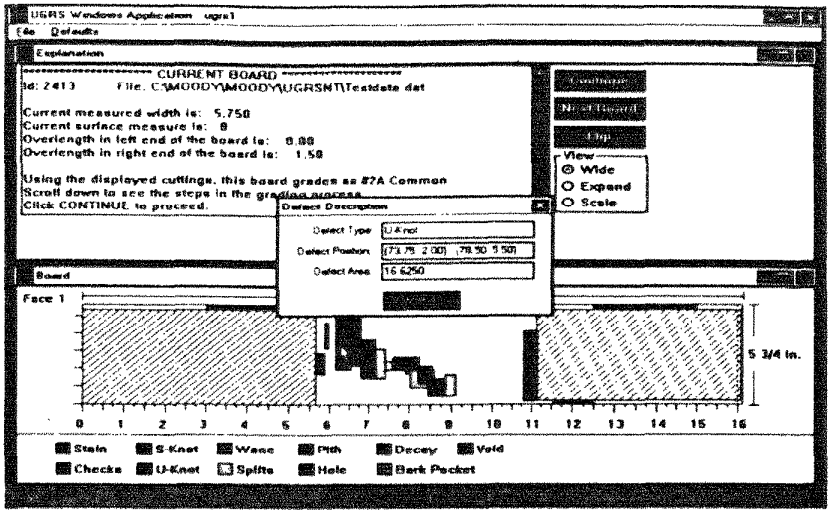

Figure 4.1.4.—Defect information window.

4.2. Initial Grading Screen

The initial grading screen for the options shown in Figure 3.2.2. is shown in Figure 4.2.1. Si "maximum area" was not chosen as an option, UGRS quit at the first solution it found that n the minimum cutting unit requirements for a grade. In this solution, UGRS found two cutting totaling 57.531 cutting units (Fig. 4.2.1.). If the maximum area option had been selected, U would have continued searching all potential solutions to find the one resulting in the most cutting units. In this case, four grading cuttings totaling 66.641 cutting units would have bee displayed (Fig. 4.2.2.).

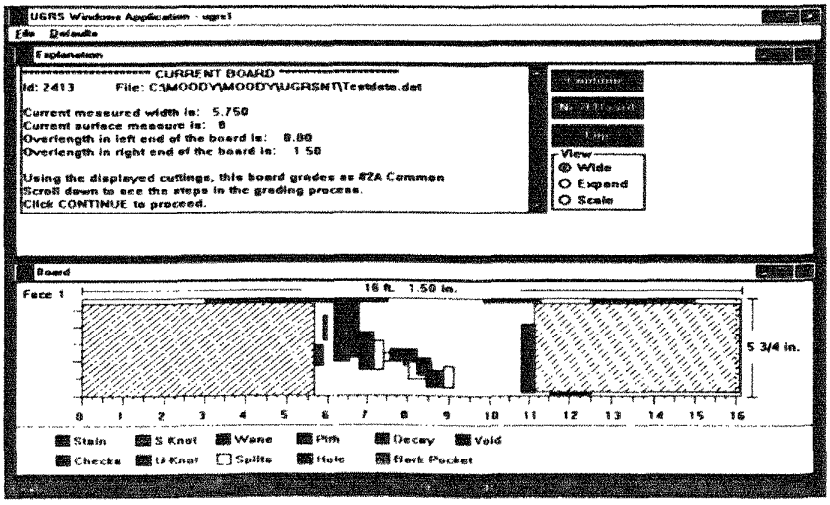

Figure 4.2.1.—Initial grading screen without maximum area selected.

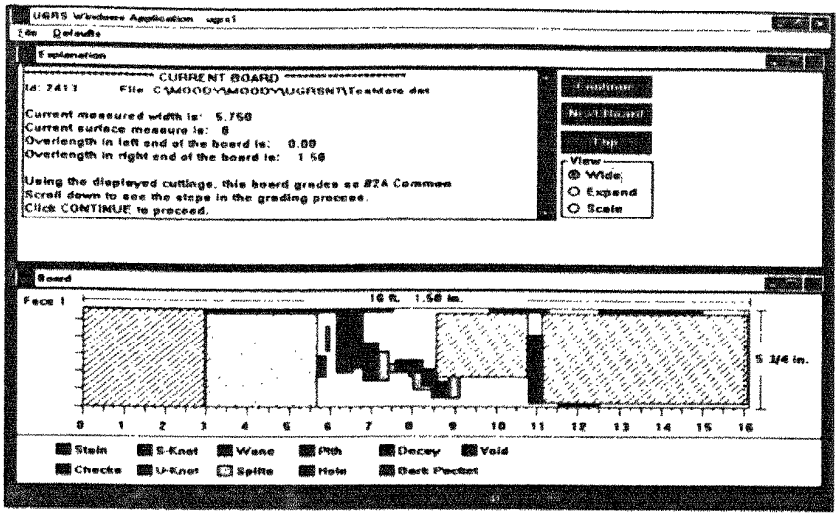

Figure 4.2.2.—Initial grading screen with maximum area selected.

4.3 Grading Description

Information about the grading process displayed in the Explanation Window includes notification about all violations detected, the search for cutting units, the cutting unit solution found, and the final grade of the board (Fig. 4.3.1.). In general, when UGRS is grading a board, the face under consideration is displayed. Specifically, when grading for FAS, #1 Common, #2A Common, and #3A Common, the worse face usually is displayed. When grading F1F and Selects, the better or worse face will be displayed depending on the face being graded.

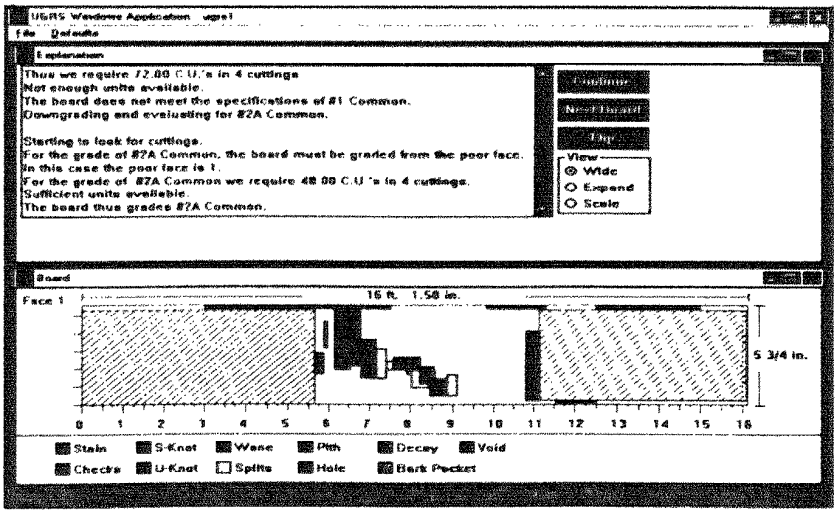

Figure 4.3.1.—Typical grading screen during grading.

4.4 Final Grading Screen

Once a grade has been determined, UGRS displays a screen similar to that shown in Figure 4.4.1. This screen includes the final grade, the value of the board based on the prices in the Price file, and the cutting unit solution found. The cutting unit solution is displayed graphically in the Board Window.

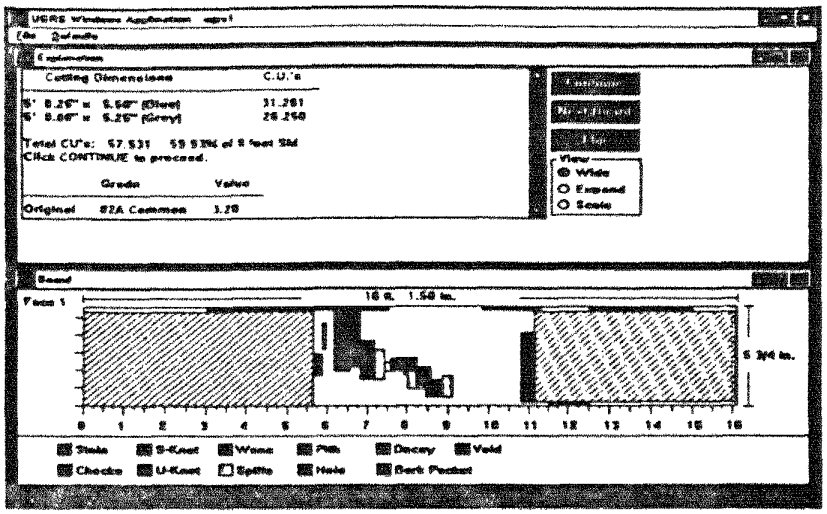

Figure 4.4.1.—Final grading screen.

4.5. Overrides

UGRS allows you to change some of the grading decisions and see the effect of these changes on the board grade. The choice of the grading face and the way overlength is divided between the ends are two examples. When you are overriding violations of specific rules (e.g., split length violations for FAS), a window appears that allows you to decide whether to allow the violation to disqualify the board for the grade under question or ignore the violation and consider the board for the grade.

The following is a complete list of potential overrides.

General Overrides
- Good/poor face selection
- Overlength placement

FAS Overrides
- Length shorter than 8 feet
- Width narrower than 6 inches
- Knots larger than one-third of the surface measure
- Hole larger than one-third of the surface measure
- Splits diverging more than 1 inch per foot
- Splits longer than twice the surface measure
- Wane length along the top exceeding half the length
- Wane length along the bottom exceeding half the length
- Pith length exceeding the surface measure
- Left first foot clear face less than 50 percent
- Right first foot clear face less than 50 percent
- Left first foot sound wood less than 75 percent
- Right first foot sound wood less than 75 percent

F1F Overrides
- Length shorter than 8 feet
- Width narrower than 6 inches
- Knots larger than one-third of the surface measure
- Hole larger than one-third of the surface measure
- Splits diverging more than 1 inch per foot
- Splits longer than twice the surface measure
- Wane length along the top exceeding half the length
- Wane length along the bottom exceeding half the length
- Pith length exceeding the surface measure
- Left first foot clear face less than 50 percent
- Right first foot clear face less than 50 percent

Left first foot sound wood less than 75 percent
Right first foot sound wood less than 75 percent
Wane exceeding #1 Common back wane restrictions
Pith exceeding #1 Common back pith restriction

Selects Overrides
Length shorter than 6 feet
Width narrower than 4 inches
Knots larger than one-third of the surface measure
Hole larger than one-third of the surface measure
Splits diverging more than 1 inch per foot
Splits longer than twice the surface measure
Wane length along the top exceeding half the length
Wane length along the bottom exceeding half the length
Pith length exceeding the surface measure
Left first foot clear face less than 50 percent
Right first foot clear face less than 50 percent
Left first foot sound wood less than 75 percent
Right first foot sound wood less than 75 percent
Wane exceeding #1 Common back wane restrictions
Pith exceeding #1 Common back pith restriction
Wane width exceeding one-third of the width for a board 4 to 6 inches wide
Wane length exceeding one-half of the length for a board 4 to 6 inches wide

#1 Common Overrides
Length shorter than 4 feet
Width narrower than 3 inches
Defects present on the grading face when surface measure is 1
Pith longer than half the length

#2A Common Overrides
Length shorter than 4 feet
Width narrower than 3 inches

#3A Common Overrides
Length shorter than 4 feet
Width narrower than 3 inches

To activate overrides, go to the opening screen and select Defaults. Choose Overrides and then select any or all of the grade overrides you want to consider (Fig. 4.5.1.).

Overrides that are enabled appear in three of the four UGRS operating modes: Grading Training, Grading, or Both (grading and remanufacturing) (Fig. 3.2.2.). There are no overriding options in the Remanufacturing mode. UGRS first shows the standard solution and then the override results. When both grading and remanufacturing are enabled, grading will be completed before remanufacturing begins.

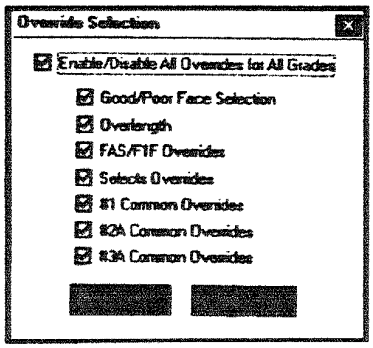

Figure 4.5.1—All overrides enabled.

UGRS examines each board to determine whether it qualifies for the grade in question and begins with the highest grade (FAS). A defect or size limitation that causes a downgrade is described in the Override Window; the user can override the UGRS decision. An example of a knot size violation for the Selects grade is shown in Figure 4.5.2. When this window is displayed, you must choose Yes to override the violation or No to prevent overriding the violation. Select Flip to inspect the other side of the board. If the Override Window covers part of the screen you would like to see, click and hold the left mouse button in the title bar to drag it to another location.

The override for overlength placement is slightly different than other overrides. If you select Yes when asked if you want to override how the overlength is displayed, the line defining the placement of overlength must be indicated. Move the cursor at the point on the board where you want the overlength. When the overlength line is in the desired location, click the left mouse button. A window will open that indicates the placement of the overlength. Choose OK to continue.

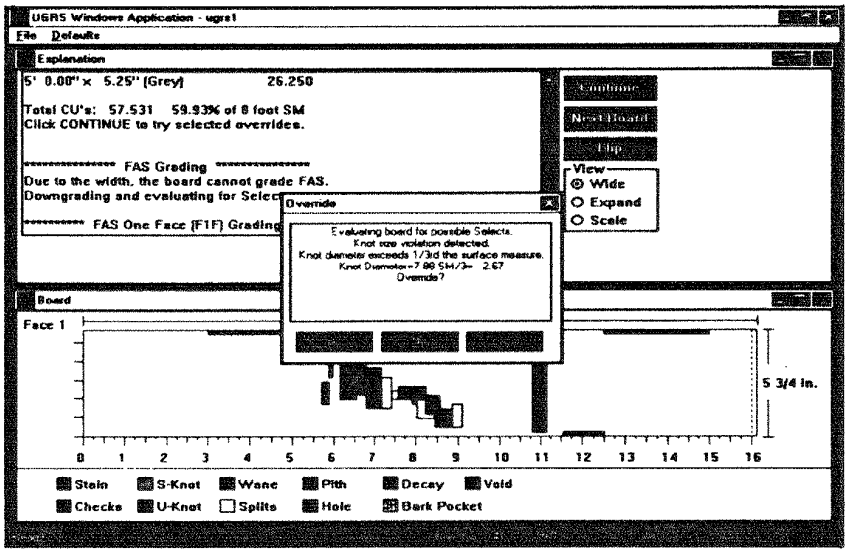

Figure 4.5.2.—Override violation window.

4.6. Remanufacture Screen

UGRS provides two options for remanufacturing boards to smaller boards of higher total value. From the Options Window (Fig. 3.2.2.), you can select Remanufacturing or Both. When Remanufacturing is selected, UGRS grades and, if possible, remanufactures the board. If the board cannot be remanufactured, UGRS displays a statement stating this. The remanufactured results for board 2413 from the **testdata.dat** data set is shown in Figure 4.6.1. Expect large processing times if optimum results are requested.

When Both (grading and remanufacturing) is selected, the board will be graded. You can review the grading results or choose Continue to view selected overrides (those you chose with the initial Defaults to Overrides selection procedure). If you do override, the final solution may differ from what UGRS originally calculated. In either case, UGRS will remanufacture the lumber based on the nonoverride solution.

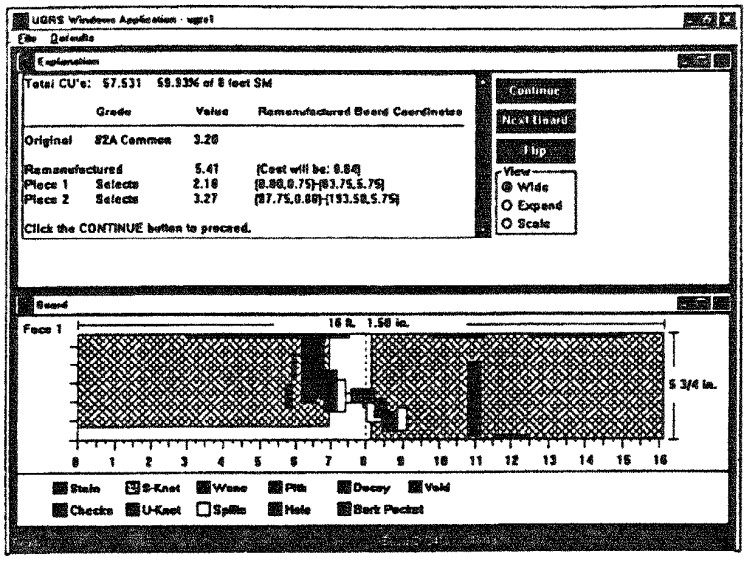

Figure 4.6.1.—Automatic remanufacture solution.

4.7. Manual Remanufacturing

After UGRS has graded and remanufactured a board, you will be given an opportunity to remanufacture it manually. If you choose this option, a window (Fig. 4.7.1.) will open that allows you to attempt to remanufacture the board.

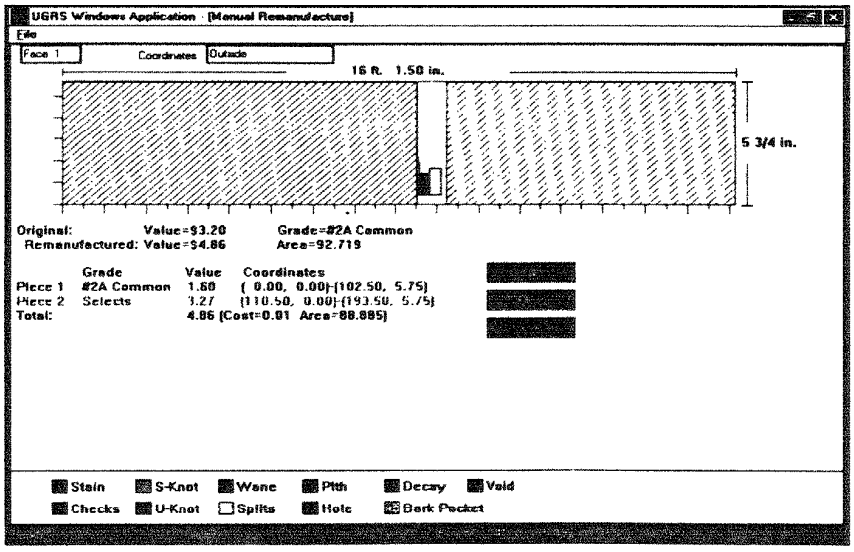

Figure 4.7.1.—Manual remanufacture of boards.

To remanufacture a board manually, place the cursor within the board and move it to the corner position of a sub-board you wish to cut from the current board. Then, holding the left mouse button, drag the corner of the board to the desired position. A sub-board will appear on the screen. UGRS will not retain sub-boards that are not at least 6 inches long or 1 inch wide should you make a mistake while drawing. You can draw as many as four sub-boards. The defects under each new board will be covered but they can be brought into view by choosing Clear.

UGRS grades each sub-board individually and determines its value after it is drawn. If you do not like the placement of a sub-board, remove it by clicking on it with the right mouse button. The results of the manual remanufacturing operation are displayed along with the original value of the board, the remanufactured value of the board, and the area of the sub-boards as calculated from the UGRS remanufacture solution. Select Clear to clear the current solution.

Following the manual remanufacturing of the board, choose Exit to return to the main user interface. A window will appear asking if you want to replace the UGRS solution with your remanufacturing solution. If you choose Yes, the UGRS solution will be replaced by the manual remanufacturing solution and will be displayed in the Board Window. The UGRS solution also will be replaced in all selected log files containing remanufacturing information.

4.8. Selecting Log, Catalog, and Review Files

When grading and/or remanufacturing boards, UGRS can store results in three formats: a Log file, a Catalog file, and a Review file (Section 2.4.). If any of these logging methods are enabled from the Options Window, you will be prompted for the names of the result files after selecting the board file to be processed. After selecting the board file, you will be prompted to select the name of the Log file (if that option is enabled). When selecting the name of the Log file, you can choose one that already exists (shown in gray). If you choose an existing file, UGRS will warn you that the file will be overwritten and that all data previously stored in it will be destroyed. Assuming you do not want to overwrite the existing file, you may create a new Log file by typing the name of the new file in the window. If the Catalog file and/or Review file is enabled, enter the name of the file in the same manner that the Log file was selected.

The Log, Catalog, and Review files created during the processing of a board file are created in the directory you specify in the file selection window. By default, these files are created in the UGRS directory (usually **c:\ugrs**) and have the same name as the board file but with a different extension. For example, if the board file is named **TESTDATA.DAT**, the resulting files would have the following default names and locations:

Log file: **C:\UGRS\TESTDATA.LOG**

Catalog file: **C:\UGRS\TESTDATA.CAT**

Review file: **C:\UGRS\TESTDATA.REV**

4.9. Grading Training

If Grading Training is selected as an option (see Section 3.2.2.), boards will be graded step by step. You will be prompted to provide information concerning the grading. Initially, a screen similar to that shown in Figure 4.9.1. will be displayed.

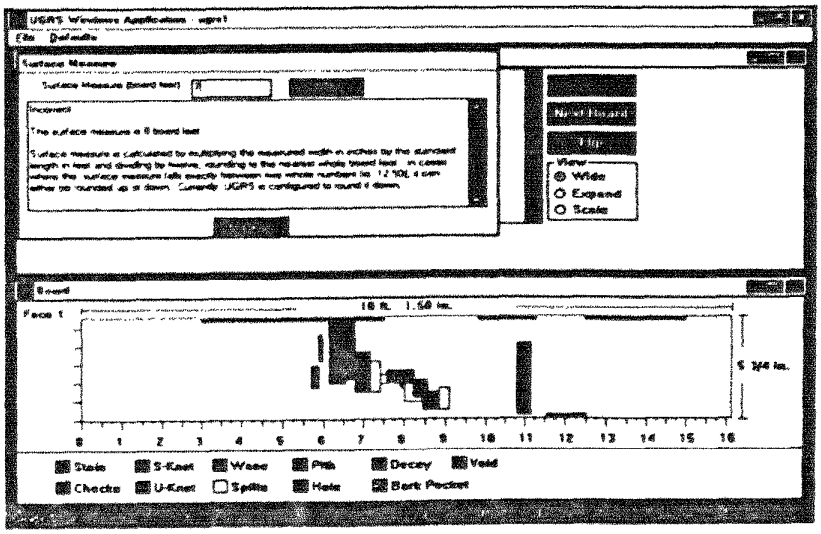

Figure 4.9.1.—Initial grading training screen.

Before grading can proceed, you must enter the surface measure of the board in the box provided. The message in the Surface Measure question window will indicate if the entered surface measure is correct and, if not, describe how to calculate the surface measure of the board. Note that while the question is displayed, you can flip the board, change the view mode, or click on defects for additional information. You cannot select Continue in the Explanation Window (shown in gray) to avoid entering the surface measure.

After the surface measure is entered and Continue is selected, another question is displayed requesting that you enter the grade of the board (Fig. 4.9.2.). In this case, choose a grade by double-clicking one of the displayed grades. A message will be displayed indicating whether the entered grade is correct. As with the surface measure operation, you can flip the board, change the view mode, and click on defects for additional information while the question is displayed.

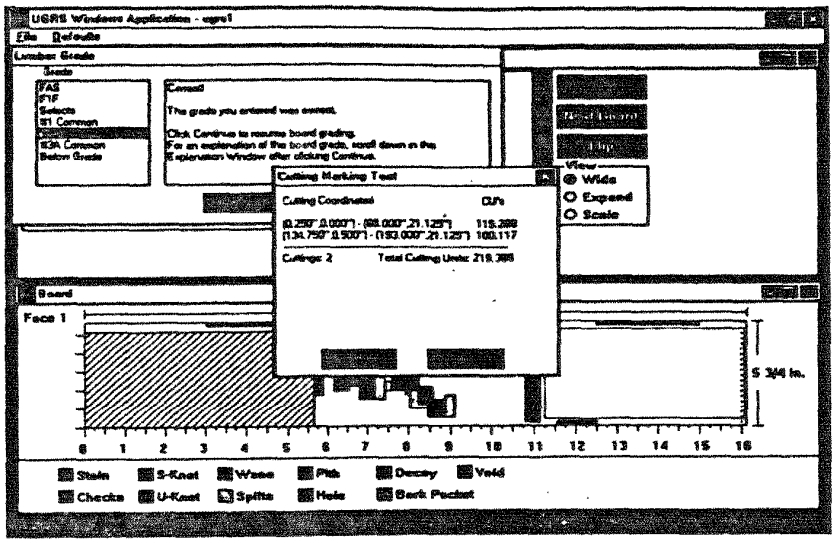

Figure 4.9.2.—Grade question and size of selected cutting.

A grading cutting tool is provided for finding cutting units. Grading cuttings can be drawn on the board by moving the cursor to the point where you want the cutting to begin. Click and hold the left button and then drag the cutting to the point where you want it to end. A cutting will be drawn on the board and a window will open that informs you of the number of cuttings drawn, the coordinates, and the total number of cutting units enclosed in the drawn cuttings. To remove the window, choose OK to continue drawing cuttings or choose Clear to remove all cuttings drawn. Use the right mouse button to remove a drawn cutting. Note that cuttings that are not at least 12 inches long or 3 inches wide will not be accepted to help avoid accidently drawing cuttings that are too small for use in grading.

Creating/Modifying a Board File: the BMOD Utility

With the UGRS board manipulation utility (BMOD) you can create, copy, and modify board files. To create board files outside of UGRS, review the information in Appendix A. Generally, when board files are created, the number of boards in any file is limited to 2,000. Users should note that all wane defects must be encoded beginning at the edge of the board so that the edge of the defect touches the upper or lower edge of the board. This prevents errors in calculations of wane width.

5.1. Three Widths of a Board

For computer-aided grading, a board must be placed in a rectangle whose sides touch the sides and ends of the board. When the board is a perfect rectangle, the sides and ends of the board and the enclosing rectangle are the same. For air- or kiln-dried boards affected by different

shrinkage or tapered boards, there often will be gaps or spaces between the board perimeter and the enclosing rectangle. In UGRS, this gap or space is labeled as "void."

Void is not a true defect because it occurs outside the board. Therefore, size and length of void are not evaluated as, for example, the size of a knot or length of wane would be when calculating FAS or Selects grade is calculated. When creating boards, it is important not to use a defect to represent void. If a defect is substituted between the board edge and the enclosing rectangle, the defect size limitations of FAS and Selects can easily be exceeded. Also, using the surface measure of the enclosing rectangle may require more cutting units per grade than are available on the board.

The inclusion of void along the outside edge of a board means there are three widths that must be accounted for when grading a board such as that shown in Figure 5.1.1. These are the enclosing rectangle or bounding width, the width at the narrow end, and the measured width. The bounding width is not important to the user of UGRS, but it is necessary for processing within the program. The width of the narrow end is the width used in selling the board. The measured width is that used to calculate the surface measure of the board. For tapered boards, it is taken one-third of the length from the narrow end of the board. For perfectly rectangular boards, all three widths are the same.

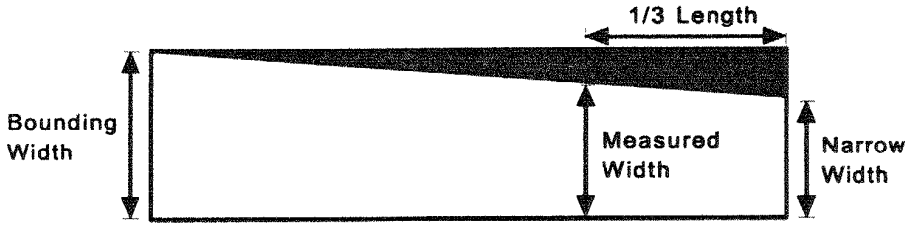

Figure 5.1.1.—Tapered board with measured width/bounding width.

5.2. Opening Screen

The board modification utility is started by clicking the BMOD icon in the UGRS folder (Fig. 5.2.1.). From the file option you can create a board file, append to an existing file, delete boards from a file, or copy an existing board file.

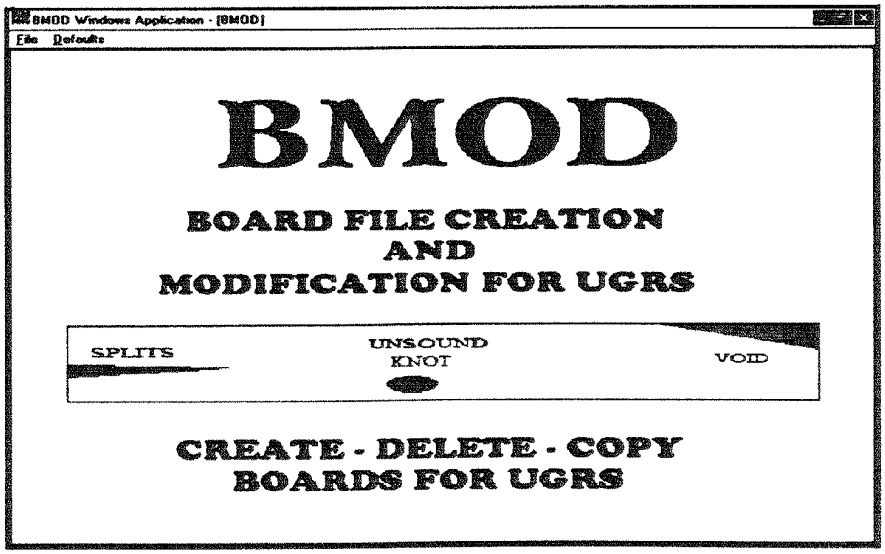

Figure 5.2.1.—BMOD opening screen.

If an existing file is chosen when creating a new board file, a window will open warning that you have selected an existing file. **If you choose to continue, all data within the selected existing file will be deleted.** You also must choose an existing file when appending new boards to the end of an existing file. Choose Cancel to prevent data from being destroyed.

The Defaults option includes **Units,** which allow you to specify the number of units per inch to be used when creating the board file (the default is 4 units per inch), **Rectangular Defects,** which requires you to make rectangular defects when creating a new board, and **Polygonal Defects,** which allows you to create polygonal defects when creating a new board. With the latter, you can create defect shapes that more closely resemble the shape of an actual defect; however, the shapes are used only for display purposes. UGRS converts the polygons to rectangular defects for grading purposes by calculating the dimensions of the smallest rectangle enclosing the defect. **The supplied sample boards and the Red Oak Data Bank (Gatchell et al. 1998) contain rectangular defects. To maintain consistency, create board files using rectangular defects.**

When you are appending boards to an existing file, BMOD chooses the method used to encode defects within the existing board file regardless of the defect type selected.

5.3. Creating a Board File

When Create a New Board File is selected, you will be asked to supply the name of a new board file in a file selection window. When the board file is selected, a screen (Fig. 5.3.1.) will open asking you to enter requested board information. This information will be verified and must be correct before proceeding. After entering the board information, select Continue to bring up the board creation window (Fig. 5.3.2.). This screen will display information about the board and allow you to place defects on it.

To create a new board file, select a defect type by clicking the desired defect at the bottom of the screen. At this point, the Defect Mode will change from No Defects to Entering. The defect is then defined by placing the cursor on the board and clicking.

When defining polygonal defects, each click defines a new vertex up to a maximum of nine vertices per defect. When all vertices are defined, draw the defect by clicking the right mouse button. To define rectangular defects, click once on the board, hold down the left button, and drag the square to the desired position. The Defect Mode now will change from Entering to Reviewing. You can continue to enter defects by selecting new types at the bottom of the screen.

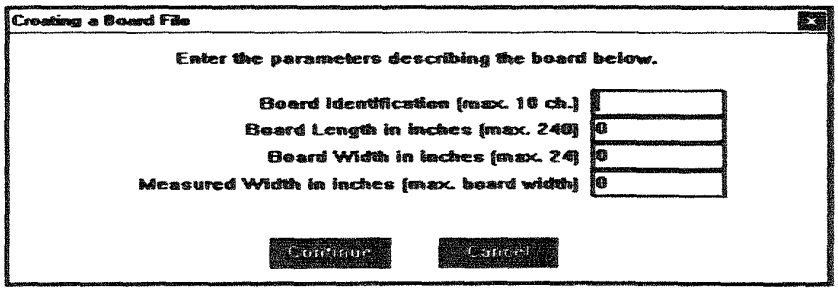

Figure 5.3.1.—Board information window.

In the Reviewing mode, defects can be reviewed and modified. First, set the Defect Number to the desired defect by entering it in the accompanying box or by clicking on the desired defect on the board. Then enter the desired vertex in the associated box. Coordinates of the vertex can be changed by entering the new values in the X and Y coordinate boxes. To change the defect type, click in the box to the left of Defect Type and choose a new type from the bottom of the screen. Once the board is completed to your satisfaction, select the Next Board to enter another board or Save And Exit to save the board file and return to the main menu.

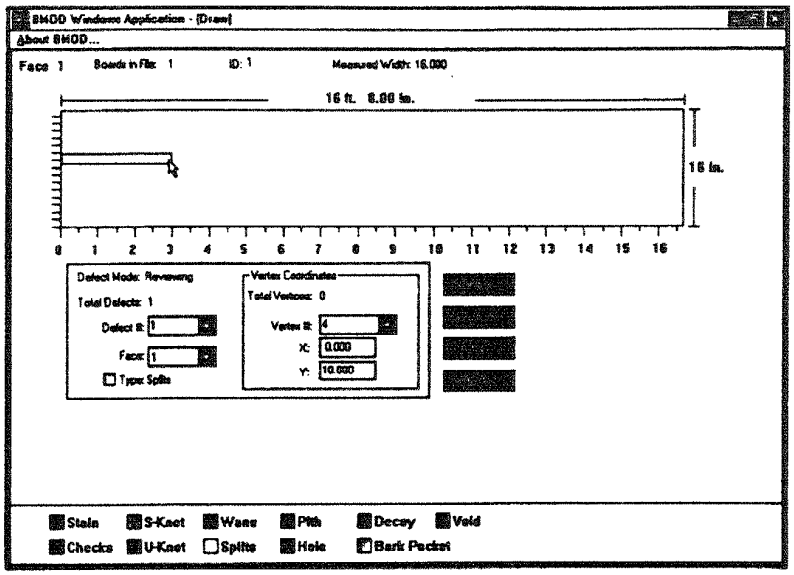

Figure 5.3.2.—Board creation window.

5.4. Appending Boards to Existing File

To append new boards to an existing board file, choose the Append Board to Existing File Option from the main menu. As mentioned previously, you must select an existing board file to be modified. BMOD reads the board file and sets the defect type to the one contained in the board file. Defects are entered in the format used in the selected file. A new board is then created and added to the file.

5.5. Deleting Boards from Existing File

To delete boards from an existing file, select Delete Boards from Existing File from the main menu. Once this option is selected, choose a board file using the file selection window (Fig. 5.5.1.). This window includes a Board IDs screen that lists the identification assigned to each board in the file, and a Deleted Board screen that is initially empty. As boards are selected for deletion, their ID's are switched from the Board IDs to the Deleted Boards window.

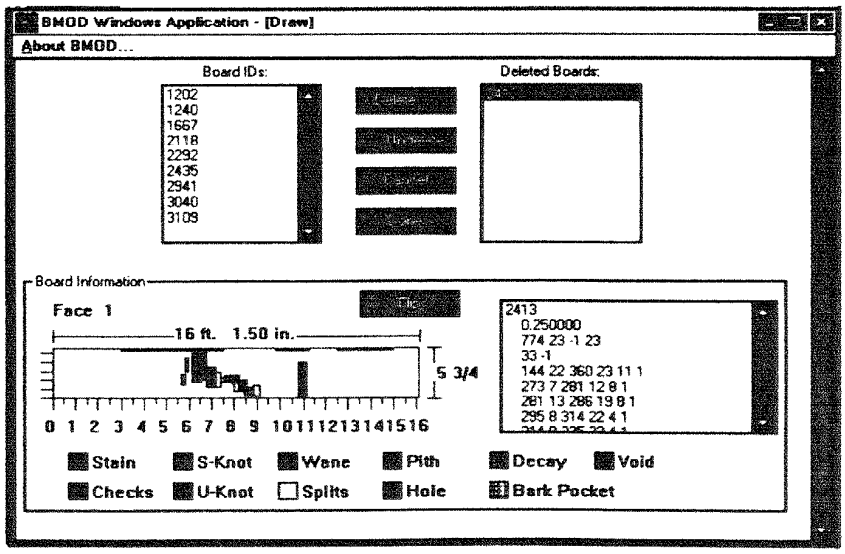

Figure 5.5.1.—Board deletion window.

A Board Information box contains information about the currently selected board, including a picture of the board complete with rulers and text indicating the face of the board being displayed. Choosing a Flip button allows you to view the other face of the board. A Board Data File Entry window lists the data associated with the displayed board in text format (see Appendix A).

To delete boards from a file, select a board by clicking on it in the Board IDs window. The information in the Board Information box will change to reflect that associated with the selected board. To transfer the ID of the selected board to the Deleted Boards window, select Delete>> or double-click on the selected board for each board you want to delete. Choose Done to delete the boards and return to the main menu.

5.6. Copying an Existing File

To copy an existing board file, choose copy under File on the main menu. A file selection box will open that allows you to choose an existing board file to be copied. When the source file is chosen, a new file selection box opens that enables you to select an existing file to be overwritten or type in a new file name to be created. Because a deleted board cannot be recovered, you should first copy a file from which you are going to delete boards.

Working with Review Files: Review Utility

The UGRS Review File Utility reads review files created by UGRS and allows you to print boards and split remanufactured boards into sub-boards, created by the remanufacturing module. The review utility is started by clicking the Review icon in the UGRS folder (Fig. 6.1.).

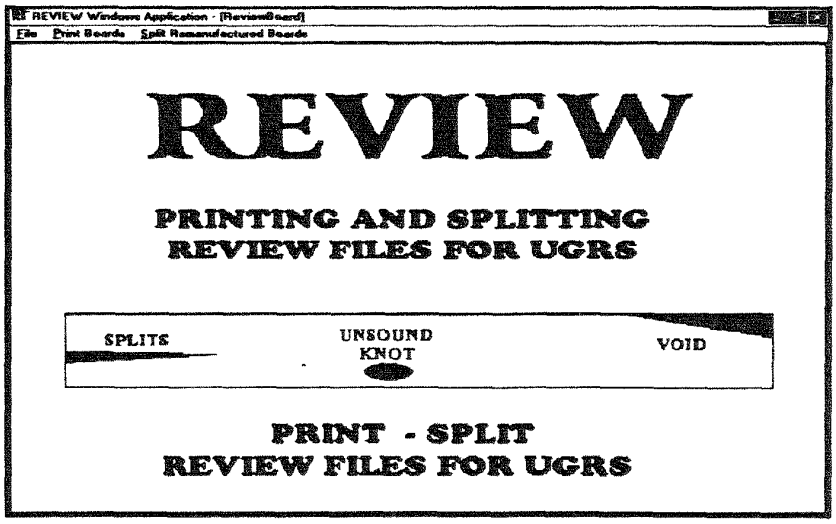

Figure 6.1.—Review utility opening screen.

6.1. Printing Boards from Review File

To print boards from a review file, select Print Boards from the main menu. You will be prompted to select a file using a file selection window (Fig. 6.1.1.). Make certain that only review files are selected as nonreview files can cause serious errors.

Select a board for printing by clicking on the board in the Board IDs window. The information in the Board Information box will change to reflect that associated with the selected board. To transfer the ID of the selected board to the Print Boards window, choose Print>> or double-click on the selected board for each board you want to print. Choosing Print All>>> moves all of the IDs from the Board IDs window to the Print Boards window. Select Print to begin printing. Then select the options that affect the printing of your document from the printer selection window (Fig. 6.1.2.).

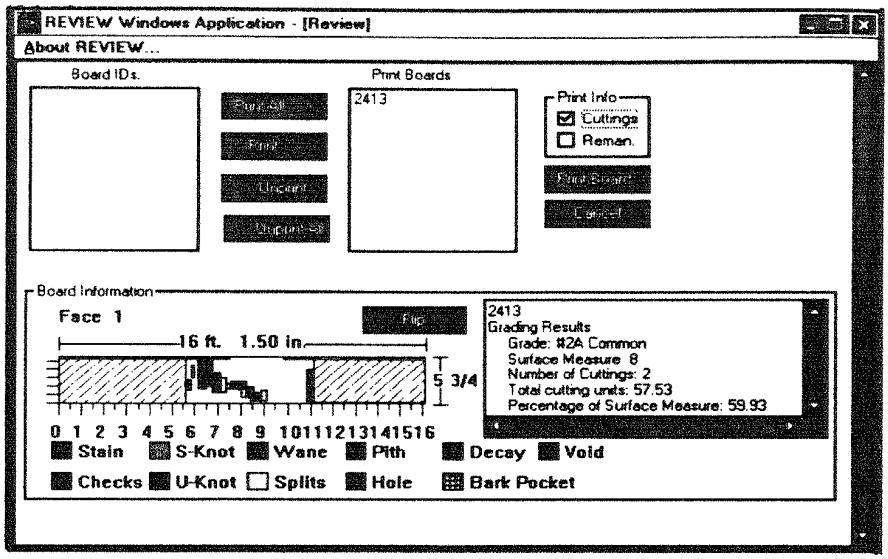

Figure 6.1.1.—Print selection window.

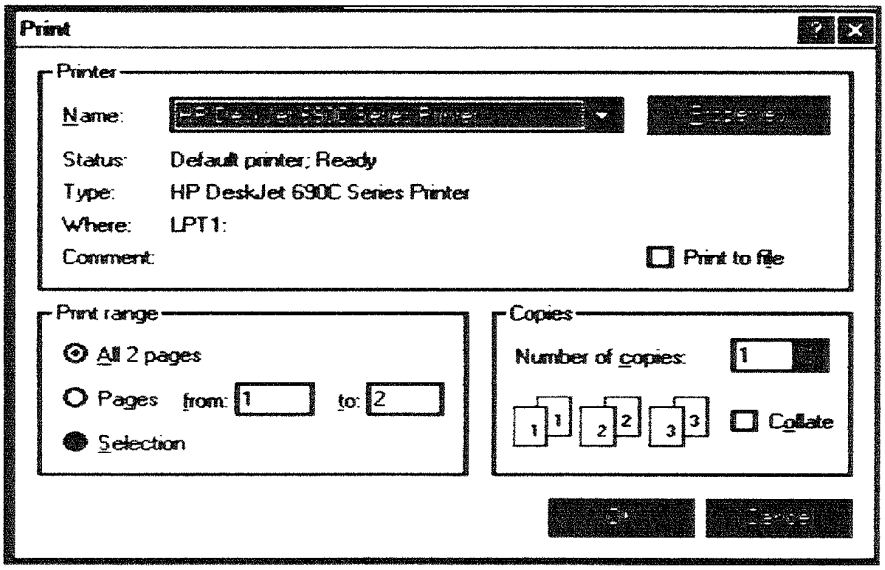

Figure 6.1.2.—Printer selection window.

6.2. Splitting Boards in a Review File

When Split Remanufactured Boards is selected from the main menu, you will be prompted to enter the name of the desired review file using a standard File Dialog box. A screen similar to Figure 6.1.1. will prompt you to select the boards you wish to split. When the boards desired f splitting are selected (IDs are in the window labeled Split Boards), select Split Boards to bring up another file dialog window. Then select the name of the new board file to be created and click OK. The boards will be split into the sub-boards used in the remanufacturing solution or saved "as is" if remanufacturing did not produce a higher value.

If a board is split into sub-boards, the ID of each sub-board will be that of the original board except for the last character. The last character will be replaced with a letter (a,b,c, etc.), indicating that this is a sub-board of the original.

Literature Cited

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National Hardwood Lumber Association. 1998. **Rules for the measurement and inspection hardwood and cypress lumber.** Memphis, TN: National Hardwood Lumber Association.

Appendix A

Board File Structure

To be read properly by UGRS, board data files must follow one of two formats. One describes defects as rectangles (referred to as rectangular board data) while the other describes defects as polygons (referred to as polygonal board data). UGRS processes both rectangular defect data and polygonal defect data in the same way but displays the data differently. For rectangular data, UGRS processes the data as rectangular and also displays the defects as rectangles. For polygonal data, UGRS converts the polygonally described defects into rectangles and then processes the data as if they were rectangular; however, UGRS displays the defects as polygons. If a board is created using the BMOD utility, defects can be created with the polygonal or rectangular format. The supplied sample boards and the Red Oak Data Bank (Gatchell et al. 1998) contain rectangular defects, so board files should be created using rectangular defects to maintain consistency. Any deviation from the specified file formats will cause the processing of the associated board file to be aborted or result in erroneous data.

The number of boards in any file is limited to 2,000. Because the way UGRS calculates the width of wane on a board, all wane defects should be encoded beginning at the edge of the board. To prevent errors in width caculations, wane should be encoded so that the edge of the defect touches the upper or lower edge of the board.

Rectangular Board Data

For the rectangular defect description, the board data file contains five types of data that are read in one line at a time.

1. The first line of data is expected to contain a name or number used to identify the board. This name may contain a maximum of eight characters that can be entered from a standard computer keyboard.
2. The second line of the data file contains the value (in inches) assigned to each unit that is used to specify the coordinates of the defects on the board. This resolution is not fixed as this program might be used with a computer-aided vision system. The resolution with which each system measures defects may vary, so this value is allowed to vary. For example, if the defects are specified in 1/4-inch units, the value entered in this record would be 0.25.
3. The third line of the data file contains the length and width of the board as an integer number of the units cited. The first number should be the length followed by the width. These two numbers must be separated by a separator (a space or a comma). The maximum length and width of the board are 240 and 24 inches, respectively; the minimum length and width are 1 inch each. For example, suppose the data are specified in 1/4-inch units (grading resolution = 1/4 = 0.250) and the board is 10 feet long and 8 inches wide. The third record of the data file would read as 480 32 or 480, 32.

The final part of this field is optional and contains the measured width of the board (as opposed to the bounding width). The measured width always is less than or equal to the bounding width of the board. The measured width can be specified by means of two additional fields on the same line as that of length and width. After length and width have been specified, a negative number is specified to tell the program that it is a nonrectangular board and the next field is the measured width. If the measured width of a board is 7 inches and the length and the width are 10 feet and 8 inches, respectively, at 1/4-inch resolution, the data are specified as:

480 32 -1 28 or 480, 32, -1, 28.

4. The fourth record of the data file contains the total number of defects for the board. This is an integer. The maximum number of defects allowed by UGRS is 200. This is followed on the same line by a negative number to indicate that it is rectangular board data. If there are seven defects, the data are specified as 7 -1 or 7, -1.
5. The fifth and subsequent lines describe each defect. There must be as many lines as the number of defects specified or the program will abort. If there are more lines, UGRS will abort or provide erroneous results. The line containing the defect information consists of six integers. They are listed from left to right and should be separated by a space or comma. The numbers, listed in the order they must appear from left to right, are:

   a) The X coordinate of the left boundary of the defect;
   b) The Y coordinate of the lower boundary of the defect:

c) The X coordinate of the right boundary of the defect;
d) The Y coordinate of the top boundary of the defect;
e) The defect type specified by its integer code (Table A1);
f) The face on which the defect appears (1 or 2).

Table A1.—Defect codes recognized by UGRS

Defect type	Defect code
STAIN	1
CHECKS	2
SOUND KNOT	3
UNSOUND KNOT	4
WANE	5
SPLIT OR SHAKE	6
PITH	7
HOLE	8
DECAY	9
BARK POCKET	10
VOID	11

As an example of rectangular defect description, the board in Figure A1 will be encoded using the rectangular defect file format. The locations of the defects on the board are specified in Cartesian coordinates using the lower left corner of the board as the origin. The face that is used is irrelevant so long as the same corner is used for both faces. We will assume that the board face "facing" the user is Face 1 and that the other side is Face 2. When specifying the defects on the reverse face, UGRS assumes that they are transparent (can be brought through) to the front face and share the same coordinate system used to specify defects on the front face.

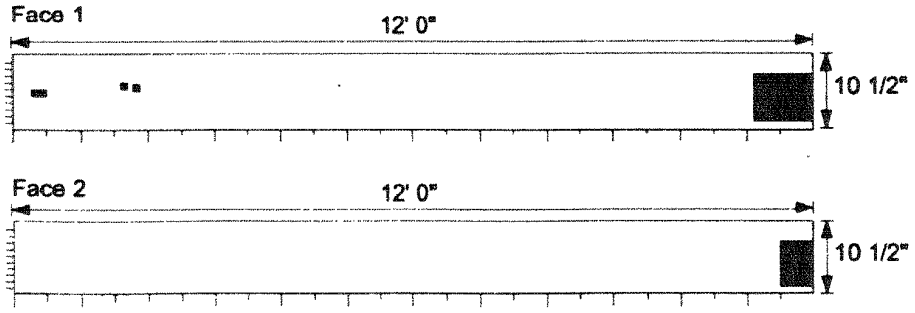

Figure A1.—Sample board for data file creation.

The coordinate plane used in specifying the defects is marked out in integer units in the x and y direction. Each unit corresponds to the unit of resolution used in specifying the defects. The procedure used to specify the location of defects is illustrated by an example. Figure A1 shows the two faces of a sample board. The board is 12 feet long and 10-1/2 inches wide. We will assume that the resolution used to specify the defects is one-quarter inch. The board is 576 units long and 42 units wide. Notice that Face 1 contains four defective areas: an unsound knot in the middle of the left end, two small unsound knots further to the right, and split/shake on the right end. If void is present on the board, it must be identical on each face since it represents the absence of lumber.

On Face 2 there is one defect, split/shake on the right end. In specifying the location of the split/shake on this face, UGRS assumes that it is viewed looking through the board from the

front. Thus, the split/shake on the right end side of Face 2 would fall beneath the split/shake on Face 1.

Specifying the rectangular defects that lie on the two faces of the board requires that the user specify three pieces of information: the location of the defect, the face on which the defect appears, and the type of defect. The location of the defect is determined by the rectangular region that encloses it. The location of the rectangular region is described by specifying the lower left and upper right hand corners. Additionally, large, irregular defects can be broken into adjacent and smaller rectangles to more accurately represent the defect. When specifying the defective regions, the user should recall that the grading program regards all of the area enclosed within each rectangle as defective.

Assuming that the board is given the identification 532, the encoded rectangular data for the board in Figure A1 is as follows (note that within the data file itself, data entry should begin in column 1):

532	(board identification)
0.250	(resolution of units)
576 42 -1 42	(length and width of board, negative number, and measured width)
5 -1	(number of defective regions, negative number for rectangular data)
19 20 21 21 4 1	(left end unsound knot on Face 1)
88 24 89 25 4 1	(left end unsound knot on Face 1)
90 23 91 24 4 1	(left end unsound knot on Face 1)
539 2 576 29 6 1	(right edge split/shake on Face 1)
552 2 576 29 6 2	(right edge split/shake on Face 2)

If desired, the board data file can contain information for more than one board. This is accomplished by listing the next set of board data directly after the preceding board.

Polygonal Board Data

For the polygonal defect description, the board data file contains five types of data that are read in one line at a time. The first three lines of data are the same as for rectangular defects.

The fourth record of the data file contains the total number of defects for the board. This is an integer. The maximum number of defects allowed by UGRS is 200. If there are seven defects, the data are specified as 7. Note that the absence of a negative number (unlike the rectangular format) indicates a polygonal board format.

The final set of lines following the number of defects describes each defect. The first line of each set of lines that describes a defect consists of three integers. The numbers, in order from left to right, separated by a space or comma, are: a) the number of vertices describing the boundary of each defect, b) the defect type specified by its integer code (Table A1), and c) the face on which the defect appears.

There should be as many lines as the number of vertices per defect. Each line containing the defect coordinates consists of two integers separated by a space or a comma. The first integer contains the x coordinate and the second contains the y coordinate. Each of the coordinates should be in terms of the number of resolution units as described previously.

With one exception, the board in Figure A1 is encoded similarly using the polygonal and rectangular defect file formats.

Specifying the polygonal defects that lie on the two faces of the board requires that the user specify four pieces of information (rectangular defects require only three): the number of vertices, the type of defect, the face on which the defect appears, and the location of the defect. The location of the defect is determined by the polygonal region that encloses it. The location of the polygonal region is described by specifying the location of each vertex in terms of X and Y coordinates. As with the rectangular region, when specifying the defective regions, the user should recall that the grading program regards all of the area enclosed within each polygon as defective.

Assuming that the board is given the identification 532, the encoded polygonal data for the board in Figure A1 are as follows (within the data file itself, data entry should begin in column 1):

532	(board identification)
0.250	(resolution of units)
576 42 -1 42	(length and width of board, negative number, and measured width)
5	(number of defective regions)
4 4 1	(left end unsound knot on Face 1)
19 20	(first vertex left end unsound knot on Face 1)
21 20	(second vertex left end unsound knot on Face 1)
21 21	(third vertex left end unsound knot on Face 1)
19 21	(fourth vertex left end unsound knot on Face 1)
4 4 1	(left end unsound knot on Face 1)
88 24	(first vertex left end unsound knot on Face 1)
89 24	(second vertex left end unsound knot on Face 1)
89 25	(third vertex left end unsound knot on Face 1)
88 25	(fourth vertex left end unsound knot on Face 1)
4 4 1	(left end unsound knot on Face 1)
90 23	(first vertex left end unsound knot on Face 1)
91 23	(second vertex left end unsound knot on Face 1)
91 24	(third vertex left end unsound knot on Face 1)
90 24	(fourth vertex left end unsound knot on Face 1)
4 6 1	(right edge shake/split on Face 1)
539 2	(first vertex right end split/shake on Face 1)
576 2	(second vertex right end split/shake on Face 1)
576 29	(third vertex right end split/shake on Face 1)
539 29	(fourth vertex right end split/shake on Face 1)
4 6 2	(right edge shake/split on Face 2)
552 2	(first vertex right end split/shake on Face 2)
576 2	(second vertex right end split/shake on Face 2)
576 29	(third vertex right end split/shake on Face 2)
552 29	(fourth vertex right end split/shake on Face 2)

The board data file can contain information for more than one board. This is accomplished by listing the next set of board data directly after the preceding board.

Appendix B

Price Data File Format

The data for the price file consists of six lines; each line lists the price per 1,000 board feet of each grade. Therefore, each line lists the price for the grades of FAS, F1F, Selects, #1 Common #2A Common, #3A Common, and Below Grade. A sample file might appear as follows:

1100.00	(Price for 1000 board feet of FAS)
1100.00	(Price for 1000 board feet of F1F)
1090.00	(Price for 1000 board feet of Selects)
700.00	(Price for 1000 board feet of #1 Common)
400.00	(Price for 1000 board feet of #2A Common)
335.00	(Price for 1000 board feet of #3A Common)
50.00	(Price for 1000 board feet of Below Grade)

Cost Data File Format

The data for the cost file consists of three lines. The first line reflects the cost incurred per board. The second and third lines reflect the cost of remanufacturing per linear foot of the board rip and crosscuts. A sample might appear as follows:

.01	(Cost per board)
.005	(Cost per lineal foot of rip cuts)
.005	(Cost per lineal foot of crosscut)

Definition File Format

This file stores the default parameters for program information. It is read when UGRS is started in order to restore parameters to the values during the previous session. At the exit of UGRS, this file is updated to reflect any changed parameters. A sample file might appear as follows:

SYSTEM.RUL	(Name of the default rule file)
SYSTEM.PRI	(Name of the default prices file)
SYSTEM.COS	(Name of the default cost file)
0	(Surface Measure rounding: 0 - round down, 1 - round up)
1	(Unused)
2	(Board selection method: 0 - sequentially, 2 - ID, 3 - Location)
300	(Maximum processing time per board in seconds)
2	(Remanufacturing algorithm: 0 - Edging and Trimming, 1 - Division Based, 2 - both Edging and Trimming and Division Based, 3 - Exhaustive)
1048335	(Overrides, 32 bit binary number with a bit set allowing override and not set disallowing override. The bits are defined as follows - 4 bits per section: ZZ UU UU #3C #2C #1C SEL FAS with each bit as: others, wane, poor face, length/width. Section ZZ controls poor face and overlength overrides in bits 1 & 2 respectively; UU is unused.)
0	(Operations: 0 - Grading and Remanufacturing, 1 - Grading Training, 2 - Remanufacturing Only, 3 - Grading)
0	(Scant boards accepted: 0 - no, 1 - yes)
20	(Clear area search accuracy: integer from 0 to 20)
0	(Batch mode: 0 - no, 1 - yes)
0	(Maximum area solution: 0 - no, 1 - yes)
0	(Require higher grade when remanufacturing: 0 - no 1 - yes)
1	(Logging: 0-None, 1-Log, 16-Catalog, 17-both)

Rule File Format

The Rule file stores all the rules that are used in computing a board's grade. A sample file is listed below. Note that the expressions with the < and > brackets are comments and can be included in the Rule file. All comments must occupy an entire line. Data cannot be placed on the same line as a comment.

<THIS IS THE DATA FILE FOR THE>
<STANDARD SET OF GRADING RULES>
< >
<THIS VARIABLE IS THE NUMBER OF GRADES ALLOWED (EXCLUDING BELOW GRADE)>
6
<THIS VARIABLE IS THE MINIMUM WIDTH REQUIRED TO MEET THE MINIMUM GRADE>
2.75
<THESE VARIABLES ARE THE NUMBER OF POSSIBLE DIFFERENT MINIMUM SIZED CUTTINGS FOR EACH GRADE>
2
2
2
2
1
1
<THESE VARIABLES ARE THE NUMBER OF SIZE CATEGORIES FOR EACH OF THE DIFFERENT GRADES>
5
5
6
7
8
1
<THESE VARIABLES ARE THE MINIMUM ALLOWABLE ROUGH WIDTHS FOR EACH OI THE GRADES>
6.0
6.0
4.0
3.0
3.0
3.0
<THESE VARIABLES ARE THE MINIMUM ALLOWABLE ROUGH LENGTHS FOR EACH OF THE GRADES>
96.0
96.0
72.0
48.0
48.0
48.0
<THESE VARIABLES DENOTE WHETHER THE CUTTINGS ARE REQUIRED TO BE SOUND BACK FOR EACH OF THE GRADES. 1=YES, 0=NO>
1
0
1
1
1
1
<THESE VARIABLES DENOTE WHETHER THE CUTTINGS MAY BE SOUND INSTEAD OF CLEAR-FACE FOR EACH OF THE GRADES>
0
0
0
0
0
0
<THIS VARIABLE DENOTES THE MAXIMUM HOLE SIZE ALLOWED IN CLEAR-FACE CUTTINGS>
0.0
<THIS VARIABLE DENOTES THE MAXIMUM KNOT SIZE ALLOWED IN CLEAR-FACE CUTTINGS>

0.0
<THIS VARIABLE DENOTES THE NUMBER OF VARIOUS DEFECTS OR OTHER TYPES OF NON-CLEAR WOOD ALLOWED IN CLEAR-FACE CUTTINGS>
0
<THIS ARRAY IS THE CODES FOR THE DEFECTS ALLOWED IN CLEAR-FACE CUTTINGS. THE NUMBER OF ELEMENTS MUST BE THE SAME AS THE PREVIOUS VARIABLE>
<THIS IS THE DATA FOR THE FIRST GRADE>
<MINIMUM LENGTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN ASCENDING ORDER>
60.0
84.0
<MINIMUM WIDTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN DESCENDING ORDER>
4.0
3.0
<MAXIMUM NUMBER OF CUTTINGS ALLOWED FOR EACH SIZE CATEGORY. NUMBEF LISTED MUST BE THE SAME AS NUMCAT(1)>
1
1
2
3
4
<MINIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBER LISTED MUST BE THE SAME AS NUMCAT(1)>
4
6
8
12
16
<MAXIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBER LISTED MUST BE THE SAME AS NUMCAT(1)>
5
7
11
15
100
<THESE VARIABLES DENOTE WHETHER AN EXTRA CUTTING IS ALLOWED FOR EACH OF THE SIZE CATEGORIES. 1=YES, 0=NO>
0
1
1
1
0
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES BASED ON THE NORMAL NUMBER OF CUTTINGS>
.8333333
.8333333
.8333333
.8333333
.8333333
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES WHEN AN EXTRA CUTTING IS USED (IF ALLOWED)>
.9166667
.9166667
.9166667
<THIS IS THE DATA FOR THE SECOND GRADE>
<MINIMUM LENGTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN ASCENDING ORDER>
60.0

84.0
<MINIMUM WIDTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN DESCENDING ORDER>
4.0
3.0
<MAXIMUM NUMBER OF CUTTINGS ALLOWED FOR EACH SIZE CATEGORY. NUM LISTED MUST BE THE SAME AS NUMCAT(1)>
1
1
2
3
4
<MINIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBE LISTED MUST BE THE SAME AS NUMCAT(1)>
4
6
8
12
16
<MAXIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBI LISTED MUST BE THE SAME AS NUMCAT(1)>
5
7
11
15
100
<THESE VARIABLES DENOTE WHETHER AN EXTRA CUTTING IS ALLOWED FOR EACH OF THE SIZE CATEGORIES. 1=YES, 0=NO>
0
1
1
1
0
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES BASED ON THE NORMAL NUMBER OF CUTTINGS>
.8333333
.8333333
.8333333
.8333333
.8333333
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES WHEN AN EXTRA CUTTING IS USED (IF ALLOWED)>
.9166667
.9166667
.9166667
<THIS IS THE DATA FOR THE THIRD GRADE>
<MINIMUM LENGTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN ASCENDING ORDER>
60.0
84.0
<MINIMUM WIDTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN DESCENDING ORDER>
4.0
3.0
<MAXIMUM NUMBER OF CUTTINGS ALLOWED FOR EACH SIZE CATEGORY. NUME LISTED MUST BE THE SAME AS NUMCAT(1)>
1
1
1
2

3
4
<MINIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBER
LISTED MUST BE THE SAME AS NUMCAT(1)>
2
4
6
8
12
16
<MAXIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBEF
LISTED MUST BE THE SAME AS NUMCAT(1)>
3
5
7
11
15
100
<THESE VARIABLES DENOTE WHETHER AN EXTRA CUTTING IS ALLOWED FOR
EACH OF THE SIZE CATEGORIES. 1=YES, 0=NO>
0
0
1
1
1
0
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE
RETURNED FOR EACH OF THE SIZE CATEGORIES BASED ON THE NORMAL
NUMBER OF CUTTINGS>
.9166667
.8333333
.8333333
.8333333
.8333333
.8333333
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE
RETURNED FOR EACH OF THE SIZE CATEGORIES WHEN AN EXTRA CUTTING IS
USED (IF ALLOWED)>
.9166667
.9166667
.9166667
<THIS IS THE DATA FOR THE FOURTH GRADE>
<MINIMUM LENGTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN ASCENDING
ORDER>
24.0
36.0
<MINIMUM WIDTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN DESCENDING
ORDER>
4.0
3.0
<MAXIMUM NUMBER OF CUTTINGS ALLOWED FOR EACH SIZE CATEGORY. NUMB
LISTED MUST BE THE SAME AS NUMCAT(1)>
1
1
1
2
3
4
5
<MINIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBE
LISTED MUST BE THE SAME AS NUMCAT(1)>
1

2
3
5
8
11
14
<MAXIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBER LISTED MUST BE THE SAME AS NUMCAT(1)>
1
2
4
7
10
13
100
<THESE VARIABLES DENOTE WHETHER AN EXTRA CUTTING IS ALLOWED FOR EACH OF THE SIZE CATEGORIES. 1=YES, 0=NO>
0
0
1
1
1
0
0
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES BASED ON THE NORMAL NUMBER OF CUTTINGS>
1.00
.75
.6666667
.6666667
.6666667
.6666667
.6666667
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES WHEN AN EXTRA CUTTING IS USED (IF ALLOWED)>
.75
.75
.75
<THIS IS THE DATA FOR THE FIFTH GRADE>
<MINIMUM LENGTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN ASCENDING ORDER>
24.0
<MINIMUM WIDTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN DESCENDING ORDER>
3.0
<MAXIMUM NUMBER OF CUTTINGS ALLOWED FOR EACH SIZE CATEGORY. NUMBER LISTED MUST BE THE SAME AS NUMCAT(1)>
1
1
2
3
4
5
6
7
<MINIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBER LISTED MUST BE THE SAME AS NUMCAT(1)>
1
2
4

6
8
10
12
14
<MAXIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMB
LISTED MUST BE THE SAME AS NUMCAT(1)>
1
3
5
7
9
11
13
100
<THESE VARIABLES DENOTE WHETHER AN EXTRA CUTTING IS ALLOWED FOR
EACH OF THE SIZE CATEGORIES. 1=YES, 0=NO>
0
1
1
1
0
0
0
0
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE
RETURNED FOR EACH OF THE SIZE CATEGORIES BASED ON THE NORMAL
NUMBER OF CUTTINGS>
.666667
.5
.5
.5
.5
.5
.5
.5
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE
RETURNED FOR EACH OF THE SIZE CATEGORIES WHEN AN EXTRA CUTTING IS
USED (IF ALLOWED)>
.666667
.666667
.666667
<THIS IS THE DATA FOR THE SIXTH GRADE>
<MINIMUM LENGTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN ASCENDING
ORDER>
24.0
<MINIMUM WIDTHS FOR THE MINIMUM SIZED CUTTINGS. LIST IN DESCENDING
ORDER>
3.0
<MAXIMUM NUMBER OF CUTTINGS ALLOWED FOR EACH SIZE CATEGORY. NUME
LISTED MUST BE THE SAME AS NUMCAT(1)>
20
<MINIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMBE
LISTED MUST BE THE SAME AS NUMCAT(1)>
1
<MAXIMUM SURFACE MEASURE CONSIDERED BY EACH SIZE CATEGORY. NUMB
LISTED MUST BE THE SAME AS NUMCAT(1)>
100
<THESE VARIABLES DENOTE WHETHER AN EXTRA CUTTING IS ALLOWED FOR
EACH OF THE SIZE CATEGORIES. 1=YES, 0=NO>
0

<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES BASED ON THE NORMAL NUMBER OF CUTTINGS>
.333333
<THESE VARIABLES DENOTE THE PERCENTAGE OF CLEAR AREA THAT MUST BE RETURNED FOR EACH OF THE SIZE CATEGORIES WHEN AN EXTRA CUTTING IS USED (IF ALLOWED)>