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VENEER RECOVERY PREDICTION AND ANALYSIS THROUGH COMPUTER SIMULATION[1]

Larry R. Tobin and *James S. Bethel*
College of Forest Resources, University of Washington,
Seattle, Washington 98105

ABSTRACT

An analytical procedure was developed which features the use of a simulation model in the analysis of grade recovery and yield in the production of rotary cut veneer. This analytical method differs from previous efforts in this field in that it permits simultaneous analysis for several veneer grades under a set of priorities built into the program.

A technique was developed for transferring green veneer characteristic data from photographs to digital form, using electronic equipment to allow rapid and accurate data collection. Data were recorded in X-Y coordinates and stored on magnetic tape compatible to available electronic computer systems.

A computer program was subsequently developed to predict veneer recovery in two, three, or four grades simultaneously, using the veneer characteristic data on tape as input. Three major variables in the veneer production operation—grade requirements, sheet widths, and clipping specifications—can be manipulated. This feature allows evaluation of effects on veneer yield of changes in these variables by simply reprocessing the same basic data under different sets of conditions. Results of several trial runs, using a number of combinations of variable conditions, are included to demonstrate several possible applications of the program.

The process of manufacturing rotary cut veneer involves the conversion of a log to a thin sheet of wood and the disassembly of this sheet into groups based upon quality specifications. These veneer components are generally produced for eventual reassembly into plywood or laminated structures. The economic feasibility of the operation depends to a very large degree upon the extent of recovery of usable materials from the primary breakdown. Since the blocks are subject to the usual variability typical of materials of biological origin, the manufacturing operation differs from one log to another and usually involves many rapid judgments concerning grades and sizes. The factory workman must perform in accordance with very general instructions. The quality of instructions and the ability of the operating employee to comply with these orders have a major bearing on the recovery of usable veneer, the value of the recovered material, and the cost of the operation.

The principal control mechanism available to the veneer manufacturer has generally been the traditional yield study, in which blocks are converted to veneer according to the relevant specifications, and

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the output is then classified and measured. This procedure has at least two limitations: 1) it is difficult to determine whether the operating instructions have been carefully followed; and 2) it is impossible to reconstitute the block and rerun the conversion on the same material. These limitations make it difficult to compare alternative methods of processing, to separate quality control problems from specification problems, and to utilize data collected in the course of a yield study to evaluate other operation criteria on a comparative basis at a later date.

For example, it may be feasible to evaluate yield of veneer in terms of a current grade specification and set of clipping instructions given to the machine operator. If the grade specifications and/or the clipping instructions are later changed, a new yield study is required. Comparison of the two studies becomes, at least in part, a function of the comparability of the quality of blocks in the two studies. It is also a function of the skill with which the clipper operators comply with manufacturing instructions in each case.

In traditional grade recovery study, the mill must necessarily hold constant production variables such as grade requirements and clipping specifications, at least with respect to a given set of blocks. A group of blocks can be processed under only one set of operating conditions; no opportunity exists for quantitative evaluation of probable effects of changes in production variables on the grade recovery from that same group of blocks. Results of studies of this type thus represent recovery that is currently available under existing conditions. Changes in log grade mix, log grading rules, veneer grade requirements, desired veneer grade mix, or clip specifications may lend uncertainty to the validity of the results. Also, no accurate bases exist for anticipating potential effects of contemplated changes in any of the above variables under this type of grade recovery study.

Over time, recovery data may also be rendered obsolete through the operation of factors beyond the immediate control of the manufacturer. Commercial product standards for plywood are changed periodically, as are log grades. In addition, the over-all quality of logs, at least in the Pacific Northwest, is constantly declining, and most mills are continually being forced to utilize logs of lower quality. These environmental factors, plus an expanding technology, may tend over time to limit the usefulness of information derived in the usual grade recovery study.

The use of a simulation procedure for the conduct of yield studies has the potential of solving some of these problems. In this approach, the basic characteristics of the veneer from the log or block may be defined with respect to kind, size, and location; permanently recorded so that the veneer can be figuratively clipped according to any particular specification or operating instruction; and the yield calculated according to the grade classifications of interest. The same veneer can then be restudied an infinite number of times with different product quality specifications and manufacturing criteria. The differences in yield are then presumably a function of the differences in specifications and manufacturing criteria. The influence of between-run log quality variation can be eliminated.

There are a number of advantages that can be ascribed to this method of yield study. Among these are:

1. Since the same basic data can be used as input an unlimited number of times, repetitive costly collections of field data on veneer quality can be eliminated or reduced to a minimum once a basic data bank on veneer quality has been established for a given species.
2. If a suitable simulation program can be developed for a particular manufacturing process, changes in grade specifications and/or operating procedures can be evaluated prior to initiating them in the factory. These evaluations can be in terms of product yield or operating costs or both.
3. Proposed changes in the basic manufacturing process, for example in equipment, can be evaluated via modifications in the simulation program. These changes can be instituted in the simulation program

prior to the installation of the changes themselves, and indeed they may be utilized as a basis for deciding whether the change should be made at all.

4. Actual in-plant yield and associated costs can be sampled and compared to theoretical yields and costs emanating from the simulation program as a quality control or production control procedure.

While these ideas have not been developed with respect to veneer production, they have been tested with reference to hardwood dimension production and shown to be practical. Efforts to devise methods wherein the same raw material can be re-evaluated under various combinations of production practices and requirements have been in evidence in the literature for at least two decades. The Timber Engineering Company (Anonymous 1950) in 1948 marked theoretical cuttings on hardwood boards and then evaluated potential yields of hardwood dimension stock under a variety of specified conditions by measuring and tallying the potential cuttings. Similar studies were reported for black walnut by White (1950) and for hard maple by Wylie (1950). Peter and Bamping (1962) reported on use of transparent templates containing various theoretical combinations of saw lines to study effects of sawing methods on the yield and value of lumber from Southern pine logs. Peter (1967) recently reported the use of the same procedure for the study of yellow poplar.

The first reported attempt at analytical evaluation of veneer recovery took place at North Carolina State University (Bethel and Hart 1960; Hart and Thomas 1962; Masachi 1956; Rand 1955; Yandle 1954). Part of this research involved the use of a clear acetate sheet ruled in one-inch squares to record the type and location of green veneer quality characteristics in terms of X-Y coordinates. Data generated through the use of this device were then used as input in a computer program designed to evaluate the potential veneer yields under six minimum cutting widths for a given set of grade requirements. It was not possible with this program, however, to evaluate the recovery for two or more grades simultaneously.

The same concept was employed in studies of dimension stock yield also conducted in North Carolina. Thomas (1962, 1965) reported the use of the acetate sheet recording method in conjunction with a computer program designed to simulate rough mill reduction operations. Dunmire and Englerth (1967, 1966) have refined the original data collection technique, by using a more rapid, but still hand operated, device for recording defect coordinates. They also report the use of another computer program, similar to that of Thomas, to obtain accurate information concerning the yield of dimension stock, in various sizes of cuttings, to be expected from hardwood factory grade lumber (Wodzinski and Hahn 1966). The same program has been adapted to an analysis of the effects of lumber edging practice on the yield of dimension stock from hard maple lumber in Canada (Flann, Lamb, and Nielson 1967).

These simulation studies related to hardwood dimension stock recovery suggest several advantages over conventional yield studies. Recording data permanently in a form directly compatible with computers allows re-evaluation of the same data any number of times under a variety of imposed theoretical conditions. Programs designed to simulate some stage of the production process in effect eliminate the operator variance factor, usually a largely unquantified source of variation. Parameters within the program can be changed to simulate changes in operator instructions, i.e., changes in requirements as to acceptability and size limitations for various types of defects, cutting sizes, and priorities for various combinations of these types of variables. Re-evaluation of the same data under changed conditions allows changes in recovery to be attributed solely to the effects of the changes made. Similarly, comparative evaluation of different logs or boards under the same set of conditions leads to conclusions based solely on log-to-log or board-to-board variation. Similar advantages should accrue from the application of these same principles to veneer recovery studies as compared to conventional methods. This project was designed to explore the validity of this thesis.

The project had two objectives:

1) to devise an improved method of generating a data bank of information on veneer quality;

2) to develop a simulation model that would be appropriate to the analysis of data from such a data bank.

The template overlay method of recording product characteristics used in earlier studies of veneer and lumber quality is time-consuming and limited with respect to precision. It involves several manual recordings and transfers of data, permitting the introduction of clerical error. Finally, once the initial quality record is made, it is impossible to check for recording error since the original product material must normally be disposed of immediately. Accordingly, it was decided that for the purpose of this study the immediate pick-up of information from the raw material would be accomplished through photographing the veneer to be studied. This procedure was adopted for several reasons. If it ultimately became desirable to generate large quantities of veneer quality information for a data bank, this could be accomplished by photographing green veneer directly behind the lathe with equipment mounted on the machinery. Since the amount of data required to test the validity of this simulation model was not large, the photographs used to generate input information in this study were actually obtained by collecting all of the veneer peeled from *four small Douglas fir blocks.* The veneer was clipped into 4 ft × 8 ft sheets without regard to quality characteristics, and each sheet was photographed in the laboratory on 35 mm color film developed in strip form. A sequential record of each photograph was maintained so that the total veneer output of each block could be figuratively reassembled for analysis. The photographic process was calibrated so that original dimensions could be computed when necessary. This procedure provided a permanent record of product characteristics for later information recording and recheck if required, and the bulky raw material was released for processing. Although the photography was conducted in the laboratory for the purpose of this study, work undertaken by the Pacific Northwest Forest and Range Experiment Station indicates that acceptable photographs for this purpose could be obtained behind the lathe without handling the material at all. While this study utilized a 100% sample of the veneer from the specimen blocks, the work of Yandle (1954) indicates that sampling for veneer quality is feasible. Sampling could be utilized in collecting data for a simulation model such as described here.

Transfer of quality characteristic data from photographs to computer-compatible input records was achieved through the use of the Benson-Lehner Digitizing System. This system permits the investigator to scan the photograph and record the quality information displayed in digital form directly onto magnetic tape for use in a computer.

The digitizing system consists essentially of the following components:

1) a transparent working surface and a precision projector for enlarging and displaying the photographic record of veneer quality;

2) an instrument for recording and accumulating digital data directly on magnetic tape.

In use, film images are projected onto the back of the working surface. A movable "cursor" is used to locate and record coordinates relative to an arbitrary zero coordinate. A keypack permits insertion of alphanumeric information whenever required.

To convert veneer quality characteristics to digital form, it was necessary to develop a classification which permitted these characteristics to be identified and differentiated with respect to type and size. Twelve separate categories of veneer defects were identified (first two columns of Table 1). The categories were designated to include all characteristics contained in the log at the time of delivery to the veneer lathe which might affect the grade of resulting

TABLE 1. *Grade specifications for grades A, B, C, and D*

Characteristics equal to or smaller than the size listed are permissible in the respective grades. "A" indicates all defects of this type permitted; "N" indicates none permitted. Sizes listed are in inches and all denote size across grain (a) unless noted (w) with grain.

		Grade			
Code	Defect	A	B	C	D
01	Knots (S & T)	N	1	1½	A
02	Knots (T but not S)	N	N	1½	A
03	Knotholes	N	N	1½	3
04	Pitch streaks	¾	1½	A	A
05	Pitch pockets	N	N	1	2½
06	Rough and torn grain	N	N	A	A
07	Borer holes, tunnels	N	1⁄16a 1w	⅝a 1½w	A
08	Other openings	⅛a ¼w	⅛a ¼w	A	A
09	White pocket	N	N	N	12
10	Other decay	N	N	N	2a 2w
11	Bark pockets	N	N	N	2a 2w
12	Stain, discoloration	A	A	A	A

veneer. The large number of defect categories was used because different types of defects are treated in different ways for grading purposes. Furthermore while various issues of the commercial standard were used to make judgments concerning defect categories, provision had to be made for the possibility of using the data to evaluate operations in terms of some future standard. Actually, if a large data bank were to be developed, it might be prudent to consider refinement to an even larger number of categories.

Information pick-up on the digitizing equipment involved identifying each individual defect, recording its coded category, and locating two (or four, depending on defect category) points on the periphery of the defect in coordinates. This input record provides sufficient information to enable the computer, properly programmed, to identify type, size, and relative location of each defect. Because the photographs for this study were in arbitrary units of 4 ft × 8 ft sheets of veneer, the analytical program contained an instruction to ignore existing dimensioning clips and to treat all veneer from a given block as an unbroken sheet. Roundup material was recorded in a separate category and could be included in yield analysis if required. For the purpose of this study it was treated as reject material.

Once techniques for the collection and recording of data had been devised, the next steps were to develop an appropriate simulation model and to test it. The model assumes that the sheet of veneer is subdivided into strips of veneer one inch wide (across grain). A one-inch strip is the smallest individual unit of veneer that is considered; all measurements and clip locations are made on the basis of whole inches. The amount of veneer downgraded is thus somewhat overstated, since clips will never be located at the next whole inch interval beyond the actual boundary of the defect, unless the defect boundary happens to coincide exactly with the edge of a one-inch strip. This effect can be seen in Fig. 1, where the amount of veneer downgraded for the tight knot and the smaller knothole is greater than the actual width of the defects. This is not true for the large knothole, which falls exactly between the edges of adjacent one-inch segments.

The across sheet strip was selected as a unit in recognition of the fact that veneer conversion practice involves subdividing the veneer sheet through cuts made completely across the sheet in a clipping operation. The model later assumes that the whole sheet of veneer being analyzed can be arranged in terms of sequential summations of one-inch units into second level size classes in terms of up to five classifications, based on veneer grades. A larger number of classifications could be selected for implementation of the model if desired.

The model recognizes that in practice a clipper operator is not instructed arbitrarily to clip a sheet of veneer into higher grades regardless of size. He normally does not clip out a one-inch strip of clear. If the width of a piece of high grade is too narrow for practical or economic use, it is left intact and combined with adjoining pieces to form

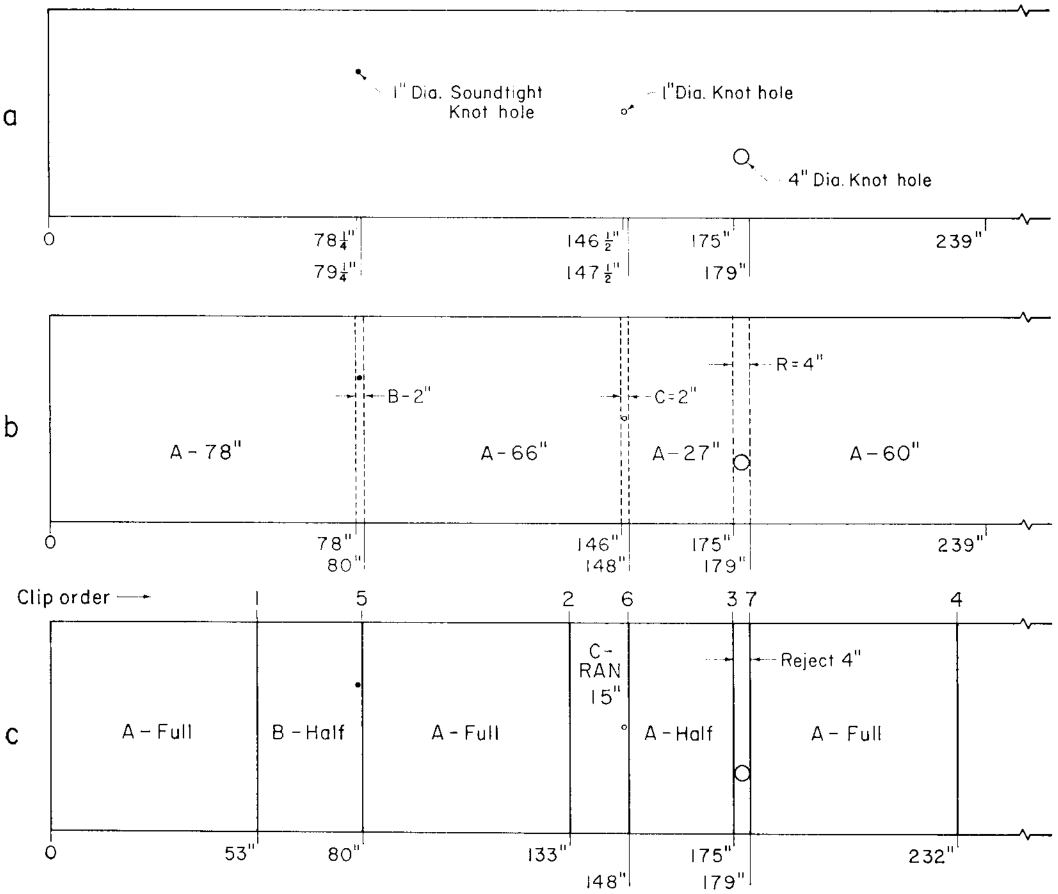

Fig. 1. Illustration of computer program method of "grading" and "clipping."

a piece of usable size although of lower grade. Accordingly, the model provides for the introduction of constraints in the form of clipping rules for minimum and desired size of clipped pieces. Also, the model recognizes the practice of clipping to multiples of whole sheet size when appropriate.

The model was programmed* in Fortran IV for the IBM 7040/7094 Direct Couple System. The program is designed to evaluate the recovery of veneer one block at a time under as many as four grades in a single pass. There was purposely no attempt made to model the program after any specific mill situation; rather it was intended that sufficient flexibility be built into the program to allow for adaptation to a given situation with a minimum of effort. In its basic form, the program evaluates recovery for A, B, C, and D grades [under current grading rules (Product Standards Section, National Bureau of Standards 1966), Table 1] plus reject, under a priority structure for full, half, and random sheets. Specific sheet width requirements can be readily changed, and a change in veneer grade requirements involves only a series of relatively simple modifications in one subroutine. The program can be used to evaluate any combination of up to four grades in its present form, these combinations not necessarily involving any or all of the A, B, C, or D grades used to test the model in

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[*] Copies of the source program, explanatory notes, and associated flow diagrams are available through the Institute of Forest Products, University of Washington.

this study. All of these points are illustrated in the discussion of trial runs.

Starting with the input data stored on tape, the computer is programmed to consider the effect of each recorded veneer characteristic on the potential grade of that portion of the veneer in which the defect is located. All veneer first is assumed to be of the highest grade under consideration. The type and size of each recorded characteristic is then compared to the requirements for the highest grade. If the defect is not acceptable in the highest grade, the section of veneer in which the defect is located is assigned the highest grade that will accept that particular defect. This process continues until all defects have been considered in the entire sheet from one block. The result of this process, completed in one subroutine, is a table showing the grade and width, in inches, of consecutive graded pieces for the entire sheet from one block. This table is then used in subsequent analysis to determine the optimum combination of clip locations under sheet widths and clipping specifications desired.

This process can be illustrated as in Fig. 1, which represents a hypothetical section of veneer with three defects at various stages of analysis. Part A of Fig. 1 illustrates the location and size of the defects. Under current grading rules (see Table 1), the knot is unacceptable in A grade but is allowed in B. The smaller knothole is unacceptable in any grade higher than C, and the larger knothole is unacceptable in any grade. Part B of Fig. 1 illustrates the section after it has been graded by the computer, and Part C shows the theoretical location of clips. For the purpose of this operation, all veneer is treated as though it were Grade A, and then the significance of each defect is analyzed and reflected in adjustments in the graded sheet.

Table 2 represents the grade-width table previously mentioned as appropriate to these hypothetical data.

In its present form the program instructs the computer to look for full sheets, half sheets, and random sheets in that order. Higher grades are always preferred to lower ones, and the computer attempts to recover the highest possible grade consistent with size constraints. The computer is instructed to consider, first of all, pieces accepted in the highest possible grade. It then moves sequentially through each succeeding lower grade until each graded section has been processed. If, for example, a given piece has been graded as A—the highest grade—and is greater than the minimum width for a full sheet, at least one full sheet will be clipped out. The remainder will be treated in one of a variety of possible ways, depending upon the grades and sizes of pieces following the one in question.

If the above piece, on the other hand, had been less in width than the minimum for full sheets, the computer would attempt to find a combination of this and adjoining pieces that would make a full sheet, even though the resulting grade would be lower. If it found no such combination, the computer would compare the piece in question to the minimum for half sheets and would either clip a half sheet of A, or, if the piece were too small, would attempt to find a combination large enough. Failing this, it would go through the same process for random size. Eventually, the piece in question would either be clipped as A grade or combined with an adjoining sheet with a lower grade. The computer would then move on to the next piece of A and eventually to the pieces of lower grade until the entire sheet had been clipped into some combination of the grades and sheet sizes specified.

Applying this procedure to the section of veneer in Fig. 1 would result in a series of seven clips and seven pieces of veneer with the grades indicated in Part C. To arrive at this point, the computer, using the specifications for trial run Number 1 in Table 2, would clip a full sheet of A from the first graded piece and then add the remainder to the adjoining piece of grade B. This combination would make a half sheet, which is preferred under the constraints specified, to the alternate random sheet of A and a small piece of reject. The same analysis would result in another full sheet

TABLE 2. *Grade-width table from Figure 1, Part b*

Grade	Width
A	78
B	2
A	66
C	2
A	27
R	4
A	60

of A and a random piece of C further along on the sheet. A half sheet of A would be clipped out ahead of the large knothole because the knothole must be rejected and a combination of the 27 inches of A and the preceding piece of C (now 15 inches) would not qualify for a full sheet. A full sheet would also be clipped from the piece following the large knothole.

In subsequent subroutines, the computer would consider A grade as above, and then proceed to clip out remaining pieces of each lower grade until finally all pieces including reject had been clipped as shown in Part C of Fig. 1. Results would then be summarized and prepared for final print out.

Output may consist of summarization tables showing simply the amount of veneer resulting in each sheet size of each grade expressed in total inches and in percent of total veneer in each individual block. If desired, however, output may be expanded easily to include the number of clips and the location of each, a table showing the exact sequence and location of pieces clipped out, and a series of tables indicating progress at various stages in the analytical procedure. With the latter tables, it is possible to trace the exact operations of the computer in grading and in processing the graded pieces.

To illustrate applications of the program in terms of a variety of grade specifications and subject to a variety of constraints, a series of trial runs were made on the data obtained from the four blocks. Results of seven runs are presented in Table 3. Figures in Table 3 were abstracted from more detailed outputs as described above. It is important to point out that the figures themselves have no meaning except to serve as illustrations that the program obtains different results when requirements are changed. No attempt has been made to attach significance to any of the results obtained; the sample of blocks was much too small for this type of evaluation, and they were not at all representative of the spectrum of log quality available for veneer production. The purpose here is merely to point out the flexibility of the model and some of the uses to which it might be adapted.

The basic grade requirements used in the trial runs are presented in Table 1. Some changes were made for various runs as noted below. An additional grade (D-Back) was established for Run No. 7, but this involved essentially an intermediate step between original grades C and D. The grades essentially follow current grading rules. No provision was made for the possibility of patching in this model, except for some cases under grade D, where other-

TABLE 3. *Grade, sheet size, and clip specifications for 7 trial runs*
Letters F, H, Q, R denote Full, Half, Quarter, and Random sheets, respectively.

Run	Grades	Grade req.	Min.	Clip
1	A, B, C, D	Std.	14″	FHR
2	A, B, C, D	Std.	7″	FHR
3	A, B, C, D	Std.	14″	FHQ
4	A, B, C, D	Std.	n.a.	FH only
5	A, B, C, D	Defects 1, 2, 3 more restrictive	14″	FHR
6	A, B, C, D	Defects 1, 2, 3 less restrictive	14″	FHR
7	B, C, DB, D	Std.	14″	FHR

TABLE 4. *Comparison of seven trial runs percent of total veneer—4 blocks*

Grade	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7
A	0	0.7	0	0	0	0.8	–
B	0.4	0.6	0.4	0	0.4	1.0	0.4
C	52.7	56.3	52.2	50.9	13.8	65.8	52.7
DB	–	–	–	–	–	–	17.5
D	22.0	21.3	21.0	18.1	59.3	7.0	4.5
R	24.9	20.9	26.4	31.0	26.5	25.3	24.9
Total usable	75.1	79.1	73.6	69.0	73.5	74.7	75.1
Number of clips	86	112	88	74	99	90	87

wise prohibitive defects were allowed if small enough to be potentially patched out. Provision of additional patching rules in the model would be entirely feasible.

The seven trial runs contained requirements as shown in Table 3. "Min." indicated minimum width for acceptable random pieces. The specifications under clip denote sheet sizes evaluated (F = Full, H = Half, Q = Quarter, R = Random). In all cases, full sheets required a minimum width of 53 inches, half sheets were set at 27 inches, and quarter sheets required 14 inches. The change made in Run No. 5 was simply to tighten knot and knothole size limitations for each grade by one-half inch. (For example, C grade permitted knots of only 1 inch instead of 1½ inches). The opposite was done in Run No. 6; requirements for knots and knotholes were eased by ½ inch. No changes were made in other defect requirements in these two runs.

The figures in Table 3 (expressed in percentages of total veneer in all four blocks, except for number of clips which are absolute) illustrate the effects of the changes made in the run specifications. Again the figures themselves have no real significance for other than illustrative purposes. No discussion of the figures themselves will be given, except to state that results in general appear to change in the direction expected when specifications for grades, sheet sizes, or clipping orders are changed. For example, comparisons can be made between Runs 1 and 2 (sheet size), Runs 1, 3, and 4 (clip order), Runs 1, 5, and 6 (defects 1, 2, and 3 size requirements), and Runs 1 and 7 (grade structure).

Another possible alternative that is not illustrated would be to use the same program for evaluation of only one, two, or three grades rather than four. This would require only minor changes in the program.

SUMMARY

The project was designed to develop feasible procedures for assembling a data bank of veneer quality and a simulation model which could be used to evaluate veneer grade recovery in terms of a variety of grade requirements and operating strategies. The use of photographs to accomplish initial pick-up and storage of material characteristics proved to be advantageous. The Benson-Lehner Digitizing System was adaptable to the task of efficiently converting veneer quality characteristics to digital input data for analysis. A model was developed which described the veneer production operation in terms of veneer grades and processing restrictions. The model was programmed for computer data processing and proved to be useful and adaptable to a variety of conditions.

Major advantages associated with the use of the Benson-Lehner system are the speed and accuracy with which data can be picked up and recorded. The same task can be performed manually, but time involved in collecting large quantities of data could be prohibitive, and opportunities for recording uncorrectable mistakes are greatly increased. Photographing veneer directly behind the lathe, as is proposed, would permit nondestructive sampling of material and would eliminate handling of the veneer. The permanent photographic record would permit redigitizing if it were ever necessary.

Advantages of digital data stored on tape are perhaps obvious. Data retrieval as frequently as is needed is relatively simple. If an adequate data bank of basic veneer quality information were developed, grade recovery studies and evaluation of changes in processing restrictions could be quickly evaluated without costly data collection.

The use of the simulation model for the prediction of veneer grade recovery allows reprocessing the same data under several combinations of controllable variables to evaluate the effects of those variables on resulting recovery. A second advantage of the simulation model approach is that variance in results due to the human element in the operation of machines can be ignored. Differences in grade recovery from logs processed under identical requirements and specifications can be attributed solely to log-to-log variation.

The program developed was intentionally not adapted to any specific mill situation. Consequently, some changes may have to be made in applying these techniques to a given situation. In particular, clipping priorities (order of clipping for different size sheets for the various grades) may have to be altered. Also, no allowance is presently made for such factors as clipping tolerances and grade fall down due to handling and transfer. The program predicts recovery on a green veneer basis; if dry veneer equivalents are desired, conversion factors will have to be developed. It has been shown that dry yield can accurately be predicted from green yield, at least for hardwoods (Henley, Woodfin, and Haskell 1963).

Other areas for further research are also indicated. Photographic techniques will have to be perfected if the concept of obtaining photos with equipment mounted on the peeling machinery is to be adopted. A rational sampling plan for photographing veneer would reduce the absolute amount of data needed for most purposes. Yandle (1954) developed a plan for a specific purpose several years ago, and his approach should be considered.

Potential applications of the techniques developed, with regard to production operations, include evaluation of veneer recovery as affected by: 1) changes in veneer grade requirements, sheet size requirements, and clipping specifications; 2) clipping orders; and 3) the make-up of log input. The program can be refined to follow exactly the specified clipping orders, whereas the clipper operator cannot consider all possible alternatives at normal operating speeds. In measuring the effects of changes in log input, it is possible to compare results from different log grades or mixes of grades processed under similar conditions. The simulation program offers a number of advantages over traditional recovery study procedures in this respect.

Other applications and extensions for techniques of this sort are conceivable. For example, studies of correlations between exterior log characteristics and interior wood quality might be facilitated by analysis procedures similar to those described.

The use of the simulation model as proposed would require the development of a large quantity of veneer quality data. The assembly of such a data bank would be expensive and might best be undertaken by a public agency or trade association, the results to be made available to the public or to member firms.

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Beginning with this issue, *Wood and Fiber* will publish abstracts of articles from appropriate foreign journals. These abstracts will not be printed in a separate section, as are Thesis Abstracts, but will be spaced throughout the journal at the ends of regular articles. Francis C. Beall, of Pennsylvania State University, is chairman of the committee responsible for these abstracts. Other members of the committee are: R. M. Kellogg, R. T. Lin, R. L. Ethington, Ali Moslemi, J. D. Wellons, E. G. King, D. D. Nicholas, J. D. Snodgrass, and Joe Yao.

In addition to members of the Editorial Board of *Wood and Fiber*, the following individuals have reviewed papers published in this issue:

E. T. Choong
G. L. Comstock
Lawrence Leney

L. J. Nemath
Darrel Nicholas
J. F. Siau