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OPTIGRAMI Users Manual

David G. Martens
Kenneth R. Whitenack
Robert L. Nevel, Jr.

The Authors

David G. Martens, research forest products technologist, received a B.S. degree in forest products from Iowa State University in 1961 and an M.S. degree in wood technology from Iowa State in 1963. After graduation, he joined the staff at the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Princeton, West Virginia, where he has been conducting or supervising research to improve the efficiency of wood use.

Kenneth R. Whitenack, mathematical statistician, received a B.S. degree in mathematics from Concord College, Athens, West Virginia, in 1968. He completed graduate courses at North Carolina State University and Virginia Polytechnic Institute and State University from 1968 to 1970. He joined the Northeastern Forest Experiment Station at Princeton, West Virginia, in 1967.

Robert L. Nevel, Jr., forest products industry specialist, received a B.S. degree in forest technology from The Pennsylvania State University in 1965 and an M.F. degree in wood technology from Yale University in 1968. He then joined the Northeasten Forest Experiment Station's Forestry Sciences Laboratory at Princeton and later transferred to the Forest Inventory and Analysis unit at Broomall, Pennsylvania, in 1978.

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Abstract

A computer program called OPTIGRAMI has been developed to determine the optimum, or least-cost, grade mix of hardwood lumber required to produce a given cutting order of furniture dimension parts. If the optimum mix is not available, OPTIGRAMI can be used to determine the next best alternative. The Users Manual describes the steps involved in using the program.

OPTIGRAMI is an acronym for OPTImum GRAde MIx. With this computer program, you can determine the optimum, or least-cost, mix of lumber grade volumes required to produce a given cutting order in a furniture rough mill. If this mix is not available, the next best alternative can be determined. OPTIGRAMI can also be used in making decisions on improving lumber use practices, evaluating lumber purchasing policies, and scheduling for the dry-kiln and rough mill. A thorough discussion of how OPTIGRAMI can be used to help solve day-to-day rough-mill decisions is contained in "OPTIGRAMI: Optimum lumber grade mix program for hardwood dimension parts" (Martens and Nevel 1985). It can be obtained from the Northeastern Forest Experiment Station's Forestry Sciences Laboratory, P.O. Box 152, Princeton, West Virginia 24740. This manuscript is a user's manual describing the simple steps required to run OPTIGRAMI.

OPTIGRAMI was written for the person with little computer experience and is user friendly. Input to the program is straightforward and includes numerous prompts for the user's benefit.

Because the program is designed for use on any IBM mainframe computer with a mathematical programing system (MPS) in its program library, access can be through an on-site computer or through a remote terminal.

Remote Terminal

For those wishing to use a remove terminal, OPTIGRAMI has been placed on the Computerized Management Network (CMN), a national time-sharing computer service managed by the Virginia Cooperative Extension Service. The CMN software library contains many other problem-solving programs and resides on the computer at Virginia Polytechnic Institute and State University (VPI&SU), Blacksburg, Virginia. Information on accessing CMN is provided at the end of this section.

To make OPTIGRAMI run, you simply enter the command "OPTIGRAMI". The main menu, shown in Figure 1, will appear on your screen and indicate your options. By pressing one of four function (PF) keys, you can request a file for editing or analysis, determine if a submitted analysis has been returned to your user-id, get the HELP file, or exit the program.

Consequently, if you wish to make an OPTIGRAMI analysis, you press the PF4 key. The screen will read "enter file name" (Fig. 2). It also lists the file names that you have previously run. To enter a file name, you may either (a) enter a name of from one to eight characters in the file name field and then press the ENTER key, or (b) position the cursor at the name of one of your existing files and then press ENTER (this copies the name at the cursor to the file name field at the top of the screen); then press ENTER again to validate the name you have selected. A message will appear at the bottom of the screen indicating that the requested file is an old file.

Now that you have selected your file, press the PF8 key, as shown at the bottom of the screen, to proceed to the File Options screen (Fig. 3). As shown, you press a PF key to select whether you want to edit the selected file (PF4), submit the file for processing (PF5), or specify your job priority (PF6).

Our example shows that we are interested in making an analysis, so press PF4 to proceed to the Data Entry screen (Fig. 4). Fields for all necessary data input are labeled. These include date, cutting order name, species, thickness, lumber grades to be selected and their respective costs, yield adjustments, and volume constraints. On the data entry screens, you can move the cursor with the cursor controls or skip from field to field with the TAB key.

Our example Data Entry screen (Fig. 5), specifies hard maple lumber, 4/4 thickness, and Grades No. 2 Common, No. 1 Common, and First and Seconds (FAS). The input cost for each grade, expressed in dollars per M bf (thousand board feet), is the sum of all costs through the rough mill. Cost items to be included are at the discretion of the user but might include the costs for lumber, delivery, drying and handling, rough-mill processing and overhead inventory, and inspection.

The predicted yield values that form the basis for the OPTIGRAMI analysis are those developed by the USDA Forest Service's Forest Products Laboratory (Englerth and Schumann 1969). These yields were developed for hard maple lumber, but they can be applied to most species graded by the National Hardwood Lumber Association rules.

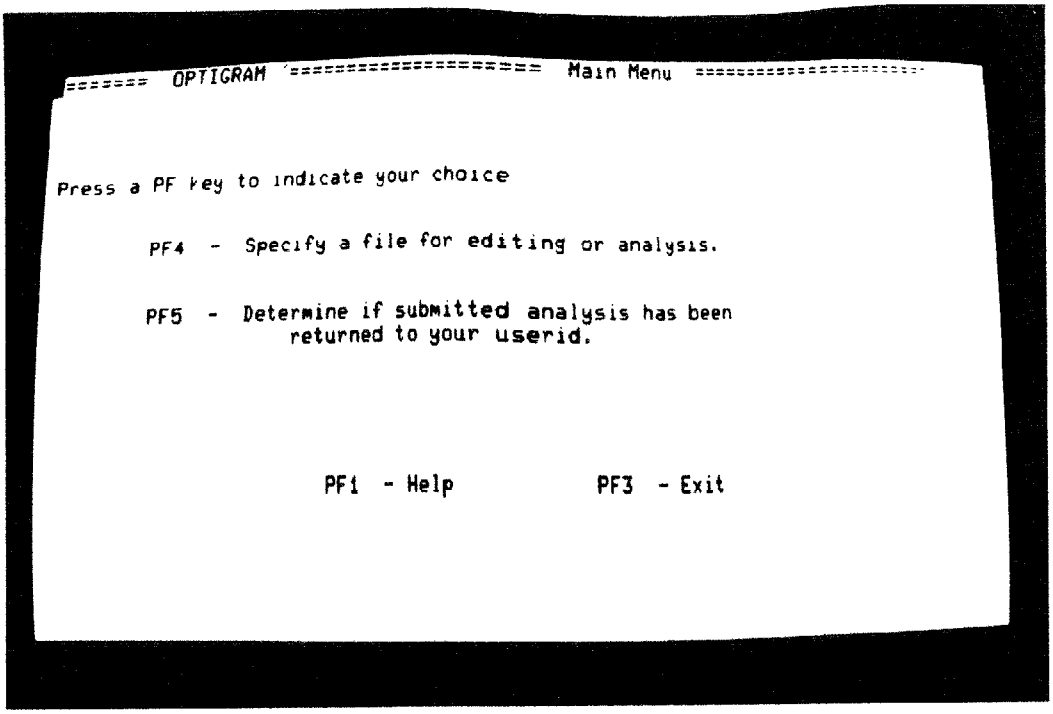

Figure 1.—Main menu

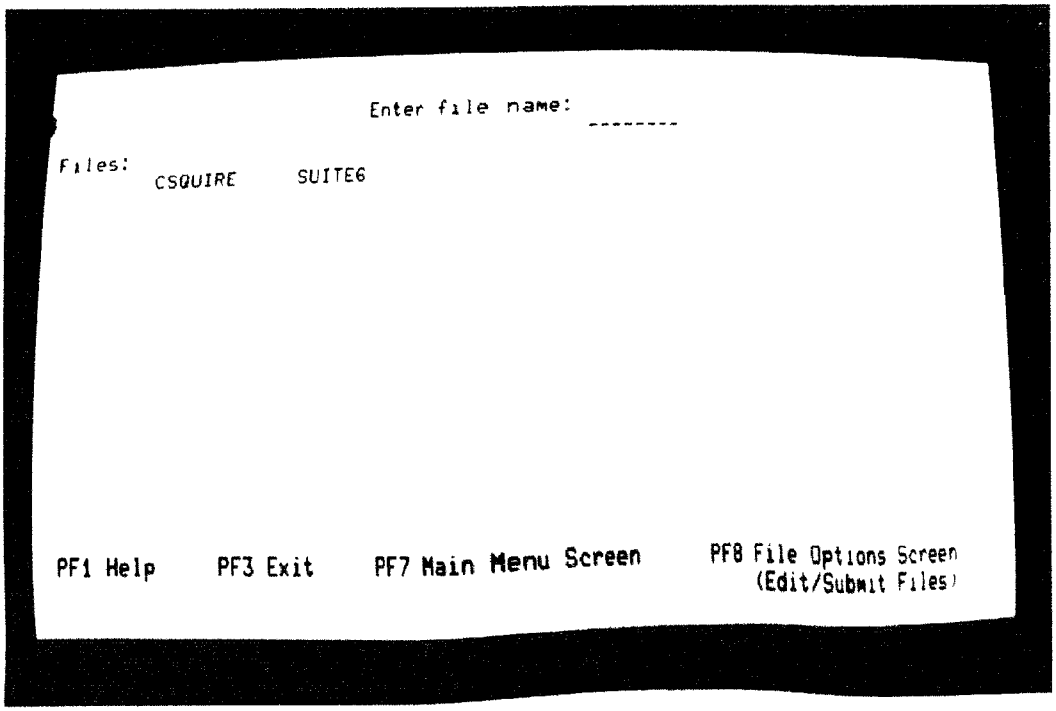

Figure 2.—File name screen.

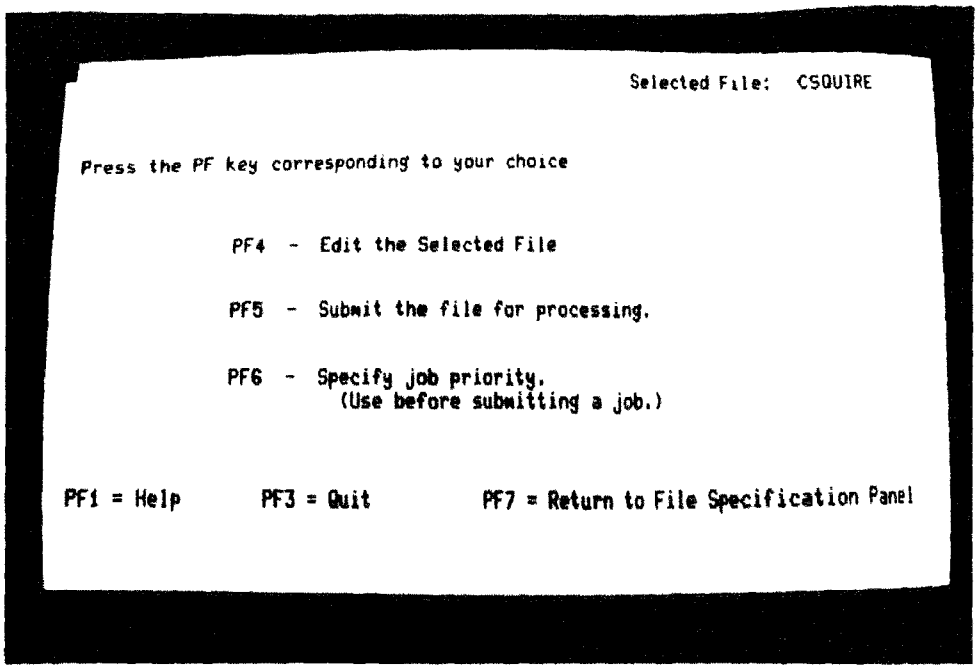

Figure 3.—File option screen.

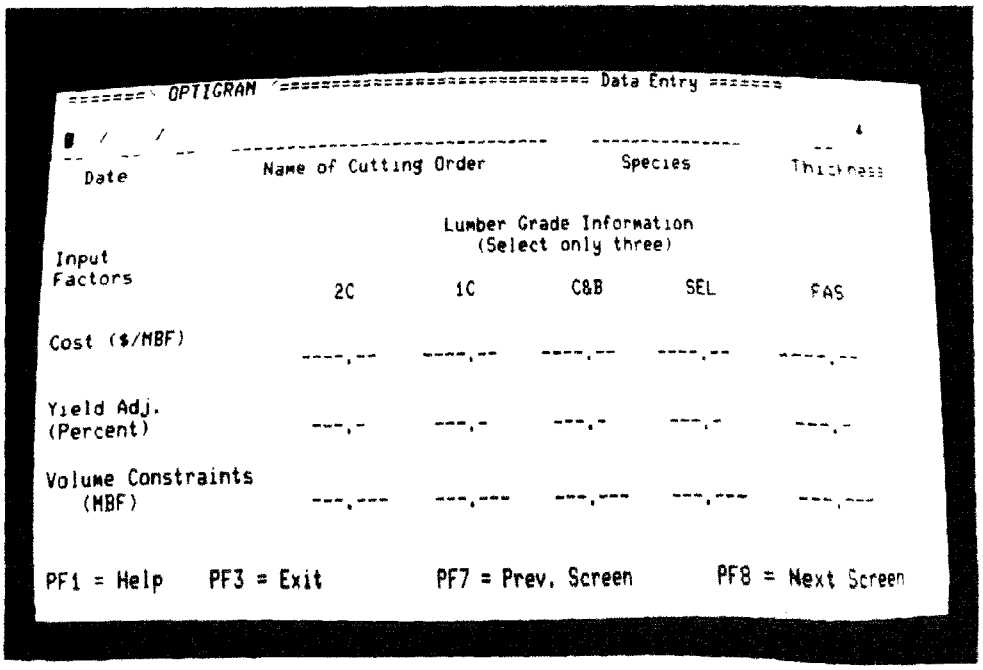

Figure 4.—Blank data entry screen.

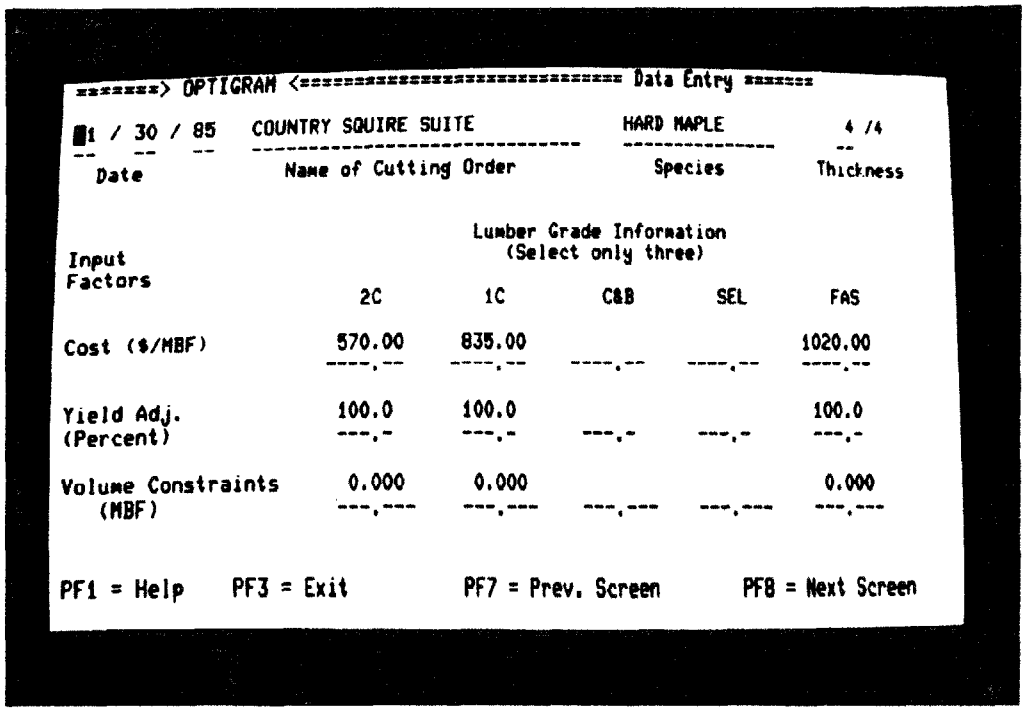

Figure 5.—Completed data entry screen.

Experience with using these yields indicates that it may be appropriate to adjust these yield values to reflect actual rough-mill efficiency, heavier thicknesses of lumber, admissible defects, specific species characteristics, or very stringent quality control specifications.

Recommended percent yield reductions (Dunmire 1971) for thicknesses over 4/4 are:

	Lumber thickness in inches		
Grade	*5/4*	*6/4*	*8/4*
FAS	2	3	4
SEL	3	4	5
1C	3	4	5
2C	4	5	6

Dimension yields are based on clear-one-face parts. The recommendation for percent yield reduction for clear-two-face parts is 2 percent.

Our example (Fig. 5) shows that we made no yield reductions; consequently, it reads 100.0 percent. If we had wanted to reduce a specific grade by 8 percent, we would have entered 92.0 in the yield adjustment field for that grade.

Note that the yield tables will accommodate cutting lengths from 10 to 96 inches and specified widths up to 6 inches. However, the maximum length that can be derived from a specific grade is 96 inches for FAS and Select, 90 inches for No. 1 Common and Better (C&B), 80 inches for No. 1 Common, and 40 inches for No. 2 Common. Yields for C&B are based on a mixture of 25 percent FAS, 25 percent Selects, and 50 percent No. 1 Common.

Likewise, our example does not indicate any volume constraints. If we had a limited amount of one of our grades available, say 8 M bf, we would have entered 8.000 in the volume constraint field for that grade. The optimum grade mix may or may not use any of that grade, but it would not indicate more than 8 M bf of it in the solution.

We now press PF8 to move to the next screen, which is where we enter our cutting order (Fig. 6). OPTIGRAM! can accommodate 50 specific cutting sizes—30 on this screen and 20 on the next screen (Fig. 7). Each is entered by length, width, type, and number of pieces. Type of part is indicated by an R or S. R is used for panels that will be glued up from random width pieces, and S is used when each part is to have a specified width. Part sizes do not need to be entered in any particular order.

Pressing the PF8 key takes us to screen 2 of the cutting order (Fig. 7), and pressing PF8 again takes us back to the File Options screen (Fig. 3). If we press PF6 on the File Options screen, we can specify our job priority (Fig. 8). Five levels of priority can be selected from idle (least expensive) to urgent (most expensive). If no selection is made, the program is set to run on idle priority.

Assuming that we are satisfied with our priority, we press PF5 to submit our file for processing. We will receive a message at the bottom of the screen indicating that "OPTIGRAM job submitted. Check for results after 10 minutes."

We can now press PF4 to make changes in our file if we want to rerun it with different lumber input costs, yield adjustments, or volume constraints. If we want to enter another analysis, we can press PF7 to go back to the File Specification screen (Fig. 2).

To receive OPTIGRAM! output, return to the Main Menu screen (Fig. 1) and press the PF5 key to determine if the submitted analysis has been returned to your userid. If it has not come back, a message at the bottom of the screen says "No OPTIGRAM output has been returned. Try again later." If the output has

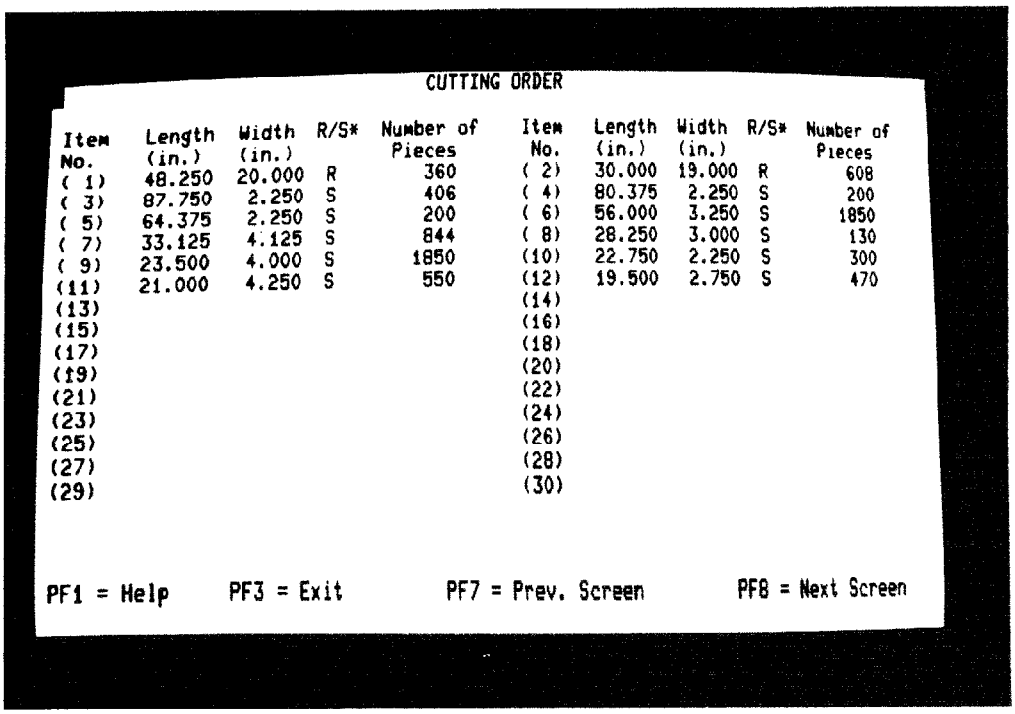

Figure 6.—Cutting order (screen 1).

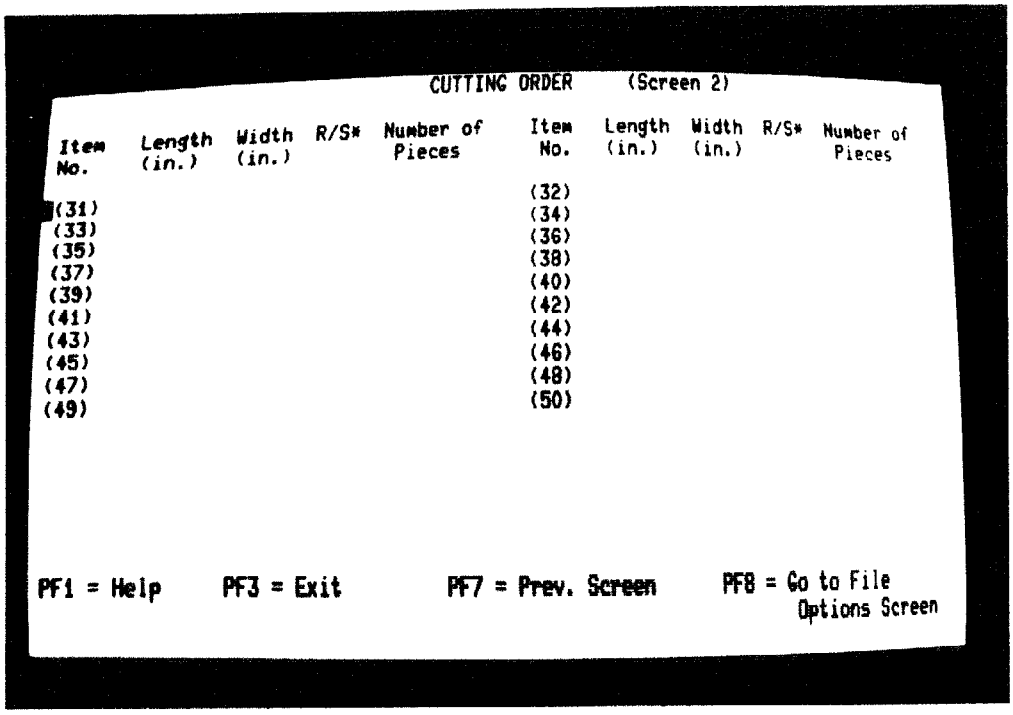

Figure 7.—Cutting order (screen 2).

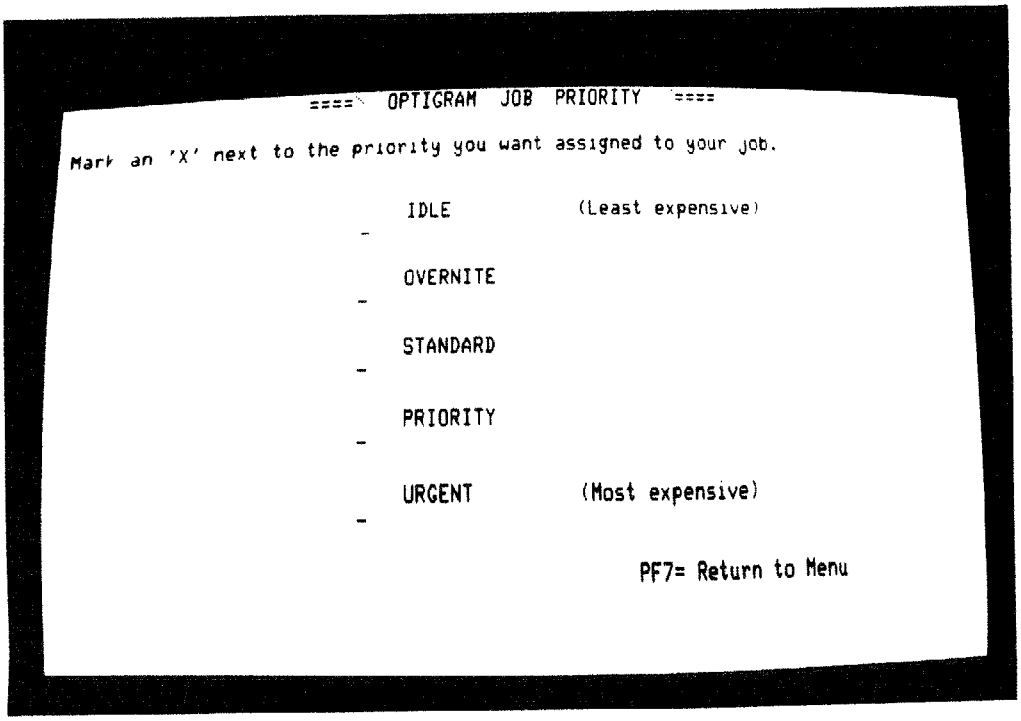

Figure 8.—OPTIGRAM job priority.

returned, it will indicate that it is in your reader. To look at the output, press PF11 as indicated on the screen. This makes the entire OPTIGRAMI output available to you. You can look through it by pressing the PF8 and PF7 keys to scroll forward and backward, respectively.

The OPTIGRAMI output is divided into four sections. The first is the input information section (Fig. 9) that provides a record of the input data used in the analysis. Included are the date, cutting order name, species, thickness, lumber costs for each grade, any yield adjustments or volume constraints used, and a listing of the cutting order.

The next two sections (Fig. 10) provide the least-cost grade mix required to produce the cutting order and the range and sensitivity analysis information. The optimum grade mix provides the amount of each grade required, the cost of each grade based on the input costs, the net board feet of cuttings expected from each grade, and the expected percent yield of each grade. The same information is provided for the total cutting order.

The range and sensitivity analysis provides information on how sensitive the least-cost grade mix is to changes in the input cost of the various grades. It shows the range over which the input cost of each grade can move without a change in the least-cost grade mix, assuming that the input cost of the other grades remains constant. It also shows, for each grade, the input cost at which there would be an alternative least-cost grade mix and the associated gross volume indicates how much lumber of that grade would be used in the alternative mix. For instance, the example shows an input cost for No. 1 Common lumber of $835 per M bf, and the least-cost solution uses 5.298 M bf of it. However, the lower limit of the input cost range for No. 1 Common indicates that if the input cost decreased to $834.23 per M bf, assuming that the input costs of the other grades remained unchanged, there would be an alternative least-cost grade mix that used 10.281 M bf of No. 1 Common lumber. In other words, at that input cost, two combinations of grades have identical total costs. However, one combination uses almost twice as much No. 1 Common lumber as the other. For a more complete discussion of the interpretation of the range and sensitivity analysis and how it can be used as a tool in making management decisions, obtain a copy of the OPTIGRAMI report (Martens and Nevel 1985) mentioned earlier.

The final part of the printout is the "Optimum Solution Cutting Information" (Fig. 11). It describes how the required cuttings can be obtained from the optimum grade mix. For each grade used, it shows the gross volume of rough lumber required, the cutting sizes to be obtained, the expected number of each size cutting to be obtained, and the anticipated quantity of each cutting obtained.

It also provides the board feet of shorts anticipated from each grade. The shorts figure represents the unused net board footage of 10-inch-long cuttings that would be available from each grade. As such, it indicates how well the raw material is being used.

In addition to information on each lumber grade, this section also summarizes information for the entire cutting order. Included in the summary are total gross volume of lumber required, the net board feet of cuttings to be obtained, the total board feet of shorts anticipated, and the total number of pieces required.

The "Optimum Solution Cutting Information" section would normally be given to the rough mill foreman for his use in assigning cutting lengths to specific saw operators. Generally, the longer length cuttings are derived from a single grade, the medium length cuttings from a combination of two grades, and the shorter length cuttings from all grades.

If you wish to keep the output, press the PF9 key to transfer it to your CMN disk space as a permanent record or to have it printed. If you have a printer attached to your terminal, you can have your results printed by using the command "TPRINT" followed by the file name that you used in your file name screen shown in Figure 2. You can also discard the output by pressing the PF2 key or have it printed at VPI&SU by pressing the PF4 key. VPI&SU will send you the results. By pressing the PF3 key, you will return to the Main menu.

On every screen requiring the selection of an option or the input of data, the PF1 key has been labeled HELP. By pressing it, a help file will be displayed on the screen to explain each of the options available to you.

CMN can be accessed with any ASCII terminal and a modem. You also can use a microcomputer with a communications program as a terminal. When accessing CMN by dialing the computer directly via long distance telephone lines, you must have a CMN userid and password. These can be obtained by contacting:

Virginia Polytechnic Institute and State University
Virginia Cooperative Extension Service
Extension Computing Resources
Plaza I, Building D
Blacksburg, Virginia 24061
(703) 961-5184

There is no initial fee or hookup charge for CMN. However, there is a small monthly userid ownership charge. Each CMN userid receives a monthly billing that includes a complete listing of all charges for each time CMN was used. Also upon completion, every CMN program displays the cost for using the program. The total cost for a CMN session is displayed when

Figure 9 **Input Information Section of OPTIGRAMI Printout**

July 10, 1984—COUNTRY SQUIRE SUITE—HARD MAPLE[a]

LUMBER GRADE[b]	PRODUCTION COSTS[c] (*Dollars/M bf*)	GRADE YIELD ADJUSTMENT FACTOR[d]	VOLUME CONSTRAINTS[e] (*M bf*)	LUMBER THICKNESS[f] (*Inches*)
NUMBER 2 COMMON	570.00	100.0	None	4/4
NUMBER 1 COMMON	835.00	100.0	None	4/4
FIRST AND SECONDS	1020.00	100.0	None	4/4

INPUT CUTTING ORDER

CUTTING SIZE LENGTH (*Inches*)	CUTTING SIZE WIDTH (*Inches*)	TYPE OF CUTTING RANDOM (R) OR SPECIFIED (S)	NUMBER OF CUTTINGS	NET BOARD FEET OF CUTTINGS
48.250	20.000	R	360	2412.5
30.000	19.000	R	608	2406.7
87.750	2.250	S	406	556.7
80.375	2.250	S	200	251.2
64.375	2.250	S	200	201.2
56.000	3.250	S	1850	2338.2
33.125	4.125	S	844	800.9
28.250	3.000	S	130	76.5
23.500	4.000	S	1850	1207.6
22.750	2.250	S	300	106.6
21.000	4.250	S	550	340.9
19.500	2.750	S	470	175.0
Total			7768	10873.9

[a] Cutting order identification, species, and date.
[b] Standard lumber grades chosen to be evaluated.
[c] Total production cost per M bf assigned to each grade.
[d] Adjustment made to the yield of each grade.
[e] Volume constraints imposed on each grade.
[f] Lumber thickness being considered.

Figure 10 **Least-Cost Grade Mix Solution and Range and Sensitivity Analysis**

Information Sections of OPTIGRAMI Printout

LEAST-COST GRADE MIX SOLUTION

July 10, 1984—COUNTRY SQUIRE SUITE—HARD MAPLE[a]

SUMMARY BY GRADE

SELECTED GRADES[b]	INPUT COST/M bf[c] (*Dollars*)	GROSS VOLUME[d] (*M bf*)	TOTAL PRODUCTION COST[e] (*Dollars*)	BOARD FEET OF CUTTINGS[f]	PERCENT YIELD[g]
NUMBER 2 COMMON	570	7.268	4142	3541.4	48.7
NUMBER 1 COMMON	835	5.298	4424	3378.1	63.7
FIRST AND SECONDS	1020	5.855	5972	3954.5	67.5
TOTALS		18.421	14538	10873.9	59.0

RANGE AND SENSITIVITY ANALYSIS INFORMATION

SELECTED GRADES		INPUT COST AND LEVELS/M bf[h] (*Dollars*)	ASSOCIATED GROSS VOLUMES (M bf)[i]
NUMBER 2 COMMON	Upper	572.59	5.785
		570.00	7.268
	Lower	559.27	7.985
NUMBER 1 COMMON	Upper	851.64	4.947
		835.00	5.298
	Lower	834.23	10.281
FIRST AND SECONDS	Upper	1021.18	2.609
		1020.00	5.855
	Lower	1009.27	6.188

[a] Identifying name or title of the cutting order, species, and date.
[b] Standard lumber grades chosen to be evaluated by OPTIGRAMI.
[c] Total production cost per M bf assigned to each grade.
[d] Quantities of each grade contained in the least-cost grade mix.
[e] Total costs for the amount of each grade of lumber used in the least-cost mix.
[f] Quantity of cuttings expected from each grade.
[g] Anticipated percent yield to be obtained from each grade.
[h] Range of input costs for each grade.
[i] Volume of that grade used in the alternate least-cost grade mix at that level of input cost.

Figure 11 **Optimum Solution Cutting Information Section of OPTIGRAMI Printout**

OPTIMUM SOLUTION CUTTING INFORMATION

July 10, 1984—COUNTRY SQUIRE SUITE—HARD MAPLE

SELECTED GRADES	LUMBER THICKNESS	GROSS VOLUME	CUTTING SIZE[a] LENGTH	WIDTH	TYPE OF CUTTING	NUMBER OF CUTTINGS[b]	NET BOARD FEET[c]
	(Inches)	*(M bf)*	- - - - *(Inches)* - - - -				
NUMBER 2 COMMON	4/4	7.268					
			30.000	19.000	R	608	2406.7
			28.250	3.000	S	130	76.5
			23.500	4.000	S	1117	729.2
			22.750	2.250	S	300	106.6
			21.000	4.250	S	172	106.4
			19.500	2.750	S	311	116.0
NET BOARD FEET/GRADE[d] = 3541.4							
BOARD FEET SHORTS[e] = 625.0							
NUMBER 1 COMMON		5.298					
			48.250	20.000	R	360	2412.5
			64.375	2.250	S	200	201.2
			33.125	4.125	S	202	191.8
			23.500	4.000	S	733	478.5
			21.000	4.250	S	91	56.4
			19.500	2.750	S	101	37.7
NET BOARD FEET/GRADE = 3378.1							
BOARD FEET SHORTS = 217.2							
FIRST AND SECONDS		5.855					
			87.750	2.250	S	406	556.7
			80.375	2.250	S	200	251.2
			56.000	3.250	S	1850	2338.2
			33.125	4.125	S	642	609.0
			21.000	4.250	S	287	178.1
			19.500	2.750	S	57	21.3
NET BOARD FEET/GRADE = 3954.5							
BOARD FEET SHORTS = 140.5							

TOTAL GROSS VOLUME (M bf)	TOTAL NET BOARD FEET	TOTAL SHORTS (bf)	TOTAL NUMBER OF PIECES
18.421	10873.9	982.8	7768

[a] Cuttings obtained from each grade in the least-cost solution.
[b] Expected number of each cutting to be obtained from each grade.
[c] Anticipated quantity of each cutting obtained from each grade.
[d] Total quantity of all cuttings expected from each grade.
[e] Cumulative unused net board footage of 10-inch-long cuttings available in each grade.

you enter the LOGOFF command. You may also determine the total charges incurred at any point in the CMN session by entering the command "CHARGES".

When you contact the Extension Computing Resources staff at VPI&SU, they will assign you a userid that consists of five characters followed by a numerical code. You will select your own password that will be known only to you. It must consist of five to eight characters and, for security reason, ought to be changed periodically.

When you LOGON with your CMN userid and password, you will have access to more than 60 programs contained in the CMN library. They cover a broad range of subjects including crop and farm management, general finance and accounting, taxes and estate planning, machinery and equipment, and information retrieval.

Although the use of OPTIGRAMI may seem confusing, it is really very easy to follow and operate. Should any question arise, the HELP files will provide the answer.

Mainframe

Potential users who have access to an IBM mainframe computer may obtain a copy of our OPTIGRAMI program library by sending a blank tape to the Forestry Sciences Laboratory, P.O. Box 152, Princeton, West Virginia 24740. We will have the library copied onto it and return it to sender with documentation of its contents. There will be no charge to the user.

If the IBM mainframe in question does not have a Mathematical Programing System (MPS) in its program library, it will be necessary to obtain it before OPTIGRAMI will function. An MPSX can be obtained from an IBM representative or an MPSIII can be obtained from KETRON, Inc., Management Science System Division, 1400 Wilson Boulevard, Arlington, Virginia 22209.

Acknowledgments

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Literature Cited

Dunmire, Daniel E., III. **Predicting yields from Appalachian red oak logs and lumber.** In: Oak symposium proceedings; 1971 August 16-20; Morgantown, WV. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1971. 94-99.

Englerth, George H.; Schumann, David R. **Charts for calculating dimension yields from hard maple lumber.** Res. Pap. FPL-118. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory; 1969. 12 p.

Martens, David G.; Nevel, Robert L., Jr. **OPTIGRAMI: Optimum lumber grade mix program for hardwood dimension parts.** Res. Pap. NE-563. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 10 p.