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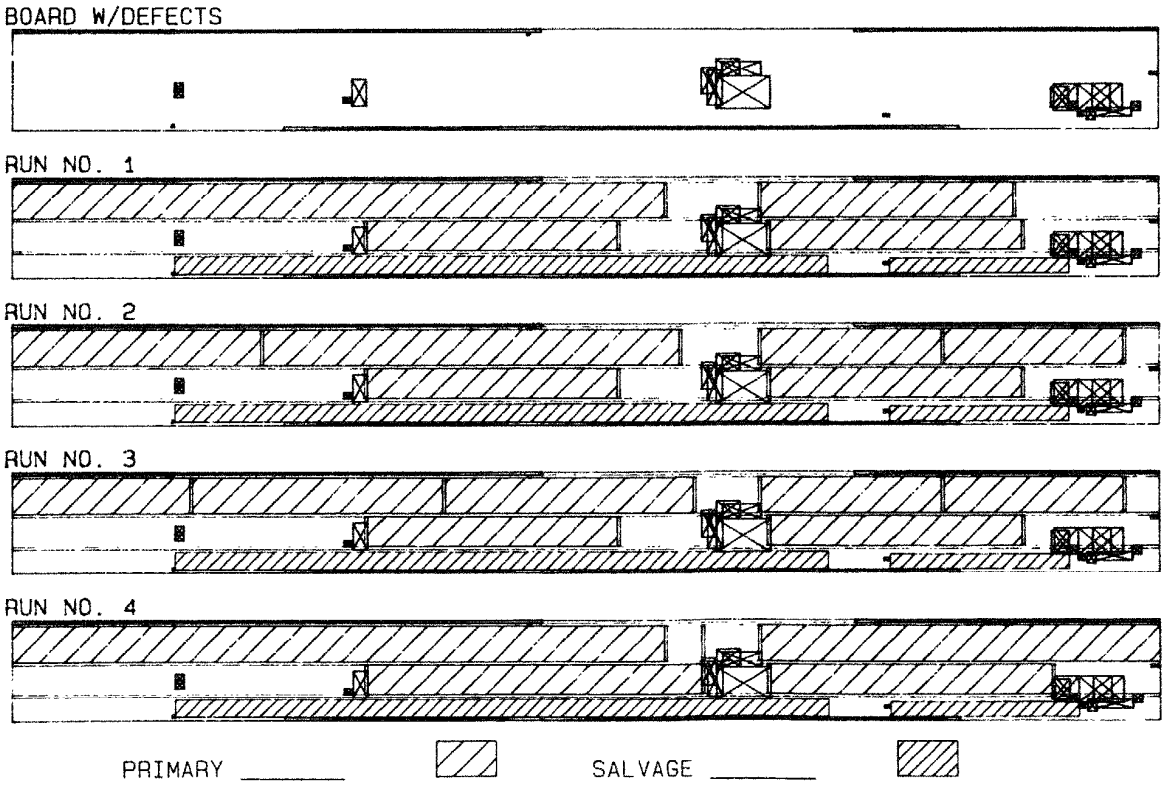
GR-1ST: PC Program for Evaluating Gang-Rip-First Board Cut-Up Procedures

Kristen G. Hoff
Edward L. Adams
Elizabeth S. Walker



Abstract

As the price of the better grades (Firsts & Seconds and Selects) of lumber continues to climb, many furniture and cabinet manufacturers have begun to process parts from No. 1 and No. 2 Common lumber. However, getting the optimum parts yield from these lower grades of lumber is difficult when using the traditional crosscut-first procedure. A gang-rip-first procedure is one solution to this problem, and a microcomputer program called GR-1ST (gang-rip-first) is now available. GR-1ST output provides: (1) parts yield information for each board, (2) a printer plot of each board and its defects plus the resulting saw cuts and the parts produced, and (3) parts summary information for the parts produced from all boards processed during the computer run. As the required board defect data files become available, this program will allow researchers and plant managers to determine optimal gang-rip-first procedures for producing needed parts from different grades of lumber.

The Authors

KRISTEN G. HOFF is an industrial engineer with the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Princeton, West Virginia. She received a B.S. in math and computer science from Concord College in 1985 and is presently completing advanced training in industrial engineering. She joined the Northeastern Station in 1987.

EDWARD L. ADAMS is a forest products technologist with the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Princeton, West Virginia. He received a B.S. in forest management and an M.S. in forest mensuration at West Virginia University. He worked for the USDA Forest Service in Oregon from 1960 to 1963 and joined the Northeastern Station in 1958.

ELIZABETH S. WALKER is a computer programmer with the Northeastern Forest Experiment Station's Forestry Sciences Laboratory at Princeton, West Virginia. She received a B.S. in math and computer science from Concord College in 1985. She joined the Northeastern Station in 1988.

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Northeastern Forest Experiment Station
5 Radnor Corporate Center
100 Matsonford Road, Suite 200
P.O. Box 6775
Radnor, Pennsylvania 19087

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Introduction

Furniture and cabinet manufacturers traditionally have produced needed parts (cuttings) from Firsts & Seconds (FAS) and Selects lumber. This lumber is usually crosscut first in a manner that allows the defect-free parts to be ripped from the resulting crosscut sections. This crosscut-first procedure works well with better grades of lumber that contain relatively few defects. However, as the price of this lumber has increased, many manufacturers have started to use lower priced, No. 1 and No. 2 Common lumber. The added number of defects in these lower grade boards makes it difficult to obtain a near optimum yield from the lumber in a crosscut-first operation. The further the manufacturers are from the optimum parts yield, the less savings they realize from the lower priced lumber.

Earlier work (Hallock 1980) on cutting yields from standard hardwood lumber grades when gang ripping boards has some limitations when applied to today's cut-up situations. To overcome these limitations, research was done on increasing parts yields from the lower grades of lumber by using gang-rip-first procedures (Gatchell 1987). Furniture and cabinet manufacturers have shown an increasing interest in the gang-rip-first procedures that has resulted in a search for answers to some basic questions: What is the optimum gang-ripping procedure for a given parts situation and grade of lumber? Can the needed part lengths be obtained? And, how much waste will be produced? A computer program called GR-1ST (Gang-Rip-First)[1] is now available to help answer these questions. This report provides an overview of the GR-1ST program and its output.

GR-1ST Program

GR-1ST is a modified version of an unpublished program (MULRIP) developed by Abigail R. Stern and Erwin H. Bulgrin (1977 and 1978) at the USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin. The MULRIP program, based on a computer program called RIPYLD (Stern and McDonald 1978), was developed for the USDA Forest Service, Forestry Sciences Laboratory, Princeton, West Virginia, to provide optimum gang-rip-first solutions for processing hardwood boards into cuttings for furniture parts, cabinet parts, or parts for gluing up panels. GR-1ST is an expanded program for evaluating different gang-rip-first possibilities.

The optimum solutions produced by the GR-1ST program are based on the surface area yield of parts. To modify the program to include optimum value of parts would increase the size of the program so much that it would not work on most personal computers (PC's).

To make GR-1ST easier to use, it was written in Microsoft's[2] FORTRAN (Version 4.1) and compiled for use on a microcomputer. To run the program you need a microcomputer with: (1) an 80286 or 80386 microprocessor; (2) math coprocessor; (3) MS-DOS, Version 3.3 or later; (4) 5.25-inch floppy disk drive with 1.2 megabyte storage capacity, or a 3.5-inch disk drive with 1.44 megabyte storage capacity; and (5) printer with graphics capabilities. In addition, you also must have input data files containing digitized board and defect data for the species and grades of lumber to be processed by the GR-1ST program.

A general discussion of (1) the required board data file, (2) the program limitations, and (3) the program options follows.

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

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

Required Board Data File

First, the board data file must contain the board lumber grade, board identification number, number of defects in the board, and the width of the board. Next, it must contain the X and Y coordinates of the lower left corner and the upper right corner of the rectangle that encloses the entire board. Then, it must contain the X and Y coordinates of the lower left corner and the upper right corner of the rectangle used to box in each defect and void found inside the rectangle that encloses the board. Voids, as used here, represent the areas between the board outline and the rectangle enclosing the board. Because the program works in 1/4-inch increments, the coordinates and the board width must be recorded in 1/4-inch increments. This procedure must be repeated for each board. A graphic representation of a board that has been digitized using this procedure is shown at the top of Figure 1.

If the GR-1ST program is to cut parts that are clear on both faces from the digitized boards, the defects on both sides of the boards must be digitized. If the parts are to be clear on one face, it is only necessary to digitize the defects on the best face of each board. However, it is recommended that all defects be digitized and identified as to defect type and the side of the board on which they occur. This will allow the GR-1ST program user to evaluate the production of both clear-two-face parts and clear-one-face parts as well as parts that allow certain types of defects. This is discussed further in "GR-1ST User's Manual: For Running a Gang-Rip-First Board Cut-Up Procedure Program".[3]

At present, two digitized board data files are being developed at the Forestry Sciences Laboratory. One file is for No. 1 Common red oak lumber and the other is for No. 2 Common red oak lumber.

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[3]Adams, Edward L.; Hoff, Kristen G.; Walker, Elizabeth S. in preparation. GR-1ST User's Manual: For Running a Gang-Rip-First Cut-up Procedure Program. Gen. Tech. Rep., Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.

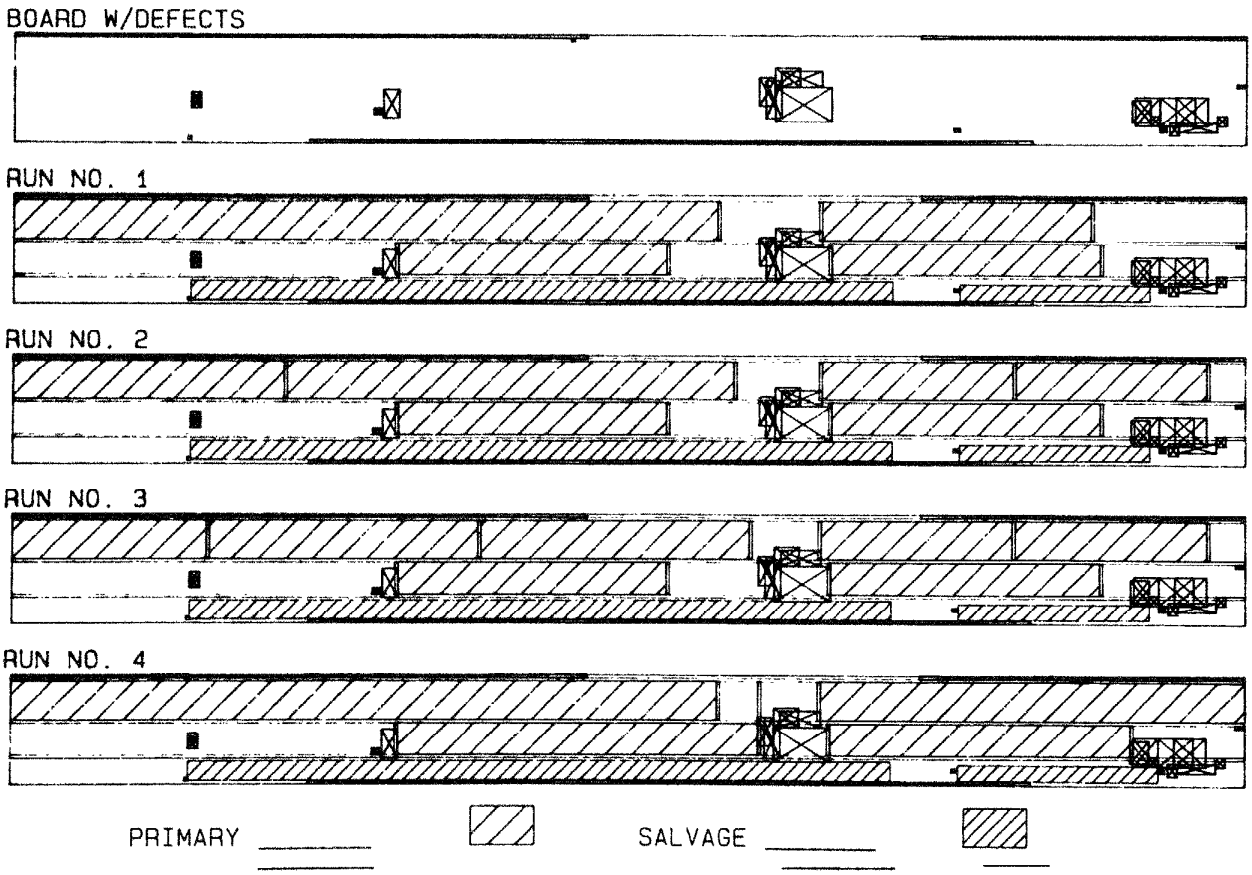


Figure 1.—Graphic representation of a board and its defects plus the GR-1ST results for four different gang-rip-first situations.

Program Limitations

It was necessary to incorporate a number of limitations into the GR-1ST program so that it would run on a microcomputer with a reasonable run time. Although it was necessary to limit the allowable board sizes, number of defects per board, number of parts per board, specified widths and lengths of parts, number of saw spacings, saw kerf, and salvage parts optimization, these limitations should not adversely affect the usefulness of the program. A discussion of the program limitations follows:

Board Size. — The maximum board length is 16 feet 5 inches. The maximum board width depends on the board plotting option used during the computer run. If the boards along with their defects, saw cuts, and resulting parts are not to be plotted or if they are to be plotted on a pen plotter at a later date, the maximum board width is 16 inches. However, if the user wishes a printer plot of this information as the board is being processed by the computer, the maximum allowable board width is 14 inches.

Defects Per Board. — A maximum of 400 rectangles representing defects is allowed for each board in the board defect data file.

Parts Per Board. — A maximum of 200 parts may be cut from an individual board. This includes any combination of primary and salvage parts. Primary parts are defined as parts that meet the specified part sizes and can be produced with only crosscuts made in the initially gang-ripped-strips. Salvage parts do not meet the specified sizes and generally require additional rip cuts followed by one or more crosscuts after the initial gang-rip-cuts and crosscuts.

Specified Part Dimensions. — A maximum of 10 part lengths and 3 part widths may be specified when looking for the optimum cutting procedures for a board or group of boards. The specified lengths are used for both the primary and the salvage parts. The specified widths are used for only the primary part widths.

Number of Saw Spacings. — The program allows only six saw spacings including the space between the fence and the first saw. If the program has been instructed to edge the board on both sides before processing, the edge saws are not included in the saw spacing determination. It should be noted that the width of the saw spacings can affect the width of the boards that can be processed. For example, if variable saw spacings are used, boards cannot be processed that are wider than 6 times the widest designated saw spacing plus six saw kerfs. If a fixed arbor or equal-spaced saws with a movable outer blade are used, boards cannot be processed that are wider than the sum of the six designated saw spacings plus six saw kerfs. That is, the program will not allow the processing of any board that does not fall between the fence and the outside saw blade.

Saw Kerf. — In processing the boards into parts, the program uses a 1/4-inch saw kerf. This kerf thickness cannot be changed.

Salvage Parts Optimization. — In processing boards, GR-1ST only optimizes on surface yield of primary parts. It will not optimize on the surface yield of salvage parts or on total surface yield of parts including both primary and salvage parts. When determining the salvage parts in a ripped section, the program chooses the largest salvage part first and then the next largest part. This process continues until no more parts can be produced from the ripped section. The advantages of optimizing on salvage or total part yields were outweighed by the disadvantages of a much larger program and considerably greater processing times per board for other optimization methods.

Program Options

When setting up the program to simulate a gang-rip-first sawing procedure on a board or group of boards, several options are available. At the start of a computer run, the options appear on the video screen, and the user is prompted for answers. These options include: (1) program output, (2) pieces per clear primary section, (3) part length determination, (4) width of primary parts, (5) minimum width of salvage parts, (6) board edging, and (7) saw arbor type. A discussion of these options follows.

Program Outputs. — The user has a choice of obtaining any or all of three different options for program output. The first option provides yield information for each individual board processed. The second provides printer graphic representations of the boards, defects, saw cuts, and resulting parts as the boards are being processed. If the printer plots are called for, the graphic representation also will be shown on the video screen as each board is being processed. The third option provides parts summary information for all boards processed during the computer run.

Pieces Per Clear Primary Section. — A clear primary section is a clear section between defects in one of the ripped strips resulting from the gang ripping of the board. If random length pieces are to be cut from the board, the "Pieces Per Clear Primary Section" has no effect and should be set to 1. However, if pieces are to be cut to specified lengths, the user must enter from 1 to 10 desired part lengths as discussed below.

If the "one piece per clear primary section" option is selected, the program will crosscut the longest possible designated part length from the clear primary section. This is illustrated in the graphic representation for run No. 1 (Fig. 1).

If the "two pieces per clear primary section" option is selected, the program will replace the longest single part with two shorter designated part lengths if the sum of their surface area yields is greater than that of the longest single part. This is illustrated in the upper left clear primary section of run No. 2 (Fig. 1).

If the "three pieces per clear primary section" option is selected, the program will cut from one to three of the designated part lengths from the clear primary section depending on which provides the greatest surface area yield. This is illustrated in the upper left clear primary section of run No. 3 (Fig. 1).

If a clear primary section is equal to or greater than 2 times the longest designated part length, GR-1ST will always cut as many of the longest length as possible and then cut the next shorter designated part length that can be cut from the remaining part of the section.

Printer Output

The major portion of the GR-1ST output is sent directly to the printer as it is produced. This eliminates data storage problems that might occur if all of the outputs were sent to the hard disk or a floppy diskette. This is especially true when processing a large number of boards through the program. The output includes: (1) computer run options; (2) yield information for individual boards; (3) printer plots of the boards, defects, saw cuts, and resulting parts; and (4) parts yield summaries for boards processed during an individual computer run.

Run Options (Fig. 3) — Regardless of the output options selected by the user, this page is always printed. Figure 3 shows the run options as they have been set up for the particular computer run.

The example shows that only one piece per clear primary section was called for and the parts were to be of specified lengths (15, 21, 35, 40, and 55 inches). If random part lengths had been specified, a minimum length and a maximum length would have been printed instead of the specified lengths.

Next, the output shows specified part widths. Here only one width (2.00 inches) was specified. Following the part widths specifications, the output shows the specified minimum width for salvage parts, 1 inch.

Then, the example shows that the boards are to be edged by 1/4 inch on each edge before being processed into parts. If the answer had been "No" to the board edged question, the edging trim allowance line would not have been shown in the output.

Finally, the output shows that the run was to evaluate a gang saw with an arbor with equally spaced saws plus a movable outer saw. The movable saw was toward the right fence, and the width limit for the adjustment decisions was 1.00 inch. If the run had been to evaluate a variable arbor saw, the last three lines would not be shown in the output. And, if the run had been to evaluate a standard fixed arbor saw, the last three lines would have been replaced by a line showing the order of saw spacings starting at the right fence.

Also note that if the user selects the output option for having only the parts yield summary tables printed out, a list of the board numbers that were processed during the run will be printed after the above information.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).....1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM).....0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00   .00   .00   .00   .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..... 2.00   .00   .00
MINIMUM WIDTH FOR SALVAGE PARTS..... 1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N).....Y
     EDGING TRIM IN 1/4 INCHES.....1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE).....2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
        (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).....2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..... 1.00
```

Figure 3. — GR-1ST output showing run options for a computer run.

```
GRADE   2CP          BOARD NUMBER     25          TOTAL NUMBER OF DEFECTS  30

  LENGTH =  96.50  WIDTH =   8.25

PRIMARY PARTS
             35.00    X  1.25
             15.00    X  1.25
             21.00    X  2.00
             21.00    X  2.00
             21.00    X  2.00
             21.00    X  2.00
             21.00    X  2.00
             40.00    X  2.00
             40.00    X  2.00
    SURFACE AREA = 457.50
         % YIELD =  57.47

SALVAGE PARTS
             21.00    X  1.00
    SURFACE AREA =  21.00
         % YIELD =   2.64

              BOARD AREA  =     796.13  SQ.IN.
               TOTAL YIELD =     60.10  PERCENT


CUMULATIVE TOTAL PRIMARY PARTS SURFACE AREA YIELD ...    457.50
CUMULATIVE TOTAL SALVAGE PARTS SURFACE AREA YIELD ...     21.00
CUMULATIVE TOTAL BOARD SURFACE AREA ..............       796.13
CUMULATIVE TOTAL PARTS YIELD (PERCENT OF BOARDS) .....  60.10

CUMULATIVE TOTAL WIDTH OF PARTS BY LENGTH

       PRIMARY PARTS                    SALVAGE PARTS
   LENGTH          TOTAL          LENGTH          TOTAL
   15.00            1.25          15.00             .00
   21.00           10.00          21.00            1.00
   35.00             .00          35.00             .00
   40.00            4.00          40.00             .00
   55.00            1.25          55.00             .00
     .00             .00            .00             .00
     .00             .00            .00             .00
     .00             .00            .00             .00
     .00             .00            .00             .00
     .00             .00            .00             .00
```

Figure 4 — GR-1ST output showing yield information for an individual board.

Yield Information for Individual Boards (Fig. 4) — If the yield information for each individual board option is selected, the information shown in Figure 4 will be printed for each board processed during the computer run. This information starts with the board lumber grade, board number, total number of defects in the board, board length in inches, and board width in inches.

Next, for the primary parts, the output provides the length and width, in inches, for each primary part, plus the total surface area in square inches, and percent yield of primary parts. This percent yield is based on the percentage of total parts surface area compared to the total surface area of the board. The same information for the salvage parts follows the primary parts output.

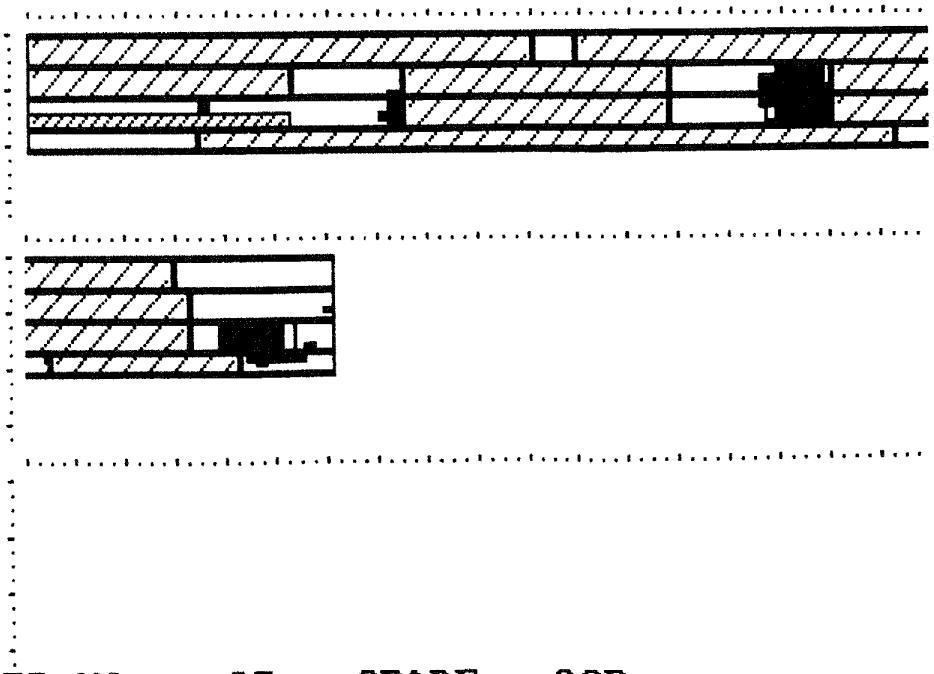
Next, the output provides the total board surface area in square inches along with total yield in percent of the total board surface area of both primary and salvage parts.

Finally, the output provides cumulative information for a number of factors for the processing of all boards up to and including the board for which the output is being printed. This information includes cumulative totals for primary parts surface area yield, salvage parts surface area yields, board surface area, parts yields as a percentage of total board surface area, and width of parts by length for both primary and salvage parts.

Note that since the output in Figure 4 represents a computer run on only one board, the cumulative values represent only information for that one board. Also, the last part of the output, cumulative total width of parts by length for both primary and salvage parts, will not be printed if the random length option is used in making the GR-1ST run. When the random length option is used, many different part lengths are produced and printing the cumulative total widths for all of the part lengths would not be beneficial.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).................1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM)..................0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00   .00   .00   .00   .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..................... 2.00  1.25   .00
MINIMUM WIDTH FOR SALVAGE PARTS..................................... 1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N)...................................Y
     EDGING TRIM IN 1/4 INCHES..........................................1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE).........2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
          (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).......2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..................... 1.00
```



BOARD NO. = 25 GRADE = 2CP

Figure 5 — GR-1ST output showing the printer plot of a board and its defects along with the resulting saw cuts and parts produced.

Printer Plot of Individual Boards (Fig. 5) — When the printer plot option is selected, the printer provides a graphic representation of each board including its outline, defects, saw kerfs, and resulting parts. As shown in Figure 5, the run options that were printed on the first page of the output (Fig. 3) are repeated together with the graphic representation of the board. This assures which run options were used to produce the results in the plot.

The plot of the board follows the run options. It is plotted in 6-foot sections — the first or top plot is the left-hand section of the board. Each mark on both the X-axis and the Y-axis represents 1 inch. The wide crosshatches represent primary parts and the narrow crosshatches represent the salvage parts.

If you compare the run options from Figure 3 with the run options from Figure 5, you will find that the widths for primary parts differ. The original run options show only one width of 2.00 inches. As stated earlier, when making a run using equally spaced saws with a movable outer blade, only one width can be used. However, if you look at the widths for primary parts shown above the plot, you will see that a width of 1.25 inches has been added. When using the movable blade option, the width of the last strip will always be added to the primary widths. And any part in this last strip that meets this width will be included as a primary part. Notice in the plot of the board, such parts are crosshatched as primary parts. The decision was made to call these parts primary instead of salvage because the user controls their widths by entering the width limit for adjusting the floating blade to produce them.

In all processing options other than the floating blade option, if a gang-ripped-strip does not meet one of the primary part widths, any part cut from that strip is considered a salvage part and will be tallied and plotted as such.

Parts Yield Summary Tables — If the parts yield summary tables option is selected, six summary tables are printed. As with the printer plot option, the run options printed in Figure 3 are printed above each table to assure which run options were used to produce the tables. An example of each table follows.

Figure 6 shows the total surface area yields and percentages of total surface area yield of all parts (primary and secondary) by part length and width for the board or group of boards processed during the run.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).................1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM)...................0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00   .00   .00   .00   .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..................... 2.00   .00   .00
MINIMUM WIDTH FOR SALVAGE PARTS..................................... 1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N).....................................Y
     EDGING TRIM IN 1/4 INCHES.....................................1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE)..........2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
          (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).......2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..................... 1.00
```

****

SURFACE AREA YIELD OF PARTS (ALL PARTS)

(SURFACE AREA & PERCENT BY LENGTH AND WIDTH)

****

	WIDTH										
LG	1.00	1.25	2.00	.00	.00	.00	.00	.00	.00	.00	TOTAL
15	0.	19.	0.	0.	0.	0.	0.	0.	0.	0.	19.
	.00	3.92	.00	.00	.00	.00	.00	.00	.00	.00	3.92
21	21.	0.	210.	0.	0.	0.	0.	0.	0.	0.	231.
	4.39	.00	43.89	.00	.00	.00	.00	.00	.00	.00	48.28
40	0.	0.	160.	0.	0.	0.	0.	0.	0.	0.	160.
	.00	.00	33.44	.00	.00	.00	.00	.00	.00	.00	33.44
55	0.	69.	0.	0.	0.	0.	0.	0.	0.	0.	69.
	.00	14.37	.00	.00	.00	.00	.00	.00	.00	.00	14.37
TOT	21.	88.	370.	0.	0.	0.	0.	0.	0.	0.	479.
	4.39	18.29	77.32	.00	.00	.00	.00	.00	.00	.00	100.00

Figure 6 — GR-1ST output showing surface area yield of parts (all) by length and width.

Figure 7 shows the total primary surface area yields and percentages of total primary surface area yield of primary parts by part length and width for the board or group of boards processed during the run. At the top of the table, it also shows the percentage of total primary surface area yield in relation to the total surface area yield.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).....................1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM).....................0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00   .00   .00   .00   .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..........................  2.00   .00   .00
MINIMUM WIDTH FOR SALVAGE PARTS.......................................  1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N).....................................Y
     EDGING TRIM IN 1/4 INCHES.............................................1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE).............2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
          (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).......2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..................... 1.00
```

****

SURFACE AREA YIELD OF PARTS (PRIMARY PARTS)
95.61 PERCENT OF TOTAL YIELD
(SURFACE AREA & PERCENT BY LENGTH AND WIDTH)

****

	WIDTH										
LG	1.00	1.25	2.00	.00	.00	.00	.00	.00	.00	.00	TOTAL
15	0.	19.	0.	0.	0.	0.	0.	0.	0.	0.	19.
	.00	4.10	.00	.00	.00	.00	.00	.00	.00	.00	4.10
21	0.	0.	210.	0.	0.	0.	0.	0.	0.	0.	210.
	.00	.00	45.90	.00	.00	.00	.00	.00	.00	.00	45.90
40	0.	0.	160.	0.	0.	0.	0.	0.	0.	0.	160.
	.00	.00	34.97	.00	.00	.00	.00	.00	.00	.00	34.97
55	0.	69.	0.	0.	0.	0.	0.	0.	0.	0.	69.
	.00	15.03	.00	.00	.00	.00	.00	.00	.00	.00	15.03
TOT	0.	88.	370.	0.	0.	0.	0.	0.	0.	0.	458.
	.00	19.13	80.87	.00	.00	.00	.00	.00	.00	.00	100.00

Figure 7 — GR-1ST output showing surface area yield of parts (primary) by length and width.

Figure 8 shows the total salvage surface area yields and percentages of total salvage surface area yield of salvage parts by part length and width for the board or group of boards processed during the run. At the top of the table, it also shows the percentage of total salvage surface area yield in relation to the total surface area yield.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).................1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM)..................0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00   .00   .00   .00   .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..................... 2.00   .00   .00
MINIMUM WIDTH FOR SALVAGE PARTS..................................... 1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N)...................................Y
     EDGING TRIM IN 1/4 INCHES..........................................1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE)..........2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
          (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).......2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..................... 1.00
```

****

SURFACE AREA YIELD OF PARTS (SALVAGE PARTS)
4.39 PERCENT OF TOTAL YIELD
(SURFACE AREA & PERCENT BY LENGTH AND WIDTH)

****

	WIDTH										
LG	1.00	1.25	2.00	.00	.00	.00	.00	.00	.00	.00	TOTAL
15	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00
21	21. 100.00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	21. 100.00
40	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00
55	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00
TOT	21. 100.00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	0. .00	21. 100.00

Figure 8 — GR-1ST output showing surface area yield of parts (salvage) by length and width.

Figure 9 shows the number of all parts (primary and salvage) produced and percentages of total parts produced by part length and width for the board or group of boards processed during the run.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).................1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM)..................0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00    .00    .00    .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..................... 2.00    .00    .00
MINIMUM WIDTH FOR SALVAGE PARTS..................................... 1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N).....................................Y
     EDGING TRIM IN 1/4 INCHES.....................................1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE)..........2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
          (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).......2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..................... 1.00
```

****

NUMBER OF PARTS PRODUCED (ALL)

(NUMBER & PERCENT BY LENGTH AND WIDTH)

****

	WIDTH										
LG	1.00	1.25	2.00	.00	.00	.00	.00	.00	.00	.00	TOTAL
15	0	1	0	0	0	0	0	0	0	0	1
	.00	10.00	.00	.00	.00	.00	.00	.00	.00	.00	10.00
21	1	0	5	0	0	0	0	0	0	0	6
	10.00	.00	50.00	.00	.00	.00	.00	.00	.00	.00	60.00
40	0	0	2	0	0	0	0	0	0	0	2
	.00	.00	20.00	.00	.00	.00	.00	.00	.00	.00	20.00
55	0	1	0	0	0	0	0	0	0	0	1
	.00	10.00	.00	.00	.00	.00	.00	.00	.00	.00	10.00
TOT	1	2	7	0	0	0	0	0	0	0	10
	10.00	20.00	70.00	.00	.00	.00	.00	.00	.00	.00	100.00

Figure 9 — GR-1ST output showing the number of parts produced (all) by part length and width.

Figure 10 shows the number of primary parts produced and percentages of total primary parts produced by part length and width for the board or group of boards processed during the run. At the top of the table, it also shows the percentage of total primary parts produced in relation to the total number of parts produced.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).................1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM)...................0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00   .00   .00   .00   .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..................... 2.00   .00   .00
MINIMUM WIDTH FOR SALVAGE PARTS..................................... 1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N)...................................Y
     EDGING TRIM IN 1/4 INCHES..........................................1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE)...........2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
          (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).......2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..................... 1.00
```

****

NUMBER OF PARTS PRODUCED (PRIMARY)
90.00 PERCENT OF TOTAL PARTS
(NUMBER & PERCENT BY LENGTH AND WIDTH)

****

	WIDTH										
LG	1.00	1.25	2.00	.00	.00	.00	.00	.00	.00	.00	TOTAL
15	0	1	0	0	0	0	0	0	0	0	1
	.00	11.11	.00	.00	.00	.00	.00	.00	.00	.00	11.11
21	0	0	5	0	0	0	0	0	0	0	5
	.00	.00	55.56	.00	.00	.00	.00	.00	.00	.00	55.56
40	0	0	2	0	0	0	0	0	0	0	2
	.00	.00	22.22	.00	.00	.00	.00	.00	.00	.00	22.22
55	0	1	0	0	0	0	0	0	0	0	1
	.00	11.11	.00	.00	.00	.00	.00	.00	.00	.00	11.11
TOT	0	2	7	0	0	0	0	0	0	0	9
	.00	22.22	77.78	.00	.00	.00	.00	.00	.00	.00	100.00

Figure 10 — GR-1ST output showing the number of parts produced (primary) by part length and width.

Figure 11 shows the number of salvage parts produced and percentages of total salvage parts produced by part length and width for the board or group of boards processed during the run. At the top of the table, it also shows the percentage of total salvage parts produced in relation to the total number of parts produced.

GR-1ST

```
NUMBER OF PIECES PER CLEAR PRIMARY SECTION (1, 2, OR 3).................1
PART LENGTH DETERMINATION (0 = SPECIFIED ; 1 = RANDOM)...................0
PART LENGTHS.. 15.00 21.00 35.00 40.00 55.00   .00   .00   .00   .00   .00
WIDTHS FOR PRIMARY PARTS (MAX. 3)..................... 2.00   .00   .00
MINIMUM WIDTH FOR SALVAGE PARTS..................................... 1.00
BOARDS TO BE EDGED (BOTH EDGES) (Y/N).....................................Y
     EDGING TRIM IN 1/4 INCHES.............................................1
ARBOR TYPE: (0 = VARIABLE; 1 = FIXED; 2 = MOVABLE OUTER BLADE)...........2
CODE FOR ADJUSTING WIDTH OF LAST STRIP:
          (1 = TOWARD LEFT FENCE ; 2 = TOWARD RIGHT FENCE).......2
     WIDTH LIMIT FOR ADJUSTMENT DECISION (IN.)..................... 1.00

*****************************************************************************
                    NUMBER OF PARTS PRODUCED (SALVAGE)
                       10.00 PERCENT OF TOTAL PARTS
                    (NUMBER & PERCENT BY LENGTH AND WIDTH)
*****************************************************************************
                                        WIDTH
LG | 1.00   1.25   2.00    .00    .00    .00    .00    .00    .00    .00 | TOTAL
---+------+------+------+------+------+------+------+------+------+------+------
15 |     0      0      0      0      0      0      0      0      0      0|     0
   |   .00    .00    .00    .00    .00    .00    .00    .00    .00    .00|   .00
---+------+------+------+------+------+------+------+------+------+------+------
21 |     1      0      0      0      0      0      0      0      0      0|     1
   |100.00    .00    .00    .00    .00    .00    .00    .00    .00    .00|100.00
---+------+------+------+------+------+------+------+------+------+------+------
40 |     0      0      0      0      0      0      0      0      0      0|     0
   |   .00    .00    .00    .00    .00    .00    .00    .00    .00    .00|   .00
---+------+------+------+------+------+------+------+------+------+------+------
55 |     0      0      0      0      0      0      0      0      0      0|     0
   |   .00    .00    .00    .00    .00    .00    .00    .00    .00    .00|   .00
---+------+------+------+------+------+------+------+------+------+------+------
TOT|     1      0      0      0      0      0      0      0      0      0|     1
   |100.00    .00    .00    .00    .00    .00    .00    .00    .00    .00|100.00
```

Figure 11 — GR-1ST output showing the number of parts produced (salvage) by part length and width.

Disk Output

During a GR-1ST run, two output data files are sent directly to either a hard disk or a floppy diskette. These files are provided to allow the user to obtain plots of the processed boards on a pen plotter if needed and to further analyze the parts produced from a group of boards if required. The information in the files represents the results from the last GR-1ST run. They are erased at the beginning of each new run. If these files are to be used at a later date, they must be renamed before the next GR-1ST run.

When processing a large number of boards during a given computer run, it may be necessary to send these data files to a hard disk instead of to a floppy diskette. A floppy diskette may not have enough space to hold the files. The size of the files depends on the number of boards being processed, the number of defects in the boards, and the number of primary and salvage parts produced. Therefore, when processing a large number of boards, we recommend that the files be sent to a hard disk.

Board Plot Data File (PLOTD) — This file contains all of the information necessary to plot the boards and their defects along with the saw cuts and parts produced by the computer processing of the boards. For each board processed, the file contains: (1) board grade, (2) board identification number, (3) number of defects, (4) X and Y coordinate information found in the board defect data file used to describe the board and its defects, (5) X and Y coordinates for the saw cuts resulting from the computer cut up of the board, and (6) X and Y coordinates for both the primary and salvage parts cut from the board. All of the coordinates in the file are in 1/4-inch increments.

Output Parts Data File (SAS) — This file contains data that can be sent to a computer statistical package to provide additional statistical information for analyzing the parts produced from a group of boards during a GR-1ST run. For each board it contains: (1) length and width of the board, (2) length and width of each primary part produced, and (3) length and width of each salvage part produced. All of the lengths and widths in the file are in inches.

Discussion

The GR-1ST program provides optimum solutions for user selected gang-rip-first board cut-up procedures. Other than computer hardware and a DOS operating system, all that is needed to use the system is a copy of the GR-1ST program and a board defect data file. A copy of the program and a 10 board defect data file are available upon request by contacting one of the authors at:

USDA Forest Service
Forestry Sciences Laboratory
Route 2, Box 562-B
Princeton, WV 24740

Phone: (304) 425-8106
FAX: (304) 425-1476

"GR-1ST User's Manual: For Running a Gang-Rip-First Board Cut-Up Procedure Program"[3] will be provided with the program to aid in its use. This manual takes the user through step-by-step procedures for evaluating different gang-rip-first situations. An individual who has read this paper and follows the instructions in the user's manual should have no problems using the GR-1ST system.

Acknowledgements

GR-1ST is the result of conceptual input from Charles Gatchell, who developed a research program on gang ripping of low-grade hardwoods when he was Project Leader of the Low-Grade Hardwood Utilization Research Work Unit. The authors wish to thank him for his suggestions in the development and validation of this program and for making available a 10 board sample of digitized data for demonstrating the program.

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

As the price of the better grades (Firsts & Seconds and Selects) of lumber continues to climb, many furniture and cabinet manufacturers have begun to process parts from No. 1 and No. 2 Common lumber. However, getting the optimum parts yield from these lower grades of lumber is difficult when using the traditional crosscut-first procedure. A gang-rip-first procedure is one solution to this problem, and a microcomputer program called GR-1ST (gang-rip-first) is now available.

Keywords: Computer software, lumber, rip sawing

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