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OPTIGRAMI For PC's: User's Manual (Version 1.0)

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Abstract

OPTIGRAMI for PC's is a version of the mainframe program OPTIGRAMI (OPTimum GRAded Mix) written for the personal desktop computer. As with the mainframe program, a user can determine the optimum or least-cost mix of lumber grade volumes required to produce a given cutting order in a furniture rough mill, dimension mill, specialty parts mill, or any plant cutting clear parts from rough lumber of known grades.

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Introduction

OPTIGRAMI for PC's is a version of the mainframe program OPTIGRAMI (OPTimum GRAde Mix) written for the personal desktop computer. As with the mainframe program, a user can determine the optimum or least-cost mix of lumber grade volumes required to produce a given cutting order in a furniture rough mill, dimension mill, specialty parts mill, or any plant cutting clear parts from rough lumber of known grades. A thorough discussion of how OPTIGRAMI can be used to 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, Forestry Sciences Laboratory, Rt. 2 Box 562B, Princeton, West Virginia 24740.

Version 1.0 does not contain the range and sensitivity analysis found in the mainframe version. However, it is possible at one step in Version 1.0 to indirectly determine the price range for each grade (see Appendix I). The sensitivity of the least-cost solution cannot be determined with this program.

For users not acquainted with the range and sensitivity analysis of the mainframe version, it provides information on how good the current least-cost solution is relative to the next best alternatives. The range and sensitivity analysis shows the range over which the input cost of each lumber grade can move without a change in the least-cost grade mix, assuming the input cost of the other grades remains unchanged. By varying the input cost of one grade while holding the others constant, the mainframe version determines at what level of input cost there would be a change in how the grades are used to obtain the cuttings required. The sensitivity section then shows the volume of the grade that would be used at that input cost. We want to include a range and sensitivity analysis in future PC versions and are working toward that goal.

Hardware Requirements

Minimum Requirements

The following will provide satisfactory execution time for an analysis involving a maximum of 75 cuttings and 3 grades of lumber for a given cutting bill.

- An IBM/IBM-compatible computer with a minimum of 512K bytes of system memory.
- An 80-column monochrome or color display monitor.
- Two 5¼-inch, double-sided, double-density floppy disk drives, or one floppy disk drive (for above disk type) and one hard disk drive (hard disk drive is preferred).
- A printer.
- PC DOS version 2.00 or higher or comparable MS-DOS.
- Diskette containing OPTIGRAMI-PC programs.
- LP88/LP87 version 7.03 program distributed by Eastern Software Products, Inc., P.O. Box 15328, Alexandria, VA 22313, (703) 360-7600. As of 1/31/89, the price was \$149.

Note: The PC version of OPTIGRAMI was developed using the commercial linear program LP88/LP87 (Eastern Software Products 1987). This program was chosen because it provides most of the information needed. Other linear programs may be available or developed that will accomplish the same goal. The use of another linear program may require minor modifications of OPTIGRAM.EXE, the program that creates the linear program input file.

Additional Hardware

- A math coprocessor chip: Execution time can be reduced by as much as 75 percent using the LP87 version, which is specifically written to employ the faster floating point arithmetic of the math coprocessor chip. The chip should be considered a necessity when cutting orders exceed 50 cuttings.
- An electronic (RAM) disk emulator with a *minimum* storage of 192K: Device drivers for DOS 2.00 and 2.10 usually can be supplied by manufacturers of memory and combination boards to create electronic disks with their products. MS-DOS version 3.00 and higher supplies a device driver called VDISK.

The emulator is necessary for even a minimum satisfactory execution time where cutting bills exceed 75 cuttings.

Description of Programs In Package

The OPTIGRAMI for PC's package consists of eight programs. Seven are in compiled Basic language programs (Filename.EXE):

OPTINPUT.EXE.—Creates the cutting order file from input of individual cutting order piece information:

Length.

Width.

Cut to the specified width—maximum 5.99 inches—or width to be achieved from random width cuttings.

Number of pieces.

Output file—Filename.INP.

OPTIGRAM.EXE.—Creates the input file for the linear program (LP88 or LP87) and an information file used by the report writer (OPTIPRIN.EXE). OPTIGRAM uses Filename.INP as input and information on the raw material available (grades, prices, thicknesses, volume limitations, and cutting yield adjustments) from which cutting orders can be obtained. Use for all hardwood species that are graded in accordance with the Standard Hardwood Grading Rules. (Separate executive programs are used with yellow-poplar and black walnut.)

Output files—Filename.DAT

—Filename.INF

OPTIYELL.EXE.—Use in place of OPTIGRAM when cutting bill species is yellow-poplar.

OPTIWAL.EXE.—Use in place of OPTIGRAM when cutting bill is black walnut.

OPTIPRIN.EXE.—Produces the report for the cutting order being analyzed.

Input files—Filename.LPS
—Filename.INF

OPRINYELE.EXE.—Use in place of OPTIPRIN when producing a report for yellow-poplar.

OPRINWAL.EXE.—Use in place of OPTIPRIN when producing a report for black walnut.

The eighth program is the commercial linear program from Eastern Software Products, Inc.

Linear Program.—Determines the least-cost combination of lumber grades required to produce a given order of hardwood dimension parts.

Input file—Filename.DAT
Output file—Filename.LPS

Background

The OPTIGRAMI program uses a linear programming technique to correlate the cost associated with each grade of lumber with the predicted yields of each cutting size obtainable from that grade to determine the combination with the lowest total cost.

The predicted yield values that form the basis used by the analysis input program OPTIGRAM 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. For OPTIGRAMI for PC's, there are two exceptions—yellow-poplar and black walnut.

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

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

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

Grade	Lumber thickness in inches		
	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 percentage of yield reduction for clear-two-face parts is 2.

For ALL species, the program will accommodate specified (S) widths (no glue-line) up to 6 inches. Greater widths (panels) can be entered but must be entered as random (R) since they will be made up from random width pieces. Note: If widths under 6 inches can be made of glued up parts, then the cutting may be designated random (R).

The yield values for yellow-poplar used by the analysis input program OPTIYELL were obtained from charts published in "Produce Yellow-Poplar Furniture Dimension at Minimum Cost by Using YELLOPOP" (Martens 1986a). The grade classes used for this species are: FAS, Firsts and Seconds One Face (F1F), 1C, No. 2A Common (2A), and No. 2B Common (2B).

The program can accommodate cutting orders containing lengths from 10 to 96 inches. However, the maximum length piece obtainable from each grade is limited to: 96 inches for FAS and F1F, 80 inches for 1C, and 40 inches for 2A and 2B.

The yield values for black walnut used by the analysis input program OPTIWAL were obtained from charts published in "Reduce Dimension Cost by Using WALNUT" (Martens 1986b). The grade classes used for black walnut are: FAS, SEL, 1C, and 2C.

The program can accommodate cutting orders containing lengths from 10 to 96 inches. However, the maximum length piece obtainable from each grade is limited to: 96 inches for FAS, 90 inches for SEL, 80 inches for 1C, and 70 inches for 2C.

Operating Instructions

(Screens Are Shown in Appendix II)

To avoid confusion we recommend that the same filename be used for all files involving the same cutting order.

Filenames are limited to 8 characters plus an extension. The extensions of the filenames have been set and should not be changed.

When using any of the programs *except LP88 or LP87*, the user must press the RETURN key following any entry from the keyboard. When LP88 or LP87 is run, most entries require the RETURN key to be pressed; however, there are

places where a question that is answered with a Y (yes) or N (no) does not require the RETURN key to be pressed. These will be noted in the program operation instructions. Use of the RETURN key when it should not be pressed could place the user in a part of the program that cannot be used in this analysis.

In these instructions the screens are described in chronological order by screen number. The screens that appear in a given run will vary as to what the user desires to accomplish.

Data Input Program (OPTINPUT)

Enter OPTINPUT

Follow directions until SCREEN 1 appears, make selection.

- If "1" New Cutting Bill ----- go to I.
- If "2" Modify Existing Cutting Bill ----- go to II.

- I SCREEN 2 Enter the **drive** where you wish file to reside. Enter name under which cutting order is to be filed.
- SCREEN 3 Enter the **name** of the cutting order.
- SCREEN 4 Enter the number of cuttings. Then proceed to enter the **cutting information** for each cutting as follows:
Length (in inches), Width (in inches), "S" for Specified or "R" for Random, and the number of pieces of that size cutting.
Length — 10 inches through 96 inches.
Width — 1.0 inch minimum.
R/S — 1.0 to 6.0 the S(specified)/R(random) entry may be either ("S" if cutting is a single width, not glued up strips; or "R" if greater than 6.0).

Note: Use ENTER to move cursor between entries.

A signal will be given when the number of entries indicated have been entered. At this point you can check the entries for errors. If an error is detected, enter that cutting's number and reenter the correct values. Enter "0" to indicate that all data are correct.

Note: The cutting order data input screen allows the input of 25 cuttings or multiples thereof. If more than 25 (or multiples) cuttings, the program will pause to allow the checking and correction of that group of entries. The cuttings may be entered in any order. After cutting order input from above has been entered, the information will be filed under the filename that was selected in Screen 2 (Filename.INP).

The program will now go to Screen 12.

- II SCREEN 5 Enter the **drive** where the file you wish to change or modify resides. Enter the **name** of the file to be modified.
- SCREEN 6 Select either **changing** information for given cutting(s) or **deleting** given cutting(s) "1", or **adding** cuttings "2". (If, in the same cutting order, cuttings are to be changed or deleted as well as others being added, change or delete before adding.)
If "1" changing or deleting --- go to IIa.
If "2" adding ----- go to IIb.
- IIa SCREEN 7 To change the information of a cutting, enter the number of that cutting and enter the correct information—length (LEN), width (WD), R/S, and number of units (UNITS).
To delete a cutting, press RETURN for each of the four required entries. When all required changes or deletions are completed, enter "0" to indicate all are correct.
At this point, user will be asked if **additional cuttings** are to be added to this cutting order. If **yes**, go to IIb; otherwise continue.
- SCREEN 8 User may retitle the cutting order at this point. Enter "Y" or "N" when asked if user wishes to reidentify the cutting order. If "N", go to Screen 9. If "Y", the user will be asked to enter the **name** for the new cutting order name.
- SCREEN 9 User at this point chooses whether to file modified cutting bill under a new **Filename** or replace original file with the modified information. Enter "1" or "2". If "1", enter new **Filename** when asked for. Go to IIb, Screen 12.
- IIb SCREEN 10 Enter the **number** of cuttings being added.
- SCREEN 11 Program will allow user to enter the number of additional cuttings requested. Enter the new information in the same way that the original data were entered. Once entered, information can be corrected if necessary by entering the number of the cutting that contains the error and then entering the correct data (see screen 7). When all information is correct, enter "0".
Follow instructions as given for SCREENS 8 and 9.
- SCREEN 12 User now may choose to create or modify another cutting order (enter "Y"), or leave the program (enter "N"). If yes, the user will then be asked if the present diskette needs to be replaced with another diskette.

LP88/LP87 Input File Creation Program (OPTIGRAM)

If the species is yellow-poplar, use OPTIYELL.
If the species is black walnut, use OPTIWAL.

Enter OPTIGRAM:

Follow directions until SCREEN 14 appears. Four questions will be asked: what drive is data located on (enter drive), what is the Filename of the input file (enter Filename), and what name is the output to be filed under (enter Filename). Usually the name selected for the output file is the same as that which has been used to this point, however, the user is given a choice here to use the same filename or select another. The last question asked is to what drive is the output file to be assigned (enter drive).

SCREEN 15 Here the user is asked to enter:

Title: for the cutting order being run—there is a 30 character limitation.

Date:

Species: designation users' choice except as noted below. Note: When using the yellow-poplar or black walnut program, the species will not have to be entered. These programs are designed to make the correct species entry.

SCREEN 16 Enter the **number** of grades of lumber available from which the cutting order can be cut. Enter, in ascending order, the grades available and their corresponding production cost (first grade, then cost). The cost of each grade, expressed in dollars per thousand board feet (Mbf), should represent the sum of all costs associated with that grade through the rough mill. Production cost items to be included are at the discretion of the user but could include the cost for lumber purchase, delivery, drying and handling, rough mill cut-up, inventory, and overhead. Enter the lumber thickness in **number of quarters**: 1 = 1/4, 2 = 2/4, 3 = 3/4, 4 = 4/4, 5 = 5/4, 6 = 6/4, and so on.

SCREEN 17 If there is a limit to the **volume** of one or more of the available grades, enter "Y" and then enter the **number of grades** with volume limitations. Then for each grade where limitations exist, enter the **grade and volume available**. If there are no volume limitations, enter "N".

SCREEN 18 If the **yield table values** of one or more of the available grades are to be adjusted because of experience, testing, or other reason, enter "Y" and then enter the **number of grades** with yield adjustments. For each grade where an adjustment is required of the basic yield values to be used, enter the

grade and the percentage. For example, if basic yield values are to be reduced by 10 percent, enter 90. If there are no yield limitations, enter "N".

MAKE sure at this point that the printer is available and on.

SCREEN 19 This is the information the user needs to remember to run Linear Program LP88/LP87. This information is also available on the printout resulting from running this program. You will need to remember Filename plus extension (Filename.DAT), number of constraints, and number of nonslack variables for the next series of inputs.

LP88/LP87 Program

Note: "screen #'s" will not appear when program is run.

Enter **LP88** or **LP87** (use LP87 if PC has the math coprocessor chip installed).

SCREEN 20 The cursor will be at the word BEGIN. Using down arrow, move cursor to the last entry "Store the Inverse in Product Form (Y/N)" and replace **NO** with **YES**. Move cursor back to **BEGIN** (if more than 50 cuttings, follow instructions in note below before moving cursor to BEGIN) and press RETURN (ENTER). Press **F1** (SETUP MENU)—**Restart point**.

Note: If the number of cuttings is 50 or more, move cursor to "Storage for Coefficients (memory or filename)" and replace "memory" with a Filename or drive plus Filename (d:Filename) if file is to reside on other than the default disk (file is temporary and will be erased automatically). If PC does not have a hard disk drive, a blank formatted floppy disk must be inserted in designated drive.

If number of cuttings is 75 or greater, the PC should have been previously configured to use electronic (RAM) disk emulator and at this screen, move cursor to "Storage for Inverse (Filename or memory)" and replace "memory" with drive plus Filename (d:Filename). Drive is drive designator of emulator. Storing inverse on a hard disk or 1 + megabyte floppy will allow program to run but a much greater amount of time is required.

SCREEN 21 Press **F7** (INPUT FILE). The questions asked in this screen will appear in order as the previous one is answered.

Name of Use same name being
New Problem: used for Filename of
 cutting order file.

Objective: Always enter **MIN**.

Number of This is the number
Constraints: shown in screen 19 of
 the OPTIGRAM run. The
 number can also be
 obtained from
 OPTIGRAM run printout.

Number of Comes from same
Nonslack screen or printout as the
Variables: number of constraints.

There may be a delay before Screen 22 comes up while the computer is working. The length of the delay depends on the brand and capacity of the computer running the programs. When the problem name that was entered appears in the upper left corner, the computer has finished with the previously entered information (when the screen first appeared the word "NONE" showed). When it appears, the name will be in reverse video (background and character coloration will be reversed of the normal screen presentation). During the operation of this program, the name in reverse video indicates that particular operation has ended. The program is waiting for keyboard input.

SCREEN 22 Name of Sequential Input File? **Drive:** (if file resides on another drive)

Filename.DAT (.DAT MUST be included for this entry). Example:

d:Filename.DAT if file is not on default disk or Filename.DAT if file resides on default disk. Note: The input file created is a sequential file and the LP88/LP87 program asked for it in that term. Echo Elements to the Print File (Y/N): enter **N** (**DO NOT** press RETURN).

Press **F10** (this returns operator to Master Menu).

Press **F2** (Solve).

SCREEN 23 EXECUTE will be shown in reverse video, press RETURN (Enter). Computer will now run calculations. Note: It may take an extended period of time for a program to run. The running time depends first on the number of cuttings in the cutting order and then on the computer, the operating system, and other factors. Changes in values shown indicate the program is operating. When calculations are completed, the program name (upper left) will change to reverse video. If the program runs with no error to completion, the statement SOLUTION IS OPTIMAL appears beside name.

Press **F8** (Output) bottom line will change to output menu

Press **F7** (Save S).

SCREEN 24 A list of questions and statements will appear. **EXECUTE**, appearing in reverse video, will be first on the list. Move cursor to entry for question No. 1 (Save Basis Vectors), enter **NO**. Move to No. 2 (Save Primal Values), enter **YES**. If file (output of this run) is to be stored on another drive, move to last statement where the Filename appears and enter Drive Designation followed by a colon (:) and the Filename (d:Filename). If the file IS NOT to be stored on another drive location, no changes in the last statement will be made. When all entries are correct, move cursor using the up arrow to EXECUTE and press RETURN (Enter). Note: At this point the

price range may be obtained as described in Appendix I.

When name appears in reverse video, press **F10** (Return).

SCREEN 25 (Master Menu replaces former menu on bottom line.)

Screen will appear similar to screen 23 during calculation operation.

To leave program, Press **F10**, then enter "Y" in answer to the question "Do you want to end session?" (DO NOT press RETURN after pressing "Y".)

If another file (Filename.DAT) is to be run, user may enter "N" (DO NOT press RETURN after pressing "N") in place of "Y".

Entering "N" will return to the point (restart point under screen 20) where the user can repeat the steps for running LP88/LP87. At this point, press **F1**.

Print Program

(Printout program—use Filename.LPS, output of LP88/LP87 and Filename.INF, output of OPTINPUT.)

Note: If species is yellow-poplar, use OPRINYEL. If species is black walnut, use OPRINWAL.

Enter **OPTIPRIN**.

SCREEN 26 Enter **Drive** (where information for cutting order desired is filed).

Enter **Filename**.

Report will be printed.

Literature Cited

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Appendix I. — Obtaining Production Cost Range of Lumber by Grades

The cost (production) range table is obtained only during the LP88/LP87 program run. It has to be accomplished during the LP88/LP87 program run at Screen 24, **Output Menu**. This is the screen where the solution is saved to disk when F7 (SAVE S) is pressed. To obtain the cost range, press **F3-COST** Range (make sure your printer is on and ready). The printed table will contain the first 1 to 5 variables in descending order of grade (depending on the

number of grades used—3 grades used, 3 values shown; 2 grades used, 2 values shown), the inputted cost and cost range (example follows). The table may be obtained during any run of LP88/LP87 and may be run at anytime so long as **Filename.DAT** is available. However, we suggest that unless the run time for LP88/LP87 is relatively short the cost range table be printed during the initial run if there is even the slightest use for the cost range.

Example: Cost Range Table

CSQUIRE	SOLUTION IS MINIMUM OBJECTIVE ROW RANGES		COST	6864647.593	DATE TIME	03-30-1989 11:12:02
VARIABLE	STATUS	VALUE	COST/UNIT	MINIMUM	MAXIMUM	
X.1	BASIS	821.85771	1020.0000	990.79523	1022.4449	
X.2	BASIS	4942.8898	835.00000	833.37941	854.98479	
X.3	BASIS	3331.6487	570.00000	566.23924	575.87335	
X.4	NONBASIS	.00000000	.00000000	- 48.62496	NONE	
X.5	NONBASIS	.00000000	.00000000	- 48.62496	NONE	
X.6	NONBASIS	.00000000	.00000000	- 48.62496	NONE	
X.7	NONBASIS	.00000000	.00000000	.52.56783	NONE	
X.8	BASIS	*66.93954	.00000000	- 223.6566	3.6287217	
X.9	NONBASIS	.00000000	.00000000	- 280.8500	NONE	
X.10	NONBASIS	.00000000	.00000000	- 280.8500	NONE	
X.11	NONBASIS	.00000000	.00000000	- 280.8500	NONE	
X.12	BASIS	64.166664	.00000000	NONE	13.600637	
X.13	BASIS	9.8623125	.00000000	276.39802	203.74038	
X.14	BASIS	1600.0000	.00000000	NONE	48.624796	
X.15	BASIS	331.52777	.00000000	NONE	48.624796	
X.16	BASIS	100.00000	.00000000	NONE	48.624796	
X.17	BASIS	240.00000	.00000000	NONE	52.567831	
X.18	BASIS	233.06046	.00000000	- 3.628721	223.65667	
X.19	NONBASIS	.00000000	.00000000	.00000000	NONE	
X.20	NONBASIS	.00000000	.00000000	.00000000	NONE	
X.21	BASIS	375.00000	.00000000	.00000000	280.85008	
X.22	NONBASIS	.00000000	.00000000	- 13.600637	NONE	
X.23	BASIS	390.15933	.00000000	- 10.468909	.00000000	
X.24	BASIS	550.00000	.00000000	NONE	.00000000	
X.25	BASIS	573.12500	.00000000	NONE	.00000000	
X.26	NONBASIS	.00000000	.00000000	.00000000	NONE	
X.27	NONBASIS	.00000000	.00000000	- 784.9961	NONE	
X.28	BASIS	649.97836	.00000000	.00000000	11.035977	

Appendix II. — OPTIGRAMI Screens

Note: The **boldface** entries shown at the various steps are for illustration only. The output of these illustrations — COUNTRY SQUIRE SUITE (Martens et al. 1986) and MODIFIED COUNTRY SQUIRE SUITE — are shown in Appendices III and IV, respectively.

Screen 1

Do you want to —

- (1) ENTER a new cutting bill
 - (2) MODIFY an existing cutting bill
- ENTER (1 OR 2) — 1

Screen 2

INPUTTED CUTTING ORDER WILL BE FILED ON DISK
FILE CREATED (filename.INP) — CUTTING ORDER for a given job order
On which drive is your data located (A-D) :C
What NAME would you like to give to this FILE :CSQUIRE

Screen 3

Enter IDENTIFICATION for this cutting order
COUNTRY SQUIRE SUITE

Screen 4

***** CUTTING ORDER *****
** FOR EACH SIZE — ENTER LENGTH(in), WIDTH(in), (R)andom or (S)pecified **
** and NUMBER OF PIECES **
First, ENTER THE NUMBER OF SIZES IN THE CUTTING ORDER — No. = 12
** FOR EACH SIZE — ENTER LENGTH(in), WIDTH(in), (R)andom or (S)pecified **
** and NUMBER OF PIECES **

PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS	PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS
(1)	48.25	20.	R	360	(2)	30.	19.	R	608
(3)	87.75	2.25	S	406	(4)	80.375	2.25	S	200
(5)	64.375	2.25	S	200	(6)	56.	3.25	S	1850
(7)	33.125	4.125	S	844	(8)	28.25	3.	S	130
(9)	23.5	4.	S	1850	(10)	22.75	2.25	S	300
(11)	21.	4.25	S	550	(12)	19.5	2.75	S	470

CHECK ABOVE ENTRIES — IF ANY NEED CHANGING
ENTER NUMBER OF PIECE NEEDING CORRECTION — OTHERWISE ENTER "0"

Screen 5

On which drive is your data located (A-D) :C
What is the FILENAME of the file you are modifying :CSQUIRE

Screen 6

Do you want to —

- (1) CHANGE values of or DELETE cuttings
 - or
 - (2) ADD cuttings (note — make changes or deletions first)
- ENTER (1) or (2) — 2

Screen 7 CSQUIRE

PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS	PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS
(1)	48.25	20.	R	360	(2)	30.	19.	R	608
(3)	87.75	2.25	S	406	(4)	80.375	2.25	S	200
(5)	64.375	2.25	S	200	(6)	56.	3.25	S	1850
(7)	33.125	4.125	S	844	(8)	28.25	3.	S	130
(9)	23.5	4.	S	1850	(10)	22.75	2.25	S	300
(11)	21.	4.25	S	550	(12)	19.5	2.75	S	470

CHECK ABOVE ENTRIES — IF ANY NEED CHANGING
 ENTER NUMBER OF PIECE NEEDING CORRECTION — OTHERWISE ENTER "0"
 TO DELETE A CUTTING — PUSH RETURN FOR EACH ENTRY (LEN, WD, R/S & NO.)
 A NEW CUTTING MAY BE SUBSTITUTED
 FOR ANY UNNEEDED CUTTING BY ENTERING NEW CUTTING INFORMATION.

Screen 7 con't

Are there additional cuttings to be added to this cutting order? (Y/N) **N**

(Note: if Y, screen 10 would appear)

Screen 8

The IDENTITY Title of this modified cutting order is the same as the original —

** COUNTRY SQUIRE SUITE **

Do you want to REIDENTIFY (Y/N) **Y**

Enter the new IDENTITY for this modified cutting order —

** MODIFIED COUNTRY SQUIRE SUITE **

Screen 9

Do you want to FILE this modified cutting order —

(1) Under a new Filename

or

(2) Replace original file

ENTER (1 or 2) — **1**

What NAME would you like to give this FILE :**MSQUIRE**

Screen 10

How many cuttings are being added to this cutting order? **2**

Screen 11

PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS	PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS
(13)	20.	15.	S	220	(14)	10.	12.	R	100

CHECK ABOVE ENTRIES — IF ANY NEED CHANGING
 ENTER NUMBER OF PIECE NEEDING CORRECTION — OTHERWISE ENTER "0" **13**

(Note: on #13 an error was made when 15-inch width was entered as "S")

Screen 11 (con't)

PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS	PIECE NO.	LENGTH	WIDTH	R/S	No. of UNITS
(13)	20.	15.	R	220	(14)	10.	12.	R	100

CHECK ABOVE ENTRIES — IF ANY NEED CHANGING
ENTER NUMBER OF PIECE NEEDING CORRECTION — OTHERWISE ENTER "0" 0

Screen 12

DO YOU WISH TO CREATE OR MODIFY ANOTHER CUTTING ORDER? (Y/N) N

(Screen 13 — NOT USED)

Screen 14

P88/LP87 INPUT CREATED BY THIS PROGRAM and FILED ON DISK
INPUT Filename asked for below is CUTTING ORDER Filename
2 FILES CREATED — INFORMATION (Filename.INF) & LP PROGRAM INPUT (Filename.DAT)
On which drive is your data located (A-D) :C
Enter cutting order FILENAME (input file) :CSQUIRE
Enter NAME of FILE for the output of this run :CSQUIRE
Which drive is the above output file to be assigned (A-D) :C

Screen 15

Enter a TITLE for this problem ----- COUNTRY SQUIRE SUITE
Enter the DATE ----- 2/20/89
Enter SPECIES used in cutting order ----- HARD MAPLE

Screen 16

**** LUMBER GRADES REFER TO STANDARD HARDWOOD LUMBER GRADING RULES ****
(FAS, SELECTS, #1COM & BETTER, #1COM, #2COM)
ENTER NUMBER OF LUMBER GRADES AVAILABLE (1-5)? 3
GRADE CODES — 1 = FAS; 2 = SELECTS; 3 = #1COM & BETTER; 4 = #1COM; 5 = 2COM
FOR EACH GRADE SELECTED ABOVE, ENTER THE GRADE CODE & VALUE
GRADE CODE? 1 COST/THOUSAND? 1020
GRADE CODE? 4 COST/THOUSAND? 835
GRADE CODE? 5 COST/THOUSAND? 570
WHAT IS THE THICKNESS OF THE LUMBER AVAILABLE?
ENTER THICKNESS IN QUARTERS (4 = 4/4, 5 = 5/4, ETC.) 4

Screen 17

VOLUME LIMITATIONS FOR THIS ANALYSIS
DO YOU WISH TO LIMIT THE MAXIMUM AMOUNT OF GRADE THAT CAN BE USED (Y/N) Y

(Note: If Y above, screen below would appear)

VOLUME LIMITATIONS FOR THIS ANALYSIS
DO YOU WISH TO LIMIT THE MAXIMUM AMOUNT OF GRADE THAT CAN BE USED (Y/N) Y
(IF YES, ENTER — AS PROMPTED BELOW — THE NUMBER OF GRADES WITH
VOLUME LIMITATIONS, THE GRADE AND VOLUME AVAILABLE)
EXAMPLE — 6000 OF #5 (5 = #2COM) will optimize based on a maximum allowable
usage of 6000 Bd. Ft. of No. 2 Common —
CODES OF GRADES SELECTED FOR USE
1 = FAS 4 = #1COM; 5 = #2COM
NUMBER OF GRADES WITH VOLUME LIMITATIONS? 1
GRADE CODE? 4 VOLUME AVAILABLE? 4000

Screen 18

YIELD LIMITATIONS FOR THIS ANALYSIS
FOR THIS CUTTING ORDER
DO YOU WISH TO ADJUST THE PREDICTED YIELDS (Y/N) N

(Note: If Y above, screen below would appear)

YIELD LIMITATIONS FOR THIS ANALYSIS
FOR THIS CUTTING ORDER
DO YOU WISH TO ADJUST THE PREDICTED YIELDS (Y/N) Y
(IF YES, ENTER — AS PROMPTED BELOW — THE NUMBER OF GRADES WITH
YIELD LIMITATIONS, THE GRADE AND YIELD AVAILABLE)
(EXAMPLE — 95 will optimize based on 95 percent of predicted yields)
CODES OF GRADES SELECTED FOR USE
1 = FAS 4 = #1COM; 5 = #2COM
NUMBER OF GRADES WITH YIELD LIMITATIONS? 2
GRADE CODE? 4 YIELD LIMITATIONS? 97
GRADE CODE? 5 YIELD LIMITATIONS? 93

Screen 19

REMEMBER THE FOLLOWING
THEY ARE NEEDED TO RUN THE LINEAR PROGRAM (LP88/LP87)
PORTION OF THE PROGRAM PACKAGE
NO. OF CONSTRAINTS = 44
NO. OF VARIABLES = 32
LP88/LP87 INPUT filename = C:CSQUIRE.DAT

Note: When entering Filename (when asked for) into "LP88/LP87"
precede it with drive where file is located if not on default disk
Example: A:Filename.DAT

Screen 20

LP88 — Version 7.03
Linear Programming for the IBM PC
(C) 1989 by ESP, Inc.

For assistance with this program
call the ESP Customer Hotline:
(703) 360-7500

KEY	MASTER MENU	SETUP MENU	EXECUTION MENU	OUTPUT MENU
F1	SETUP MENU	FILES LIST	PAUSE TOGGLE	PRIMAL VALUES
F2	SOLVE PROBLEM	NEW PROBLEM	STEP TOGGLE	DUAL VALUES
F3	RERUN w/BASIS	DISPLAY/EDIT	INVERT MATRIX	COST RANGES
F4	RESTART w/INV	SAVE PROBLEM	CHANGE CONTROLS	RHS RANGES
F5	GET SOLUTION	CONVERT TO DUAL	PIVOT SELECT	INVERSE MATRIX
F6	OLD PROBLEM	OLD PROBLEM	DELTA SELECT	INV*A MATRIX
F7	BATCH MODE	INPUT FILE	SHORT PRINTOUT	SAVE SOLUTION
F8	OUTPUT MENU	PRINT PROBLEM	OUTPUT MENU	SAVE MENU
F9	CONFIGURE	READ WORKSHOP	RECORD PIVOTS	WRITE WORKSHEET
F10	END SESSION	RETURN	RETURN	RETURN
Esc	HELP	HELP	HELP	HELP

Select and <Enter> to Begin Session
Designation for Listings (Printer or File Name)
Printer Carriage Width (Number of Columns)
Form Feed Before Printing a Table (Y/N)
Storage for Coefficients (Memory or File Name)
Storage for Inverse (Memory or File Name)
Store the Inverse in Product Form (Y/N)

Begin
Printer
80
No
Memory
Memory
Yes

Appendix III. — Input Information for Country Squire Suite

OPTIGRAMI — INPUT INFORMATION
2/20/89 — COUNTRY SQUIRE SUITE — HARD MAPLE

LUMBER GRADE	PRODUCTION COSTS	GRADE YIELD ADJUSTMENT	VOLUME CONSTRAINTS	LUMBER THICKNESS
	(Dollars/Mbf)	Factor	(Mbf)	(Inches)
FIRSTS and SECONDS	1020	100	None	4/4
NUMBER 1 COMMON	835	100	None	4/4
NUMBER 2 COMMON	570	100	None	4/4

INPUT CUTTING ORDER

CUTTING SIZE		TYPE OF CUTTING RANDOM(R) OR SPECIFIED(S)	NUMBER OF CUTTINGS	NET BOARD FEET OF CUTTINGS
LENGTH	WIDTH			
(in)	(in)			
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
48.250	20.000	R	360	2412.5
33.125	4.125	S	844	800.9
30.000	19.000	R	608	2406.7
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

LEAST-COST GRADE MIX SOLUTION
2/20/89 — COUNTRY SQUIRE SUITE — HARD MAPLE
Summary By Grade

	INPUT COST/Mbf	GROSS VOLUME	TOTAL PRODUCTION COST	BOARD FEET OF CUTTINGS	PERCENT YIELD
SELECTED GRADES	(Dollars)	(Mbf)	(Dollars)		
FIRSTS and SECONDS	1020	1.703	1738	1193.1	70.0
NUMBER 1 COMMON	835	10.197	8515	6136.0	60.0
NUMBER 2 COMMON	570	6.958	3966	3544.9	50.9
TOTALS		18.859	14218	10873.9	57.7

RANGE and SENSITIVITY ANALYSIS INFORMATION

SELECTED GRADES	INPUT COST and LEVELS/Mbf	ASSOCIATED GROSS VOLUMES (Mbf)
	(Dollars)	
FIRSTS and SECONDS	UPPER LOWER	1.703
NUMBER 1 COMMON	UPPER LOWER	10.197
NUMBER 2 COMMON	UPPER LOWER	6.958

OPTIMUM SOLUTION CUTTING INFORMATION
2/20/89 — COUNTRY SQUIRE SUITE — HARD MAPLE

SELECTED GRADES	LUMBER THICKNESS	GROSS VOLUME	CUTTING SIZE		TYPE OF CUTTING	NUMBER OF CUTTINGS	NET BOARD FEET
	(Inches)	(Mbf)	-----	(Inches) -----			
FIRSTS and SECONDS	4/4	1.703					
			87.750	2.250	S	406	556.7
			80.375	2.250	S	200	251.2
			56.000	3.250	S	157	199.0
			33.125	4.125	S	17	16.2
			21.000	4.250	S	264	163.4
			19.500	2.750	S	18	6.7
NET BOARD FEET FOR GRADE = 1193.1							
NUMBER 1 COMMON		10.197					
			64.375	2.250	S	200	201.2
			56.000	3.250	S	1693	2139.6
			48.250	20.000	R	360	2412.5
			33.125	4.125	S	827	784.6
			23.500	4.000	S	637	415.7
			21.000	4.250	S	183	113.5
			19.500	2.750	S	186	69.3
NET BOARD FEET FOR GRADE = 6136.0							
NUMBER 2 COMMON		6.958					
			30.000	19.000	R	608	2406.7
			28.250	3.000	S	130	76.5
			23.500	4.000	S	1213	791.9
			22.750	2.250	S	300	106.6
			21.000	4.250	S	103	64.1
			19.500	2.750	S	266	99.1
NET BOARD FEET FOR GRADE = 3544.9							
TOTAL GROSS VOLUME		TOTAL NET BOARD FEET		TOTAL NUMBER OF PIECES			
(Mbf)							
18.859		10873.9		7768			

Appendix IV. — Input Information for Modified Country Squire Suite

OPTIGRAMI — INPUT INFORMATION
2/20/89 — MODIFIED COUNTRY SQUIRE SUITE — HARD MAPLE

LUMBER GRADE	PRODUCTION COSTS	GRADE YIELD ADJUSTMENT	VOLUME CONSTRAINTS	LUMBER THICKNESS
	(Dollars/Mbf)	Factor	(Mbf)	(Inches)
FIRSTS and SECONDS	1020	100	None	4/4
NUMBER 1 COMMON	835	100	None	4/4
NUMBER 2 COMMON	570	100	None	4/4

INPUT CUTTING ORDER

CUTTING SIZE		TYPE OF CUTTING RANDOM(R) OR SPECIFIED(S)	NUMBER OF CUTTINGS	NET BOARD FEET OF CUTTINGS
LENGTH	WIDTH			
----- inches -----				
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
48.250	20.000	R	360	2412.5
33.125	4.125	S	844	800.9
30.000	19.000	R	608	2406.7
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
20.000	15.000	R	220	458.3
19.500	2.750	S	470	175.0
10.000	12.000	R	100	83.3
TOTAL			8088	11415.6

LEAST-COST GRADE MIX SOLUTION
2/20/89 — MODIFIED COUNTRY SQUIRE SUITE — HARD MAPLE
Summary By Grade

	INPUT COST/Mbf	GROSS VOLUME	TOTAL PRODUCTION COST	BOARD FEET OF CUTTINGS	PERCENT YIELD
SELECTED GRADES	(Dollars)	(Mbf)	(Dollars)		
FIRSTS and SECONDS	1020	1.703	1738	1193.1	70.0
NUMBER 1 COMMON	835	10.197	8515	6215.9	61.0
NUMBER 2 COMMON	570	7.751	4418	4006.6	51.7
TOTALS		19.652	14670	11415.6	58.1

RANGE and SENSITIVITY ANALYSIS INFORMATION

SELECTED GRADES	INPUT COST and LEVELS/Mbf	ASSOCIATED GROSS VOLUMES (Mbf)
	(Dollars)	
FIRSTS and SECONDS	UPPER LOWER	1.703
	1020.00	
NUMBER 1 COMMON	UPPER LOWER	10.197
	835.00	
NUMBER 2 COMMON	UPPER LOWER	7.751
	570.00	

OPTIMUM SOLUTION CUTTING INFORMATION
2/20/89 — MODIFIED COUNTRY SQUIRE SUITE — HARD MAPLE

SELECTED GRADES	LUMBER THICKNESS (Inches)	GROSS VOLUME (Mbf)	CUTTING SIZE LENGTH WIDTH ----- (Inches) -----	TYPE OF CUTTING	NUMBER OF CUTTINGS	NET BOARD FEET
FIRSTS and SECONDS	4/4	1.703				
			87.750 2.251	S	406	556.7
			80.375 2.250	S	200	251.2
			56.000 3.250	S	157	199.0
			33.125 4.125	S	17	16.2
			21.000 4.250	S	264	163.4
			19.500 2.750	S	18	6.7
NET BOARD FEET FOR GRADE = 1193.1						
NUMBER 1 COMMON		10.197				
			64.375 2.250	S	200	201.2
			56.000 3.250	S	1693	2139.6
			48.250 20.000	R	360	2412.5
			33.125 4.125	S	827	784.6
			23.500 4.000	S	533	348.2
			21.000 4.250	S	286	177.5
			19.500 2.750	S	186	69.3
			10.000 12.000	R	100	83.3
NET BOARD FEET FOR GRADE = 6215.9						
NUMBER 2 COMMON		7.751				
			30.000 19.000	R	608	2406.7
			28.250 3.000	S	130	76.5
			23.500 4.000	S	1317	859.4
			22.750 2.250	S	300	106.6
			20.000 15.000	S	220	458.3
			19.500 2.750	S	266	99.1
NET BOARD FEET FOR GRADE = 4006.6						
TOTAL GROSS VOLUME (Mbf)		TOTAL NET BOARD FEET		TOTAL NUMBER OF PIECES		
19.652		11415.6		8088		