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Title: Green-end Veneer Recovery and Losses: A Detailed Study in Types and Volumes

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Previous studies have indicated that the largest loss associated with green veneer production occurs at the green veneer clipper. It has been reported that up to 26 percent of the block volume is lost during clipping. However, because of today's processing sophistication, this value is no longer considered current nor was it determined by direct measurement. Therefore, no conclusions could be drawn regarding the overall accuracy of the clipping operation. This project involved the development of a direct measurement technique, whereby the veneer on the downstream side of the clipper was photographed during the peeling and clipping operation. The resulting film images were digitized in the laboratory. Six hundred Douglas-fir (Pseudotsuga menziesii) peeler blocks in four diameter classes ranging on the small end from 10.00 to 29.99 in. were obtained from five Pacific Northwest mills for this study. All veneer volumes and resulting recovery values are reported. That component normally designated as trash was partitioned into distinct components and quantified. The green-end performance was further analyzed to determine the amount of potentially

recoverable material presently being lost in the clipping stage.

The merchantable veneer recovered at the five mills, ranged from 65 percent to 82 percent of the total block volume with veneer recovery factors ranging from 3.49 to 4.27. The average total mill loss at the clipper ranged from five percent to ten percent of the total block volume. Merchantable veneer volumes could potentially be improved anywhere from 1.5 percent to four percent at the clipper. This information could be useful to clipper and scanner manufacturers as well as being of interest to mill management to serve as a reference base regarding the potential for recovery improvement at the green-end.

Green-end Veneer Recovery and Losses: A Detailed Study in Types and Volumes

by

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◆ *This thesis is dedicated ...*

...to my patient and truly understanding wife, Louise, for her continuous support of my efforts and unfailing love, without which the attainment of this goal would have been impossible; and

...to my parents, who have awaited this date so understandingly, so patiently, and for so very long.

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I. INTRODUCTION

Today, more than ever before in its history, the forest products industry is being challenged to more efficiently utilize the nation's limited timber resources. This challenge originates from three fronts.

1. There exists a continuing decline in timber harvest levels [1,2,3]. This immediate problem is compounded further by the fact that recent studies have concluded that the Western timber regions may experience a timber shortfall by the year 2000 [2,4,5,6]. The present shortages and those expected in the near future will constitute not only losses in total volumes harvested but also in log quality and log mix [7,8]. Even if more intense forest management practices are implemented, not only must the industry await economic maturity, indications are that even that effort will not substantially diminish the suggested timber shortfall [1,5,6]. To further compound the problem, competing land use is continuing to reduce the amount of land available for growing tomorrow's forests.

2. There exist moderate but steadily increasing demands for housing and its attendant need for wood-based building materials [9,10,11,12]. The prospective long-run population growth, economic activity and income suggest that the demand for wood products will probably continue into the next century [9,10].

3. There exists a continual increase in stumpage prices at rates substantially faster than the revenues received from the veneer produced (see Fig. 1). The long-run outlook is for increasing competition for the available timber and its concomitant increases

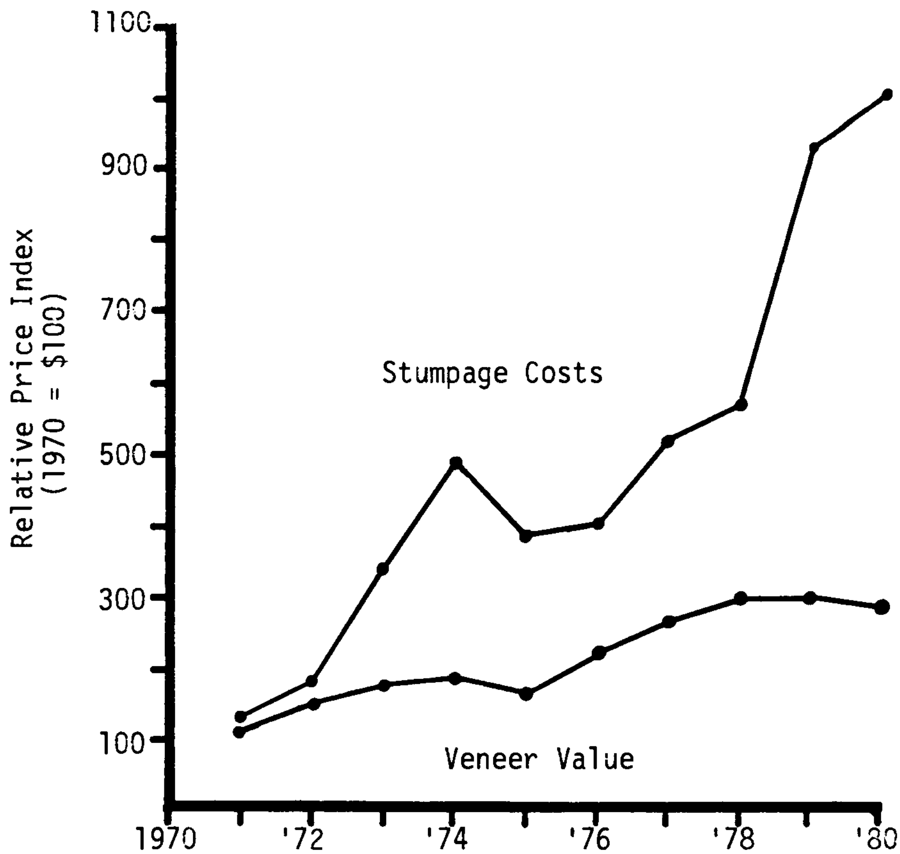

Figure 1. Stumpage costs increasing faster than veneer revenues received.

for stumpage and timber products. To the producer, this translates into a more restrictive economic situation. The production facility is forced to function in an increasingly narrow operating margin. This unique economic event most profoundly affects plywood and lumber operations far more than any other segment of the industry where only about 50 percent of the raw material is actually converted into finished products [14,15,16]. This is also an industry in which raw material costs represent 70 to 80 percent of the total production costs [14,17].

According to Phelps [2], there are three possibilities for solving the problem of timber shortage. These are:

1. increasing the volume of net imports,
2. growing more timber in domestic forests, and
3. improved utilization of timber presently harvested.

Only in the latter possibility will improvements provide immediate as well as long-term economic gains. Substantial profit improvements can be mediated by reducing the "effective" material costs through more refined processing techniques. Maximizing efforts at this particular leverage point can move a processing facility out of an average or sub-average operating climate and into a more profitable position within the market. Therefore, because of the high cost of raw materials, recovery is the most critical parameter that a mill manager controls. It should be noted that recovery may be in terms of either maximizing wood material or maximizing profit. This paper does not address grade considerations; hence, the recovery values discussed here are in terms of a strategy to maximize wood volume only.

However, to make a desired change for the better, an organization must know the current operating status of the facility. It is only then that improvement strategies may be properly planned and subsequently implemented. It is essential to determine how effectively or ineffectively the process is operating.

In its most rudimentary form, a recovery analysis of the green-end requires only two easily obtained values: the incoming net block volume of a set number of blocks and a measure of the merchantable veneer peeled from that unit of blocks. This may be carried out on a Scribner or a cubic volume basis. The net block scale is obtained either from an individual scaling the blocks or from the X-Y charger print-out in terms of board foot (Scribner) scale. The volume of merchantable veneer is obtained by measuring the height, in inches, of the material in each of the veneer pull carts (the fulls, halves, randoms and trimmed fish-tails) and converting to a square foot (3/8") basis. The veneer volume may also be obtained directly from some veneer clipper scanners. From these two production values a Veneer Recovery Factor can be calculated.

$$\text{Veneer Recovery Factor (VRF)} = \frac{\text{sq. ft. (3/8" basis) of merchantable veneer}}{\text{net bd. ft. (Scribner) block scale}}$$

This veneer recovery factor (henceforth to be indicated simply as VRF) is employed throughout the industry. However, it represents only an approximation of the merchantable veneer to block volume ratio. It is an approximation mainly because of the inherent inadequacies in the Scribner scale. The Scribner scale substantially under estimates true volume of small diameter logs and additionally is not considered adequate because:

1. It is not an exact measurement but was meant only as an estimate of block volume by its originator.
2. It does not consider volumes outside the scaling cylinder.
3. It assumes all logs are sawed into one-inch boards with a specified 1/4" kerf and therefore does not address the peeling operation.
4. These estimates are based on nominal rather than actual dimensions.
5. It does not consider residue by-products.

Overall, it is not an adequate measure of wood fiber and for that reason, is inappropriate in today's forest products industry [18,19]. The use of a cubic based measure would more accurately describe the incoming block volume and therefore provide a better indicator of processing ability.

$$\text{Cubic Recovery Ratio (CRR)} = \frac{\text{cu. ft. of merchantable veneer}}{\text{cu. ft. of block scale}}$$

The cubic recovery ratio (henceforth to be indicated simply as CRR) is also not without its drawbacks, even if it is more appropriate in measuring block volumes. There is no universally agreed upon method of calculating the cubic block volume of free stems. However, the two-end conic formula may be the most adequate and the most feasible in a production environment and was used in this project (see the Block Volume Computation section).

Even if the inadequacies of determining the block volume were overcome, there would still remain the problems of quantifying the volume of veneer produced. Measuring the pile of sheets in each cart with a tape measure is rather crude, to say the least. At best, it is again an approximation. There is also no capacity in this measuring scheme to take into account, the variation in clipped sheet width. The spur length is relatively constant but the variation in full and half sheet width can fluctuate. This lack of accurate sheet volume determinations with approximating methods is further accentuated when attempting to quantify the highly inconsistent stacks of randoms and trimmed fish-tails. Financial forecasting, production planning, profit analysis and capital expenditures should require the most accurate information that is reasonably attainable. In a worst case situation, a recovery value that is off only a few percent may in reality reverse an otherwise profitable decision. Gone are the days of new technology heralding improvements of fifteen to twenty percent of the recovered veneer volume. Operators of today are willing to listen to offers of increasing their recovered veneer by values of only two or three percent. Figure 2 illustrates the impact of an increase of only a few percent on profit potential. For instance, for a mill producing 70 million square feet of veneer (3/8-inch basis) per year, increasing its recovery factor by only one percent, and selling that increase in veneer at $30/M, would realize an increase in profit of nearly $70,000 annually. Industry on the average is doing a relatively good job of converting its raw materials into marketable items. It is obvious, however, that further improvements can be made. As with any measurement and control system, the level of difficulty or the cost of gaining increased control approaches infinity. That is, increased recovery is an inversely related function of overall system error. In this day of processing sophistication, approximations are no longer adequate. Accurate information on which to make sound judgments is essential to remain viable in today's market. One needs very sensitive measurement or processing systems to realize the full benefit of any improvement rationale. Very sensitive measurement systems are also necessary to determine whether the recovery potential exists to warrant increasingly sophisticated and expensive processes. A method for detecting losses accurately within a very narrow range is now available and presented here.

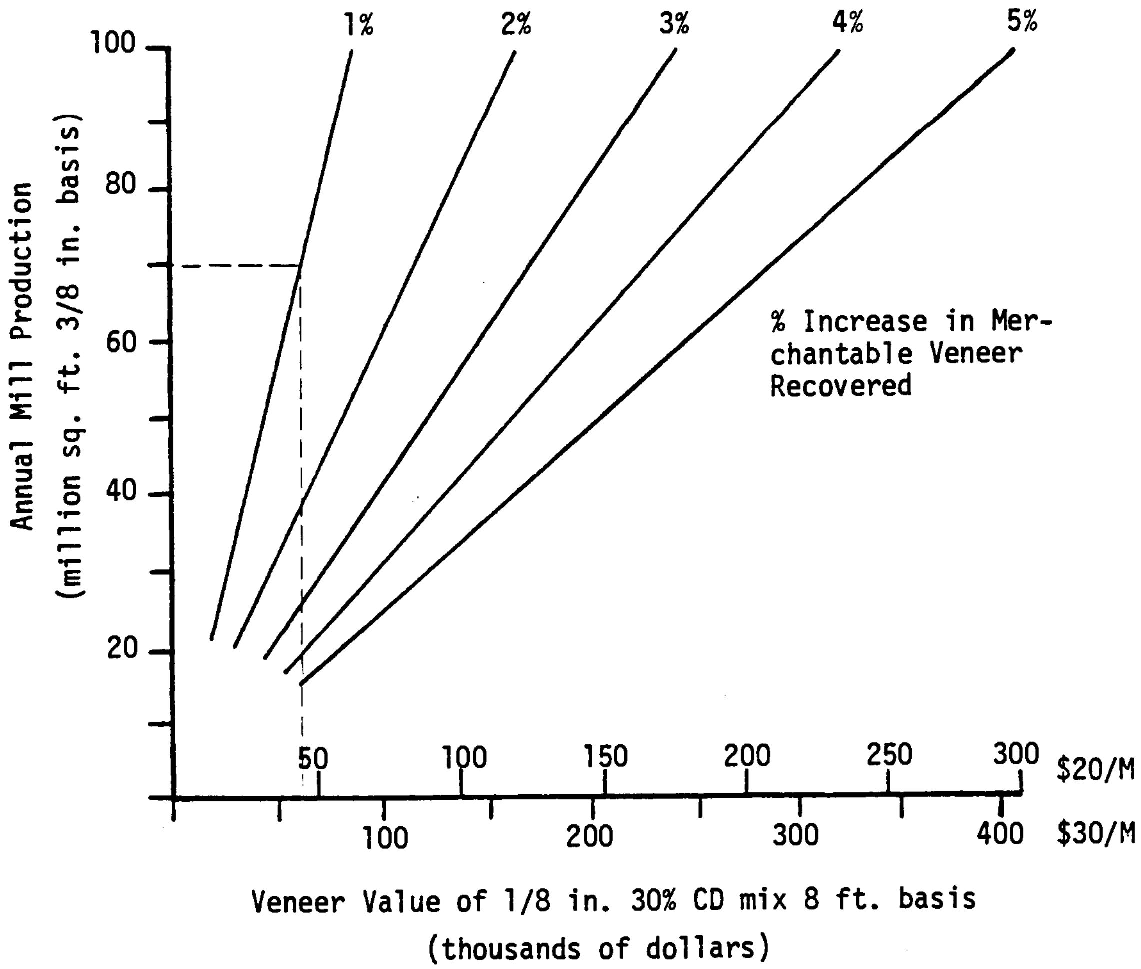

Figure 2. Annual potential increase in revenue at veneer values of $20/M and $30/M in thousands of dollars.

II. OBJECTIVES

The objectives of this project were:

A. to directly measure and analyze the volume of potentially recoverable material presently being lost at the green-end clipper

   1. to directly measure and analyze veneer recovery associated with green-end clipper
   2. to accurately assess specific categories of losses originating in green veneer production

B. to develop a technique that would allow for the direct measurement of potentially recoverable veneer lost at the clipper

   1. to provide mill management with precise method for sound recovery prediction on which to base future capital expenditures
   2. to standardize techniques and equipment to allow mill management to conduct a similar in-house analysis.

The purpose of this investigation was to develop a technique that would allow mill management to quantify the amount of potentially recoverable veneer presently being lost at the green-end clipper. To that end, only five specific Northwest mills were examined. For that reason, the recovery factors and other pertinent green-end values considered here, are not values representative of the entire industry nor should they be construed as such. The lack of both random mill and block sampling as well as not employing a representative mill sample size, disallows any industry-wide conclusions. The design of this experiment allows significant conclusions to be made only about these five mills in particular. Due to the competitive nature of the industry, complete anonymity has been guaranteed to those participating facilities in exchange for their assistance in the implementation of this project.

III. LITERATURE REVIEW

Recovery analyses are commonplace within the forest products industry and particularly on an in-hou-e basis. Because of its strategic value in this highly competitive industry, figures representative of the industry are guarded with some secrecy within the industry. Even though industry-wide recovery data are available through such sources as the American Plywood Association and the U.S. Forest Service, very little information exists on specific block loss components. The lack of representative literature in this subject area bears this fact out. That fact is further compounded when searching for recovery information relevant to either a specific species or a specific region of the country as was required by this investigation.

The results of several veneer recovery studies are available, many of which originate from the Pacific Northwest Forest and Range Experiment Station [20,21,22,23,24]. Of these studies, only Woodfin's [23] attempted to identify individual categories of losses.

One of the earliest studies is one by Clark and Knauss in 1956 [20]. It involved twenty-four mills in the Northwest, peeling an unknown number of Douglas-fir blocks, graded as No. 1, No. 2 and No. 3 Peeler blocks and included the Special Peeler grade. These blocks ranged from 18 to 36 inches in diameter. Compared to the block quality of today, the blocks in this particular study would be considered blocks of exceptional quality and size. They were cold peeled and quantified by veneer grade, on a dry veneer basis. The expressed purpose was only to provide veneer grade yields, under "average" processing conditions. Their findings demonstrated that the VRF declined with diameter and that they were in the 2.30 to 2.54 range.

A very early and unique application of digitizing within the forest products industry was carried out by Tobin and Bethel in 1969 [21]. Their project called for the peeling of four small Douglas-fir blocks which were clipped into four-by-eight-foot sheets. These sheets were then photographed and subsequently digitized with the resulting digitized sheet data being "clipped" by a computer algorithm. Grade requirements, sheet width and clipping specifications could be varied. Since the blocks were not representative of industry-wide quality or size, the project's purpose was, as stated, not to simulate any particular mill situation or establish industry-wide values for grade recovery. Very prophetically, its stated purpose was to demonstrate the flexibility of the digitizing process and to suggest its potential in future veneer recovery analyses.

The most significant Douglas-fir recovery studies undertaken in the Northwest have been carried out by Lane et al. [22], Woodfin [23], and Fahey [24] of the Pacific Northwest Forest and Range Experiment Station. Lane et al. randomly selected trees of both size and quality that reflected typical timber as processed in the west side Douglas-fir region. The harvest provided 3,042 peeler blocks graded from No. 1 Peeler through the No. 3 Sawmill and ranged from 9 to 60 inches at the small end. The blocks were peeled at ten locations throughout the Northwest under conditions reported to be typical of the day. The results were presented in terms of dry veneer tally with the VRF and the CRR reported to be 2.71 and 52.67 for the study. The residue quantity was obtained by subtracting the sum of the veneer and core volumes from the incoming block volume and represents the spur, the round-up and the green-end clipper loss combined. The veneer, core and residue quantities are presented in Figure 3. The resulting veneer produced 39.3 percent full sheets, 29.8 percent half sheets and 30.9 percent random strips. Procedures were presented in which a mill manager might estimate, by adjusting his log mix and employing the regression lines provided, the total production of dry untrimmed veneer on a 3/8-inch basis.

Woodfin [23] was the first to provide some insight into veneer volume losses at the green-end clipper. In a study of over 5,500 veneer blocks, 2,802 of which were Douglas-fir, veneer losses were reported for four Western species: coastal Douglas-fir, western hemlock, red and white fir and Black Hills ponderosa pine. Standing trees were selected and harvested in the range of log size and quality representative of the particular region for each species. At thirteen mills, the blocks were scaled, peeled, re-measured at round-up, cores measured and the resulting veneer dried. An average dry veneer width and thickness were used to calculate the cubic and square foot volumes of veneer. The width of the random strips and fish-tails were measured to the nearest one inch. The dry veneer volume was adjusted to a green volume basis by applying an average shrinkage factor of 5.5 percent for all species. Clipper losses were determined by subtracting all the above component volumes from the total block volume. The average veneer recovery ratio for all the Douglas-fir mills was 2.65 on a dry veneer basis. The breakdown of the Douglas-fir block components of this study are shown in Figure 4.

It should be noted that the green-end clipper losses are reported to represent the largest portion of the block losses and were determined to be 21.7 percent. However, this study was implemented in mills not having scanner-controled clippers [25].

Fahey [24] carried out a similar project that included 768 second growth Douglas-fir blocks of No. 3 Special Peeler and No. 2 and No. 3 Sawmill grade blocks. All were peeled at a single production facility in two thicknesses: 1/10 in. and 1/6 in. Each thickness was clipped with a different strategy. Once peeled, the veneer was graded and tallied dry. No description was provided as to the specific tally method but it is assumed to have followed the procedure as used by Woodfin in the previously described study. Cores and the quantity called residue (spur, round-up, clipper, dryer and shrinkage losses) were

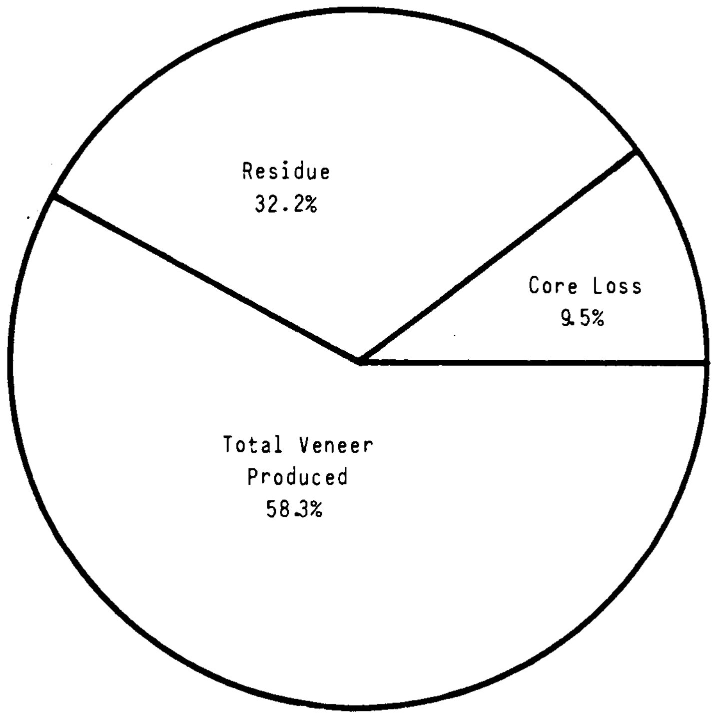

Figure 3. Components of old growth Douglas-fir block components as determined by Lane et al.

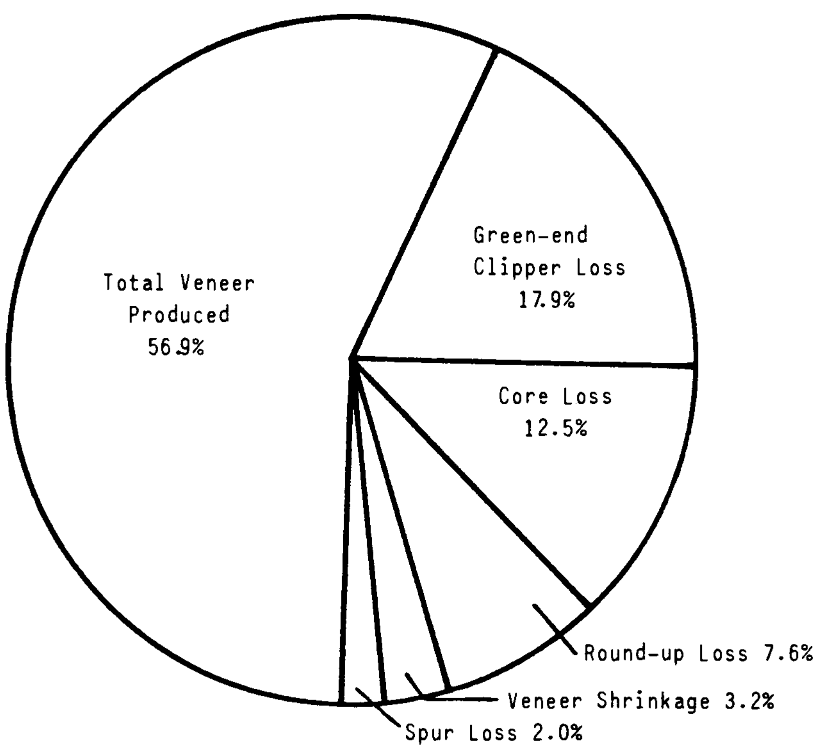

Figure 4. Components of Douglas-fir blocks as determined by Woodfin.

determined by subtraction. See Figure 5 for the block component breakdown. His analysis indicated a strong relationship between diameter and recovery ratio. The 1/10 in. veneer had a VRF of 2.60 and the 1/6 in. veneer, a VRF of 2.72.

However, in all recovery studies presented, the raw material loss values were approximated and determined by subtracting the sum of all other losses from the total incoming block volume, rather than by direct measurement. In these studies, the merchantable block components and residue losses were simply approximated in several areas:

1. Veneer volumes were tallied dry and adjusted to green volumes.
2. Adjustments to green volumes were made with the use of a common "average" shrinkage factor.
3. Full and half sheets were not individually measured.
4. Randoms and fish-tails were measured to only the nearest one inch.
5. Residue and/or clipper losses were determined indirectly by subtraction from the block volume.
6. Veneer volume calculations employed nominal veneer thickness rather than actual production veneer thickness.

With the rising cost of raw material, labor and capital, it is imperative that the forest products industry find methods to improve recovery, productivity and product value. The initial step in meeting this challenge is to accurately determine processing recovery values and existing raw material recovery potential. A procedure is described that allows for direct assessment of the veneer up to and including the green veneer clipper.

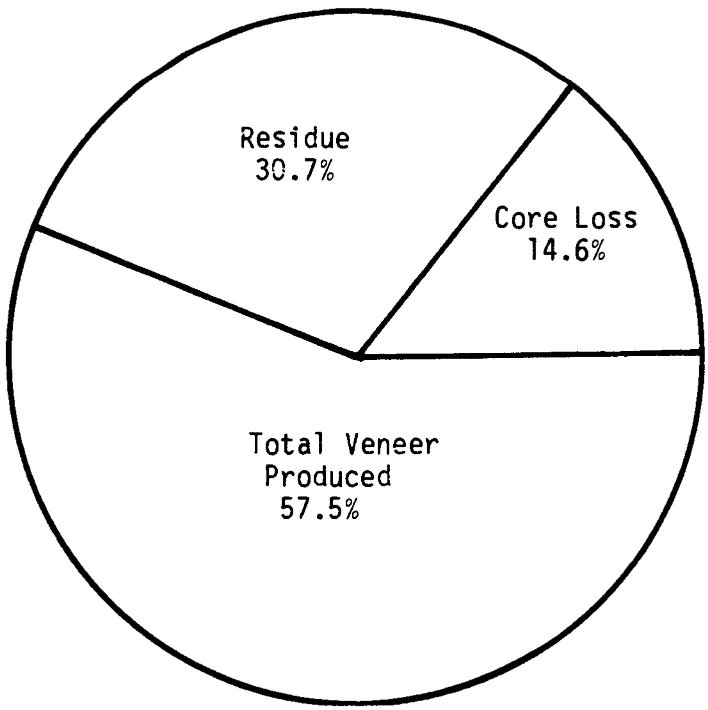

Figure 5. Components of second growth Douglas-fir blocks as determined by Fahey.

IV. METHODS AND MATERIALS

A. Theoretical Considerations

1. Experimental Design

There are many experimental investigations in which a factorial arrangement is desired; that is, a design in which the total of all experimental factors are randomly confounded with one another. However, it is sometimes not possible to completely randomize the entire order of the experiment. There were two experimental factors under consideration in this project: the mill or veneer production facility being examined and the diameter class of the veneer block being peeled. In order to meet the project objectives, it was necessary to examine the effect of these two factors on both the actual veneer recovery values and on the amount of "potentially" recoverable veneer normally lost in the peeling/clipping process. An experiment in which a primary factor is applied to whole plots and to which one or more secondary factors are applied to form sub-plots, is often called a split-plot design. This is a restricted factorial design. Here the main effect, the five mills being examined is confounded with diameter. The secondary effect diameter is divided into four diameter classes (based on the small-end diameter measurement) or sub-plots as follows:

Diameter Class #1	10.00 to 14.99 in.
Diameter Class #2	15.00 to 19.99 in.
Diameter Class #3	20.00 to 24.99 in.
Diameter Class #4	25.00 to 29.99 in.

The analysis of the whole plots will allow the observation of effects due to the processing facility while the sub-plot analysis will examine the effects of diameter and the mill vs. diameter interaction. This two-factor design consists of thirty replicates or veneer blocks per cell. The total sample size, therefore, consists of 600 veneer blocks.

2. Sample Size Determinations

With the design of any experiment, it is essential that a statistically appropriate determination of sample size be made. It is the correctly chosen sample size that will allow inferences, with some specified degree of confidence, to be made about the population under study. Too small a sample may provide data too inaccurate to be useful, thereby reducing the value of the results or effort expended. Likewise, too large a sample implies a waste of time and/or financial resources. The choice is often reduced to an examination of cost vs. the precision desired. Each of the two constraints must be weighed against one another to determine an efficient or appropriate combination of the two.

Once a particular parameter of interest within the study is chosen, there are four basic elements required to estimate the sample size as required within the design specifications of the investigator. First, a desired level of confidence must be chosen. This confidence level indicates the allowable statistical error one is willing to assume. A confidence level of 95 percent has been employed here. Secondly, a standard deviation for that specific parameter must be designated which measures the operating precision of a particular system. This value must be either estimated, provided by the literature from previous studies or obtained by conducting a small-scale pilot study. Thirdly, a tolerance must be specified which defines the minimum sensitivity to which that specific parameter is able to be detected. The fourth element required, of course, is an equation that links the desired system precision, the statistical confidence level and the detection sensitivity with the sample size required. In the design of this experiment, a sample size determination was required for both the determination of the number of veneer measurements required to provide a representative average veneer thickness for each mill and for the number of blocks to be peeled at each mill.

It was desired to determine the number of veneer sheet measurements required to make an accurate determination of the actual veneer thickness as peeled by the mill. The desired sensitivity was decided to be within ± 0.001-inch from the mean thickness of the peeled veneer at a 95 percent confidence level. The literature indicates a thickness standard deviation of 0.004 inches as not being at all uncommon [14,26,27]. A preliminary estimate of the required sample size can then be determined by the following equation:

$$n = \left(\frac{t_{.05}\ s}{c}\right)^2 \qquad \text{Equation 1}$$

where the t value originates from Student's t distribution at a 95 percent confidence level and at some specified degrees of freedom (infinite degrees of freedom assumed initially). An estimate for a sample standard deviation is represented by s while the c is the desired detection sensitivity for the specific design parameter thickness. Substituting,

$$n = \left(\frac{1.96 \times 0.004}{0.001}\right)^2 \cong 62 \text{ measurements}$$

To refine this first approximation, one must refer back to a t-distribution table for $t_{(.05,62)}$ value and recalculate as follows:

$$n = \left(\frac{2.00 \times 0.004}{0.001}\right)^2 \cong 64 \text{ measurements}$$

This represents the minimum number of veneer measurements required under the designated constraints. However, this value was adjusted upwards to 100 measurements since there was little confidence in the 0.004 standard deviation value as provided by the available literature. The final estimate of 100 approaches the number of measurements required at a 99 percent confidence level ($n_{t(.01)} = 107$) and is certainly even more acceptable. Therefore, for this project, 100 thickness measurements were taken to determine a representative veneer thickness at each mill.

It was determined that a major goal of this project would be to compare the VRF between mills and diameter classes and it was necessary to be sensitive to within ± 0.1 VRF. Fahey [24] provided

VRF values for each inch of diameter on 450 second growth Douglas-fir blocks ranging from 10 to 28 inches in the No. 2 and No. 3 Sawmill grades. A standard deviation determination could easily be made from his extensive data presentation. His data was divided into four diameter classes from 10 to 30 inches. An average VRF was determined for all blocks in each of the four diameter classes within each of the two block grades. This yielded eight cells of individual means as indicated in Table 1.

Table 1. Categorized means according to block diameter and grade as determined from Fahey.

Diameter Class (inches)	No. 2 Sawmill grade	No. 3 Sawmill grade
10.00 to 14.99	$\overline{Y}_1 = 2.470$	$\overline{Y}_5 = 2.510$
15.00 to 19.99	$\overline{Y}_2 = 2.910$	$\overline{Y}_6 = 2.118$
20.00 to 24.99	$\overline{Y}_3 = 2.800$	$\overline{Y}_7 = 2.543$
25.00 to 29.99	$\overline{Y}_4 = 2.670$	$\overline{Y}_8 = 2.215$

From this set of data, an approximation for a sample mean and standard error (an estimate of the true population mean and standard deviation, respectively) can be made. An estimate of the population mean $\overline{Y}$ is described by Equation 2.

$$\overline{Y} = \frac{\overline{Y}i}{n} \qquad \text{Equation 2}$$

An estimate of the population mean $\overline{Y}$, is calculated by finding the average of the sample means. Substituting into Equation 2,

$$\overline{Y} = \frac{20.235}{8} = 2.53$$

The standard error for this sample is calculated by Equation 3.

$$s = \sqrt{\frac{\sum(\bar{y}_i - \bar{Y})^2}{n-1}} \qquad \text{Equation 3}$$

The standard error is determined by substitution of the sample means into Equation 3 to obtain:

$$s = \sqrt{\frac{0.510}{7}} = 0.270$$

Substituting this standard error and the t-value used previously into Equation 1,

$$n = \left(\frac{1.96 \times 0.270}{0.1}\right)^2 \cong 29 \text{ blocks}$$

As in the previous estimation, this is only a first approximation and likewise, to obtain a refined estimate, a $t_{(.05,29)}$ value is obtained from a standard t-distribution table and a new sample size is calculated.

$$n = \left(\frac{2.04 \times 0.270}{0.1}\right)^2 \cong 30 \text{ blocks}$$

Therefore, a minimum of 30 blocks would be required under the stipulated experimental constraints.

3. Block Cubic Volume Determination

In the United States, there exists no single cubic formula that enjoys exclusive use in determining log or block volume. The most common are Smalian's, the sub-neiloid, the two-end conic formulas, Bruce's butt log formula for Douglas-fir and the one-end Smalian with assumed taper as indicated by Hartman et al. [27]. The two-end conic was incorporated in this study, since it is less simplistic than the first two and yet more practical in a mill setting than the Smalian with assumed taper. Bruce [28] indicated that estimates based on his regression formula tended to underestimate volumes with little taper, and very few blocks in this study were considered to have any taper of consequence. The formulas used in this project and their derivations are provided in Appendix E. The block volume calculations originate from the two-end conic formula and it was from this basis that the core, spur and theoretical veneer volume formulas were specifically derived for use in this project.

B. Mill Data Collection Procedures

This study was conducted at five cooperating mills located within Oregon and Washington. Prior to conducting the study at each mill, the management and the representatives of the representative clipper and scanner manufacturers were requested to examine their equipment to assure proper maintenance and operation.

The veneer recovery project consisted basically of peeling a specified sample of carefully selected peeler blocks and photographing the clipped veneer as it exited the green veneer clipper. A spray unit with six spray nozzles was used to mark the peeled veneer as it left the lathe. By marking the veneer with a specific series of highly visible spray lines, it would be a simple matter, on film, to identify the diameter class from which that particular ribbon originated. Once developed, the information on the film was digitized to determine veneer areas. It was this data, in addition to the associated block and core data, that was processed by the Fortran 5 CLPLOSS Veneer Recovery Program. The diagram in Figure 6 summarizes the basic procedures employed in this project. A more comprehensive presentation follows.

The data collection process required a minimum of two individuals and at least two working days for each mill. The work schedule required for the implementation of this project follows:

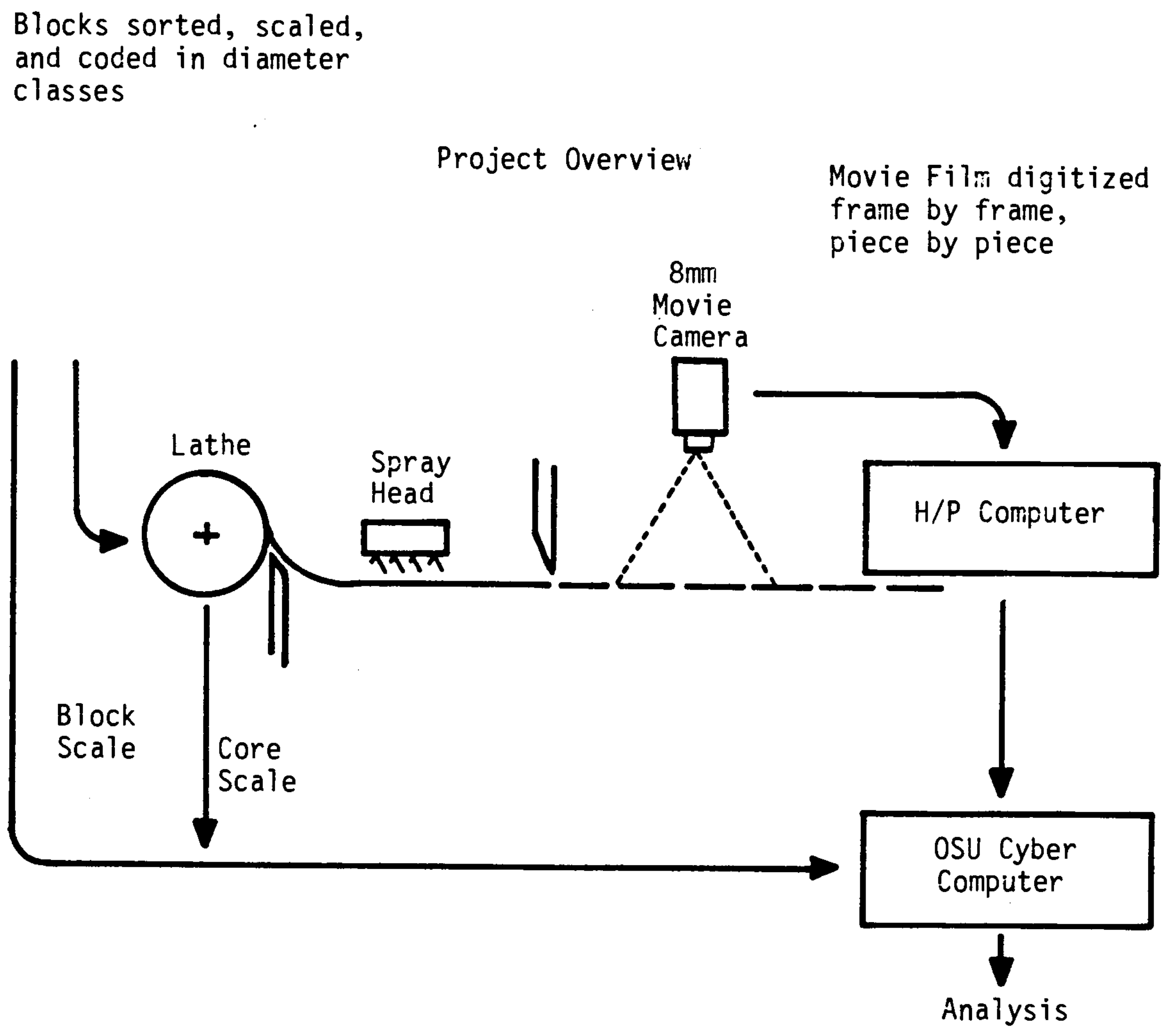

Figure 6. Overview of the CLPLOSS Veneer Recovery Project.

Day 1 • Select, scale and mark 128 acceptable blocks

Day 2 • Erect scaffolding and camera mount
- Set up spray system
- Film the peeling operation
- Measure and photograph the control sheet
- Determine an average thickness for the peeling operation
- Make peeler core measurements
- Obtain plant equipment specifics and equipment settings

Upon prior arrangement, the management at each mill was requested to provide 128 No. 2 and No. 3 Sawmill grade Douglas-fir blocks in four diameter classes ranging from 10.00 to 29.99 inches on the small diameter end. Although only 120 blocks from each mill were actually required by the experiment design, two additional blocks in each diameter class were to be provided in the advent of spin-out or cracked blocks during the peeling operation. Because of cost and time considerations, the total sample of 640 blocks could not be randomized between mills. Therefore, it was essential to obtain a sample as homogeneous or consistent as possible among the mills. For this reason, a two-stage block selection process was implemented. First, each mill was requested to select blocks meeting the following preliminary specifications:

1. acceptable No. 2 or No. 3 Sawmill grades
2. within the four diameter classes requested

Grading was done in accordance with the standard rules for the west side Douglas-fir region [29]. The blocks as selected by mill personnel were then placed on an unused log deck for further examination. From this preliminary sample, further qualifications were included to meet the specific goals of this project. It was essential to choose blocks that would tend to have a high probability of being peeled to completion, i.e., to a minimum core diameter. Therefore, any exterior defects that might cause premature block failure at the lathe were taken into consideration. The second more stringent set of criterion for block selection were as follows:

1. acceptable No. 2 and No. 3 Sawmill grades
2. scaling cylinder within the required diameter classes
3. no significant unsound wood within the chuckable area
4. no extreme sweep or butt flare
5. no severe checks, splits, shake or pitch pockets
6. no burls or knot clusters of excessive size
7. maximum scaling length not less than 100 inches

All blocks meeting the above requirements were considered acceptable for this study.

It should be noted that because of the rather rigid selection process, the blocks employed in this study are not representative of an industry-wide mix of No. 2 and No. 3 Sawmill grade blocks. Instead, they represent a slightly better-than-average sample of blocks within those grades.

The Scribner Decimal C system was used to scale the individual blocks with defect deductions noted accordingly. In addition, maximum and minimum measurements were taken for both the large and the small end of the block as well as its length. Measurements were made with a steel tape to the nearest 1/16-inch. These data were recorded on the mill data sheet (see Appendix D).

After scaling, the blocks of each of the four diameter classes were identified by spraying paint on both ends of each block. Four different colors were used to represent each of the four diameter classes. Figure 7 shows the block scaling and marking activity in progress. The eight additional blocks were additionally sprayed with a black "X" in the chuckable area. The purpose of marking the block ends was to allow the individual operating the spray system to determine the diameter class to which a block being charged into the lathe belonged and to mark it accordingly. All 128 blocks from each of the five mills were scaled and marked in this manner. After this scaling and marking process, the blocks were returned to mill personnel for conditioning. With the exception of Mill #3, the particular conditioning schedule employed at each mill can be found in Appendix D. At Mill #3, there were exceptions to the above-mentioned procedures. The blocks from this mill were not conditioned since they were brought out of a log pond and conveyed directly to the lathe. It was on the conveyor that the blocks were scaled and marked as they slowly moved toward the lathe charger.

Usually on the morning of the second day, scaffolding was erected. The final setup consisted of two 18-foot columns of scaffolding set up on either side of the conveyor just downstream of the clipper. A 16-foot plank was placed directly over the conveyor connecting the two scaffold columns. This plank was usually set at approximately the 12-foot level, depending on the conveyor height and the obstacles encountered at that ceiling height. The plank provided a walkway for the camera operator (for making adjustments and film changes) during the filming operation. A horizontal bar connected to each scaffold column at approximately the 14-foot level provided for the attachment of the 8mm Nizo 56 movie camera and the stroboscopic lamp heads. However, at Mill #3, the camera and lamps were mounted on an overhead crane gondola and, therefore, no scaffolding was needed. The flash system consisted of a Norman Enterprises, Inc. P500-alm power pack with two LH4 lampheads. The 500-alm is capable of delivering 400 watt-seconds of flash output. THe two lampheads were synchronized to the movie camera at a frame rate of approximately 70 frames per minute. This specific frame rate was fast enough to allow line speeds of up to 250 feet per minute and was the maximum rate allowable by the power pack for the four-hour peeling/filming operation. Frame rates (or flash rates) in excess of this, intermittently caused the lampheads to fail to fire. This frame rate insured that each and every single piece of veneer was contained completely in at least one frame; that is, all veneer passing through the clipper is represented fully on film. Exposure settings depended on mill conditions and varied from f/2.8 to f/5.0 using Super 8 Kodak Plus X reversal black-and-white film #7276 with an ASA of 32. To minimize distortion of the image, it was essential that the camera be situated absolutely perpendicular to the plane of the moving veneer 12 to 14 feet below. For that purpose, a highly visible Mill Sighting Device was construted (see Fig. 8). Constructed of plywood, this knock-down device consisted of a right triangle rigidly supported and mounted perpendicular to a four-square-foot base. On its vertical edge were mounted two very visible sighting targets: a red circle at the top and a white cross at the bottom. The position of both targets are very adjustable relative to one another. Affixed to the base was a small circular bubble level

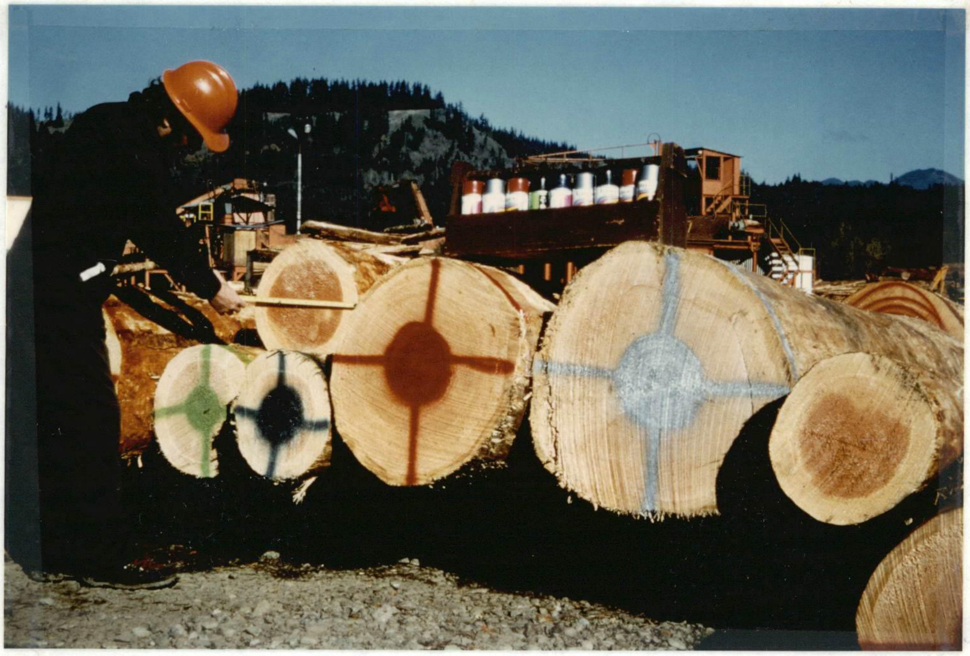

Figure 7. Block scaling and marking procedure in progress.

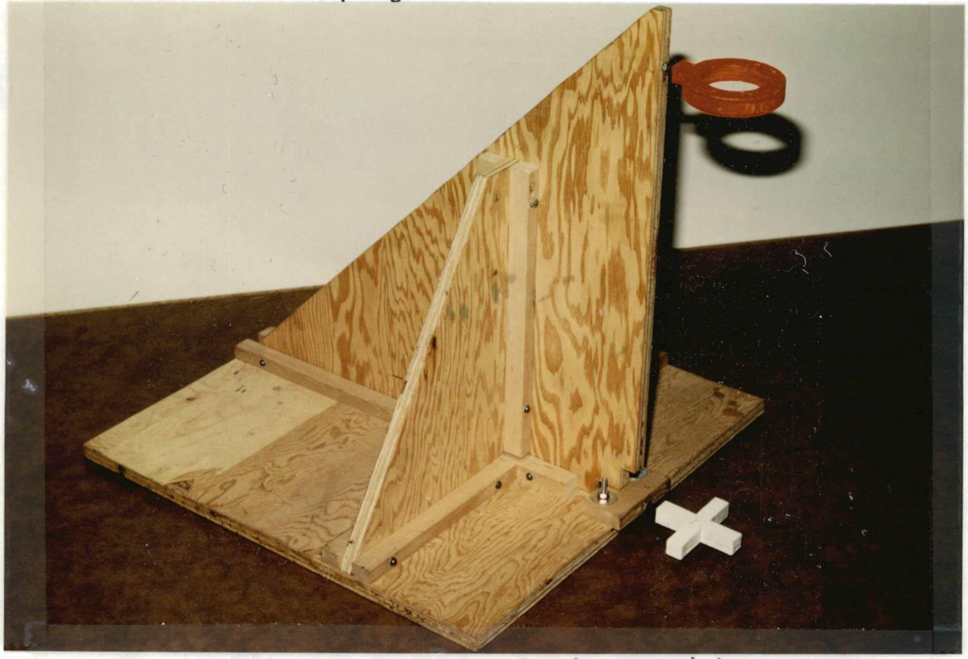

Figure 8. Mill Sighting Device used to assure camera perpendicularity with the veneer.

necessary for the adjustment of the Sighting Device. After its assembly and before its use in aligning the movie camera, the following Mill Sighting Device alignment procedures are necessary:

1. The assembled device must be placed on a hard, relatively level surface.
2. Using the buble level, level the entire base by successively shimming up the corners of the base.
3. From the red circle, suspend a small plumb bob down to a point of almost touching the white cross.
4. Continually adjust the two targets till the plumb bob hangs directly over the center of the cross intersection.
5. Then, tighten firmly all adjustment nuts.

Completing the above procedures insures the targets to be perpendicular, in two axes, to the base. By placing the adjusted Mill Sighting Device on the conveyor and in the camera field of view, the camera can be manipulated until the operator is able to see the white cross perfectly centered in the red ring. With the completion of this procedure, the camera is positioned directly over and perpendicular to the plane of the moving veneer. The camera field of view was also checked to see that it was visually square with the veneer flow.

For use during the digitizing operation, it was necessary to mark the peeled, moving veneer to provide information on the diameter class from which that veneer originated (Digitizing Section). A spray system first demonstrated by Lane [30] for marking veneer or lumber in recovery studies was borrowed from the USDA Forest Service Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. The system was attached to a one-inch pipe suspended over the conveyor on the downstream side of the lathe just beyond the trash-tipple. The six nozzles were located about 12 inches above the moving veneer and operate on a 40 psi air supply. The spray system allows the six spray heads to be operated either singly or in any combination with one another. Water soluble red and green acid dyes (identical to those employed in moisture detectors) were obtained from the Keystone Ingham Corp. The red and green dyes were mixed with water at a rate of 9 g/gal and 29 g/gal, respectively, for optimum color density and economy. Only a single color was employed at each mill. A color other than the one the mill was using at the time, was chosen to prevent confusing the dry veneer graders. Only the leading 20 feet of ribbon was sprayed to identify the block diameter from which it came. Approximately twenty gallons of dye solution were required for marking all 128 blocks in this manner. A single spray line was sprayed to indicate a Diameter #1 class, two spray lines indicate a Diameter #2 class, etc.

Figure 9 shows veneer having originated from a block in the 10.00 to 14.99 inch diameter class (Diameter #1 class). The veneer was sprayed while it was moving without interfering with production. After spray-coding the veneer, it was conveyed to the clipper for clipping and filming.

Once the scaffolding, the camera and the spray unit had been set up, the actual peeling could begin. During a scheduled break in the four-hour peeling operation, the control sheet was marked, measured and photographed. The purpose of the control sheet was to provide scalar information necessary for the veneer area calculations during the digitizing process. A full sheet was selected at random and boldly marked in a pairwise fashion at five extreme locations, as indicated in Figure 10. Each of the five dimensions was accurately measured to the nearest 1/16-inch and recorded on

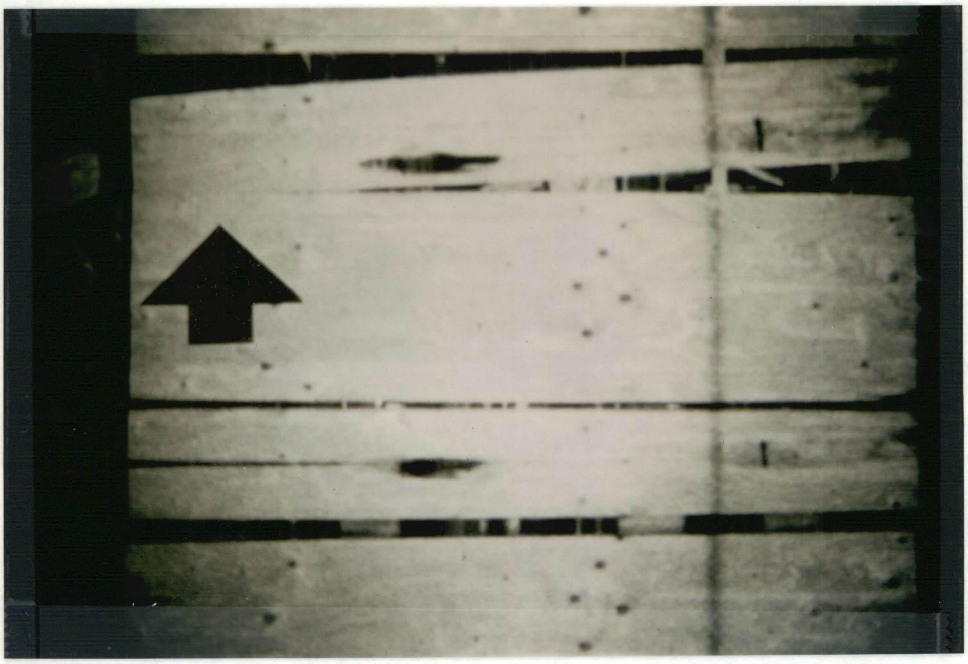

Figure 9. Veneer from the project marked as originating from a Diameter #1 class block.

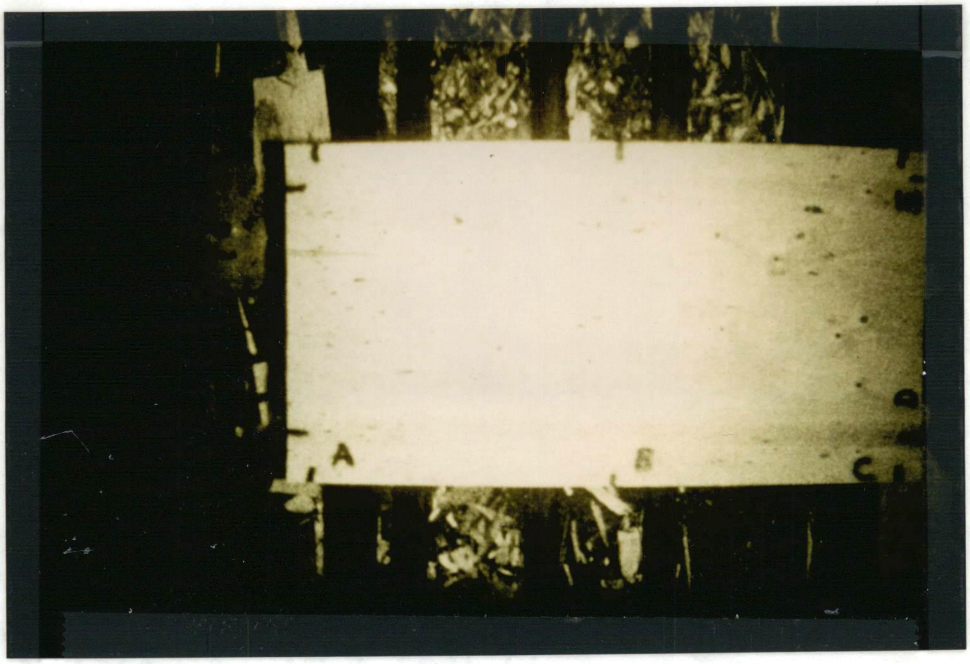

Figure 10. Example of a control sheet as it was photographed for use in this project.

the appropriate mill data sheet (see Appendix D). This sheet was then photographed with the movie camera exactly as one would photograph the veneer for the project.

Upon completion of the entire filming operation, an average thickness was determined for the veneer peeled. An average thickness representing each mill was necessary for actual yield determinations in converting veneer areas into veneer volumes. One hundred veneer measurements were taken at four specific locations for a random group of full sheets, half sheets and randoms just peeled. Once these measurements were taken and recorded on the appropriate mill data sheets (see Appendix D), an average veneer thickness representing that mills production could be calculated, the assumption here being that this average value accurately represents the peel thickness during the entire peeling operation. The lathe operator was instructed to keep the knife head in the closed position during peeling except where absolutely necessary, i.e., to clear a jammed knife. This was necessary to assure that the veneer photographed was as uniform as possible within the capabilities of the production system.

The cores ejected from the lathe were assembled and/or relocated by mill personnel to an unused and open area of the mill. Here they were spread out so that diameter measurements could be taken. The measurements were taken at three specific places along the core length (indicated as d_1, d_2 and d_5 in Appendix E). The measurements were taken at the lathe operator end, the center and the opposite end away from the operator. End measurements were made to the nearest 1/16-inch with a standard tape measure and at the center of the core with a standard steel diameter tape to the nearest 1/10-inch. These values were converted to their decimal equivalent and recorded on the appropriate mill data sheets (Appendix D). The spray paint markings were always visible even after peeling as were the two additional blocks in each diameter class marked with a black "x".

After measuring the cores, specific green-end processing data were obtained and are contained in Appendix D.

C. Laboratory Digitizing Procedures

The movie film contains information in the form of images that must be converted digitally into a more meaningful or quantitative form. It is the purpose of the laboratory digitizing operation to facilitate that conversion. As the film is projected onto the digitizer surface (or digitizer platen) and a hand-held cursor is traced over the outline of the image, the particular veneer item is translated into a series of X-Y coordinates (see Figs. 11 and 12). The digitizer surface has a resolution of ±0.01-inch, which translates to approximately ±0.10 inch on an actual sheet of veneer. These coordinates are then employed by the Digitizing Program to calculate the actual veneer areas. It is this sequence of areas that are stored on tape to be used by the CLPLOSS Veneer Recovery Program. The equipment consisted of the Hewlett-Packard 9825A micro-computer, Hewlett-Packard 9864A digitizer, Centronics 306C line printer and a Tymestudy Super-8 movie projector. Hewlett-Packard will be abbreviated to HP for the rest of this presentation.

1. Projector Alignment Procedures

There are four components in the laboratory digitizing process that must be maintained in their relative position to one another in order to provide the consistently accurate digitizer values as required by this investigation. Those components are the digitizer platen stand, the digitizer platen, the movie projector, and the projector stand. The platen stand is held into a constant position by quick-release wall-mounted clamps. The platen is maintained in the proper incline by an adjustable support rod, and the projector is positioned onto its stand by a locating jig clamped into position. The projector stand is placed into an approximate position by a series of locating marks drawn on the floor.

Figure 11. Laboratory digitizing setup as employed in this study.

Figure 12. Laboratory digitizing process underway.

To obtain accurate values from the digitizing operation, it is essential that the projector be aligned perpendicular to the inclined digitizer platen. A Plexiglas Platen Sighting Device was employed to obtain this perpendicularity in two axes (see Fig. 13). The device is similar to the Mill Sighting Device presented earlier but is much smaller. The device simply consists of a pair of right triangles glued together at 90° to one another and affixed to a Plexiglas base. On their plane of intersection are mounted two very small spheres approximately eight inches apart which act as alignment points. Prior to alignment, the platen table and the projector stand were checked to see that they were in their proper positions. By placing the Plexiglas sighting device on the platen, the light from the projector causes the two small spheres on the device to create shadows on the platen surface. The adjustment procedures require that:

1. The projector stand is positioned correctly within the confines of the four highly visible marks on the floor.
2. The digitizer platen is properly inclined with the platen support rod according to the scribe mark on the support rod.
3. The digitizer table is properly secured to the wall with the provided clamping devices.

The projector is properly aligned when the two spheres produce a single shadow in the center of the frame, rather than two. The adjustments to correct any horizontal disparity between the two shadows are made by slightly moving to the left or right, the position of the stand relative to the floor. Any vertical adjustments are made slightly changing the length of the platen support rod.

This procedure was carried out only periodically either at each new reel change or when misalignment was suspected.

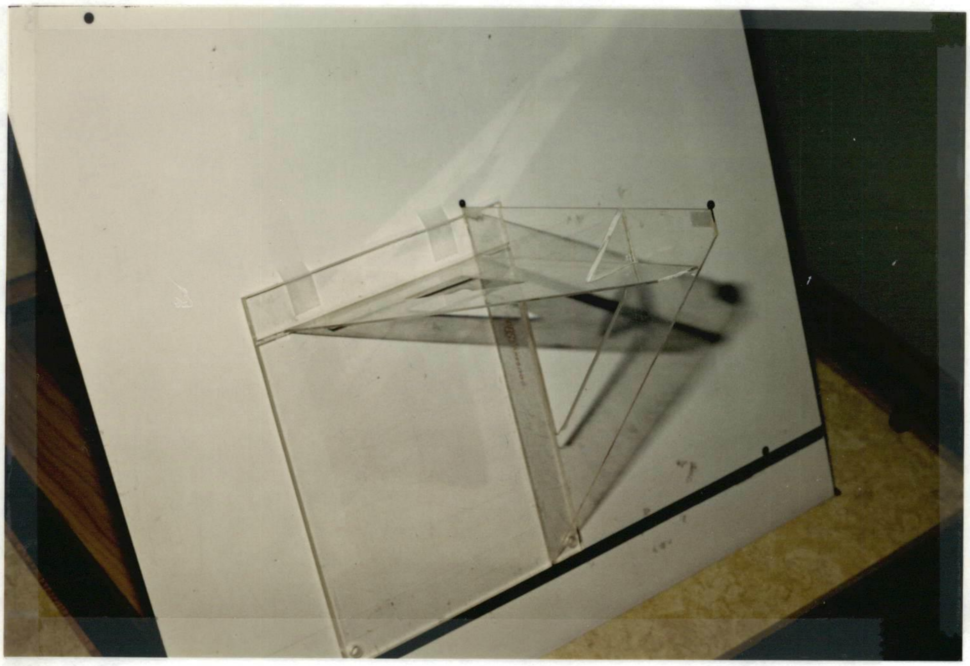

Figure 13. Platen Sighting Device as employed in the platen alignment procedures.

2. Digitizing Rationale

After observing the peeling/clipping operation at great length, it was determined that there existed basically seven specific types of individual veneer pieces. There also existed two basic types of wood losses inherent in the clipping action. The summation of individual piece areas will eventually yield recovery information, whereas the summation of all accurately and inaccurately clipped losses will provide information about the potentially recoverable veneer.

Each of the nine digitizing classes was coded in the computer with a specific one-digit number to identify its classification type. The veneer types are as follows:

Veneer Code	Veneer Classification
1	Full Sheet
2	Half Sheet
3	Random Strip
4	Untrimmed Fish-tail
5	Trimmed Fish-tail
6	Reject
7	Inaccurately Clipped Recoverable
8	Accurately Clipped Recoverable
9	Clipped Round-up

Table 2. Nine veneer classifications and codes used in this project.

Each digitizing operation was coded as to the mill, the diameter class and the block number to which the piece belonged. In addition, the piece was classified into one or more of the veneer types and digitized to determine its area. It is obvious why certain veneer pieces were digitized as fulls, halves, randoms, untrimmed fish-tails and trimmed fish-tails. However, before discussing the four remaining digitized veneer types, a few preliminary comments and definitions are necessary.

In order to examine the potential for veneer recovery, it is first necessary to more fully understand that rather large and illusive component generally referred to by the industry as trash. Generally, trash constitutes all non-merchantable veneer generated in the peeling operation. It is quite a simple matter to quantify or digitize certain veneer pieces (the fulls, halves, randoms, untrimmed and trimmed fish-tails) into distinct components, but to adequately describe the trash component, the veneer peel had to be logically partitioned into three distict areas as potential sources for trash. To adequately describe the trash component as well as the associated potentially recoverable veneer in that trash, a new and standardized set of terminology had to be established. These new terms are described here and will be used throughout the remainder of this paper. They serve to facilitate this presentation only and in no way represent general industry usage.

Figure 14 illustrates a hypothetical veneer peel beginning with the very discontinuous round-up portion and gradually developing into the continuous portion of the veneer usually called the ribbon. The entire peel is partitioned into three distinct veneer areas in which trash may originate: regions A, B and C.

In its most strict sense, round-up is that point in the peeling operation where the maximum true cylinder is achieved. Therefore, as far as scanner and this project are concerned, round-up is considered complete only after the ribbon is continuous enough to produce two consecutive full sheets, at which time the conveyor is signaled to go into its high-speed mode. To meet the needs of this project, round-up was partitioned into two distinct regions, region A and region B. All veneer produced in region A is termed trash-gate round-up. The trash-gate round-up loss component represents that trash veneer produced at the very beginning of the round-up operation. It is that veneer that has no potential for developing merchantable veneer and is diverted directly through the conveyor tipple and on to the chipper. Since that veneer is never transported on to the clipper, there exists no photographic record of

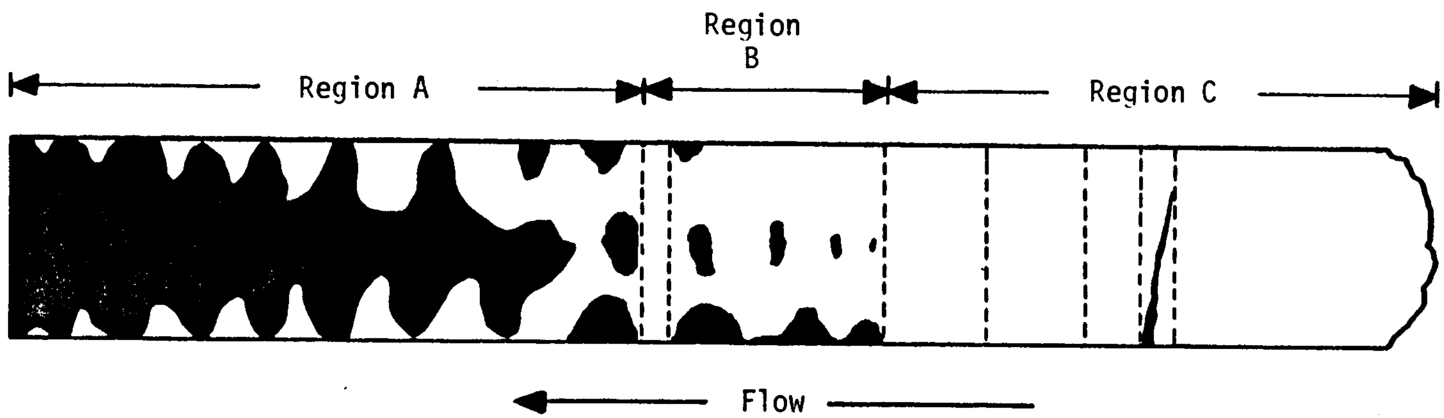

Figure 14. Example of a veneer peel showing the entire ribbon.

that component. Therefore, the trash-gate round-up component is never considered in the digitizing operation. However, it is an essential block component and must be considered in the overall recovery calculations. It is the only block component that was determined indirectly by subtracting all known block components from the known block scale volume.

Any trash veneer generated in region B of the round-up is termed clipped round-up. Clipped round-up is defined as that trash material created by the clipping operation prior to the occurrence of two consecutive full sheets. It is trash material created in an attempt to recover merchantable veneer in the discontinuous portion of the peel. Therefore, in the digitizing classification, all trash material (except fish-tail trim) generated by the clipping action prior to the occurrence of two full sheets is considered clipped round-up.

After the occurrence of two full sheets, any trash veneer generated by the clipping action in region C (except fish-tail trim), is termed reject.

The seven previously considered veneer classifications (full, half, random, untrimmed fish-tail, trimmed fish-tail, clipped round-up and reject) represent individually distinct pieces of veneer as generated by the peeling/clipping operation. However, very often on those trash pieces (fish-tail trim, clipped round-up and reject), there remains substantial quantities of good veneer. In order to quantify the amount of potentially recoverable veneer usually lost to trash, each piece of trash veneer is further examined to determine the reason for its loss. In general terms, this good wood is lost to trash because of either an accurately or inaccurately placed clip. Even though it may seem incongruous for an accurately placed clip to produce waste veneer, it will be made more evident with the forthcoming explanation. It should be noted that there will be no attempt in this presentation to designate specific mechanical or other physical reasons for any inaccurately placed clip. That aspect resides totally outside the expertise, the scope and the objectives of this project. However, with an understanding of basic clipping hierarchy and strategy, it can be established when and where the clips should have occurred and why they should have occurred there.

To facilitate the explanations of the accurately and inaccurately clipped recoverable classifications, it is necessary to establish a basic set of hypothetical scanner settings. It is these user-designated inputs that establish the constraints under which the logic of the scanner will operate. The hypothetical scanner is set up with the following basic settings:

Full SHeet	54 inches
Half Sheet	27 inches
Minimum Strip.	5 inches
Clipping Margin.	1 inch
Minimum Fish-tail Length	60 inches

For a piece of veneer to be considered as accurately clipped recoverable, it must be one in which the clipper/scanner properly placed a clip but in doing so, good veneer was lost to trash. Figure 15 illustrates a common example of wood loss in the accurately clipped recoverable classification. It must be stated that the subsequent illustrations employed in this section have not been drawn to scale and are intended for descriptive purposes only. With a defect too large for a fish-tail and 32 inches of good veneer prior to the defect, there remains enough good wood to clip out a 27-inch half-sheet as indicated, with five inches of good wood still remaining. Even though five inches of remaining wood appears to be enough for a minimum strip clip, that clip can only take place if there is at least enough material remaining for a minimum strip plus a one-inch margin on either side of the defect. That is, under the hypothetical set of instructions, six inches of veneer are required for a minimum strip clip to take place. The purpose of the margin setting is to assure that the wane or taper around a defect is fully removed. Therefore, in this example with only five inches remaining before the defect, another clip prior to the defect will not occur and four inches of good wood is lost even though the veneer was properly clipped. Assuming that the spur knives are set at 101 inches, this example of accurately clipped recoverable material resulted in the loss of 404 square inches (2.8 sq. ft.) of potentially merchantable digitized separately, the previous example was digitized in the following sequence: First the half sheet was digitized, then the entire reject piece, the accurately clipped recoverable material, and finally the following half sheet was digitized.

It should be noted that under normal circumstances, half sheets are clipped preferentially over random sheets. In the preceding example, this strategy resulted in the loss of excess veneer. Under such circumstances, most scanner manufacturers provide on their equipment a user-selected option (called either the small/random or the divide switch) that will allow two randoms to be clipped out instead of a half sheet and a small random. Since half sheets have a greater dollar value in the marketplace, it is obviously a management decisions to determine whether the goal is to maximize wood recovery or to maximize dollar value. Regardless of that fact, this option allows the recovery of as much good wood as possible in this particular situation. The use or non-use of this option was taken into consideration during the digitizing operation.

An example of inaccurately clipped recoverable material can be seen in Figure 16. Here, good veneer is lost because of an improperly placed clip. Regardless of the specific mechanical or electrical reason for the inaccurately placed clip, it did not occur where it was supposed to with the resulting loss of potentially usable veneer. The clip should have occurred one inch (the allowable margin) from the defect. In this example, there are 25 inches of good veneer before the defect, a random strip of 24 inches

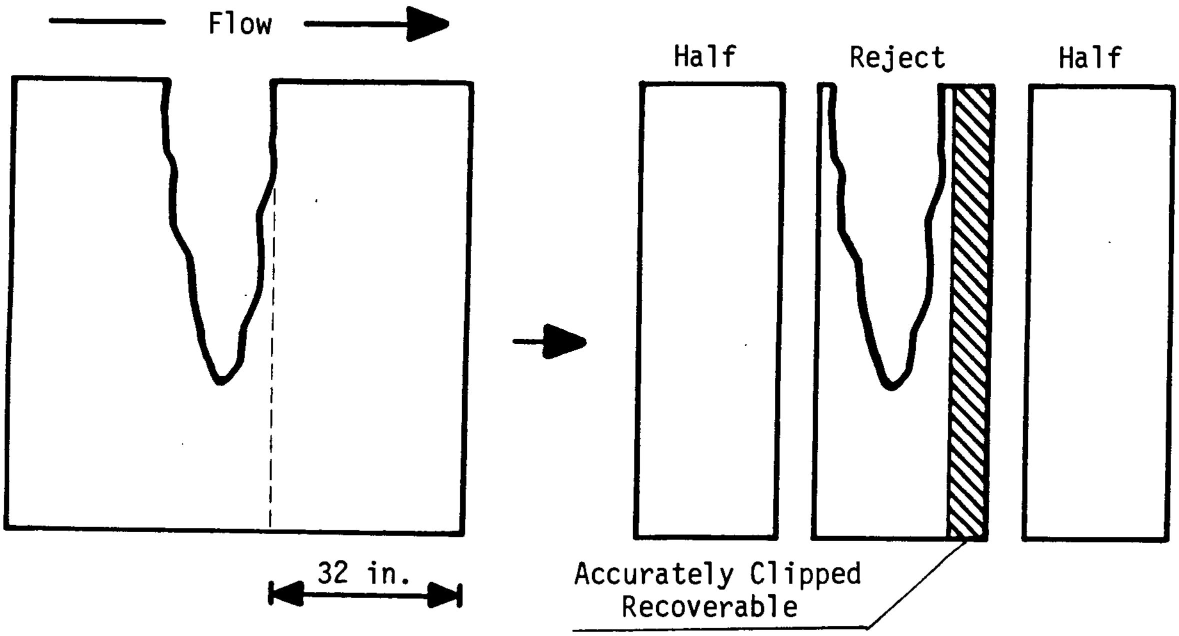

Figure 15. Example of the accurately clipped recoverable veneer classification.

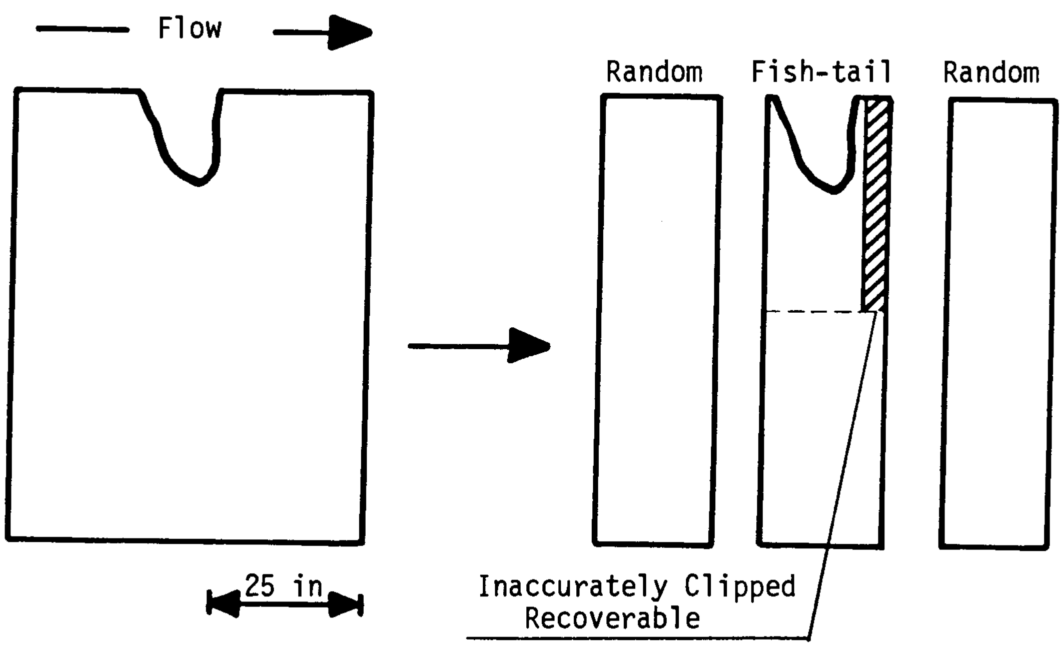

Figure 16. Example of the inaccurately clipped recoverable veneer classification.

should have been clipped out. Instead, the clip came two inches too early and only a 22-inch strip was actually clipped out. This caused a two-inch loss of potentially recoverable veneer on the fish-tail trim. Assume that the trimmed fish-tails are trimmed to 60 inches in length and the spur knives are set at 101 inches. Therefore, that early clip resulted in the loss of 82 square inches (0.57 sq. ft.) of good veneer. The digitizing sequence for this example would be as follows: First the random strip was digitized, the untrimmed fish-tail, the trimmed fish-tail, the inaccurately clipped recoverable portion and finally the second random strip.

Figure 17 illustrates a digitizing sequence in which there is the simultaneous occurrence of losses due to both accurate and inaccurate clipps. There are 58 inches of sound wood in front of the large open defect. This allows a 54-inch full sheet to be clipped out leaving four inches before the defect. For reasons previously stated, another clip is not possible until after the defect has passed. This causes the loss of three inches for the entire length of the strip or a loss of 303 square inches (2.1 sq. ft.) of good veneer. When the next clip occurs, and if it is late, which is a common occurrence with trailing edge clips, the inaccurately clipped category of veneer loss will result. In this case, if it is two inches late (that is, three inches from the defect), it would result in a loss of a piece two inches wide down the entire length of the strip, or a loss of 202 square inches (1.4 sq. ft.) of potentially recoverable veneer. The overall result of this particular clipping sequence is the combined loss of 505 square inches (3.5 sq. ft.) of good veneer.

Generally speaking, veneer volumes in the inaccurately clipped recoverable category are lost to trash because of inadequate clipper/scanner maintenance and/or design weaknesses inherent in the system (e.g., inadequate veneer tracking by the scanner timing wheel, etc.). The accurately clipped recoverable category of losses is due to improper scanner set-up and/or the clipping hierarchy as

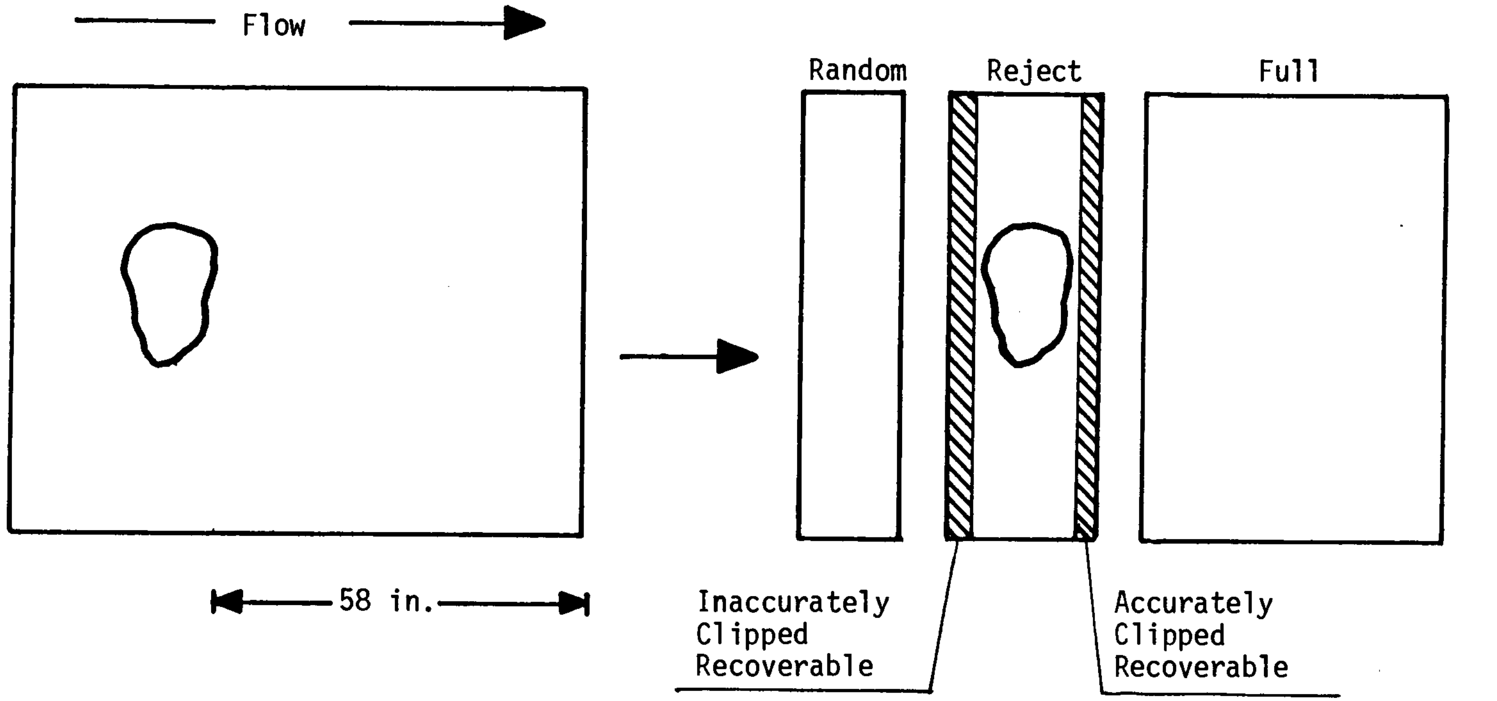

Figure 17. Example of veneer on which both the accurately and inaccurately clipped recoverable veneer classifications occur.

determined in the scanner logic by the manufacturer.

It should be noted that in two of the mills in this study, mill management had the margins set at what was considered an excessive and therefore wasteful width. For the purpose of this project, any margins wider than one inch were digitized as accurately clipped recoverable.

These digitizing procedures were carried out for every individual piece of veneer produced in the clipping of 600 peeled Douglas-fir blocks.

3. Data File Preparation

The Fortran 5 CLPLOSS Veneer Recovery Program is designed to operate from two data files called VENEER and BLOCKS (see Fig. 18). The file VENEER is created by the merging of the coded veneer files obtained from the digitizing operation. The data from each individual mill are merged together to form a single file. Likewise, all the individual files of block and core data are merged together and titled BLOCKS. These files are stored permanently and maintained separately on magnetic tape. The CLPLOSS program translates the coded veneer data from VENEER into a more meaningful form as well as calculates the associated block and core values from the BLOCKS data file. These reduced data represent the program output and the data on which the statistical analysis will be carried out.

The following generalized sequence of operations is employed in the development of the specific CLPLOSS data files. Utilizing the HP 9825A micro-computer and the HP 9874A digitizer, coded data from the laboratory digitizing operation are recorded on an HP cassette tape. Because of its relatively limited capacity, the data were transferred to CYBER, the mainframe computer at OSU, when the cassette becomes full. Once transferred with the 1200 BAUD HP TRansfer Program, the data files are checked for correctness. Once the data files are known to be correct and safely stored on magnetic tape, the HP tapes are erased, allowing them to be brought back into service in the ongoing data acquisition

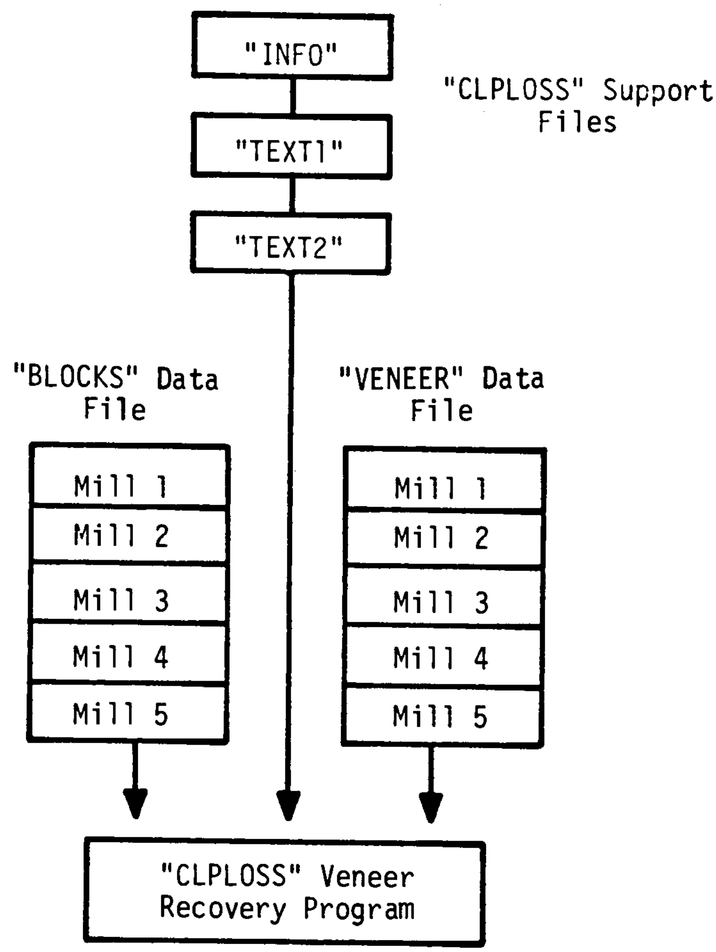

Figure 18. Data file management process for the CLPLOSS Program.

process. Redundant or simultaneous computer copies of the data are always maintained throughout the procedure to prevent any inadvertent loss of data during data manipulation.

Figure 19 presents the coded veneer information as it resides on tape as part of the VENEER data file. Included in this data file are the parameters mill number, block number, diameter class, veneer type and veneer area (in sq. ft.), respectively.

The block data used to create BLOCKS originate from the field data sheets containing both block and core data and are manually entered into CYBER. Initially the files are maintained separately for each mill. This CYBER copy is then visually checked against the field data sheet for accuracy. THe file is corrected if necessary and then recorded on magnetic tape. After all block data have been manually entered and checked to be correct, they are merged together to form the data file called BLOCKS. Figure 20 illustrates an example of the block data as it resides on tape. Included in this data field are the parameters mill number, diameter number, block number, major and minor large end diameter, major and minor small end diameter, block length, the end, center and end core diameter, the gross and net Scribner scale, respectively.

The three CLPLOSS support files are those called INFO, TEXT1 and TEXT2. The file INFO consists of a two-dimensional array containing the average veneer thickness and spur-knife setting for each of the five mills being examined (see Fig. 21). The two TEXT files contain lengthy segments of explanatory commentary necessary for the CLPLOSS output.

Once all the veneer raw data had been stored on CYBER, the data file for each mill was examined line by line using the SIPS (Statistical Interactive Programming System) statistical package available on CYBER. Upon examination of the descriptive statistics of the full, half and random veneer data for each mill, errors were noted. These errors were due to either incorrect keystrokes or incorrect digitizing procedures as initiated by the H/P computer operator. Because the raw data file contains over 104,000 lines representing

1.000	1.000	2.000	9.000	7.377
1.000	1.000	2.000	9.000	1.705
1.000	1.000	2.000	9.000	10.909
1.000	1.000	2.000	7.000	8.297
1.000	1.000	2.000	9.000	4.298
1.000	1.000	2.000	9.000	4.508
1.000	1.000	2.000	9.000	7.574
1.000	1.000	2.000	3.000	4.664
1.000	1.000	2.000	9.000	8.244
1.000	1.000	2.000	9.000	1.323

Figure 19. Example of the coded veneer data as produced during the digitizing operation.

1101	15.2500	15.2500	14.5625	14.3750	102.6250	5.3125	5.2300	5.1875	60	60
1102	12.0000	11.2500	11.5625	10.9375	102.6875	5.3750	5.3500	5.2500	30	30
1103	14.8125	14.4375	14.4375	13.7500	102.8125	5.2500	5.2500	5.1875	50	50
1104	11.5000	10.8750	11.5000	10.8/50	102.8125	5.1875	5.3000	5.1875	30	30
1105	14.1875	13.9375	13.2500	12.2500	102.9375	5.2500	5.2500	5.1875	40	40
1106	11.1875	11.0000	11.1250	10.5625	102.7500	5.3125	5.2500	5.1250	30	30
1107	12.8125	12.3750	11.8125	11.2500	102.6250	5.1875	5.3000	5.1875	30	30
1108	11.3125	10.9375	11.0000	10.7500	102.6250	5.2500	5.2000	5.1875	30	30
1110	11.1250	10.5000	10.8125	10.4375	102.8125	6.1400	6.0600	6.0800	30	30

Figure 20. Example of the data as they exist on the file called BLOCKS.

INFO

100.93750	101.03125	101.12500	101.37500	100.43750
.10135	.10056	.12726	.12750	.09798

Figure 21. Small support file called INFO containing veneer thickness and spur-knife settings for each mill.

more than 200,000 individual keystrokes, some operator errors would be expected.

The descriptive information for the full sheets from mill 1 can be seen in Table 3. It can be seen that the full sheets produced by this mill apparently range from 7.125 to 53.998 square feet in area. A standard full sheet approximates 37 square feet in area. Obviously, the range indicated is far too broad to be accepted as representative of the true population of actually clipped fulls. Examining the frequency distribution provides further insight into the apparent distribution anomalies. The true population of the fulls appears to exist somewhere between 33.750 to 39.500 square feet. Its average is 37.18681 as determined from 4,789 individual sheets. Statistically speaking, 99.7 percent of the true population of fulls from this mill should reside within three standard deviations of the observed sample mean. This is 37.18681 ± 4.11273 or within the interval between 33.07408 to 41.29954 square feet.

After examining all full sheets from all five mills, an overall interval for sheet area of from 33.500 to 41.000 square feet was considered to be correct and acceptable. Therefore, any data lines with a full sheet area outside this interval required adjustment. By examining the raw data file itself and scrutinizing the series of events and digitizing sequence, it could be determined logically on a line-by-line basis, what the keystroke for that particular line should have been or the approximate range the area should have been. The raw data files were then edited by either changing the veneer code value or changing the area to some logical and assumed value.

This process was carried out on the entire raw data file for the fulls, halves and randoms from each mill. Table 4 presents the average areas of fulls and halves as provided by SIPS. A Fortran 5 program was written to automatically search through the mill veneer file and change the lines as necessary or to flag those lines requiring individual attention. Figure 22 presents the intervals over which the fulls, halves and randoms were adjusted while

Table 3. A SIPS statistical summary on the individual uncorrected full sheet areas for mill 1.

```
DESCRIBE,4

 VARIABLE DESCRIPTION TABLE FOR VARIABLE    4

 SAMPLE SIZE                 4786
 SUM                    177970.90100
 RAW SUM OF SQUARES 6626971.33455
 COR. SUM OF SQUARES    8993.56553

 AVERAGE                    37.18573
 ST. ERROR OF MEAN            .01982
 MEDIAN                     37.28800
 MAXIMUM VALUE              53.99800
 MINIMUM VALUE               7.12500

 SAMPLE VARIANCE             1.87953
 SAMPLE ST. DEV.             1.37096
 COEF. OF VARIATION           .03687
 RANGE                      46.87300
 SKEWNESS                  -12.41176
 KURTOSIS                  183.07988
```

Table 3, continued.

FREQUENCY DISTRIBUTION
VARIABLE 4

INT	FROM	UP TO BUT NOT INCLUDING	FREQUENCY	PERCENT FREQ
	-	30.0000	24	.501
1	30.0000	30.2500	1	.021
2	30.2500	30.5000	0	0.000
3	30.5000	30.7500	0	0.000
4	30.7500	31.0000	0	0.000
5	31.0000	31.2500	0	0.000
6	31.2500	31.5000	0	0.000
7	31.5000	31.7500	1	.021
8	31.7500	32.0000	0	0.000
9	32.0000	32.2500	2	.042
10	32.2500	32.5000	0	0.000
11	32.5000	32.7500	0	0.000
12	32.7500	33.0000	0	0.000
13	33.0000	33.2500	0	0.000
14	33.2500	33.5000	0	0.000
15	33.5000	33.7500	0	0.000
16	33.7500	34.0000	1	.021
17	34.0000	34.2500	2	.042
18	34.2500	34.5000	1	.021
19	34.5000	34.7500	0	0.000
20	34.7500	35.0000	1	.021
21	35.0000	35.2500	3	.063
22	35.2500	35.5000	3	.063
23	35.5000	35.7500	3	.063
24	35.7500	36.0000	3	.063
25	36.0000	36.2500	17	.355
26	36.2500	36.5000	59	1.233
27	36.5000	36.7500	209	4.367
28	36.7500	37.0000	657	13.728
29	37.0000	37.2500	1177	24.593
30	37.2500	37.5000	1380	28.834
31	37.5000	37.7500	867	18.115
32	37.7500	38.0000	310	6.477
33	38.0000	38.2500	52	1.087
34	38.2500	38.5000	6	.125
35	38.5000	38.7500	2	.042
36	38.7500	39.0000	0	0.000
37	39.0000	39.2500	1	.021
38	39.2500	39.5000	0	0.000
39	39.5000	39.7500	1	.021
40	39.7500	40.0000	0	0.000
41	40.0000	40.2500	0	0.000
42	40.2500	40.5000	0	0.000
43	40.5000	40.7500	0	0.000
44	40.7500	41.0000	0	0.000
45	41.0000	41.2500	0	0.000
46	41.2500	41.5000	0	0.000
47	41.5000	41.7500	0	0.000
48	41.7500	42.0000	0	0.000
49	42.0000	42.2500	0	0.000
50	42.2500	42.5000	1	.021
	42.5000	-	2	0.000

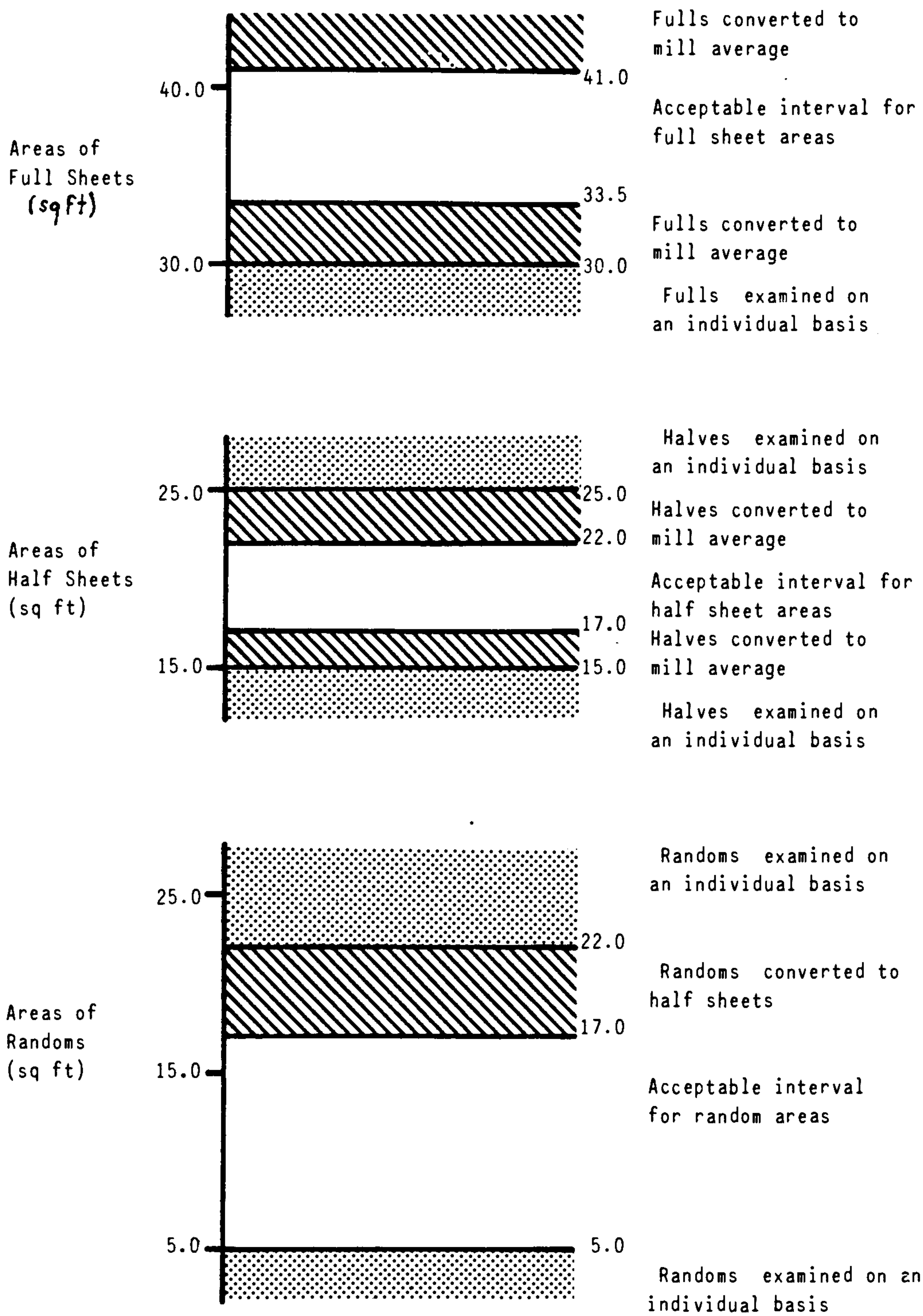

Figure 22. Sheet area intervals employed in the veneer data adjustment procedures.

Table 4. Average sheet sizes to which specific data lines within the veneer data files were converted.

	Average Full Sheet Area (sq. ft.)	Average Half Sheet Area (sq. ft.)
Mill 1	37.187	18.655
Mill 2	37.260	18.667
Mill 3	37.782	18.427
Mill 4	37.566	18.854
Mill 5	36.951	18.673

Table 5 presents the total number of changes actually implemented in the veneer data file. For example, if a full sheet measured 37.000 square feet but had a veneer code of 2, the half sheet code, there was no question that for that line of data, a keystroke error existed requiring the code to be changed to 1, the full sheet code. On the other hand, if a "full" sheet measured 53.000 square feet, it is obvious that the area is incorrect. The veneer actually digitized may have represented a full sheet plus a random with the digitizing operator not able to discern a clip line between the two. For whatever reason, the area for the full sheet was not correct. Since it was both very difficult and very time-consuming to go back to the individual frame of the movie film, the area of that full sheet was converted to the average full sheet area for that mill. The changing of a veneer code was considered an insignificant sheet area to some average value was considered a significant data change and not taken lightly. Out of the total of 42,836 data lines examined for correctness, only 453 or 1.1 percent were actually changed from their original entered value. It is for this reason that the veneer data base should not be considered incorrect or suspect.

4. Clipper/Scanner Operations

Historically, the function of clipping a ribbon of veneer has been a very simple process. A simple operator-controlled, pneumatically actuated guillotine knife clipped out defects while a simple timing mechanism or photo-electric detectors provided the

Table 5. The total of all veneer items examined including those converted in the veneer data file.

	Number of Pieces Produced and Digitized			Number of Pieces Automatically Converted to New Areas		Number of Pieces Individually Examined and Converted to New Codes		
	Fulls	Halves	Randoms	Fulls	Halves	Fulls	Halves	Randoms
Mill 1	4,773	2,369	1,627	7	77	24	13	16
Mill 2	4,691	2,170	2,680	4	49	20	21	9
Mill 3	2,110	1,508	3,427	1	116	8	9	15
Mill 4	3,480	2,151	1,450	0	87	7	6	7
Mill 5	3,678	3,709	3,013	10	102	27	28	4
Total	18,731	11,907	12,197	22	431	86	77	51

clips for the standard full and half sheets. The process was not only slow and cheap but very wasteful, even in the hands of an experienced clipper operator. With the advent of increasing raw material costs, waste eventually became an area of increasing concern. The period from 1964 to 1965 saw the introduction of computer and optical scanning technology to the clipping operation. With the marriage of these two technologies to the mechanical clipper, that production station should be perhaps more correctly termed the clipper/scanner operation and it is that term which will be employed throughout this paper when referring to that station.

Since its introduction into the industry, it has brought about significant improvements in:

1. standard sheet width accuracy and precision
2. accurate and precise defect clipping
3. increasing throughput
4. increasing profit by decreasing waste

The ultimate purpose of the green veneer clipper is to produce the maximum number of full sheets of acceptable quality. Maximizing the number of full sheets is its only purpose and the occurrence of all other components (halves, randoms and untrimmed fish-tails) exists only as a consequence of discontinuous or defect-containing veneer ribbons and occurs at the expense of recovery. The clipping operation is inherently wasteful even when it is operating correctly. Because of knots, splits and other unacceptable defects, the clipper/scanner operation functions to:

1. remove the defects with a minimum waste of good veneer
2. precisely clip standard sheets of accurate size
3. clip at high feed rates without damaging or wasting good veneer
4. produce the fewest possible production jams
5. reduce human intervention in the clipping decision process

In discussing the operation of the clipper/scanner station, it is necessary to present its basic operating principles. It is assumed that the reader is moderately familiar with green veneer production and its associated processes. Clipper/scanner components, operations, and terminology obviously vary greatly from manufacturer to manufacturer, but also from model to model. No single system will be presented here, but a general description, broad enough to encompass the basic operations inherent in even the most common of systems.

Figure 23 illustrates the three major components of a typical clipper/scanner operation: the clipper, the scanner and the logic controller. The clipper mechanically cuts the veneer, either in an automatic mode under the control of the scanner logic, or manually, through an operator override. The logic controller receives information from both the clipper and the scanner. For the clipper/scanner station to carry out its objective of maximizing the number of acceptable quality full sheets, it must be provided with information on:

1. veneer speed
2. defect location
3. defect size
4. knife position
5. management criterion

The model as presented in Figure 24 illustrates these basic inputs as required by the logic controller to accurately control the clipper in the automatic mode.

There exists basically two manufacturers for defect scanning of rotary peeled green veneer in the United States, one of which distinctly predominates the market. Their general operation will be considered here.

The measurement of veneer motion is critical to the proper placement of the knife clip. At present that measurement must be made by direct contact with the veneer. This is most often done by the use of a free-spinning tracking wheel called a line clock or timing wheel, usually about ten inches in diameter. It is mounted

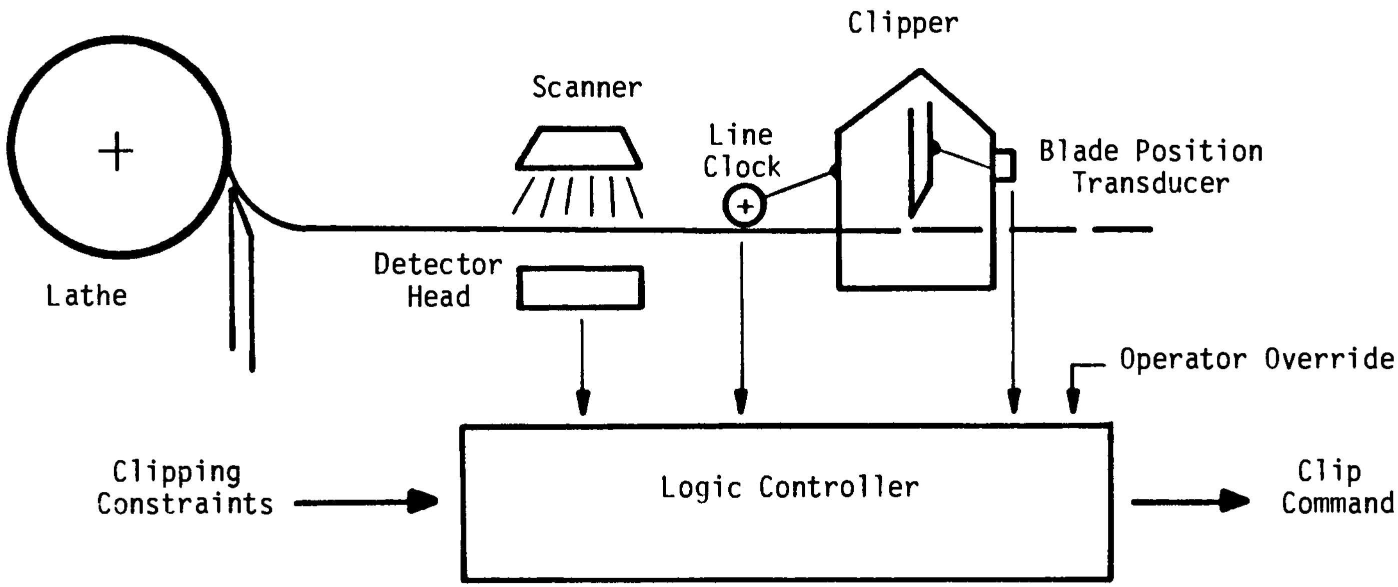

Figure 23. Major components of a typical veneer clipper/scanner operation.

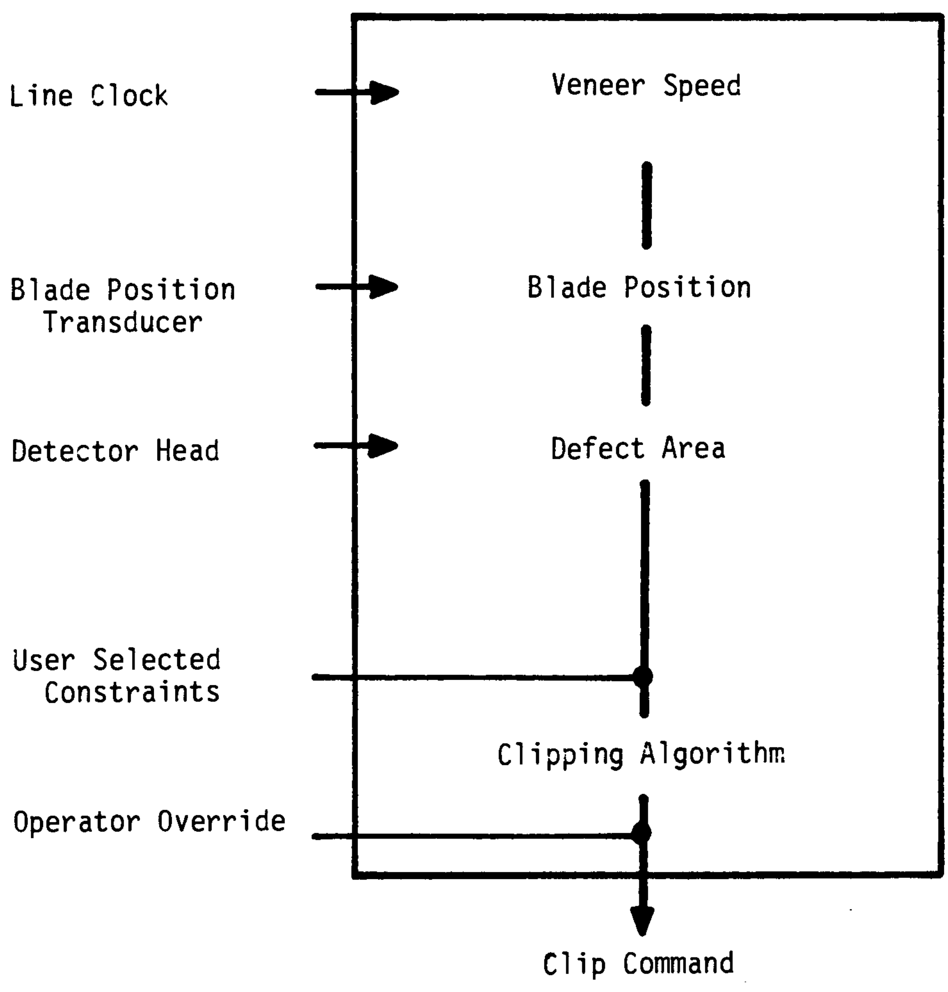

Figure 24. Basic inputs to a clipper/scanner logic controller.

about 30 inches upstream of the clipper knife and is coupled to a rotary transducer or encoder. The transducer may provide either a digital or analog signal (depending on the manufacturer) to the logic controller. The analog encoder allows the differentiation between forward and reverse moving veneer where the digital output does not. This input provides information on veneer speed and defect location in the cross grain dimension. This line speed information is constantly being updated to allow for very small and very fast changes in line speed. However, this line speed data, at best, can be considered only "apparent" or "approximate" line speed information by virtue of the method in which it is obtained. There are inherent drawbacks with this direct contact measurement method in the form of contact slippage, positional placement and wheel wear that can ultimately contribute to improper clip placement. The line speed input is by far the most sensitive factor in regard to incorrect clips. For good data to be provided to the logic controller, the line clock wheel must respond perfectly and instantaneously to reflect the true and actual movement of veneer on the clipper infeed conveyor. The use of a toothed disk or neoprene wheel minimizes any relative motion between the wheel and the moving veneer. Maintaining a high coefficient of friction between the veneer and its low mass allows the line clock to respond relatively well to rapid and minute changes in veneer speed. A line clock that is allowed to bounce and thereby reduce its contact with the moving veneer will produce an incorrect output. Use of hold down springs or a small air-loaded cylinder that maintains a constant downward pressure of the line clock onto the veneer will minimize bounce and, therefore, provide good horizontal positional placement.

Being provided with line speed information, the logic circuit is able to calculate the appropriate downstream placement of a clip. However, the calculation requires allowances for value delay, random variation, knife fall time, etc., for the clip to be accurately placed. The knife position transducer provides constantly updated information on that time interval that is required. This input is also averaged over a specified period to smooth out any random variation thus, on the average, assuring proper clip placement.

Occasions arise when a clip must be made prior to the knife returning to its topmost position, i.e., before the fall stroke cycle is completed. The veneer speed and the minimum time that is required between clip cycles, determines how narrow a piece of veneer may be clipped. The capacity for a system to accept a second clip command before the previous clip cycle is completed is extremely important in terms of veneer recovery (often called a "quick clip" or "short cycle clip"). It is obvious that the second clip must occur at some point after the knife begins leaving the veneer plane. Therefore, there is a critical minimum point of the return stroke in which a second stroke can take place. That critical point is determined by the manufacturer and is employed by the logic processor along with the input provided by the knife position transducer, to determine when a minimum clip is allowed to take place. For example, with a line speed of 250 feet per minute, this capability may mean the difference between 5.5 inches for a full clip cycle clip and 3.5 inches for a minimum strip width (respectively, 100 ms. and 70 ms. clip cycles are assumed).

Three integral components, the light source, the detector head and the logic controller, operate together to form the basic optical scanner system. It is considered an optical scanner since it is receptive to light in the visible portion of the spectrum. The scanner is a through beam sensory arrangement that detects open veneer voids only. As indicated in Figure 25, the light and dark information is translated digitally in the form of high (+) and low (-) voltage signals. The overhead incandescent light source is positioned approximately four feet above the veneer and placed about three feet upstream of the clipper knife. Directly under the light source and beneath the moving veneer is the light detector. Depending on the manufacturer, it consists of a linear array of light detectors located either directly under the veneer plane or remotely in the logic controller itself and connected individually by fiber optics. These detectors are spaced about one half-inch apart and it is this close spacing that ultimately determines the system's with grain resolution. To eliminate cross-talk between sensors, they are sequentially multiplexed which provides a corss-grain resolution of about 1/10-inch at a line speed of 200 feet per minute. As illustrated in Figure 26, it is these inputs that provide the controller with information on defect size and its relative location within the veneer ribbon.

The logic controller in the case of one manufacturer is a mini-computer and in the other case is a hard-wired, process controller, read only memory device. It is within these devices that information is updated, stored, processed and from which the clip signal originated.

The user selected constraints are designated inputs to the clipping algorithm that determine various veneer processing parameters. These inputs are usually dialed into the system from the front of the logic control cabinet. These constraints may include full sheet width, half sheet width, minimum strip, minimum fish-tail length, minimum ribbon width, within ribbon and edge flaw limits, flaw centering and margins.

Switch settings are usually in inches or tenth of inches, depending on the specific function. The correct understanding and implementation of these inputs determine effective clipping strategy and fully utuilize the recovery potential of the system. Some of the more important user-selected options of general consideration in the clipper/scanner operations are included in the Glossary.

The clipper operator manual override switch is necessary to assist in clearing veneer jams, clipping out excessively thick or

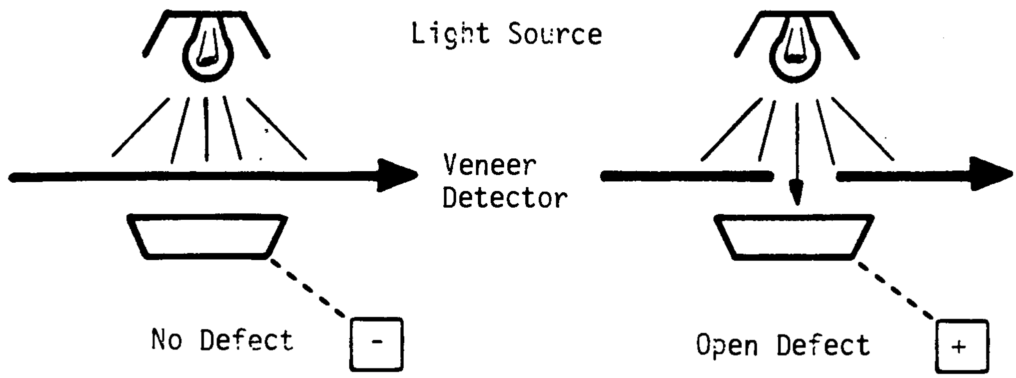

Figure 25. Typical through beam optical scanner operation.

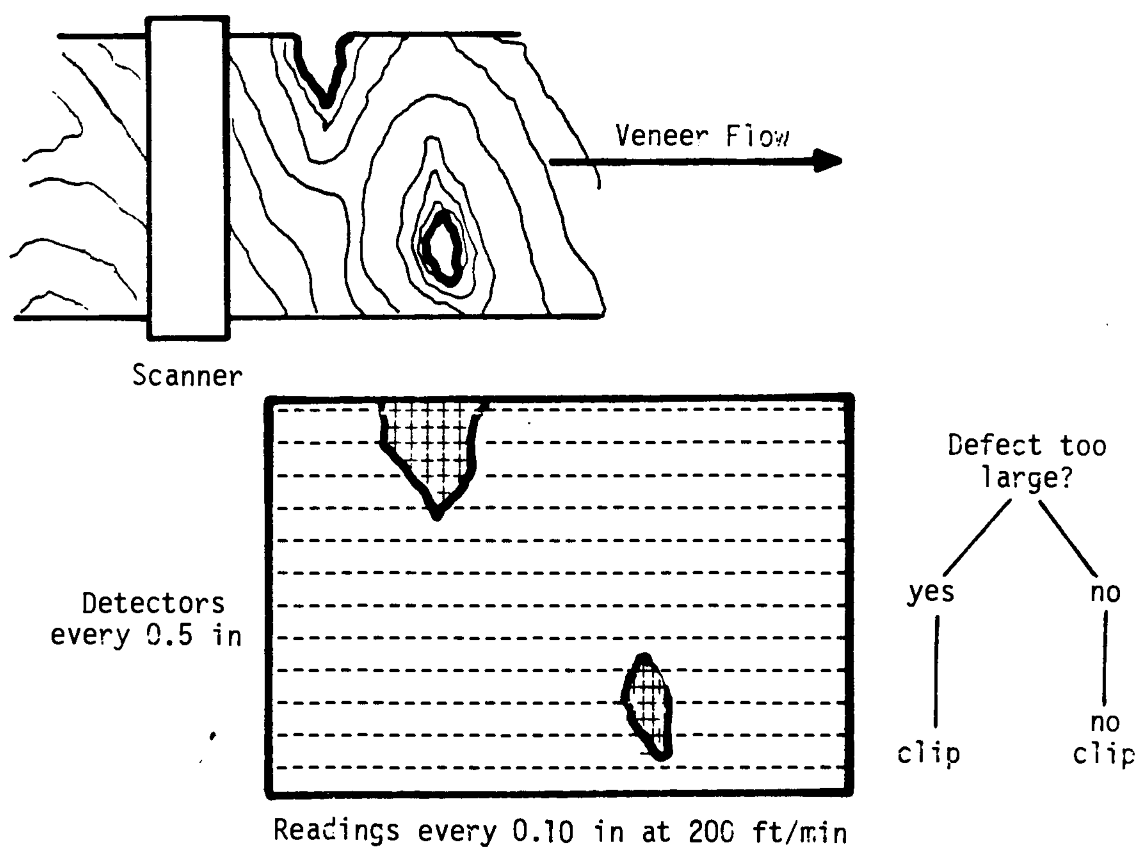

Figure 26. Simplified presentation of the scanner operation.

thin veneer, etc. This function totally circumvents the logic circuitry and allows the knife to be actuated repeatedly as long as the switch is depressed.

In regard to the clipper, only green veneer guillotine-type clippers as used in rotary peeling operations will be considered in depth here since they represent the majority of those within the industry. However, a periferal discussion of the rotary-type clipper will be provided. Of the nine clipper manufacturers in the U.S., four predominate the industry. Their general operation will be considered here.

A veneer clipper basically consists of a vertically reciprocating knife, a knife anvil, toggle linkage, one or more double-acting pneumatic cylinders and their associated pilot or servo valves. Even though there are hydraulically operated clippers, most are pneumatically actuated because of their ease of maintenance, cheaper initial costs and long life expectancy. In both cases, the pilot valves receive the clip command from the logic controller to controlling the intake and exhaust values of the actuator(s). Toggle linkage connects the actuator(s) to the knife.

In 1977, Maxey [31] helped to standardize specific terminology and to provide insight into the actual clipping mechanics. These specific terms will be presented here and employed throughout this paper. Figure 27 illustrates a typical plot of knife travel during a single clipping stroke. Time is indicated horizontally in milliseconds (1 ms. = 1/1000 sec.) and knife displacement or travel on the vertical axis in inches. The time interval occurring between receiving the clip command at the pilot valve to the time the knife actually begins its downward movement is termed the valve delay time. The reasons for valve delay time are:

1. the physical limitations of moving some quantity of fluid (air) from the air supply side of the pilot valve to fill the actuator cylinder volume itself

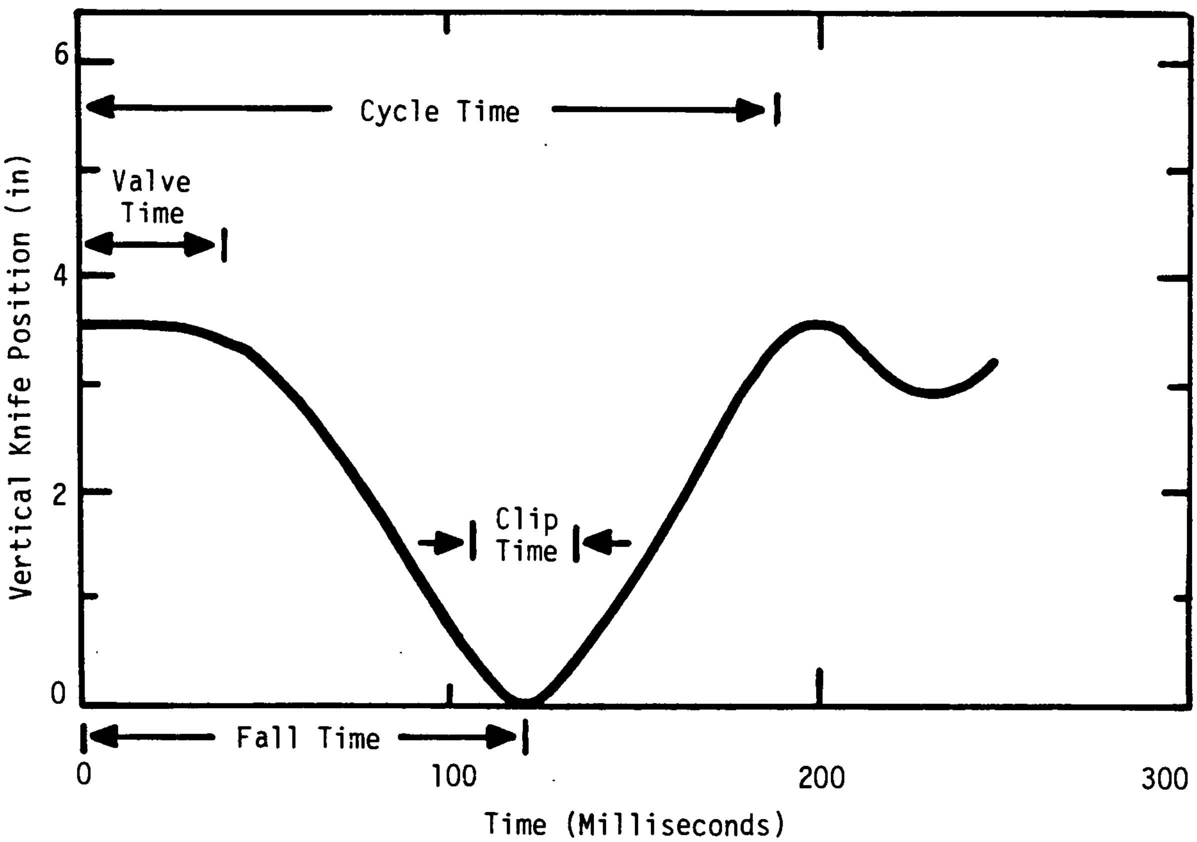

Figure 27. Typical plot of knife travel during a single clipping cycle as determined by Maxey.

2. the degree of compressability of that fluid
3. the responsiveness of the pilot valves
4. the inertial mass of the knife, toggle linkage and cylinder that must be overcome to initiate downward movement
5. the overall system maintenance of the system

The time between the occurrence of the clip command and the knife contacting the anvil is called the knife fall time. All of the above-mentioned factors may interact to retard the overall downward acceleration of the knife mass and thereby increase the knife fall time.

As the knife completes its downward stroke, it stops then begins accelerating upwards only to decelerate and finally stop in its standby position at its uppermost position. The dynamics of stopping the accelerating mass at its topmost position causes the knife to go slightly past its full up position creating a series of increasingly dampened oscillations. These oscillations may be reduced passively through the use of cushion blocks or actively, as with one manufacturer, with air brakes. The time interval from the clip command to the point when the knife returns to its uppermost position is termed its clip cycle time.

The clip cycle time is increased by the presence of the already mentioned factors, but also is significantly lengthened by:

1. a large knife gap or the distance between the knife edge at its standby position and its contact with the knife anvil
2. the lack of sequential valving (either two- or three-stage) allowing higher flow rates at the beginning of the cycle
3. a large knife assembly mass
4. poor pneumatic design (many hose corners, length of lines, restrictions, undried air, etc.)

Raw material recovery is enhanced by a very short and consistent clip cycle.

There is a point in the knife travel in which the knife comes into contact with the upper surface of the veneer. From that point the knife continues down through the wood strikes the anvil and begins its return travel to clear the cut. The length of time the knife remains in the wood is called the clip time. Since this relates directly to veneer thickness, the time presented in Figure 27 represents the clip time when considering 0.25-inch veneer. The times indicated by the graph may represent values from that study but certainly do not represent present state-of-the-art capabilities. One of the fastest guillotine clippers presently marketed is capable of averaging 100 ms. cycle times.

The requirements for a consistent and effective clipping operation are:

1. a very repeatable clip cycle
2. an attentive and capable clipper operator
3. an effective and well-maintained veneer hold down mechanism
4. a well-maintained infeed and outfeed conveyor system
5. a well-maintained clipper
6. knowledge of system clipping strategy and appropriate implementation of user-selected options
7. the use of a clean and operationally effective timing wheel
8. periodic cleaning of the clear plastic or glass detector head

The scanner system being predominately electronic, and therefore extremely reliable, does not usually enter into a preventative maintenance program.

There are many reasons for inaccurate clips:

1. machine maintenance
2. machine capabilities
3. clipping strategy

If a clipper/scanner facility is not properly maintained its true potential in raw material recovery and return an investment is not being fully realized. The use of undried or inadequately filtered air will promote inconsistent clips. Infeed and outfeed belts of improper length or tension will cause wedge clipping. An unclean or excessively worn timing wheel will accentuate clip cycle variation and wood waste.

Inherent in the guillotine clipper/scanner design are inadequacies, that since its inception have proved to be bothersome and detracted substantially from its recovery capabilities. To accurately locate the clip, the scanner logic assumes that the veneer is always where it is supposed to be as indicated by the line clock output. The line clock, from its position upstream of the knife, provides line speed information which is translated to "time-to-clip" information by the logic circuitry. With this data, the logic processor calculates that the veneer will be under the clipper knife at some discreet point in time. However, much can happen to the veneer between the time the information is obtained to the time the actual clip actually takes place. A slipping clutch or any other change in belt speed will adversely affect the clip placement. Any difference in speeds between the belts and the veneer riding on it will cause incorrect clips. For instance, on any discontinuous ribbon of veneer, the timing may have the opportunity to ride on the conveyor belt and provide belt speed which may or may not be the same as veneer speed. If the veneer is moving faster than the belts, the line clock will provide information causing a clip signal to occur too late. The simple act of cutting moving veneer with a reciprocating knife action further complicates the clipping operation. As the downward moving knife enters the veneer, its forward motion is abruptly halted. This action forces the veneer to slip on the infeed belts while further upstream. The flow is uninterrupted.

This causes two problems. First, the still moving veneer "piles" up at the knife causing the veneer to buckle, thus promoting wood damage on the leading edge, especially with thin, cold-peeled or relative brittle species of veneer. Secondly, there occur differences in speed within the same segment of veneer. Between these extremes of unimpeded flow and completely stopped veneer, the veneer is moving at some speed less than true line speed. The line clock will incorrectly represent veneer speed by a degree dependent on its placement within this interrupted veneer segment. this latter problem could be avoided by placing the line clock further upstream of the clipper knife. This would then provide a more consistent true line speed output. However, there are concomitant disadvantages such as:

1. the greater the distance between the line clock and the knife, the greater the potential for erroneous movement of the veneer
2. small low mass strips of veneer when stopped by the clipper knife take longer to re-accelerate to line speed, thereby causing the trailing edge clip to come too early

The apparently obvious solution to a high upstream placement of the line clock would be that of placing it right at the clipper knife. This reduces the timed distance to an absolute minimum. The disadvantages created by this placement would be:

1. the mechanical restrictions (actuation time) of the clipper cannot provide the necessary responsiveness
2. the veneer speed is momentarily zero right at the clipper knife thus producing erroneous output
3. the formation of the veneer buckle behind the clipper knife induces timing wheel bounce

To minimize these effects, the timing wheel is often placed between these two extremes, or about thirty inches upstream of the knife as an effective compromise.

The rotary veneer clipper eliminates many of the previously mentioned detractants of the more common guillotine clipper. In its standby position, a very thin two-edged knife is stationed horizontally above the moving veneer as illustrated in Figure 28. In its clip cycle the knife is hydraulically rotated 180° around its longitudinal centerline between two large counter-rotating anvils. The rotating knife cuts the veneer against the lower anvil and is at the same time supported by the upper anvil during the clip.

D. Computer Programs

1. Micro-computer Programs

The four Hewlett-Packard programs operate on a relatively self-explanatory basis and are contained in Appendix C. All contain substantial comment statement in the programs and automatic prompts during their operation which, with proper preparation, should allow even the novice operator to correctly use.

The four HP programs consist of a digitizing program, a control sheet program, a data file print and a 1200 BAUD transfer program. The objectives and the basic operation of each will be covered here.

For the correct use of the HP digitizing program, it is assumed that the 8mm projector is properly aligned and the digitizing platen is properly positioned (see the Projector Alignment Section). In addition, one should become acquainted with specific digitizing procedures as established for this project. Initially the program will request a file number to which space has been allocated for storage, a digitizing identification number and, finally, specific code values, i.e., the mill number (1 through 5), the code number for the peeler block diameter (1 through 4), the

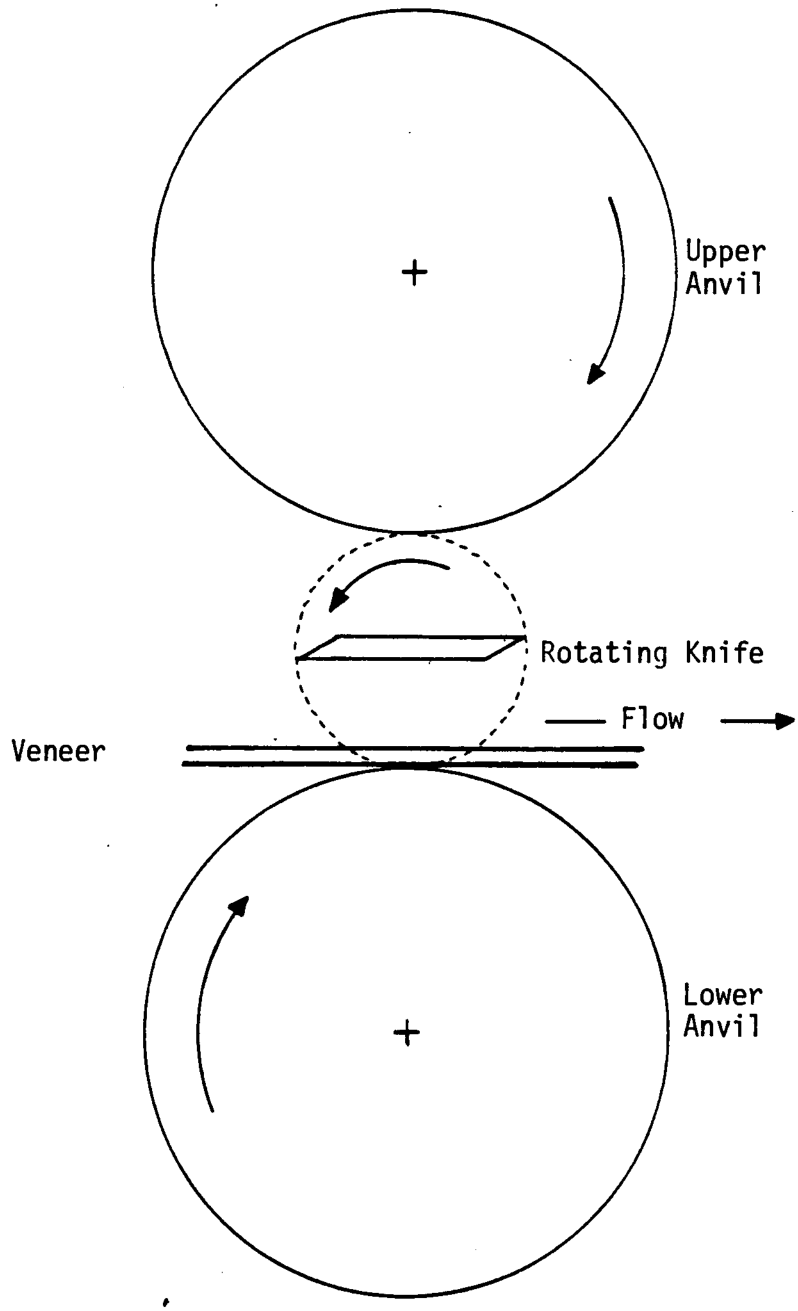

Figure 28. Example of the mechanical operation of a rotary clipper.

block or replicate number (1 through 30) and the type of veneer being digitized. As the digitizing session proceeds, the information is continuously stored on cassette tape. A nested series of DO loops facilitate the digitizing process in a logical manner and aid in reducing the total number of operator keystrokes to a minimum. The program will allow the operator to appropriately exit the process at any time.

The purpose of the control sheet program is to obtain a scalar value that is representative of the size relationship between the projected image of a full sheet and the actual full sheet size as measured in the mill (see Fig. 10). This numerical relationship is used in the digitizing program to calculate sheet areas and is individually determined for each mill. This program determines the distance between two points (the pair-wise marks on the control sheet) and displays that value in units of platen-inches. It is this value that is used to calculate the scalar value.

Once developed, the film frame containing this sheet is projected onto the digitizer platen. With the control sheet program loaded, the operator is directed to make repetitive measurements at each marked position, and then obtain an average value for the position. That is, dimension A would be digitized repeatedly, perhaps ten times, and then averaged. The same is done at each of the remaining measured sites, B through E. A ratio is then calculated:

$$\text{Scalar}_A \ \frac{\text{feet}}{\text{platen-inches}} = \frac{\text{mill measurement}_A\text{(in.)}}{\text{digitizer measurement}_A\text{(platen-in.)}} \times \frac{\text{feet}}{\text{12 inches}}$$

The scalar value for each measured location is obtained, summed and averaged, thus providing a single ratio value, representing the down-sized film image. Note the value required by the digitizing program must be on a per foot basis, hence the above conversion. This scalar value is then entered at line 55 of the digitizing program and is employed only for the particular mill from which it was taken. A unique scalar value is obtained for each subsequent mill in the same manner.

On this HP system, data files cannot simply be loaded into a HP micro-computer and printed out directly as can program files. Instead, a short program is required. Once this program is loaded into core, the operator designates the first and last file to be printed out on the Centronics line printer. Sequentially, through a series of DO loops, the data is read off the HP cassette, directed to an allocated array and sequentially, line by line, sent to the output device.

At present, this program is seldom used. However, in the beginning, as the project came on line, it was necessary in the debugging stages, to determine whether the data were actually being correctly recorded onto the cassette tape. With this program, the data file contents could be easily checked against the output as generated by the actual digitizing operation. Presently, confidence in the overall data acquisition procedure is excellent and it is for that reason the Data File Print Program is seldom used.

The 1200 BAUD HP transfer program transfers the HP cassette data to the O.S.U. mainframe computer CYBER. The transfer takes place on a line-by-line, file-by-file basis. Once the computer is connected to the modem, the program operates very simply with instructions for the proper set-up provided in the program display. Once the program is loaded into the HP computer, a file name must be entered on line 50. This will be the name of the permanent data file on CYBER.

Basically, the program is structured similar to the data file print program in that the data file on tape is read into an array allocated by the transfer program. It is from here that the actual log-on procedures enters the text mode of the text editor, transfers the data, exits the text editor, SAVES the data and carries out the log off sequence. Once the program is loaded, the operator need only enter a file name, enter the first and last file to be transferred and run the program. The HP computer transmits the data, sends a carriage return and line feed and then awaits the ready prompt (either the slash or the question mark, depending on whether it is in the control mode or text editor mode, respectively). The next line of information is then transmitted. This process continues until all the data have been transferred and the log-off procedure is initiated.

2. CLPLOSS Veneer Recovery Program

The CLPLOSS Veneer Recovery Program converts the raw data from the digitizing and scaling operations into a comprehensive and more meaningful form (see Appendix B). The program is written in Fortran 5 and is, therefore, quite transportable. Its basic objectives are to allow the analysis of:

1. green veneer recovery and losses associated with veneer production up to and including the green veneer clipper
2. the volume of potentially recoverable material presently being lost at the green veneer clipper

The data collected in the five mills and at the laboratory were used to construct the data base on which CLPLOSS was designed to operate. The base consists of two primary data files and three support files as previously described in the Data File Preparation Section (see Fig. 29). Once the raw data files had been assembled, the data were processed by the CLPLOSS Program. The basic program algorithm is presented on the subsequent page in Figure 30.

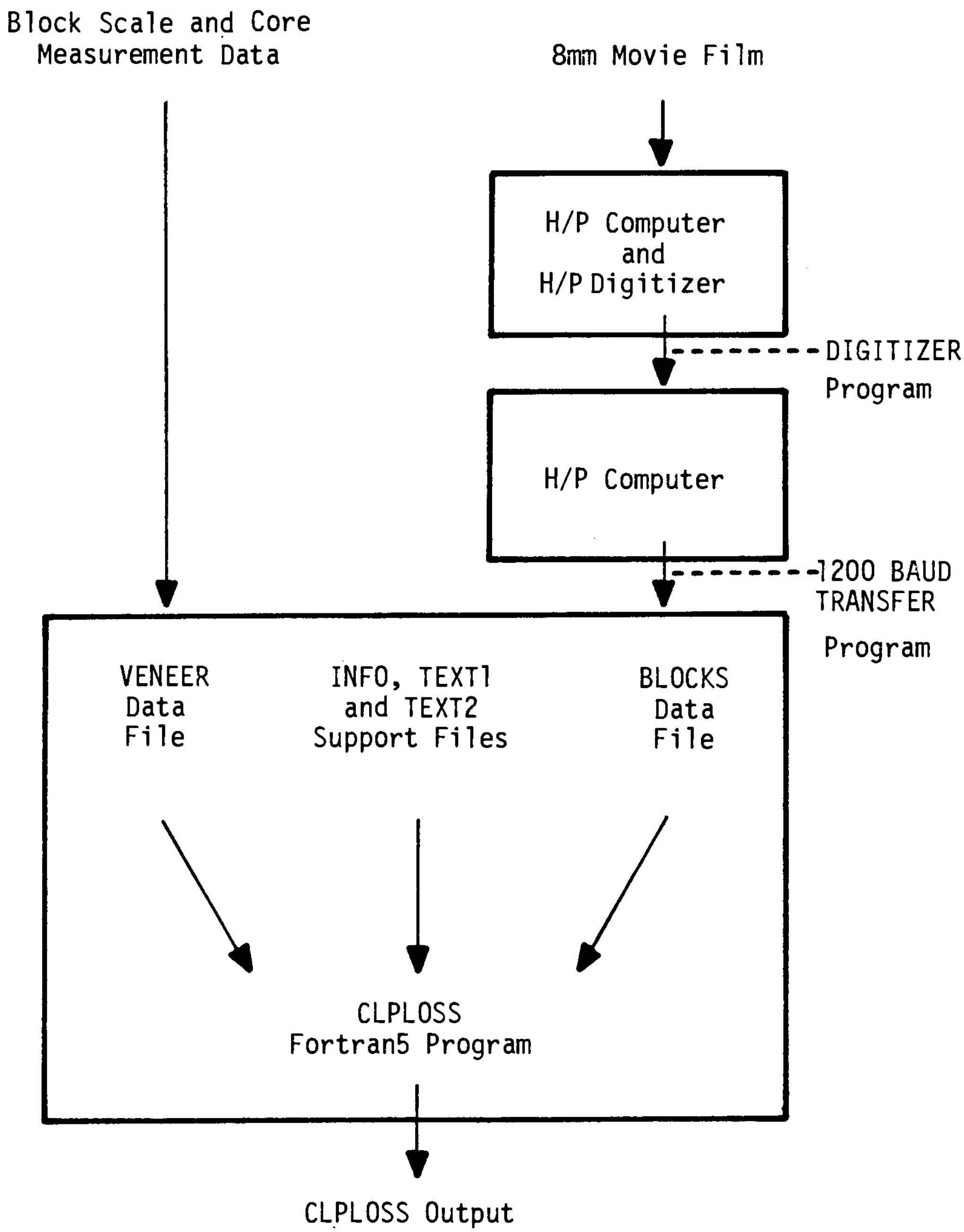

Figure 29. Data File development process for the CLPLOSS Veneer Recovery Program.

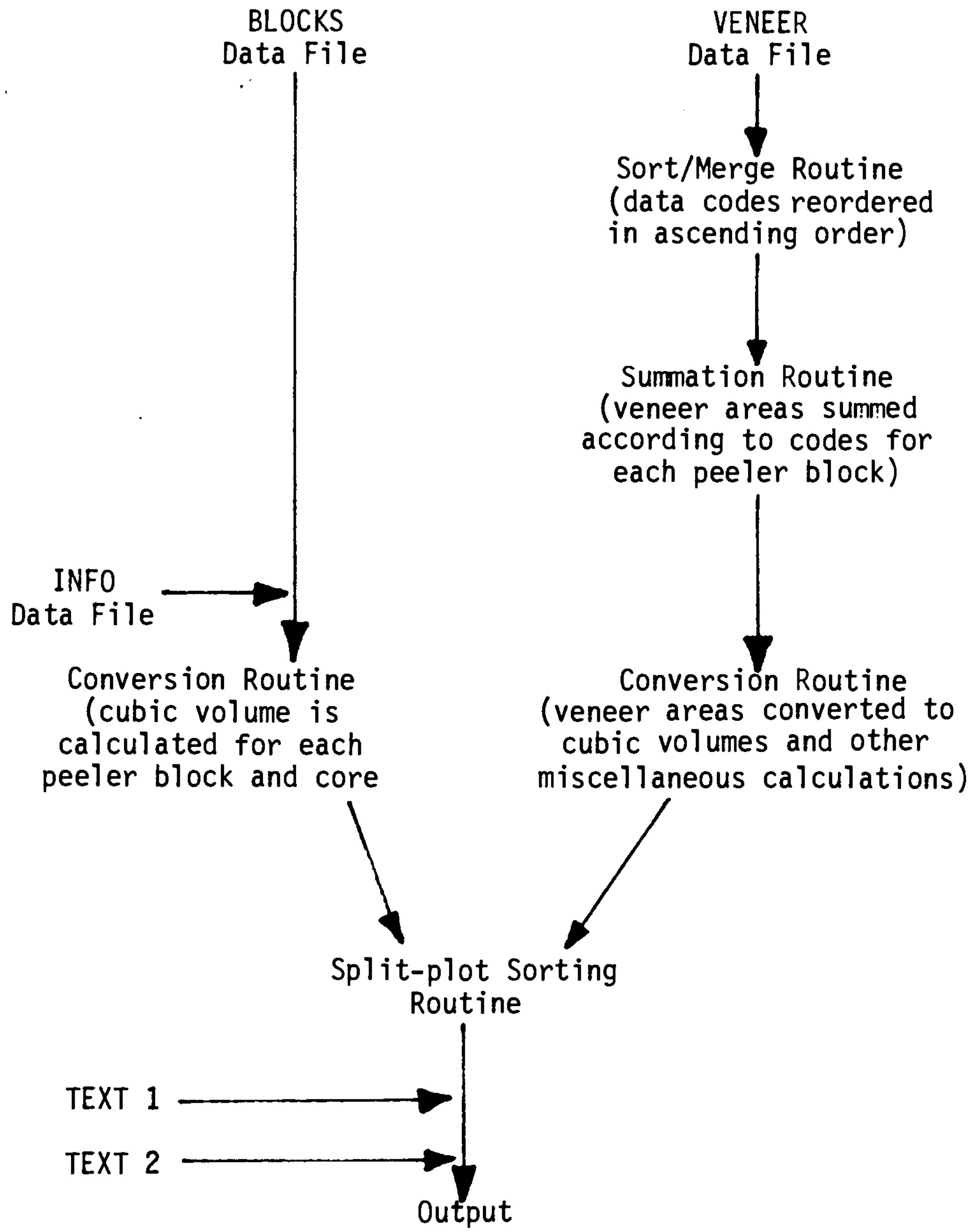

Figure 30. Outline of the CLPLOSS Veneer Program algorithm.

V. RESULTS AND DISCUSSION

This section covers the data analysis procedure, presents the reduced data and discusses the statistical results. All objectives of the CLPLOSS Veneer Recovery Project were successfully met (see Sec. II). All references to specific values obtained in this investigation originate either directly or indirectly from the CLPLOSS Computer Output in Appendix A or from the Mill Data Sheets in Appendix D.

The initial design called for thirty replicates in each split-plot cell. This would hopefully allow a split-plot analysis to be carried out to a specified sensitivity of being able to detect a difference of ± 0.1 of VRF. However, due to an inadvertent implementation error throughout the entire five mill study, the core data could not be matched with the block data on a block-by-block basis. That is, no allowance was made for marking the cores as they were ejected from the lathe and thereby allowing one to determine the specific peeler block from which it came. It was only possible to match core data according to diameter. This fact prevented the analysis from being carried out as initially intended. All veneer data that required core column data in its calculation had to be analyzed simply as a completely randomized design of five mills and four diameters. Under the completely randomized design, the analysis of the five mills required the four diameters to be treated as four replicates. Conversely, when the differences between diameters were analyzed, the five mills were treated as five replicates. This fact severely limited the number of degrees of freedom and ultimately the sensitivity of the response variables being examined. Those response variables not requiring core volumes in their calculation were analyzed as planned on a merchantable basis under the split-plot design.

The data were analyzed with the OSU host computer CYBER, employing a computer library package known as SIPS (statistical Interactive Programming System). Table 6 is a list of the response variables as presented in this report and the experimental design under which they were analyzed.

Table 6. All response variables in this project and the experimental design under which they were statistically examined

Completely Randomized Design (block cubic volume basis)	Split-plot Design (merchantable veneer volume basis)
Core Volumes	Full Sheet Volumes
Spur Volumes	Half Sheet Volumes
Trash-gate Round-up Volumes	Random Sheet Volumes
Reject Volumes	Trimmed Fish-tail Volumes
Cubic Recovery Ratio	Untrimmed Fish-tail Volumes
Veneer Recovery Factors	Reject Volumes
	Clipped Round-up Volumes
	Accurately Clipped Recoverable Volumes
	Inaccurately Clipped Recoverable Volumes
	Accurately and inaccurately Clipped Recoverable Volumes

It can be noticed that reject and trash-gate round-up data were examined under both experimental designs. Even though these two volumes are not direct components of the merchantable veneer, they are related to it in a converse manner, i.e., the greater either of these volumes, the less the merchantable veneer volume and vice versa. They are not totally independent of merchantable veneer yet they are not a direct component of it either. For that reason, it was logical to analyze these two veneer losses under both experimental designs.

As indicated in Table 7, the total quantities of raw material

Table 7. Raw material input and output for each of the five mills studied.

Volume Type	Mill #1	Mill #2	Mill #3	Mill #4	Mill #5	Total
Block Gross Volume (BF Scribner Decimal C Scale)	16,650.0	16,770.0	16,000.0	16,070.0	16,460.0	84,950.0
Block Net Volume (BF Scribner Decimal C Scale)	15,880.0	16,110.0	14,890.0	15,380.0	15,810.0	78,070.0
Block Cubic Volume (cu ft)	2,554.2	2,550.6	2,487.3	2,515.9	2,474.3	12,582.3
Theoretical Veneer Volume (cu ft)	2,152.1	2,237.8	1,980.8	2,108.9	2,173.3	10,652.9
Merchantable Veneer Volume Produced (cu ft)	2,073.1	2,084.8	1,621.8	2,054.4	2,005.8	9,839.9

processed at each of the five mills were very consistent with one another regardless of the volume measurement basis. This fact indicates that between mills, a homogeneous sample relating to overall block volumes had been properly selected.

The gross Scribner, net Scribner, cubic volume and the theoretical veneer volumes are quite similar to one another. The merchantable veneer volume indicates an apparent mill difference in processing capabilities since mill 3 is substantially lower than the other four, even though they all processed very similar volumes of raw material initially. Also, mill 3 fell short of its estimated theoretical veneer volume when compared to the other mills. This is probably due to the fact that their cores were the largest produced of all the mills. This reduced the quantity of merchantable veneer volume they were able to produce. Regardless of that mill's performance, it appears that the theoretical veneer volume is a good estimator of actual merchantable veneer capable of being produced. This is because the theoretical veneer volume as calculated represents the entire volume contained inside the scaling cylinder, inside the spur trim setting and excluding the core volume. It obviously overestimates the realistic veneer volume obtainable from that volume since it does not reflect the presence of defects. On the other hand, merchantable material originates from that same volume and also includes any merchantable veneer obtained from outside the scaling cylinder; all defect free. Therefore, since the theoretical veneer volume overestimated the merchantable veneer volume actually produced, the total defect losses inside the cylinder are apparently greater than any veneer gains made from outside that scaling cylinder. That is, the theoretical veneer volume computation overestimated the actual merchantable veneer volume produced because it does not account for defects within the scaling cylinder. It would be expected that the better the block grade, the more closely the theoretical veneer volume would estimate the actual merchantable veneer volume produced. For the blocks in this study, the theoretical veneer volume estimate exceeded the merchantable veneer volume produced by an average of 7.6 percent. Table 9 presents a summary of the various volume relationships as taken from the previous table. The net Scribner deductions between mills ranged from 3.9 to 6.9 percent of the gross Scribner volumes. Mill 3 barely produced 80 percent of its expected or theoretical veneer volume where all other mills exceeded 90 percent of their theoretical veneer volume.

It is interesting to note from Table 8 that, on the average, the percent deductions in the Scribner volume increased as the block diameter increased.

Table 8. Total percent deductions increasing as a function of increased block diameter.

Diameter Class	$\frac{\text{Total Deductions}}{\text{Total Net Scribner}} \times 100\%$
1	2.1
2	1.9
3	6.0
4	5.9

Also shown in Table 8 are CRR and VRF values for each of the five mills. In both cases, mill 3 was shown to be substantially less effective in converting their raw materials into merchantable veneer. It should be noted here that the recovery values (the VRF and the CRR) indicated in this study are somewhat higher than one might normally expect because:

1. The recovery assessment was made up to and including the green-end clipper. That is, the recovery values provided here present exact recovery at the clipper and do not reflect losses incurred further downstream.

Table 9. Various block volume relationships.

Volume Relationship (%)	Mill #1	Mill #2	Mill #3	Mill #4	Mill #5	Total
Net Volume (BF) / Gross Volume (BF)	95.4	96.1	93.1	95.7	96.1	95.3
Merchantable Veneer Volume Produced (cu ft) / Theoretical Veneer Volume (cu ft)	96.3	93.2	81.9	97.4	92.3	92.4
Theoretical Veneer Volume (cu ft) / Block Cubic Volume (cu ft)	84.3	87.7	79.6	85.2	87.8	84.7
Cubic Recovery Ratio	0.81	0.82	0.65	0.82	0.81	0.78
Veneer Recovery Factor	4.06	4.27	3.49	4.14	4.18	4.03

2. Since every piece of veneer was actually measured, actual sheet measurements and sheet thickness were employed in determining the merchantable veneer volume.

3. The blocks selected for use in this study were No. 2 and No. 3 grade saw logs. Blocks with very serious defects were excluded as candidates because of their potential for either spin-out or cracking while being peeled.

4. Since the sample of blocks were selected specifically for this project, they do not necessarily represent the usual mill mix in either size, distribution or grade.

The VRF for all five mills ranged from 3.5 to 4.3. Average mill recoveries ranged from 65 percent to 82 percent of the total block volumes. Mill 3 was lower than the rest because of two basic reasons: their production system and their average core diameter. The production system included a tray system as well as a cold peel. Also, their core diameters averaged almost two inches larger than the average of the other four mills. Both of these factors must certainly contribute to their reduced conversion efficiency.

It is interesting to note from Figure 31 that, as the average block diameter increased, the CRR increased and the VRF decreased. The CRR more correctly represents the block volumes being processed. As previously mentioned, the VRF is inherently incorrect because of the inadequacies of the Scribner scaling system. The Scribner system does not adequately describe the block volume (see Sec. I).

As an example, it is interesting to point out that even though mills 1, 2, 4, and 5 were similar in CRR, these similarities are not demonstrated in VRF values. Although mill 3 is the lowest

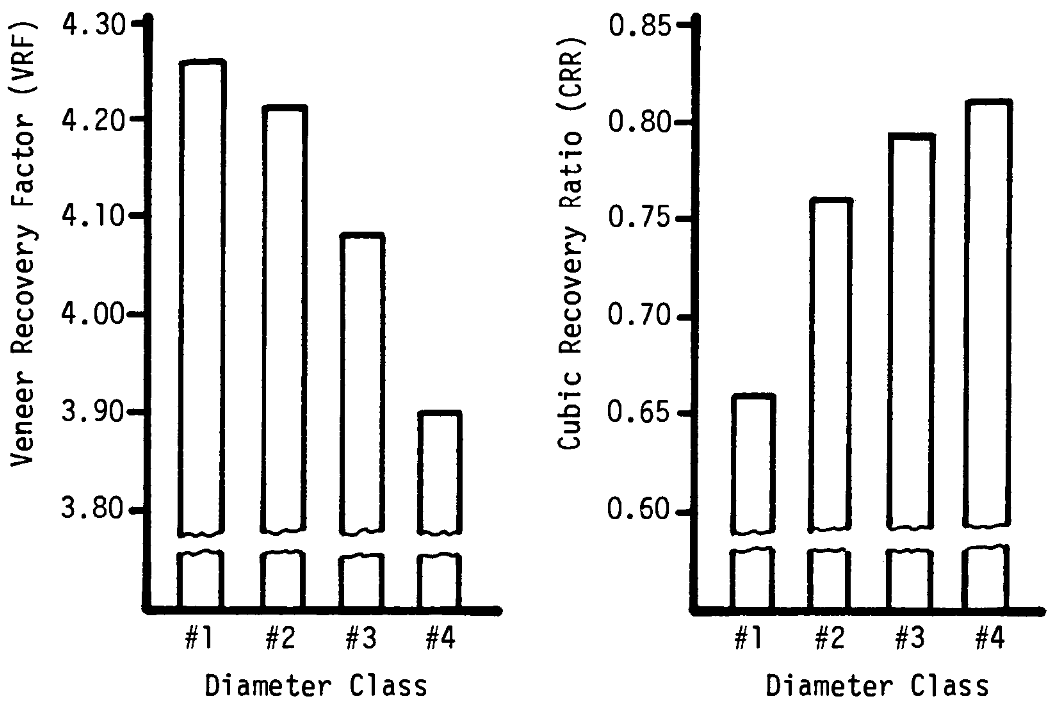

Figure 31. CRR increasing and VRF decreasing as a function of increasing block diameter.

under both methods of calculating recovery, it would be expected that mills 2 and 4, with both having a 0.82 CRR, would have a similar VRF. Instead, they have 4.14 and 4.27 VRF, respectively. Likewise, mills 1 and 5 have 0.81 as their CRR and yet they demonstrated a VRF of 4.18 and 4.06, respectively. Considering the CRR a more correct measure of performance, that increase in performance is not reflected in the VRF of mill 2 and 5. That is, the VRF of mill 4 indicates it is doing a better job of processing its raw material than mill 2, but the CRR indicates the two are doing equally well at 0.82.

The average values for all block components are presented in Figure 32. The veneer lost at the clipper (clipped round-up veneer volumes plus the reject veneer volumes) averaged 7.6 percent and ranged from 5.3 percent to 10.4 percent of the total block volume. Core and spur volumes averaged 8.1 percent and 1.6 percent of the block volume. Trash-gate round-up volumes ranged from 0.8 percent to 7.0 percent of block volume and averaged 2.3 percent for all five mills. Merchantable veneer represented an average of 74.9 percent of the block volume. Of the remaining 25.1 percent residue, the core represented the largest portion or approximately 37.8 percent of the total residue volume as indicated by Figure 33. Total losses at the clipper made up 33.3 percent of the residue volume.

Mills 1, 2, 4, and 5 produced approximately the same percentage of merchantable veneer as indicated by the CRR values on Figure 34. However, this fact is not demonstrated upon examining the respective VRF values. Mill 3 was the lowest in both CRR and VRF values. Mill 5 produced a lower percentage of fulls and a higher percentage of halves than did mills 1, 2, and 4. The volume that mill 5 lost in fulls, it apparently made up that volume in the form of increased halves and randoms. Mill 3 had the lowest volume of fulls but did not pick up that lost volume as in increased volume of halves. It apparently picked that volume up as

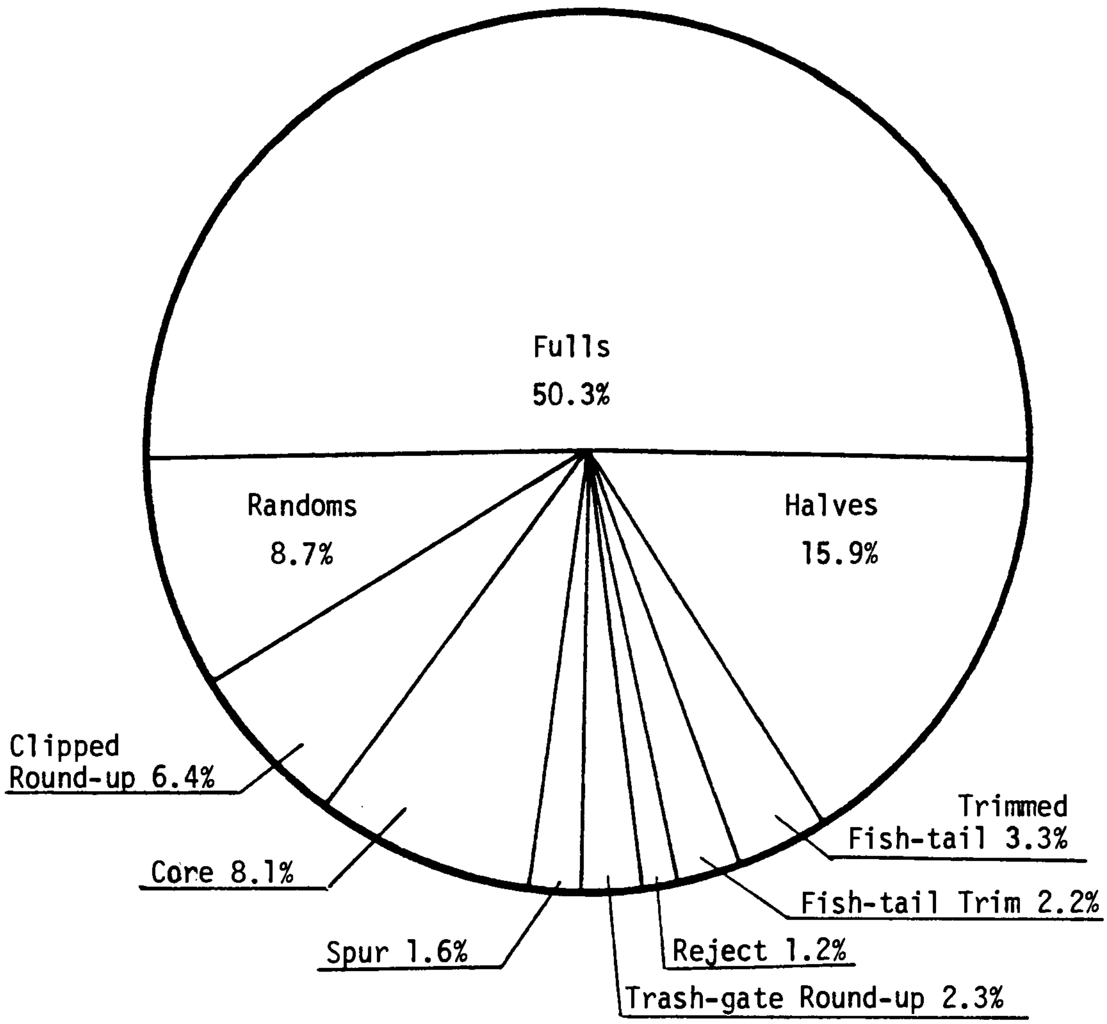

Figure 32. Block volume components as determined by this study.

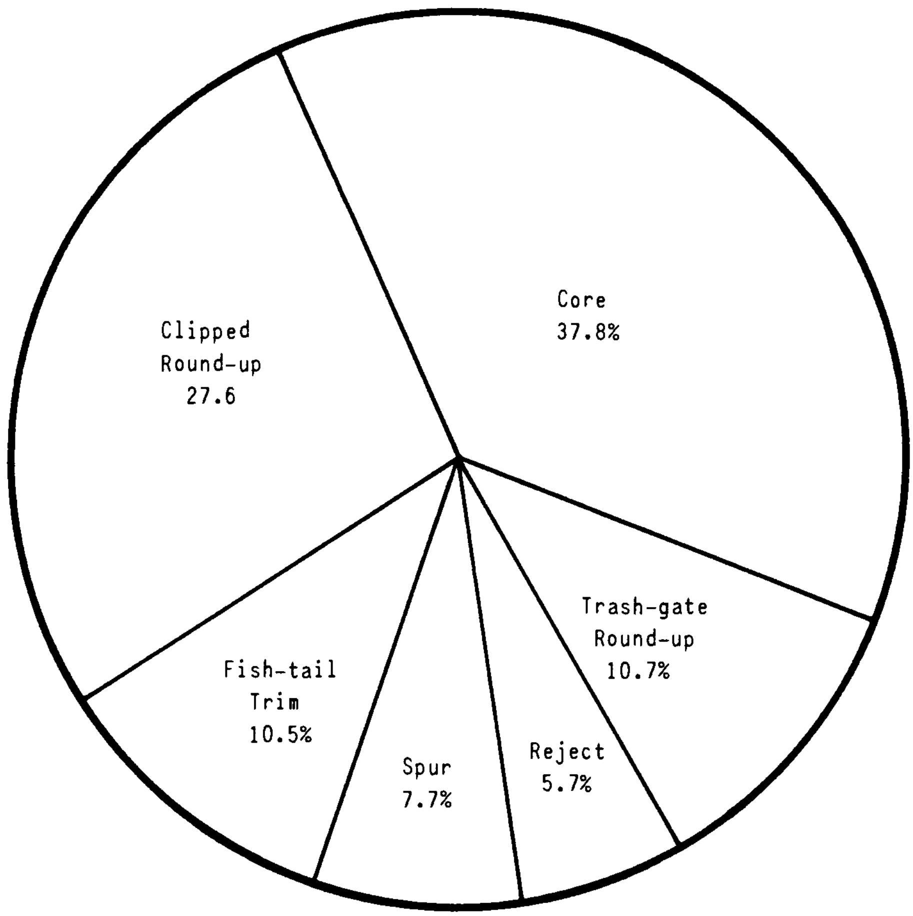

Figure 33. Residue volume components as determined by this study.

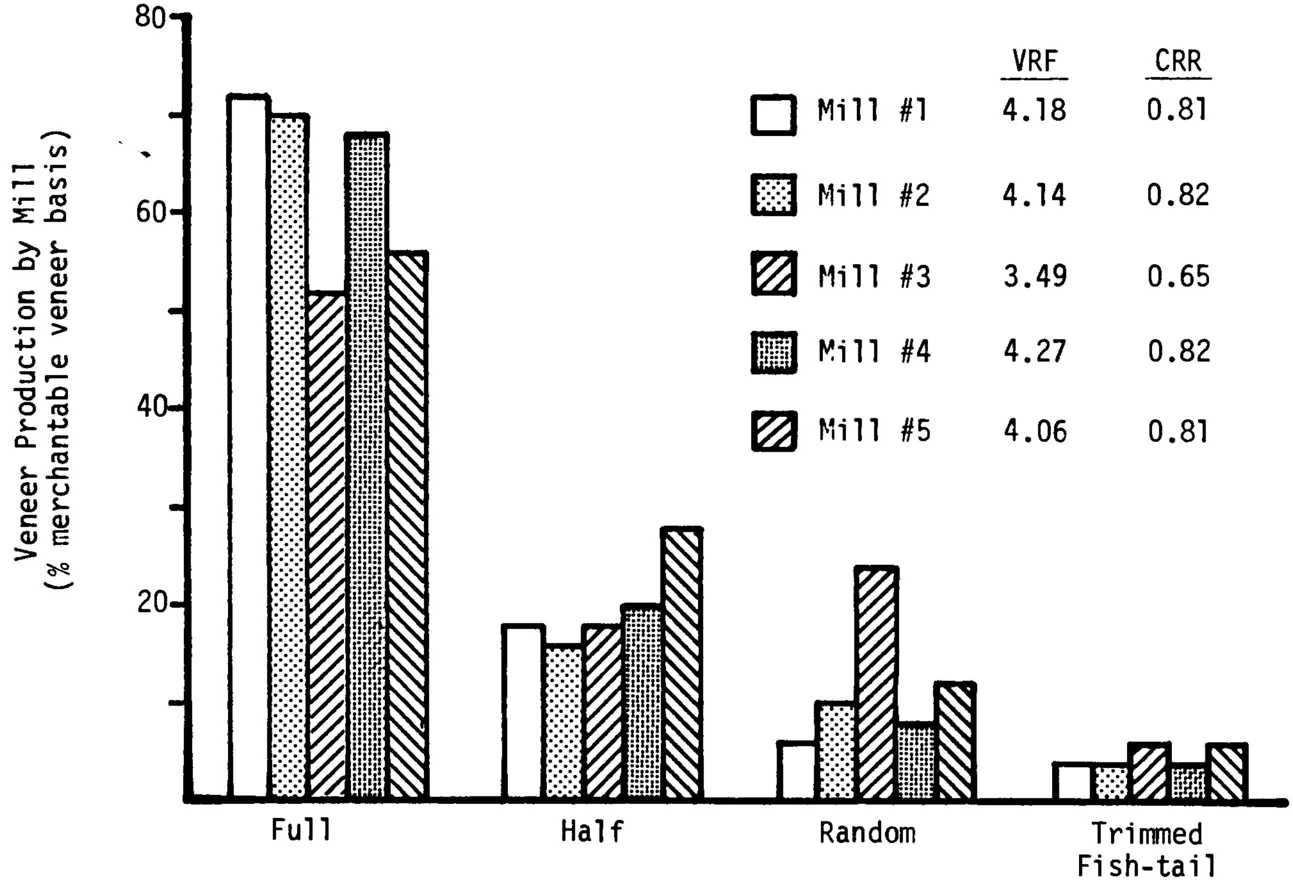

Figure 34. Merchantable veneer produced at each of the five mills in this study.

a disproportionately high volume of randoms. As mentioned before, mill 3 had the lowest recovery of all five mills and that fact is further emphasized here. Both mills 3 and 5 produced over 40 percent more trimmed fish-tail volume than did the other three mills. Mill 3 also produced almost twice the volume of randoms of any other mill. Mill 3 was apparently distinctly disadvantaged by the tray system, the cold peel and the excessively large cores. Even though mills 3, 4, and 5 had tray systems, 4 and 5 managed to do a far better job of processing veneer than 3. Mills 1 and 2 were direct coupled and were also highest in full sheet volumes.

In Figure 35, mill 3 again widely surpassed all others in two of the largest of the trash volume components: trash-gate round-up and clipped round-up. It appears that far too much round-up material is being diverted down the trash-gate. This might be caused either by block centering errors and/or poor lathe operator judgment. This information, coupled with the fact that mill 3 also generated higher-than-average clipper round-up volumes, suggests that mill 3 was taking a much longer time to reach round-up. It should be remembered here that round-up is considered complete at the occurrence of two consecutive full sheets. Even though an X-Y charger was in operation there, it may not have been operating correctly. Centering errors would be most suspect with excess volumes in these two categories and might also help explain the relatively high random and trimmed-fish-tail volumes for this mill. However, the random and trimmed fish-tail volumes are probably more strongly influenced by excess veneer cracking due to the tray system and the cold peel. Both mills 4 and 5 also had tray systems but conditioned their blocks. Even though block conditioning would be expected to reduce those losses, it is errors in block centering that would most dramatically affect the trash-gate and clipped round-up volumes. Mill 5 apparently did a good job of keeping the trash-gate round-up volumes down and thereby conveyed more potentially recoverable veneer on to the clipper.

Both mills 3 and 5 had higher volumes of reject veneer. This

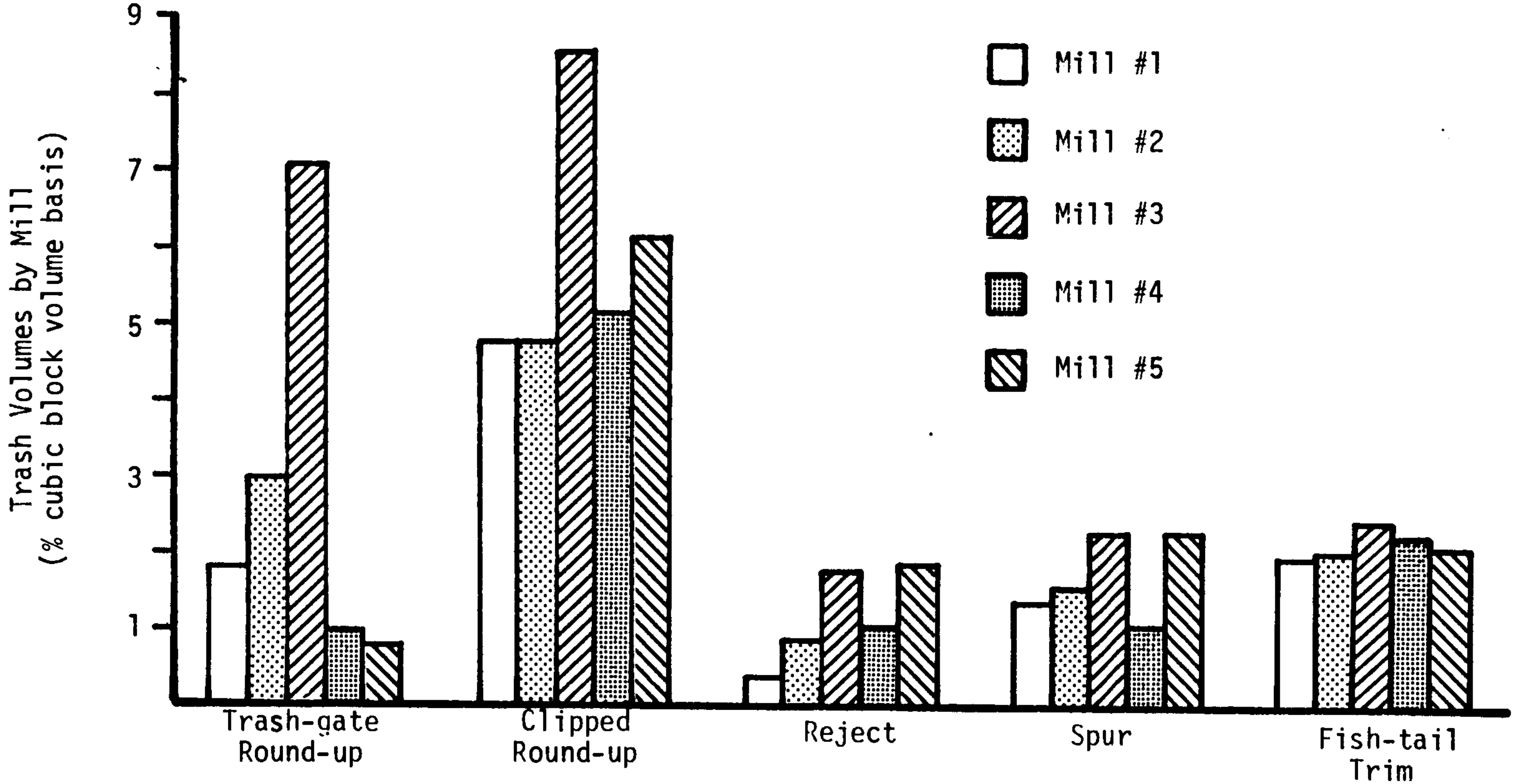

Figure 35. Residue volumes produced as a function of mill.

indicates more clipping taking place within the continuous portion of the veneer ribbon at these two mills than the other three. The cold peel at mill 3 was considered to be the cause.

The spure volumes of both mills 3 and 5 tend to be similar to one another and higher than the rest. The spur volume is a direct function of block size, block length, core diameter and spur knife setting. Since the block diameters are assumed to be constant for all five mills, the increased spur volumes for mills 3 and 5 must be due to the other three factors. Table 10 contains the average block length for the five mills in the study. Average core diameters are found in the CLPLOSS output in Appendix A and the spur knife settings are in Appendix D. Of all the mills, mill 3 had the largest difference be-ween its average block length and its spur knife setting. It had a difference of over 2.9 inches. Mill 5 had the second largest block length to spur knife difference of 2.1 inches as well as the smallest average core diameter. It is for these reasons that mills 3 and 5 generated the highest spur losses of all five mills.

Figure 36 illustrates the trash volumes as a function of block diameter. Clipped round-up volumes decreased as block diameter increased. That would be expected for as the block diameter increases, the round-up becomes a smaller proportion of the entire peeled volume. Likewise, fish-tail trim decreased with increased diameter for the same reason. Spur volumes increased as the block diameters got larger. No specific reason can be given for the relatively low trash-gate volume originating from the diameter 2 blocks. As was previously presented in Table 9, the deductions due to defects increased with an increase in block diameter. This apparently accounts for the increase in reject veneer volumes with increased diameter as an attempt is made to remove those defects at the clipper.

As might be expected, Figure 37 indicates that the average core diameter increases with increased block diameter. Greater torque is required to peel larger blocks and the increased torque creates greater stress on the wood material in the chucked area of

Table 10. Block length statistics.

Block Statistic	Mill #1	Mill #2	Mill #3	Mill #4	Mill #5
Sample Size	120	120	120	120	120
Average Length (in)	102.608	102.797	103.976	102.702	102.534
Maximum Length (in)	103.438	104.250	105.250	103.875	104.000
Minimum Length (in)	100.750	101.750	101.438	101.750	101.250
Standard Deviation	0.385	0.411	0.561	0.334	0.345

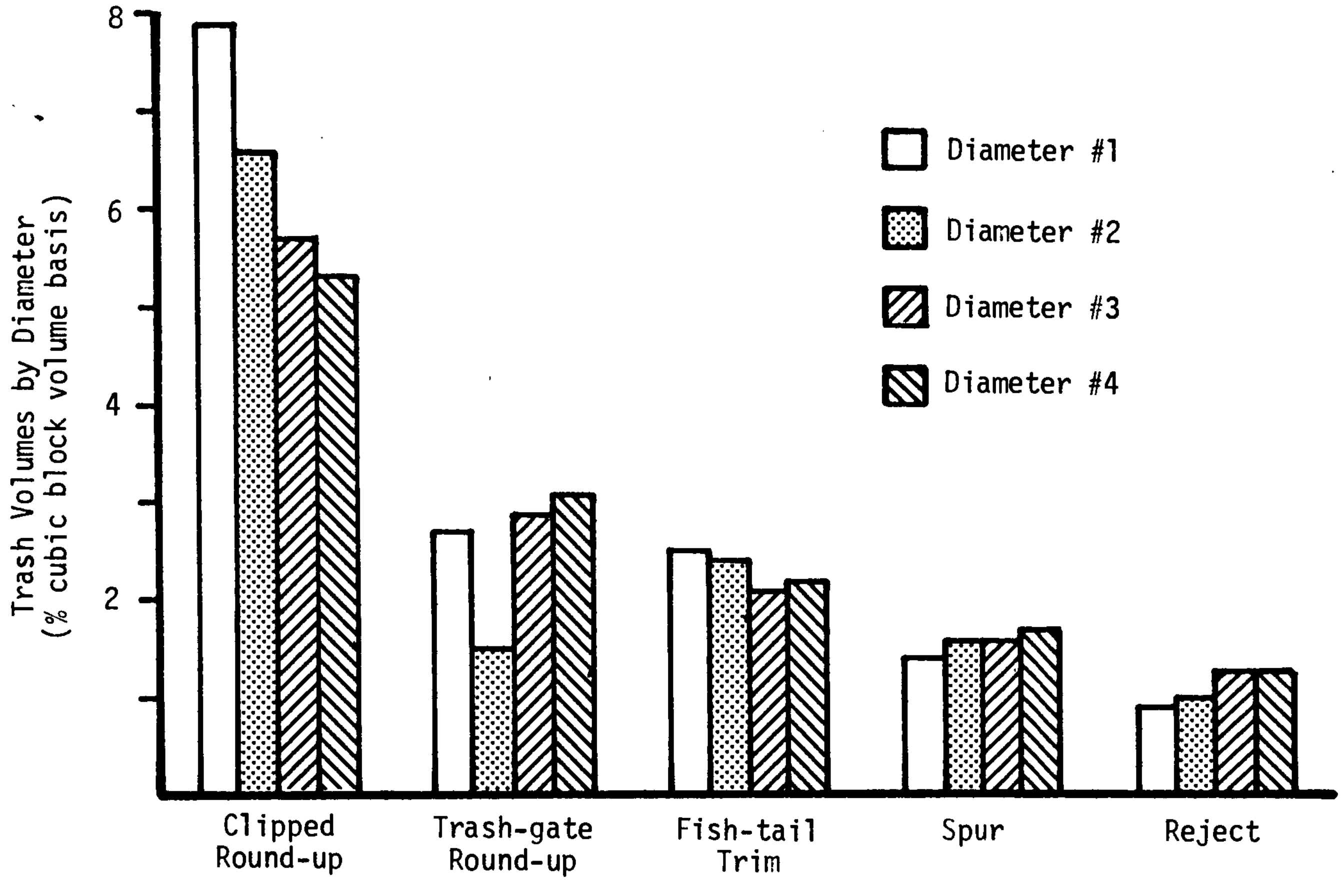

Figure 36. Residue volumes produced as a function of block diameter.

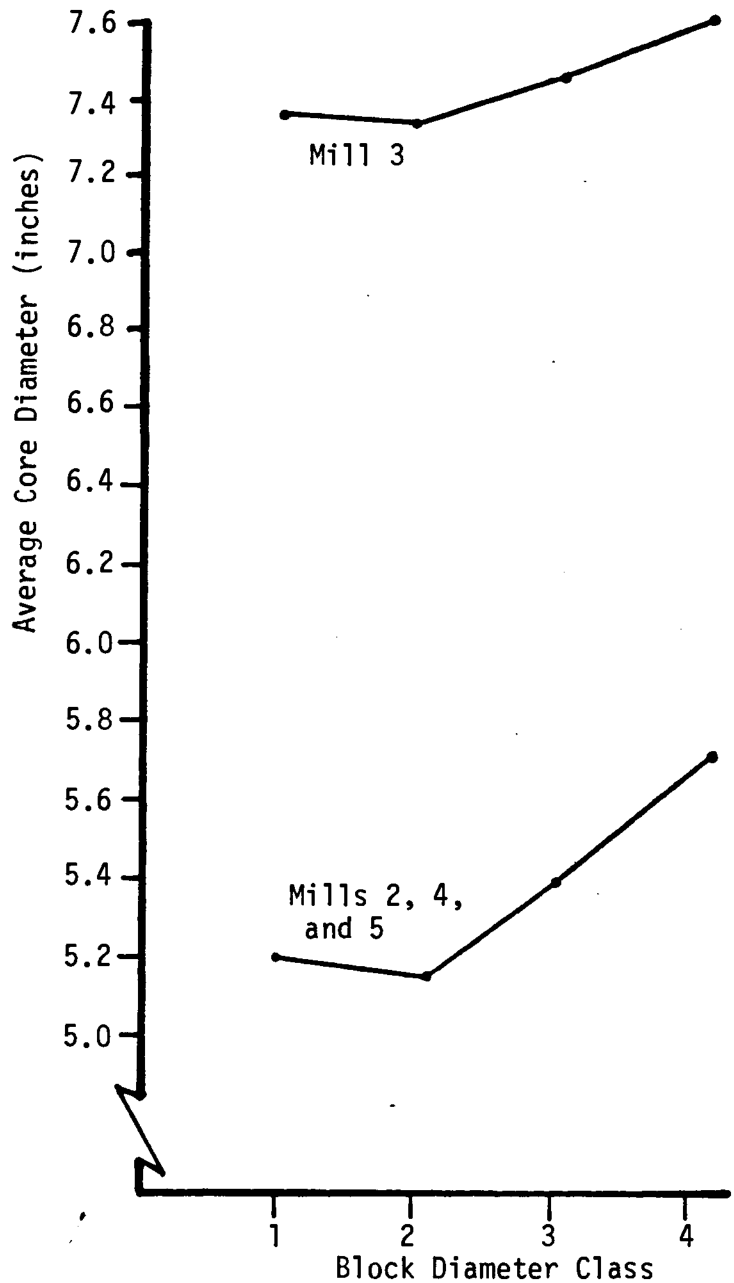

Figure 37. Average core diameters as a function of block diameter for mills 2 through 5.

the block. This increased stress with the greater length of time the blocks spend in the lathe would tend to accentuate wood failure thereby causing the cores, on the average, to be ejected prematurely; i.e., prior to achieving minimum core target size. Mill 1 was not plotted because of its use of the fixed chuck sizes.

The total potentially recoverable veneer lost at the clipper ranged from 1.1 percent to 2.6 percent of the total block volume as indicated in Table 11. In most mills, the majority of the potential increase in recovery through better clipping comes in the form of reducing the inaccurate clipping. The high percentage of accurately clipped recoverable veneer for mill 5 was primarily due to the very wide margins employed there. The margins were set at two inches where the other mills had their margins set at approximately one inch. Since a one-inch margin was considered normal, any margin setting beyond one inch was digitized as accurately clipped recoverable. For that reason, many of the defects clipped out from this mill's sample of 120 blocks was considered to have lost a total of two inches of good wood. That is, of the two inches on either side of the defect, one inch was considered an acceptable margin. The remaining one inch on a side represented material that would not have been lost had the scanner been set up correctly and, therefore, was considered potentially recoverable.

The total quantities of additional veneer that could potentially be recovered at each mill ranged from 1.1 percent to 2.6 percent on a total block volume basis or 1.4 percent to 4.0 percent on a merchantable veneer basis. It is doubtful that these entire volumes can be economically recovered at today's production rates, but certainly some portion of this might be easily recovered simply by employing good clipper/scanner maintenance and set-up procedures. Additionally, changes to the scanner logic may also help reduce these losses.

The information in Table 12 is the same as the previous table except that it summarizes potentially recoverable veneer volumes

Table 11. Summary of potentially recoverable veneer volumes as a function of mill.

	Accurately Clipped Recoverable Veneer Volume		Inaccurately Clipped Recoverable Veneer Volume		Combined Accurately and Inaccurately Clipped Recoverable Veneer Volume	
	% Block Volume	% Merchantable Veneer Volume	% Block Volume	% Merchantable Veneer Volume	% Block Volume	% Merchantable Veneer Volume
Mill #1	0.19	0.24	0.95	1.17	1.14	1.41
Mill #2	0.28	0.34	1.05	1.28	1.33	1.62
Mill #3	0.67	1.03	1.90	2.92	2.57	3.95
Mill #4	0.33	0.41	1.10	1.34	1.43	1.75
Mill #5	1.37	1.69	0.97	1.20	2.34	2.89

Table 12. Summary of potentially recoverable veneer volumes as a function of block diameter.

Block Diameter Class	Accurately Clipped Recoverable Veneer Volume		Inaccurately Clipped Recoverable Veneer Volume		Combined Accurately and Inaccurately Clipped Recoverable Veneer Volumes	
	% Block Volume	% Merchantable Veneer Volume	% Block Volume	% Merchantable Veneer Volume	% Block Volume	% Merchantable Veneer Volume
Diameter #1 10.00 to 14.99 in	0.68	1.70	1.38	3.45	2.06	5.15
Diameter #2 15.00 to 19.99 in	0.62	1.30	1.38	2.88	2.00	4.18
Diameter #3 20.00 to 24.99 in	0.59	1.09	1.04	1.94	1.63	3.03
Diameter #4 25.00 to 29.99 in	0.50	0.98	1.18	2.29	1.68	3.27

as a function of block diameter. It appears that there exists a tendency for potentially recoverable volumes to decrease as block diameter increases. With larger blocks a higher volume of continuous ribbon is produced, requiring fewer clips per cubic foot of block input. Fewer clips per cubic foot of block input results in fewer chances for the accurately and inaccurately clipped recoverable categories to occur. That trend is shown here.

As stated earlier, the data were analyzed by the SIPS statistical package residing on the CYBER mainframe computer on the OSU campus. Each response variable was individually analyzed under either of two possible experimental designs: the split-plot or the complete randomized design (see Table 6). It was desired to examine whether the variation in the 14 response variables from Table 6 was due to the main effects (mill and diameter), their interaction, or simply due to random variation. Table 13 summarizes the results of successive analysis of variance on ten response variables as examined under the split-plot design. It indicates that the mill and diameter main effects operated independently in the reject volumes. That is, there was no interaction of main effects in regard to the reject volumes. In addition, diameter had no statistically significant effect on the reject volumes. This would seem to contradict the data as presented in Figure 35 where there appears to be a substantial difference between mills with respect to reject volumes. In addition, upon examination of the computer output in Appendix A, it indicates that reject volumes (on a percent volume basis) increases with increasing block diameter. It is suggested that this apparent contradiction between the computer data and the statistical results is due to the fact that 30 blocks may not be a large enough sample size to make consistent and statistically valid inferences with regard to reject volumes. Remember, the 30 blocks were determined to be necessary in order to detect within ± 0.1 VRF. The experiment was not originally designed around detecting differences in reject volumes.

Table 13. Summary data of the analysis of variance for various block components under the split-plot design.

Response Variable	F-ratio for Differences Among Mills F^{4}_{435} .05 = 3.84 .01 = 6.63	F-ratio for Differences Among Diameters F^{3}_{435} .05 = 2.60 .01 = 3.78	F-ratios for Interaction Between Mills and Diameters F^{12}_{435} .05 = 1.75 .01 = 2.18
Full Sheet Volumes	23.135**	5.177**	3.693**
Half Sheet Volumes	11.657**	2.479	3.144**
Random Strip Volumes	73.778**	9.309**	2.871**
Trimmed Fish-tail Volumes	11.949**	7.769**	4.049**
Untrimmed Fish-tail Volumes	8.987**	8.185**	3.883**
Reject Volumes	61.60**	1.129	1.670
Clipped Round-up Volumes	33.000**	23.110**	2.091*
Accurately Clipped Recoverable Volumes	38.229**	9.882**	4.479**
Inaccurately Clipped Recoverable Volumes	23.948**	8.666**	1.858*
Combined Accurately and Inaccurately Clipped Recoverable Volumes	24.983**	9.117**	2.333**

*Significant at the 5% level.

**Significant at the 1% level.

To confirm this hypothesis, it is necessary to calculate the number of blocks that would have been necessary if reject volumes were to have been of prime consideration in the original experimental design. From summary data not included in this presentation, the standard deviation of reject volumes on a percent merchantable basis for all 600 blocks, was determined to be 1.953. This value is not to be compared with data on a percent cubic bolume basis in the computer output on a percent cubic volume basis in the computer output in Appendix A. Assuming that it is desired to be able to detect reject volumes to within ± 0.10 percent merchantable volume, one must substitute these values into Equation 1.

$$\frac{1.96 \times 1.953}{0.01}^2 \cong 1{,}466 \text{ blocks}$$

Far too many peeler blocks would have been required in each replicate in order to detect differences in reject volumes due to main effects at the 95 percent confidence level. The requirement for this unrealistic number of blocks is due to the great block-to-block variation of reject volumes on a percent merchantable basis. Substituting the actual replicate size of 30 blocks into the previous equation and solving for C, yields

$$\frac{1.96 \times 1.953}{\sqrt{30}} \cong 0.70\% \text{ reject volume}$$

This indicates that the present experimental design would allow a sensitivity of detecting only within ± 0.70 percent of reject volume based on a percent of merchantable volume. To be able to statistically test for main effects, far more blocks would indeed have been required.

In the other nine response variables tested under the split-plot design, there were indications that the mill and diameter effects operated dependently with one another at the one percent confidence level. That is, the volume of materials generated in each of these ten categories varied because of the facility processing them. These volumes were mill-dependent. The effects of diameter on volumes of the ten response variables indicated that reject and half sheet volumes were unaffected by the diameter effect. All other response variables indicated a significant diameter effect at the one percent confidence level. Once having determined the specific response variables on which the mill and diameter main effects have on the response variable, it was necessary to examine those variables in greater detail. Two-way independent comparisons were made in regard to each main effect and each of the significant response variables. Tables 14 and 15 present a pairwise summary of all significant variables as indicated from Table 13. In Table 14, the connecting brackets indicate the specific mill pair in which the main mill effects were shown to be significantly at either the five percent or the one percent confidence level. For example, full sheet volumes were significantly different at the one percent confidence level at all five mill pairs examined except at mills 1 and 2. That is, unless a one in one-hundred chance has occurred, the full sheet volumes from mills 1 and 2 were statistically the same and all other mill pair combinations were different from one another. Upon examining Figure 34, it can be seen that the full sheet volumes from these two mills are indeed quite similar to one another (73% and 71% of merchantable volume, respectively).

As anticipated, the two-way comparisons indicated at a one percent confidence level, mills 1 and 2 were similar to one another but each was statistically different from the other three. Mills 1 and 2 were direct coupled systems while mills 3, 4, and 5 were tray systems. All three mills with trays were statistically different from one another in regard to accurately clipped recoverable volumes. These differences and similarities between mills are further corroborated upon inspection of Table 11. As for the inaccurately clipped recoverable veneer volumes, all mills were at

Table 14. Summary data from a two-way independent analysis on various block components as they relate to mill.

Response Variable	Mill # 1	2	3	4	5
Full Sheet Veneer Volumes	**|———	———	|		
	**|———	———	———	|	
	**|———	———	———	———	|
		**|———	|		
		**|———	———	|	
		**|———	———	———	|
			**|———	|	
			**|———	———	|
				**|———	|
Half Sheet Veneer Volumes	**|———	———	———	|	
	**|———	———	———	———	|
		**|———	———	|	
		**|———	———	———	|
			**|———	|	
			**|———	———	|
Random Strip Veneer Volumes	**|———	———	|		
	**|———	———	———	———	|
		**|———	|		
		**|———	———	———	|
			**|———	|	
			**|———	———	|
				**|———	|

*Significant at the 5% level.

**Significant at the 1% level.

F^{4}_{238} .05 = 1.97

.01 = 2.59

Note: Data from the split-plot design with brackets indicating mills in which a statistically significant difference exists.

Table 14. (Continued)

Response Variable	Mill # 1	2	3	4	5
Untrimmed Fish-tail Veneer Volumes	**	—	|		
	*	—	—	|	
	**	—	—	—	|
		**	|		
		**	—	—	|
Trimmed Fish-tail Veneer Volumes	**	—	|		
	**	—	—	—	|
		**	|		
		**	—	—	|
				**	|
Reject Veneer Volumes	**	|			
	**	—	|		
	**	—	—	—	|
		**	|		
		**	—	—	|
Clipped Round-up Veneer Volumes	*	|			
	**	—	|		
	*	—	—	—	|
		**	|		
		*	—	|	
		**	—	—	|

Table 14. (Continued)

Response Variable	Mill # 1	2	3	4	5
Accurately Clipped Recoverable Veneer Volumes	**|	—	|		
	**|	—	—	|	
	**|	—	—	—	|
		**|	|		
		**|	—	—	|
			**|	|	
			**|	—	|
				**|	|
Inaccurately Clipped Recoverable Veneer Volumes	**|	—	|		
		**|	|		
			**|	|	
			**|	—	|
Combined Accurately and Inaccurately Clipped Recoverable Veneer Volumes	**|	—	|		
	**|	—	—	—	|
		**|	|		
		**|	—	—	|
			**|	|	
				**|	|

Table 15. Summary data from a two-way independent analysis on various block components as they relate to diameter.

Response Variable	Diameter Class # (1, 2, 3, 4)
Full Sheet Veneer Volumes	** 1–3
	* 2–3
Random Strip Veneer Volumes	* 1–2
	** 1–3
	** 1–4
Untrimmed Fish-tail Veneer Volumes	* 1–2
	** 1–3
	** 1–4
Trimmed Fish-tail Veneer Volumes	* 1–2
	** 1–3
	** 1–4
Clipped Round-up Veneer Volumes	** 1–2
	** 1–3
	** 1–4
	** 2–4

*Significant at the 5% level.

**Significant at the 1% level.

F^{3}_{298} .05 = 1.97
.01 = 2.59

Note: Data from the split-plot design with brackets indicating diameters in which a statistically significant difference exists.

Table 15. (Continued)

Response Variable		Diameter Class # 1	2	3	4
Accurately Clipped Recoverable Veneer Volumes	*	———	———		
	**	———	———	———	
	**	———	———	———	———
	*		———	———	———
Inaccurately Clipped Recoverable Veneer Volumes	**	———	———	———	
	**	———	———	———	———
	*		———	———	
Combined Accurately and Inaccurately Clipped Recoverable Veneer Volumes	*	———	———		
	**	———	———	———	
	**	———	———	———	———
	*		———	———	
	*		———	———	———

the one percent confidence level, significantly different from mill 3. Again from Table 11, mill 3 far exceeded the other four mills in the inaccurately clipped veneer volumes generated. The pair-wise tests of the combined potentially recoverable veneer volumes indicate results similar to the accurately clipped recoverable tests. That is, at the one percent confidence level, mills 1 and 2 were similar to one another, but statistically different from the other three. Mill 3 appears to be different from mill 4 and mill 4 is statistically different from mill 5. However, mill 3 is similar to mill 5 in the combined potentially recoverable veneer volumes at the one percent significance level. Again observing Table 11, the volumes for mills 1 and 2 are indeed similar to one another while mill 3 is similar in volumes to mill 5.

Likewise, in Table 15, connecting brackets indicate the pair-wise comparison in which the diameter effects is shown to be significantly different at either the five percent or the one percent level. Generally, it can be seen that volumes of material in most response variables examined for diameter effects, adjacent diameters were indicated to be significantly different from one another, at least at the five percent confidence level. However, they were apparently similar to one another in non-adjacent diameter pairs, i.e., non-bracketed pairs of diameter classes. For example, the random strip generated in each of the diameter classes, diameter 1 was different from diameter 2, diameter 1 was different from diameter 3 and diameter 1 was different from diameter 4. The bracketing as indicated, one might be tempted to conclude that diameter 2 is similar to 3 and 4 while diameter 3 is similar to diameter 4 in regard to the random volumes generated within each diameter class.

As can be seen from Table 12, the percent potentially recoverable materials in almost all cases indicate a downward trend with increased block diameters. Therefore, there existed sufficiently similarity within adjacent diameters. Table 13 indicated a significant interaction between the main effects of mill and diameter.

The very large differences in processing between mills has already been shown. As a result of the very large mill differences, the two-way comparison is only able to detect diameter effects between the largest diameter differences, i.e., between diameter 1 and all the rest. Because of the same interaction of main effects, the two-way comparison exhibited comparable results for the untrimmed fish-tail, the fish-tail and the clipped round-up veneer classifications.

Since certain response variables could not be examined under the split-plot design, they were instead examined using a completely randomized experimental design (see Table 6).

The summary Table 16 presents the response variables as examined by an analysis of variance under the completely randomized design. The loss of degrees of freedom for reasons previously stated makes one less confident about the statistical inferences being made. As expected, core volumes here were shown to be statistically different between diameters at the one percent confidence level. It appears that there is no significant statistical difference between mills. However, there is a substantial difference in core diameters between mills. It was not determined here to be significant because the variation due to block diameter was much greater than the differences due to the processing mill. That is, the variation due to the mill effect is masked by the greater variation due to the block diameter effect.

A comparable situation exists for spur, trash-gate round-up, clipper loss, reject veneer and clipped round-up veneer volumes. However, here the variation, because of the processing mill, is far greater than the effects due block diameter. As a result, these variables as tested indicated statistical significance due to the mill effect but not due to the block diameter.

CRR and VRF values were significantly different from one another at the one percent confidence level due to the effect of diameter. This fact has already been expressed and presented

Table 16. Summary data of the analysis of variance for various block components under the completely randomized design.

Response Variable	F-ratio for Differences Among Mills F_{15}^{4} .05 = 3.06 .01 = 4.89	F-ratio for Differences Among Diameters F_{16}^{3} .05 = 3.24 .01 = 5.29
Core Volumes	1.203	10.451**
Spur Volumes	15.952**	0.669
Trash-gate Round-up Volumes	5.132**	0.309
Clipper Loss Volumes	9.124**	1.203
Reject Volumes	4.706*	0.557
Clipped Round-up Volumes	4.869*	2.025
Cubic Recovery Ratios	0.173	65.432**
Veneer Recovery Factors	0.118	72.993**

*Significant at the 5% level.

**Significant at the 1% level.

previously in Figure 31. There was no apparent statistically significant difference between CRR and VRF at each of the five mills studied. However, it is obvious from previously presented data that there exists a significant difference in recovery values between mills (see Fig. 34). This can be simply explained by two reasons. First, with the loss of so many degrees of freedom, the sensitivity or the capability for detecting differences between these two response variables was severely limited. Secondly, the large variation due to diameter differences masked the effects due to mill. Stated otherwise, the original design required 30 blocks to detect differences of ± 0.1 of VRF. Under this completly randomized design, the four diameters were acting as replicates which severely limited its sensitivity to detecting small VRF differences between mills. However, because of the substantial effect of diameter on recovery, even this very limited design was able to pick up significant differences between diameters at the one percent confidence level.

In order to adequately follow-up any experimental investigation, it is necessary to examine the initial experimental design criterion in light of the new information gained. The objectives of this reevaluation are to determine whether

1. the degree of sensitivity obtained in the experiment was compatible with the initial design constraints, or
2. more cost-effective sample sizes could be utilized in subsequent experiments.

The previously presented sample size determinations for both sheet thickness measurement and replicate size will be reexamined first. The variation in sheet thickness was substantially less than the literature had indicated. From the mill data sheets in Appendix D, it can be determined that the average of all sheet thickness standard deviations is 0.003. This is substantially smaller than the 0.004 as indicated by the literature. Because of increased confidence level of five percent is considered adequate. As before, it is still considered necessary to be able to detect a sheet thickness variation of at least ± 0.001 inch.

Substituting these values into Equation 1,

$$n = \left(\frac{1.96 \times 0.003}{0.001}\right)^2 \cong 35 \text{ measurements}$$

Therefore, to obtain the required experimental sensitivity in regard to sheet thickness variation, a minimum of at least 35 sheet measurements must be taken instead of the earlier value of 100 sheet measurements. However, since 100 sheet measurements were actually made, and by using the same equation but solving for c, the desired precision for the specific design parameter thickness, the actual sensitivity in sheet thickness as it existed in the study.

$$c = \frac{1.96 \times 0.003}{\sqrt{100}} \cong 0.0006 \text{ in.}$$

Therefore, it can be determined that a sensitivity of being able to detect ± 0.0006 of an inch was operating in the sheet thickness measurement segment of this project. Since all cubic veneer volumes were calculated using the average mill thickness, it is reassuring to know that this very important factor was well within the initial design constraints.

Likewise, a similar determination can be undertaken for the number of blocks required in each split-plot cell. Here it was desired to be able to determine a change of at least ± 0.1 of VRF. However, because of the implementation error and the substantial loss of degrees of freedom, such a sensitivity would not be expected to be possible. From the data, the VRF standard deviation as determined by this study was 0.397. Assuming the former confidence levels of five percent and substituting once again into Equation 1,

$$n = \left(\frac{1.96 \times 0.397}{0.1}\right)^2 \cong 61 \text{ blocks}$$

With the standard variation as determined in this project, it can be seen that many more replicates would have been necessary at the desired VRF sensitivity and confidence level. This is compared to the thirty blocks actually employed and to the four or five effective replicates actually used for the statistical analysis under the split-plot design. Remember, when testing for mill effects, the four diameters acted as replicates and when testing for diameter differences, the five mills acted as replicates. To calculate the actual sensitivity operating in the VRF analysis of this project as it was implemented, again solve in Equation 1 for c, where n = 5 ;

$$c = \frac{1.96 \times 0.3967}{\sqrt{5}} \cong 0.35 \text{ VRF}$$

Because of the implementation error, VRF and CRR was analyzed under a completely randomized experimental design. Under this analysis, at best, the "effective" sample size was five, e.g., when testing for diameter differences, the mills were treated as replicates. It is obvious that with five effective replicates, many more blocks would have been necessary. With this substantial loss of degrees of freedom, this project was at best only sensitive enough to detect ± 0.35 VRF. However, had the error not taken place the experiment would have consisted of thirty replicates. Assuming the same standard deviation and substituting again in Equation 1,

$$c = \frac{1.96 \times 0.3967}{\sqrt{30}} \cong 0.14 \text{ VRF}$$

Had the project been properly implemented and assuming the same standard deviation, many more blocks would have been necessary to obtain the desired sensitivity for VRF. However, it is again reassuring to see that the sensitivity was still low despite the implementation error and that it was sensitive enough to detect ± 0.14 VRF. It should be noted that due to the inherent inadequacies of the VRF value as an indicator of processing efficiency, a major design consideration instead should be that of employing CRR as a design criterion and not VRF. Regardless of the implementation error, the VRF value has in it inherent variation due to the Scribner tally, which adds to the overall total variation. No such inadequacies exist in CRR. Therefore, any subsequent recovery analysis should be designed with CRR as an experimental criterion. For this reason, it would be of value to determine the degree of sensitivity to which CRR was estimated in this project. The CRR data were determined to have a standard deviation of 0.966. Solving again for c,

$$c = \frac{1.96 \times 0.097}{\sqrt{5}} \cong 0.085\ \mathrm{CRR}$$

Despite the error, CRR could be estimated to ± 0.085 CRR. Had there been no implementation error and the standard deviation remained the same, the CRR sensitivity would have been

$$c = \frac{1.96 \times 0.097}{\sqrt{30}} \cong .035\ \mathrm{CRR}\ .$$

Because of the inadequacies of the Scribner system, the recovery criterion should have been in respect to CRR and not VRF.

It is also of importance to determine whether the results gained in this project might have been biased by the digitizing effort. The procedure is undertaken in the following manner:

1. Assume a worst case situation.
2. Calculate the 95 percent confidence intervals for the full and half sheet areas for the sample.

3. Assume that all bias is due to digitizing error and the true full and half sheet areas lie at the upper limit of those respective confidence intervals.
4. Assume that all sheets are incorrect by the same degree.
5. Calculate the total difference between all sheet areas as observed in the sample and the hypothetical worst case situation.
6. Convert all area volumes to a common area on a 3/8-inch basis.
7. Calculate a VRF based on this total difference.

Assuming a worst-case situation, mill 1 produced the greatest number of full sheets and it is there that the greatest error in digitizing can occur. The sheet area standard deviations were 0.315 and 0.157 for the fulls and halves, respectively. The average areas were 37.277 square feet and 18.651 square feet at actual peel thickness, respectively. Assuming that the sample is normally distributed, one may calculate the 95 percent confidence interval estimate for the full and half sheet areas. This confidence interval can be calculated from Equation 4,

$$\bar{X} \pm 1.96 s_{\bar{X}} \qquad \text{Equation 5}$$

where $\bar{X}$ is an estimate of the population mean and s is the standard deviation for that estimated population mean. Substituting the full sheet statistics into Equation 4

$37.277 \pm 1.96 \times 0.315$ which is equivalent to

37.277 ± 0.617 square feet.

Therefore, the true full sheet area of the population lies within the 37.660 square feet to 37.894 square feet area at a 95 percent confidence level. Since a worst-case situation is being emphasized here, it is assumed that the true sheet area is at the upper interval limit on 37.894 square feet. Therefore, each sheet produced by mill 1 is assumed to be incorrect by 0.617 square feet (37.894 minus the estimated population mean). Mill 1 produced 4,733 full sheets which constitutes a total error potential of over 2,945 square feet of veneer incorrect because of the digitizing process. The same calculation sequence is carried out for the half sheet areas. For the 2,369 half sheets produced at this mill, this yields a total error potential of 730 square feet of veneer. Summing the two potential error volumes yields a total of 3,670 square feet of veneer at the peeled thickness. This mill had an average peel thickness of 0.10135-inch or 31-square-foot veneer on 3/8-inch basis. The net Scribner scale for this mill was 15,800 board feet. Therefore, the total error due to digitizing the full and half sheet areas (this represents 90% of the merchantable volume) at the 95 percent confidence level is no greater than 0.00195 of VRF. This indicates that the effect that digitizing might have on misrepresenting the true volumes is extremely small.

An in-depth veneer recovery study would be incomplete without relating the results to its logical conclusion--that of its ultimate financial benefits to those mills examined. It has already been illustrated in Figure 2 that even small improvements in merchantable veneer can provide significant financial benefits to the mill operator. It is obvious from this study as well as in industry that some mills more fully utilize their raw materials than do others. Likewise, from various recovery values and other data contained in this presentation, it is apparent that mills 1, 2, 4 and 5 are operating in a more favorable position than mill 3. However, in all cases, some potential for improvement has been shown to be possible. There is much that mill 3 can do to increase its recovery ratio (see the Recommendations section) and it is assumed that even the remaining four mills in this study had annual production volumes that ranged from 55 to 125 mm annually. Assuming only a one percent increase (some mills should be able to far exceed this degree of improvement) and with the veneer being sold at a low price of $20/M, the realized financial market potential would range from between $33,000 and $75,000 annually. Even though these amounts are substantial, they represent only a conservative estimate of the actual potential that exists. Far greater financial rewards exist for the producer that is committed to better utilizing the most costly resource, raw material.

VI. CONCLUSIONS

This study supports the following conclusions:

A. A very sensitive technique has been developed to measure green veneer losses up to and including the green veneer clipper. This technique allows for the direct determination of the potentially recoverable veneer volume as well as other associated block recovery and loss components. It is a non-contact method and does not interfere with production. With the proper design and implementation, the technique is sensitive enough to detect very small changes in the cubic recovery ratio. Although this process is somewhat labor-intensive, it is very versatile. Modifications of the techniques outlined here would facilitate many specific types of investigations in either veneer or lumber production as enumerated below.

1. Veneer Production
   a. Very comprehensive comparisons between two or more very similar peeling operations could be undertaken. For instance, given two very similar production lines, one with an X-Y charger could be directly compared with one not having the X-Y charger.
   b. A precise cost benefit analysis could be made for any X-Y charger operation, simply by peeling two matched sets of peeler blocks one with the charger on and the other with the charger turned off.
   c. Very exacting "before and after" comparisons during a period of green-end capital improvement could be undertaken. Such a comparison would assist in the justification of further capital expenditures. As an example, such an investigation might be used to accurately quantify the increased recovery due to the installation of a new clipper, X-Y charger or lathe follower system.

d. An accurate determination of trash-gate losses could be made on a species, grade, shift and/or lathe operator basis. Such information might indicate a need for increased operator training and/or justify the need for an automatic round-up feature.

e. A direct determination of freen-chain fall down could be carried out. This could be done on a shift basis and might indicate a need for additional veneer puller training.

f. It could provide a quick and very simple method of obtaining population characteristics (mean, standard deviation range, etc.) of the full and half sheets.

g. With the use of very refined and small-scaled adaptations of this technique, an on-going system of green-end management control is possible. The constant day-to-day monitoring of various green-end operations in the manner presented here would complement any strongly committed quality control program.

2. Lumber Production

a. Direct quantification of the raw material loss at the trimmer due to over-trimming. If implemented on an individual operator basis the information might indicate a need for further training. Comparisons with the trim optimizer may also be undertaken.

b. Assessing the raw material losses due to improper edging practices. This information might be compared with the edger optimizer solution or the manual edging decision.

B. This technique provided a method in which veneer losses could be accurately partitioned into very specific categories. This fact allowed for a detailed study of the green-end loss components to be carried out. For example, the potentially recoverable veneer losses were divided into two categories, the accurately and inaccurately clipped recoverable. Clipper losses were partitioned into two components, the clipper round-up and the reject volumes. The round-up of the block was partitioned into trash-gate round-up and clipped round-up components.

C. This technique was successfully employed to determine the potentially recoverable veneer as well as various recovery values and specific loss components at five cooperating mills in the Pacific Northwest. The specific conclusions in regard to those five mills are as follows:

1. The potential for recovery improvement has been shown to be considerable. If the five mills studied here were able to increase their quantity of merchantable veneer by one percent, the realized profit would range from $33,000 to $75,000 annually.

2. The potential for increasing veneer recovery at the green-end clipper has been determined to range between 1.4 percent to 4.0 percent of the merchantable veneer volume for the five mills studied.

3. Considering today's demand for high production rates, it is not considered possible for the entire 1.4 percent to 4.0 percent potentially recoverable veneer lost at the clipper to be realistically recovered. Obviously some portion of that loss may be sufficiently reduced by initiating effective clipper/scanner maintenance and proper setup procedures.

4. Total losses at the gree-end clipper are not as great as the literature indicates and they were determined to range between 4.7 percent and 8.6 percent of the total block volume for the five mills studied.

5. The five mills examined appear to be operating relatively efficiently in converting, on the average, approximately 78.2 percent of the incoming raw material into merchantable veneer.

6. An approximation of the quantity of raw material being diverted down the trash-gate conveyor has been determined. Trash-gate losses were indirectly determined to average between 0.8 percent and 7.1 percent of the block volume for the five mills studied.

D. In almost all areas examined, and of all five mills studied, mill 3 was the least effective in converting its raw material into merchantable veneer with a cubic recovery ratio at the clipper of 0.65. The main factors contributing to this low value are concluded to be its cold peel, tray system, excess margins, excess block length, excess core diameter and the possibility of improper block centering on the part of the X-Y charger.

E. The scanner must be properly and knowledgeably set up in order to fully realize its potential in improving veneer recovery. Losses due to poor setup have been shown to be considerable in the cases of mills 3 and 5 where margins were set in excess of one inch.

F. The cubic recovery ratio increased while the veneer recovery factor decreased with increased block diameter. It is concluded that the veneer recovery factor does not adequately describe recovery efficiencies because of the inherent inadequacies of the Scribner scale. The cubic recovery ratio more appropriately describes the conversion efficiency.

G. This information will be useful to clipper and scanner manufacturers as well as mill management to provide a reference point regarding the potential for recovery improvement. Equipment manufacturers have been shown that the potentially recoverable veneer volumes are substantial and warrant research into reducing those volumes. Mill management now has a technique with which their own production system may be closely examined to determine areas of recovery enhancement.

H. The potential for this technique will be to open up many new areas for investigation.

VII. RECOMMENDATIONS

The following are recommendations of this study:

A. The potentially recoverable veneer volume has been shown to be financially sufficient to warrant additional research and development into clipper/scanner operations with the goal of reducing this volume.

B. Design inadequacies inherent in the present clipper/scanner systems (e.g., inconsistent veneer tracking by the scanner timing wheel, etc.), require a combined design effort on the part of both the clipper and the scanner manufacturers. For instance, two timing wheels might be employed with one mounted very close to the knife while the other would be located approximately three feet upstream of the knife. The two outputs would be constantly compared or averaged with one another and therefore provide to the scanner logic, a more correct representation of veneer line speed.

C. In order of ease of implementation, the competitive advantage of mill 3 might be substantially improved by:

1. reducing the scanner margin setting from 1.2 inches to 1.0 inches or less.
2. peeling to a smaller core diameter by replacing the seven-inch chuck with a five-inch chuck.
3. examining the lathe operators actions with regard to eliminating excessive trash-gate veneer losses.
4. examining the X-Y charger for proper block centering with regard to eliminating excessively long block round-up.
5. bucking the peeler blocks closer to the spur length setting and bucking them more uniformly.

6. conditioning the blocks if possible.

D. The potentially recoverable veneer losses would substantially be reduced at mill 5 by reducing the scanner margin setting from 2.0 inches to 1.0 inches or less.

E. To achieve the desired sensitivity in VRF and to facilitate more confident statistical analysis under the split-plot design, core data should be matched with the block data on a block-by-block basis.

F. Because of the inadequacies of VRF, it should not be considered as a criterion in the design of an experiment. CRR more correctly reflects actual veneer recovery efficiencies and therefore should be used instead.

G. Coupling veneer recovery information from the procedures outlined here with pull-cart veneer tallies will provide an approximation of green-chain fall down.

H. In production systems with similar veneer thickness variation, about 40 veneer thickness measurements are considered necessary to achieve adequate sensitivity (i.e., being able to detect variation to ± 0.001 in.).

I. It is suggested that a photographic system, not requiring a flash system be employed. It appears that an adequate flash system is presently unavailable in meeting the requirements of this project in the production environment (400 watt-seconds of light and recycling consistently within 3/4 seconds for a continuous period of four hours with no misfires). This would require a camera with a variable frame rate, variable shutter speed and a variable shutter slit width. The potential for the use of a video camera may also exist.

J. The labor-intensive digitizing operation might be made more cost-effective and begin to approach a real time data acquisition procedure with the incorporation of an automatic image analyzing system.

K. The use of a fine-grained color film would greatly enhance the defect discimination capacity during the digitizing operation (open defects vs. closed, clips vs. cracks, thick vs. thin, discolored veneer vs. rotten veneer, etc.).

L. The economic feasibility of employing dual tandem timing wheels should be examined with the goal of reducing inaccurate clips due to improper veneer tracking.

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GLOSSARY

ACCURATELY CLIPPED RECOVERABLE - that material bound for the trash conveyor and generated by the clipper in a correct clipping sequence, based on existing scanner instructions. That is, the veneer is lost due to a properly placed clip.

ALTERNATE GRADE - the minimum strip and margin limits as set by management and functional only during block round-up.

CLIPPED ROUND-UP - that portion of round-up that passes through the clipper (prior to the occurrence of two consecutive full sheets) and is clipped as trash in an attempt to recover merchantable veneer.

CLIPPER LOSS - the total amount of trash generated at the clipper. Quantitatively, it is the sum of the clipped round-up and reject volumes.

CUBIC RECOVERY RATIO (CRR) - the cubic volume of merchantable veneer produced per cubic block volume.

CYBER - the CDC mainframe computer residing on the campus of Oregon State University.

DIGITIZE - the conversion of analog information into a digital form. In this case converting visual images into information concerning veneer areas.

DIVIDE SWITCH - a switch that will cause the logic controller to maximize the recovery of half sheets or maximize the recovery of good wood depending on its position. Sometimes referred to as the SMALL PANEL/RANDOM SWITCH.

EDGE OF RIBBON FLAW LIMITS - with grain and cross grain flaw limits which when exceeded result in that edge defect being clipped out.

FULL SHEET WIDTH - adjusts the cross grain target width for full sheets.

FLAW CENTERING - this setting positions the clips around an open defect. This can be used to adjust for timing wheel wear.

HALF SHEET WIDTH - adjusts the cross grain target width for half sheets.

INACCURATELY CLIPPED RECOVERABLE - that material bound for the trash conveyor and generated by the clipper because of an improperly placed clip.

MARGIN - the amount of material added to the front and back of the clip to allow for clipping variation and to insure that the entire flaw is clipped out.

MAXIMUM CRACK LENGTH - flaw limit that sets the maximum allowable with grain crack which when exceeded will cause that defect to be clipped out.

MINIMUM FISH-TAIL LENGTH - an edge flaw limit setting that determines the amount of good wood in the grain dimension necessary to obtain an acceptable trimmed fish-tail.

MINIMUM RANDOM WIDTH - this setting determines the minimum cross grain width allowable for random strip.

MINIMUM RIBBON WIDTH - sets the minimum width grain ribbon dimension. Any block shorter than this dimension is clipped totally as fish-tails and/or half sheets.

NORMAL GRADE - the minimum strip and margin limits as set by management and functional after round-up is achieved.

REJECT - that non-merchantable veneer generated by the clipper and occurring after the clipping of two consecutive full sheets.

ROUND-UP - that non-merchantable veneer (trash) produced prior to the clipping of two consecutive full sheets. Quantitatively it is the sum of both the trash-gate and the clipped round-up volumes.

SIPS - the statistical Interactive Programming System available on the CYBER computer and used for all statistical analyses in this project.

SMALL PANEL/RANDOM SWITCH - see DIVIDE SWITCH.

THEORETICAL VENEER VOLUME - the maximum volume of veneer capable of being produced from the maximum scaling cylinder, inside the spur knife setting and excluding the core volume.

TOTAL CLIPPING LOSS - the sum of all reject and clipped round-up material.

TOTAL ROUND-UP - the sum of all trash-gate round-up and all clipped round-up.

TRASH GATE ROUND-UP - the trash material that is diverted down to the trash conveyor before any veneer from that block actually reaches the clipper.

VENEER RECOVERY FACTOR (VRF) - the square feet of veneer (3/8-inch basis) per net Scribner board foot volume.

WITHIN RIBBON FLAW LIMITS - with grain and cross grain flaw limits which when exceeded results in that within ribbon defect to be clipped out.

APPENDICES

APPENDIX A

CLPLOSS Computer Program Output

CLPLOSS Computer Program Output

```
COPY,VENOUT

                    ######################################
                    ######################################
                    ##                                  ##
                    ##             "CLPLOSS"            ##
                    ##                                  ##
                    ##   GREEN VENEER RECOVERY PROGRAM  ##
                    ##                                  ##
                    ######################################
                    ######################################

AUGUST 27, 1982              DR. JAMES FUNCK           FOREST PRODUCTS DEPARTMENT
CYBER 70 (CDC)               THOMAS SHEFFIELD          OREGON STATE UNIVERSITY
FORTRAN5                     (503) 754-4192            CORVALLIS, OREGON 97331
FINAL VERSION

      OBJECTIVES........

        1.  TO DIRECTLY MEASURE AND ANALYZE GREEN VENEER RECOVERY ASSOCIATED WITH

                 VENEER PRODUCTION UP TO AND INCLUDING THE GREEN-END CLIPPER

        2.  TO MEASURE AND ANALYZE THE VOLUME OF POTENTIALLY RECOVERABLE MATERIAL

                 PRESENT BEING LOST AT THE GREEN-END CLIPPER

        3.  TO DETERMINE AND OUTLINE STANDARD PROCEDURES AND EQUIPMENT NECESSARY

                 FOR MILL MANAGEMENT TO CONDUCT SIMILAR ANALYSES ON AN IN-HOUSE BASIS
```

CLPLOSS Computer Program Output, continued

THE LARGEST LOSS ASSOCIATED WITH VENEER PRODUCTION, OCCURS AT THE GREEN-END CLIPPER. PREVIOUS RESEARCH HAS INDICATED THAT THIS LOSS VARIES FROM 16 TO 26 PERCENT OF THE BLOCK VOLUME. HOWEVER, BECAUSE OF TODAY'S SOPHISTICATED RECOVERY TECHNIQUES, THESE VALUES ARE NO LONGER CONSIDERED CURRENT, NOR WERE THEY DETERMINED BY DIRECT MEASUREMENT. IN THIS PROJECT, SELECTED BLOCKS WERE SCALED AND PEELED WITH THE RESULTING VENEER BEING PHOTOGRAPHED BY A 8 MM MOVIE CAMERA PLACED AT THE DOWN-STREAM SIDE OF THE VENEER CLIPPER APPROXIMATELY 15 FT. ABOVE THE CONVEYOR. THEREFORE, A PHOTOGRAPHIC RECORD EXISTS FOR ALL THE VENEER PRODUCED BY THE PEELER BLOCKS EXCEPT FOR THE VENEER BEING DIVERTED DOWN THE TRASH-GATE DURING ROUND-UP. THE FILM WAS THEN PROJECTED ONTO A DIGITIZING SURFACE, ON WHICH THE AREAS OF ALL THE INDIVIDUAL PIECES OF VENEER COULD BE MEASURED DIRECTLY WITH A VERY HIGH DEGREE OF ACCURACY. COUPLING THIS INFORMATION WITH A CLASSIFICATION OF NINE VENEER TYPES, PEELER CORE MEASUREMENTS, AND OTHER PERTINENT DATA, PROVIDED THE BASIS FOR THE FOLLOWING RESULTS OF THIS SPLIT-PLOT GREEN VENEER RECOVERY ANALYSIS.

1

CLPLOSS Computer Program Output, continued

```
##########################################################
##########################################################
##                                                      ##
##                                                      ##
##     "CLPLOSS" VENEER RECOVERY PROGRAM OUTPUT         ##
##                                                      ##
##                                                      ##
##########################################################
##########################################################
```

```
THE CLPLOSS VENEER RECOVERY OUTPUT CONSISTS OF TWO SECTIONS............

     SECTION 1-  THE VENEER DATA BASE IS PROCESSED BY A CYBER
                 SORT/MERGE ROUTINE FOLLOWED BY A SUMMATION
                 ROUTINE TO REDUCE THE CODED RAW DATA
                 ORIGINATING FROM THE DIGITIZING OPERATION.
                 THIS DATA IS READ OFF THE DATA FILE CALLED
                 'VENEER' AND IS SUMMED INTO NINE SPECIFIC
                 VENEER TYPES.  THIS SECTION OF OUTPUT
                 PRESENTS THE VENEER DATA FOR EACH PEELER
                 BLOCK PROCESSED AND IS PRESENTED ON A BLOCK
                 BY BLOCK BASIS.
```

```
SECTION 2-  THE VENEER DATA ORIGINATING FROM SECTION 1 IS
                 MATCHED ON A BLOCK BY BLOCK BASIS WITH
                 THE BLOCK AND CORE DATA READ OFF THE FILE
                 CALLED 'BLOCKS'.  A SPLIT-PLOT SORTING
                 ROUTINE PROCESSES THE BLOCK, THE VENEER
                 AND THE CORE DATA TO PROVIDE SPECIFIC
                 RECOVERY INFORMATION ON ALL ASPECTS UNDER
                 CONSIDERATION UNDER THIS PROJECT.  THIS
                 SPLIT-PLOT ANALYSIS CREATES A LISTING OF
                 BLOCK DATA AS CLASSIFIED BY PERMUTATIONS
                 OF THE TWO KEY EXPERIMENTAL PARAMETERS,
                 MILL AND BLOCK DIAMETER.
1

THE TOTAL NUMBER OF DIGITIZING OPERATIONS BEING CONSIDERED HERE ARE =    94109

THE TOTAL NUMBER OF PEELER BLOCKS BEING CONSIDERED HERE ARE =      600

CONSISTING OF    5   FACILITIES    4   DIAMETERS, AND   30   BLOCKS IN EACH
```

CLPLOSS Computer Program Output, continued

"CLPLOSS" VENEER RECOVERY PROGRAM OUTOUT

SECTION 1

(Due to its excessive length, Section 1 is not included here.)

CLPLOSS Computer Program Output, continued

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************************************************************************************************************************************************************
************************************************************************************************************************************************************
************************************************************************************************************************************************************
************************************************************************************************************************************************************


                              "CLPLOSS" VENEER RECOVERY PROGRAM OUTPUT
                                             SECTION 2


************************************************************************************************************************************************************
************************************************************************************************************************************************************
************************************************************************************************************************************************************
************************************************************************************************************************************************************
```

CLPLOSS Computer Program Output, continued

1

****** BLOCK DATA ******

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	AVERAGE BLOCK LENGTH (IN.)	AVERAGE VENEER THICKNESS (IN.)	AVERAGE LARGE END DIAMETER (IN.)	AVERAGE SMALL END DIAMETER (IN.)	GROSS SCRIBNER SCALE (BD.FT.)	NET SCRIBNER SCALE (BD.FT.)	CUBIC BLOCK VOLUME (CU.FT.)
0	1	ALL	120.	102.6	.1014	21.2	19.9	16650.0	15880.0	2554.2
0	2	ALL	120.	102.8	.1006	21.1	20.1	16770.0	16110.0	2550.6
0	3	ALL	120.	104.0	.1273	20.8	19.6	16000.0	14890.0	2487.3
0	4	ALL	120.	102.7	.1275	21.1	19.6	16070.0	15380.0	2515.9
0	5	ALL	120.	102.5	.0980	20.7	19.7	16460.0	15810.0	2474.3
0	ALL	1	150.	102.9	0.0000	13.7	12.7	6230.0	6100.0	1234.8
0	ALL	2	150.	102.9	0.0000	18.2	17.1	13010.0	12760.0	2198.4
0	ALL	3	150.	102.9	0.0000	23.6	22.3	24520.0	23140.0	3725.0
0	ALL	4	150.	103.0	0.0000	28.4	27.1	38190.0	36070.0	5424.0
0	1	1	30.	102.6	.1014	13.7	12.8	1290.0	1280.0	248.8
0	1	2	30.	102.8	.1014	18.1	16.9	2530.0	2530.0	432.5
0	1	3	30.	102.4	.1014	23.9	22.5	4990.0	4740.0	754.6
0	1	4	30.	102.6	.1014	29.0	27.5	7840.0	7330.0	1118.4
0	2	1	30.	102.7	.1006	14.3	13.7	1450.0	1440.0	275.8
0	2	2	30.	102.6	.1006	18.0	17.2	2680.0	2620.0	440.0
0	2	3	30.	102.9	.1006	24.0	22.6	5060.0	4810.0	768.0
0	2	4	30.	103.0	.1006	28.1	27.0	7580.0	7240.0	1066.8
0	3	1	30.	103.8	.1273	14.1	13.2	1340.0	1270.0	264.9
0	3	2	30.	104.0	.1273	18.1	17.0	2580.0	2510.0	441.0
0	3	3	30.	104.1	.1273	22.8	21.6	4480.0	4090.0	699.9
0	3	4	30.	104.0	.1273	28.3	26.9	7600.0	7020.0	1081.5
0	4	1	30.	102.8	.1275	13.0	11.9	1040.0	1000.0	219.8
0	4	2	30.	102.6	.1275	18.4	17.1	2580.0	2540.0	445.4
0	4	3	30.	102.6	.1275	24.1	22.3	4910.0	4660.0	755.6
0	4	4	30.	102.8	.1275	28.9	26.9	7540.0	7180.0	1095.1
0	5	1	30.	102.6	.0980	13.2	12.0	1110.0	1110.0	225.6
0	5	2	30.	102.5	.0980	18.1	17.3	2640.0	2560.0	439.5
0	5	3	30.	102.5	.0980	23.5	22.6	5080.0	4840.0	746.9
0	5	4	30.	102.5	.0980	28.0	27.0	7630.0	7300.0	1062.3

-INVALID THICKNESSES ARE INDICATED BY ZEROS

CLPLOSS Computer Program Output, continued

1

****** CORE AND SPUR DATA ******

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	AVERAGE CORE DIAMETERS (IN.) OPERATOR END	CENTER	END	TOTAL CORE VOLUME (CU.FT.)	% OF TOTAL BLOCK VOLUME	TOTAL SPUR VOLUME (CU.FT.)	% OF TOTAL BLOCK VOLUME
0	1	ALL	120.	6.17	6.17	6.09	215.5	8.4	35.0	1.4
0	2	ALL	120.	5.11	5.13	5.08	148.5	5.8	40.8	1.6
0	3	ALL	120.	7.40	7.56	7.38	320.1	12.9	56.6	2.3
0	4	ALL	120.	5.81	6.03	5.84	200.0	7.9	27.7	1.1
0	5	ALL	120.	5.14	5.27	5.14	157.4	6.4	45.0	1.8
0	ALL	1	150.	5.63	5.73	5.62	232.6	18.8	16.9	1.4
0	ALL	2	150.	5.66	5.76	5.64	234.8	10.7	34.0	1.5
0	ALL	3	150.	6.07	6.19	6.05	272.6	7.3	60.3	1.6
0	ALL	4	150.	6.33	6.45	6.33	301.5	5.6	93.9	1.7
0	1	1	30.	5.29	5.28	5.22	38.8	15.6	3.2	1.3
0	1	2	30.	5.50	5.50	5.44	42.5	9.8	6.4	1.5
0	1	3	30.	6.87	6.90	6.78	65.8	8.7	9.2	1.2
0	1	4	30.	7.01	6.99	6.93	68.3	6.1	16.2	1.5
0	2	1	30.	5.03	5.13	5.01	36.1	13.1	3.6	1.3
0	2	2	30.	5.03	5.06	5.00	35.5	8.1	6.0	1.4
0	2	3	30.	5.32	5.29	5.29	41.1	5.4	12.8	1.7
0	2	4	30.	5.05	5.05	5.03	35.8	3.4	18.4	1.7
0	3	1	30.	7.36	7.45	7.33	77.4	29.2	4.4	1.7
0	3	2	30.	7.38	7.43	7.29	77.4	17.5	9.5	2.2
0	3	3	30.	7.40	7.61	7.37	79.8	11.4	16.4	2.3
0	3	4	30.	7.48	7.74	7.55	85.5	7.9	26.3	2.4
0	4	1	30.	5.67	5.87	5.72	47.0	21.4	2.1	1.0
0	4	2	30.	5.56	5.80	5.60	45.4	10.2	4.3	1.0
0	4	3	30.	5.67	5.95	5.69	47.5	6.3	7.9	1.1
0	4	4	30.	6.33	6.49	6.35	60.1	5.5	13.3	1.2
0	5	1	30.	4.83	4.93	4.81	33.3	14.8	3.6	1.6
0	5	2	30.	4.85	5.00	4.86	34.0	7.7	7.9	1.8
0	5	3	30.	5.09	5.18	5.11	38.4	5.1	13.9	1.9
0	5	4	30.	5.79	5.97	5.77	51.7	4.9	19.6	1.8

CLPLOSS Computer Program Output, continued

1				****** ROUND-UP DATA ******					
-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	TOTAL ROUND-UP VOLUME (CU.FT.)	% OF TOTAL BLOCK VOLUME	TRASH-GATE ROUND-UP VOLUME (CU.FT.)	% OF TOTAL BLOCK	CLIPPED ROUND-UP VOLUME (CU.FT.)	%OF TOTAL BLOCK VOLUME
0	1	ALL	120.	169.3	6.6	45.9	1.8	123.4	4.8
0	2	ALL	120.	198.5	7.8	77.1	3.0	121.4	4.8
0	3	ALL	120.	381.0	15.3	167.6	6.7	213.4	8.6
0	4	ALL	120.	146.4	5.8	16.7	.7	129.7	5.2
0	5	ALL	120.	164.9	6.7	11.5	.5	153.4	6.2
0	ALL	1	150.	130.9	10.6	33.6	2.7	97.3	7.9
0	ALL	2	150.	176.2	8.0	32.3	1.5	144.0	6.5
0	ALL	3	150.	316.1	8.5	105.7	2.8	210.4	5.6
0	ALL	4	150.	436.8	8.1	147.2	2.7	289.6	5.3
0	1	1	30.	31.5	12.7	10.8	4.3	20.7	8.3
0	1	2	30.	23.6	5.5	-1.6	-.4	25.2	5.8
0	1	3	30.	49.6	6.6	20.7	2.7	29.0	3.8
0	1	4	30.	64.6	5.8	16.0	1.4	48.6	4.3
0	2	1	30.	12.4	4.5	-1.2	-.4	13.6	4.9
0	2	2	30.	30.3	6.9	11.2	2.5	19.1	4.4
0	2	3	30.	106.2	13.8	61.0	7.9	45.2	5.9
0	2	4	30.	49.5	4.6	6.1	.6	43.4	4.1
0	3	1	30.	38.7	14.6	13.0	4.9	25.7	9.7
0	3	2	30.	73.7	16.7	29.4	6.7	44.3	10.0
0	3	3	30.	96.7	13.8	39.3	5.6	57.4	8.2
0	3	4	30.	171.9	15.9	85.9	7.9	86.0	8.0
0	4	1	30.	18.1	8.2	1.7	.8	16.3	7.4
0	4	2	30.	26.6	6.0	-1.2	-.3	27.7	6.2
0	4	3	30.	21.5	2.8	-15.6	-2.1	37.0	4.9
0	4	4	30.	80.3	7.3	31.7	2.9	48.6	4.4
0	5	1	30.	30.2	13.4	9.2	4.1	21.0	9.3
0	5	2	30.	22.0	5.0	-5.5	-1.3	27.6	6.3
0	5	3	30.	42.1	5.6	.4	.1	41.8	5.6
0	5	4	30.	70.5	6.6	7.4	.7	63.1	5.9

CLPLOSS Computer Program Output, continued

1

VENEER VOLUME DATA

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	TOTAL VENEER VOLUME PRODUCED (CU.FT.)	TOTAL VENEER VOLUME PRODUCED (SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME	THEORETICAL VENEER VOLUME (CU.FT.)	THEORETICAL VENEER VOLUME (SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME	CUBIC RECOVERY RATIO	VENEER RECOVERY FACTOR
0	1	ALL	120.	2073.1	66338.0	81.2	2152.1	68866.5	84.3	.812	4.177
0	2	ALL	120.	2084.8	66714.1	81.7	2237.8	71609.5	87.7	.817	4.141
0	3	ALL	120.	1621.8	51896.3	65.2	1971.3	63080.9	79.3	.652	3.485
0	4	ALL	120.	2054.4	65742.3	81.7	2100.0	67200.5	83.5	.817	4.275
0	5	ALL	120.	2005.8	64186.6	81.1	2164.7	69271.2	87.5	.811	4.060
0	ALL	1	150.	812.5	26000.8	65.8	899.7	28789.7	72.9	.658	4.262
0	ALL	2	150.	1679.0	53728.1	76.4	1795.9	57469.0	81.7	.764	4.211
0	ALL	3	150.	2948.8	94360.4	79.2	3173.2	101542.1	85.2	.792	4.078
0	ALL	4	150.	4399.6	140788.0	81.1	4757.1	152227.9	87.7	.811	3.903
0	1	1	30.	168.7	5398.4	67.8	189.8	6075.1	76.3	.678	4.217
0	1	2	30.	346.8	11097.5	80.2	353.2	11302.8	81.7	.802	4.386
0	1	3	30.	615.3	19689.7	81.5	633.6	20275.3	84.0	.815	4.154
0	1	4	30.	942.3	30152.5	84.3	975.4	31213.4	87.2	.843	4.114
0	2	1	30.	214.4	6861.3	77.8	223.3	7144.5	81.0	.778	4.765
0	2	2	30.	354.2	11334.3	80.5	378.0	12095.9	85.9	.805	4.326
0	2	3	30.	582.7	18648.0	75.9	666.5	21329.0	86.8	.759	3.877
0	2	4	30.	933.5	29870.5	87.5	970.0	31040.1	90.9	.875	4.126
0	3	1	30.	136.6	4372.5	51.6	166.3	5320.8	62.8	.516	3.443
0	3	2	30.	267.1	8547.5	60.6	324.7	10390.7	73.6	.606	3.405
0	3	3	30.	478.2	15301.8	68.3	565.4	18094.3	80.8	.683	3.741
0	3	4	30.	739.8	23674.5	68.4	914.8	29275.1	84.6	.684	3.372
0	4	1	30.	145.7	4661.3	66.3	152.0	4862.9	69.1	.663	4.661
0	4	2	30.	353.4	11308.1	79.3	362.8	11610.7	81.5	.793	4.452
0	4	3	30.	646.9	20699.6	85.6	640.5	20496.8	84.8	.856	4.442
0	4	4	30.	908.5	29073.4	83.0	944.7	30230.0	86.3	.830	4.049
0	5	1	30.	147.1	4707.4	65.2	168.3	5386.4	74.6	.652	4.241
0	5	2	30.	357.5	11440.8	81.4	377.2	12068.8	85.8	.814	4.469
0	5	3	30.	625.7	20021.3	83.8	667.1	21346.7	89.3	.838	4.137
0	5	4	30.	875.5	28017.1	82.4	952.2	30469.3	89.6	.824	3.838

CLPLOSS Computer Program Output, continued

1				****** CLIPPING LOSS DATA ******					
-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	TOTAL CLIPPING LOSS (CU.FT.)	(SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME	TOTAL REJECT VOLUME (CU.FT.)	(SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME
0	1	ALL	120.	134.1	4292.6	5.3	10.7	342.6	.4
0	2	ALL	120.	145.1	4642.8	5.7	23.7	757.4	.9
0	3	ALL	120.	258.5	8271.1	10.4	45.1	1442.3	1.8
0	4	ALL	120.	158.5	5071.2	6.3	28.8	921.0	1.1
0	5	ALL	120.	199.4	6379.2	8.1	45.9	1470.4	1.9
0	ALL	1	150.	109.0	3488.5	8.8	11.7	373.4	.9
0	ALL	2	150.	165.7	5303.4	7.5	21.8	696.2	1.0
0	ALL	3	150.	260.3	8329.7	7.0	49.9	1597.0	1.3
0	ALL	4	150.	360.5	11535.5	6.6	70.8	2267.0	1.3
0	1	1	30.	22.1	706.2	8.9	1.3	42.7	.5
0	1	2	30.	26.8	856.6	6.2	1.6	50.6	.4
0	1	3	30.	31.3	1003.0	4.2	2.4	76.4	.3
0	1	4	30.	54.0	1726.7	4.8	5.4	172.9	.5
0	2	1	30.	16.7	535.1	6.1	3.1	98.6	1.1
0	2	2	30.	24.6	786.8	5.6	5.4	174.1	1.2
0	2	3	30.	51.9	1661.7	6.8	6.7	215.0	.9
0	2	4	30.	51.9	1659.2	4.9	8.4	269.7	.8
0	3	1	30.	28.8	921.3	10.9	3.1	100.5	1.2
0	3	2	30.	48.0	1536.8	10.9	3.7	118.7	.8
0	3	3	30.	69.6	2226.7	9.9	12.2	388.8	1.7
0	3	4	30.	112.1	3586.2	10.4	26.1	834.2	2.4
0	4	1	30.	17.8	569.7	8.1	1.5	47.6	.7
0	4	2	30.	31.1	994.1	7.0	3.3	106.5	.7
0	4	3	30.	52.2	1670.4	6.9	15.2	485.2	2.0
0	4	4	30.	57.4	1837.0	5.2	8.8	281.7	.8
0	5	1	30.	23.6	756.2	10.5	2.6	84.0	1.2
0	5	2	30.	35.3	1129.0	8.0	7.7	246.4	1.8
0	5	3	30.	55.2	1767.9	7.4	13.5	431.6	1.8
0	5	4	30.	85.2	2726.3	8.0	22.1	708.4	2.1

CLPLOSS Computer Program Output, continued

1 ****** CLIPPING LOSS DATA ******

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	ACCURATELY CLIPPED RECOVERABLE VENEER (CU.FT.)	(SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME	INACCURATELY CLIPPED RECOVERABLE VENEER (CU.FT.)	(SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME
0	1	ALL	120.	4.9	157.5	.2	24.3	778.7	1.0
0	2	ALL	120.	7.0	224.8	.3	26.7	853.8	1.0
0	3	ALL	120.	16.7	535.5	.7	47.3	1513.3	1.9
0	4	ALL	120.	8.3	267.1	.3	27.6	882.0	1.1
0	5	ALL	120.	33.9	1086.3	1.4	24.1	770.1	1.0
0	ALL	1	150.	8.4	268.9	.7	17.0	545.4	1.4
0	ALL	2	150.	13.7	437.4	.6	30.2	967.7	1.4
0	ALL	3	150.	21.8	698.1	.6	38.8	1242.3	1.0
0	ALL	4	150.	27.1	866.8	.5	63.8	2042.4	1.2
0	1	1	30.	.5	17.3	.2	3.3	105.8	1.3
0	1	2	30.	1.4	45.3	.3	6.9	222.1	1.6
0	1	3	30.	1.6	51.4	.2	4.6	148.3	.6
0	1	4	30.	1.4	43.6	.1	9.5	302.6	.8
0	2	1	30.	.7	21.1	.2	2.8	89.2	1.0
0	2	2	30.	1.5	48.4	.3	4.1	131.3	.9
0	2	3	30.	2.9	93.3	.4	9.8	313.8	1.3
0	2	4	30.	1.9	62.0	.2	10.0	319.5	.9
0	3	1	30.	1.8	57.4	.7	4.8	152.8	1.8
0	3	2	30.	2.8	89.8	.6	9.4	300.8	2.1
0	3	3	30.	4.4	140.2	.6	11.5	368.4	1.6
0	3	4	30.	7.8	248.1	.7	21.6	691.3	2.0
0	4	1	30.	.9	27.9	.4	2.6	82.9	1.2
0	4	2	30.	2.0	63.0	.4	6.7	213.5	1.5
0	4	3	30.	2.7	86.2	.4	6.8	216.9	.9
0	4	4	30.	2.8	90.1	.3	11.5	368.6	1.1
0	5	1	30.	4.5	145.2	2.0	3.6	114.6	1.6
0	5	2	30.	6.0	191.0	1.4	3.1	100.1	.7
0	5	3	30.	10.2	327.1	1.4	6.1	195.0	.8
0	5	4	30.	13.2	423.0	1.2	11.3	360.5	1.1

CLPLOSS Computer Program Output, continued

1 ****** FULL SHEET SIZE AND VOLUME DATA ******

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	INDIVIDUAL FULL SHEET AREA (ACTUAL THICKNESS) AVERAGE	STANDARD DEVIATION	TOTAL SHEET VOLUME (CU.FT.)	(SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME
0	1	ALL	120.	37.273	.365	1502.6	48081.7	58.8
0	2	ALL	120.	37.357	.429	1468.5	46993.3	57.6
0	3	ALL	120.	37.836	.715	846.6	27092.2	34.0
0	4	ALL	120.	37.619	.424	1391.0	44511.1	55.3
0	5	ALL	120.	37.178	.514	1116.5	35727.7	45.1
0	ALL	1	150.	37.202	.462	493.4	15789.2	40.0
0	ALL	2	150.	37.339	.455	1050.9	33630.4	47.8
0	ALL	3	150.	37.386	.566	2000.9	64028.0	53.7
0	ALL	4	150.	37.477	.497	2780.0	88958.4	51.3
0	1	1	30.	37.307	.379	115.0	3680.2	46.2
0	1	2	30.	37.369	.361	253.1	8100.0	58.5
0	1	3	30.	37.206	.366	493.7	15797.2	65.4
0	1	4	30.	37.281	.352	640.8	20504.2	57.3
0	2	1	30.	37.122	.357	157.4	5037.1	57.1
0	2	2	30.	37.154	.391	238.2	7621.9	54.1
0	2	3	30.	37.387	.407	378.8	12121.1	49.3
0	2	4	30.	37.465	.422	694.2	22213.3	65.1
0	3	1	30.	37.625	.377	73.4	2349.4	27.7
0	3	2	30.	37.735	.381	114.9	3675.2	26.0
0	3	3	30.	37.807	.942	276.3	8840.0	39.5
0	3	4	30.	37.928	.632	382.1	12227.6	35.3
0	4	1	30.	37.036	.507	79.9	2556.2	36.3
0	4	2	30.	37.529	.395	228.9	7324.2	51.4
0	4	3	30.	37.710	.362	450.8	14424.2	59.7
0	4	4	30.	37.662	.399	631.5	20206.4	57.7
0	5	1	30.	37.014	.551	67.7	2166.3	30.0
0	5	2	30.	37.192	.517	215.9	6909.1	49.1
0	5	3	30.	37.104	.502	401.4	12845.4	53.7
0	5	4	30.	37.266	.501	431.5	13806.9	40.6

CLPLOSS Computer Program Output, continued

1 ****** HALF SHEET SIZE AND VOLUME DATA ******

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	INDIVIDUAL HALF SHEET AREA (ACTUAL THICKNESS) AVERAGE	STANDARD DEVIATION	TOTAL SHEET VOLUME (CU.FT.)	(SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME
0	1	ALL	120.	18.641	.511	373.0	11935.2	14.6
0	2	ALL	120.	18.715	.569	340.3	10890.5	13.3
0	3	ALL	120.	18.388	.620	294.1	9410.3	11.8
0	4	ALL	120.	18.818	.700	430.1	13762.5	17.1
0	5	ALL	120.	18.621	.547	563.9	18045.1	22.8
0	ALL	1	150.	18.744	.801	159.5	5103.0	12.9
0	ALL	2	150.	18.637	.560	354.9	11357.9	16.1
0	ALL	3	150.	18.642	.590	510.7	16340.9	13.7
0	ALL	4	150.	18.640	.573	976.3	31241.7	18.0
0	1	1	30.	18.636	.578	25.5	816.0	10.2
0	1	2	30.	18.654	.559	56.4	1804.9	13.0
0	1	3	30.	18.573	.613	70.1	2243.8	9.3
0	1	4	30.	18.660	.450	221.0	7070.5	19.8
0	2	1	30.	18.574	.527	33.6	1075.8	12.2
0	2	2	30.	18.691	.510	73.5	2350.7	16.7
0	2	3	30.	18.770	.592	105.1	3362.3	13.7
0	2	4	30.	18.722	.587	128.2	4101.7	12.0
0	3	1	30.	18.339	.751	18.5	591.2	7.0
0	3	2	30.	18.464	.489	64.2	2055.3	14.6
0	3	3	30.	18.429	.637	71.3	2282.7	10.2
0	3	4	30.	18.340	.643	140.0	4481.1	12.9
0	4	1	30.	19.541	.979	43.0	1375.3	19.6
0	4	2	30.	18.739	.622	76.7	2453.0	17.2
0	4	3	30.	18.807	.580	126.9	4060.4	16.8
0	4	4	30.	18.697	.632	183.6	5873.9	16.8
0	5	1	30.	18.464	.491	38.9	1244.6	17.2
0	5	2	30.	18.612	.570	84.2	2694.1	19.2
0	5	3	30.	18.553	.509	137.2	4391.7	18.4
0	5	4	30.	18.674	.557	303.6	9714.6	28.6

CLPLOSS Computer Program Output, continued

					****** RANDOM STRIP DATA ******	
1						
-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	TOTAL (CU.FT.)	RANDOM STRIP VOLUME (SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME
0	1	ALL	120.	128.5	4110.8	5.0
0	2	ALL	120.	199.7	6389.5	7.8
0	3	ALL	120.	390.9	12507.7	15.7
0	4	ALL	120.	153.8	4920.6	6.1
0	5	ALL	120.	224.3	7177.8	9.1
0	ALL	1	150.	115.0	3678.8	9.3
0	ALL	2	150.	196.0	6272.7	8.9
0	ALL	3	150.	321.5	10286.6	8.6
0	ALL	4	150.	464.6	14868.1	8.6
0	1	1	30.	21.2	678.6	8.5
0	1	2	30.	22.1	706.2	5.1
0	1	3	30.	35.1	1123.5	4.7
0	1	4	30.	50.1	1602.6	4.5
0	2	1	30.	15.2	486.6	5.5
0	2	2	30.	31.0	991.4	7.0
0	2	3	30.	71.9	2301.6	9.4
0	2	4	30.	81.6	2609.9	7.6
0	3	1	30.	38.0	1214.6	14.3
0	3	2	30.	73.7	2359.5	16.7
0	3	3	30.	105.8	3385.2	15.1
0	3	4	30.	173.4	5548.4	16.0
0	4	1	30.	15.3	490.1	7.0
0	4	2	30.	31.1	996.4	7.0
0	4	3	30.	46.7	1494.1	6.2
0	4	4	30.	60.6	1940.0	5.5
0	5	1	30.	25.3	808.9	11.2
0	5	2	30.	38.1	1219.3	8.7
0	5	3	30.	61.9	1982.3	8.3
0	5	4	30.	99.0	3167.3	9.3

CLPLOSS Computer Program Output, continued

1 ****** FISH-TAIL DATA ******

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	TOTAL UNTRIMMED F/T VOLUME (CU.FT.)	TOTAL UNTRIMMED F/T VOLUME (SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME	TOTAL TRIMMED F/T VOLUME (CU.FT.)	TOTAL TRIMMED F/T VOLUME (SQ.FT.3/8 IN.)	% OF TOTAL BLOCK VOLUME
0	1	ALL	120.	119.7	3831.2	4.7	69.1	2210.4	2.7
0	2	ALL	120.	130.5	4177.6	5.1	76.3	2440.7	3.0
0	3	ALL	120.	152.9	4892.8	6.1	90.2	2886.0	3.6
0	4	ALL	120.	138.2	4423.1	5.5	79.6	2548.2	3.2
0	5	ALL	120.	156.4	5003.5	6.3	101.1	3236.0	4.1
0	ALL	1	150.	75.0	2398.6	6.1	44.7	1429.8	3.6
0	ALL	2	150.	129.7	4149.3	5.9	77.1	2467.0	3.5
0	ALL	3	150.	193.0	6177.2	5.2	115.8	3704.9	3.1
0	ALL	4	150.	300.1	9603.2	5.5	178.7	5719.7	3.3
0	1	1	30.	12.2	391.2	4.9	7.0	223.6	2.8
0	1	2	30.	26.8	857.2	6.2	15.2	486.5	3.5
0	1	3	30.	28.6	916.3	3.8	16.4	525.1	2.2
0	1	4	30.	52.1	1666.5	4.7	30.5	975.2	2.7
0	2	1	30.	14.3	457.2	5.2	8.2	261.8	3.0
0	2	2	30.	20.2	645.4	4.6	11.6	370.4	2.6
0	2	3	30.	45.4	1453.1	5.9	27.0	863.0	3.5
0	2	4	30.	50.7	1621.9	4.8	29.5	945.6	2.8
0	3	1	30.	11.4	366.3	4.3	6.8	217.2	2.6
0	3	2	30.	23.9	765.1	5.4	14.3	457.5	3.2
0	3	3	30.	41.4	1325.4	5.9	24.8	793.8	3.5
0	3	4	30.	76.1	2436.0	7.0	44.3	1417.5	4.1
0	4	1	30.	13.0	414.8	5.9	7.5	239.6	3.4
0	4	2	30.	29.2	933.2	6.5	16.7	534.4	3.7
0	4	3	30.	39.2	1255.0	5.2	22.5	721.1	3.0
0	4	4	30.	56.9	1820.1	5.2	32.9	1053.1	3.0
0	5	1	30.	24.0	769.0	10.7	15.2	487.6	6.8
0	5	2	30.	29.6	948.5	6.7	19.3	618.2	4.4
0	5	3	30.	38.4	1227.4	5.1	25.1	801.9	3.4
0	5	4	30.	64.3	2058.7	6.1	41.5	1328.3	3.9

CLPLOSS Computer Program Output, continued

1 ****** DATA ON A % MERCHANTABLE BASIS ******

-	MILL CLASS	DIAMETER CLASS	NUMBER OF BLOCKS	FULLS	HALVES	RANDOMS	TRIMMED FISH-TAILS
0	1	ALL	120.	72.5	18.0	6.2	3.3
0	2	ALL	120.	70.4	16.3	9.6	3.7
0	3	ALL	120.	52.2	18.1	24.1	5.6
0	4	ALL	120.	67.7	20.9	7.5	3.9
0	5	ALL	120.	55.7	28.1	11.2	5.0
0	ALL	1	150.	60.7	19.6	14.1	5.5
0	ALL	2	150.	62.6	21.1	11.7	4.6
0	ALL	3	150.	67.9	17.3	10.9	3.9
0	ALL	4	150.	63.2	22.2	10.6	4.1
0	1	1	30.	68.2	15.1	12.6	4.1
0	1	2	30.	73.0	16.3	6.4	4.4
0	1	3	30.	80.2	11.4	5.7	2.7
0	1	4	30.	68.0	23.4	5.3	3.2
0	2	1	30.	73.4	15.7	7.1	3.8
0	2	2	30.	67.2	20.7	8.7	3.3
0	2	3	30.	65.0	18.0	12.3	4.6
0	2	4	30.	74.4	13.7	8.7	3.2
0	3	1	30.	53.7	13.5	27.8	5.0
0	3	2	30.	43.0	24.0	27.6	5.4
0	3	3	30.	57.8	14.9	22.1	5.2
0	3	4	30.	51.6	18.9	23.4	6.0
0	4	1	30.	54.8	29.5	10.5	5.1
0	4	2	30.	64.8	21.7	8.8	4.7
0	4	3	30.	69.7	19.6	7.2	3.5
0	4	4	30.	69.5	20.2	6.7	3.6
0	5	1	30.	46.0	26.4	17.2	10.4
0	5	2	30.	60.4	23.5	10.7	5.4
0	5	3	30.	64.2	21.9	9.9	4.0
0	5	4	30.	49.3	34.7	11.3	4.7

EOI ENCOUNTERED.

APPENDIX B

CLPLOSS Computer Program

CLPLOSS Computer Program

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COPY,CLPLOSS
      PROGRAM CLPLOSS
C
C     THIS VENEER RECOVERY PROGRAM,DEVELOPED AT
C     THE OSU DEPT. OF FOREST PRODUCTS, ASSESSES GREEN
C     VENEER RECOVERY VALUES OF SECOND GROWTH COASTAL
C     DOUGLAS FIR AS A FUNCTION OF THE PROCESSING MILL AND
C     LOG DIAMETER.  THE NATURE OF THE VENEER LOSSES WILL BE
C     BOTH QUALIFIED AND QUANTIFIED.  LOSSES UP TO AND
C     INCLUDING THE GREEN-END VENEER CLIPPER, ARE EXAMINED
C     BY THIS PROJECT.  THE OBJECTIVES OF THIS PROGRAM WILL
C     BE TO PROVIDE:
C
C          1. CLIPPER AND SCANNER MANUFACTURERS WITH DATA
C             POTENTIALLY NECESSARY FOR IMPROVING EXISTING
C             RECOVERY STRATEGY
C
C          2. MILL MANAGEMENT WITH DECISION MAKING CRITERION
C             FOR FUTURE CAPITAL EXPENDITURES
C
C          3. THE STANDARDIZED PROCEDURES NECESSARY TO
C             CONDUCT A SIMILAR IN-HOUSE ANALYSIS
C
C
C     THIS PROGRAM CONSISTS OF BASICALLY TWO SECTIONS...
C
C          SECTION 1 - EMPLOYS A CYBER SORT/MERGE ROUTINE AS
C                      WELL AS A SUMMATION ROUTINE, TO
C                      REDUCE THE CODED RAW DATA FROM THE
C                      H/P DIGITIZING OPERATION.  CYBER READS
C                      OFF THE DATA FILE CALLED 'VENEER'.
C                      THIS RAW DATA FILE IS COMPRISED OF
C                      NINE VENEER TYPES AND AREA, WHICH WHEN
C                      SORTED, CREATES A TEMPORARY FILE
C                      CALLED 'SORTOUT'.  THE AREAS IN THIS
C                      INTERMEDIATE FILE, ARE THEN SUMMED
C                      ACCORDING TO THE NINE SPECIFIC VENEER
C                      TYPES.  ONCE SUMMED, THE INFORMATION
C                      IS USED TO CREATE A FILE CALLED
C                      'VENOUT' WHICH PROVIDES SPECIFIC
C                      VENEER DATA ON A BLOCK BY BLOCK BASIS.
C
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CLPLOSS Computer Program, continued

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C
C        SECTION 2 - IS A SPLIT PLOT ANALYSIS OPERATING OFF
C                    THE ABOVE REDUCED BLOCK DATA IN THE
C                    'TBLOCK' ARRAY.  THIS ANALYSIS CREATES
C                    A LISTING OF BLOCK DATA AS CLASSIFIED BY
C                    PERMUTATIONS OF THE TWO KEY PARAMETERS,
C                    MILL AND DIAMTER.  THIS SECTION OPERATES
C                    OFF A PERMANENT FILE 'BLOCKS' AND THE
C                    NEWLY CREATED TEMPORARY FILE CALLED
C                    'SORTOUT'.
C
C
      INTEGER DIA,BLK,CODE,HIBLK,HIGHT,REP,ERROR,HIVEN,HIGHM,HIGHB,HIGHD
      REAL IACRT,IACRTA,IACRTB,IACRTP
      CHARACTER*13 LABS(29), LINE*130
      DIMENSION TEMP(29,64),TBLOCK(5,4,30,28),VENTHK(5),VENLEN(5)
      COMMON/FIRST/  FULLT,FULLS,FULLK,HALFT,HALFS,HALFK,RANT,
     1    UTFTT,TFTT,REJT,ACRT,IACRT,CLPRUP,FULLC,HALFC
      COMMON/SECOND/  TBLOCK,BLKS,STHK,SBLEN,SDMAJ,SDMIN,SSCBVG,SSCBVN,
     1      SCOR1,SCOR3,SCOR5,SCORVO,SSPRVO,STHVOL,SFULLT,SFULLS,
     2      SFULLK,SHALFT,SHALFS,SHALFK,SRANT, SUTFTT,STFTT,SREJT,
     3      SACRT,SABCVO,SCORVP,SSPRVOP,SIACRT,SCLPRU,
     4      BLENAV,DMAJAV,DMINAV,COR1AV,COR3AV,COR5AV,
     5      TOVOLA,TOVOLB,TOVOLP,THVOLA,THVOLB,THVOLP,CRR,
     6      VRF,CLLOSA,CLLOSB,CLLOSP,ACRTA,ACRTB,ACRTP,REJA,REJB,
     7      REJP,IACRTA,IACRTB,IACRTP,FULLAV,FULLSD,FULLA,FULLB,
     8      FULLP,HALFAV,HALFSD,HALFA,HALFB,HALFP, RANA,
     9      RANB,RANP,UTFTA,UTFTB,UTFTP,
     A      TFTA,TFTB,TFTP,TGRUP,TGRUPP,CLRUPP,RUPVOL,RUVPLP,
     B      FULLM,HALFM,RANM,TFTM,SFULLC,SHALFC
      COMMON /THIRD/ TEMP
C
C     ************************************
C     ************* SECTION 1 ************
C     ************************************
C
C
C     PROCEDURES WILL NOW BE ESTABLISHED TO DIRECT CYBER
C          TO CONVERT THE RANDOM H/P RAW DATA INPUT INTO
C          AN ASCENDING AND SEQUENTIALLY ORDERED FILE
C          CALLED 'SORTOUT'.  IN THAT FILE, THE THREE
C          INDICATOR VARIABLES (MIL,DIA,BLK) ARE ORDERED
C          TO PRODUCE CELLS OF THE FIFTH DEPENDENT
C          VARIABLE (AREA).
```

CLPLOSS Computer Program, continued

```
C
C
      DATA TBLOCK/16800*0.0/,TEMP/1856*0.0/
      OPEN(5,FILE='INFO')
      READ (5,134) VENLEN
      READ (5,134) VENTHK
      OPEN(1,FILE='SORTOUT')
      OPEN(3,FILE='VENEER')
      CALL SMSORT (80)
      CALL SMFILE (4HSORT,5HCODED,3,6HREWIND)
      CALL SMFILE (6HOUTPUT,5HCODED,1,6HREWIND)
      CALL SMKEY (1,1,10,0,7HDISPLAY,6HASCII6,1HA)
      CALL SMKEY (21,1,10,0,7HDISPLAY,6HASCII6,1HA)
      CALL SMKEY (11,1,10,0,7HDISPLAY,6HASCII6,1HA)
      CALL SMEND
      CLOSE(3)
      PRINT*,'SORT/MERGE ON RAW VENEER DATA COMPLETE'
      PRINT*,'THE SORTED VENEER DATA WILL NOW BE SUMMED'
      PRINT*,'      ON A BLOCK BY BLOCK BASIS'
      OPEN(2,FILE='VENOUT')
      CALL ZEROA
C
C     THE ORDERED RAW DATA FROM THE TEMPORARY FILE 'SORTOUT'
C         WILL NOW BE CLASSIFIED BY MILL, DIAMETER, AND
C         BLOCK.  PIECE AREAS, SUM OF AREAS SQUARED AND
C         PIECE COUNT ARE SUMMED FOR EACH BLOCK.  THE
C         SUMMATION OPERATION TAKES PLACE WHEN THE INDICATOR
C         VARIABLES OF THE LINE READ, DIFFERS FROM THE LAST
C         LINE READ.
C
      HIGHM = 5
      HIGHD = 4
      HIGHB = 30
      ERROR = 0
      I = 0
      HIVEN = 0
      HIBLK = 0
      PI = 3.1415927
      HIGHT = 0
      OPEN(4,FILE='TEXT1')
  101 READ(4,'(A)',END=102 )LINE
      WRITE(2,'(A)')LINE
```

CLPLOSS Computer Program, continued

```
      GO TO 101
  102 MIL = 9999
      READ(1, 135,END=109)MIL,BLK,DIA,CODE,AREA
      HIVEN = HIVEN+1
      IF (HIVEN.EQ.1) THEN
      J = MIL
      K = DIA
      L = BLK
      ENDIF
C
C     THE CONTROL VARIABLES OF THE INPUT VENEER DATA FILE
C          ARE EXAMINED TO DETERMINE WHETHER OR NOT THEY
C          ARE WITHIN THE USER SPECIFIED LIMITS.  IF
C          FOUND TO BE INCORRECT, AN ERROR MESSAGE AND A
C          NUMBER ARE PRINTED, AND THE RUN CONTINUES.
C
C
      IF (MIL.LT.1.OR.MIL.GT.HIGHM.OR.DIA.LT.1.OR.DIA.GT.HIGHD.OR.BLK.LT
     1,1.OR.BLK.GT.HIGHB) GO TO 103
      IF (MIL.EQ.0.OR.DIA.EQ.0.OR.BLK.EQ.0.OR.CODE.EQ.0.OR.AREA.EQ.0)
     1 GO TO 105
      GO TO 107
  103 IF (ERROR.GT.0) GO TO 104
      WRITE (2,137)
      WRITE (2,138)
      ERROR = 1
      WRITE (2,139) HIVEN
      GO TO 102
  104 WRITE (2,139) HIVEN
      GO TO 102
  105 IF (ERROR.GT.0) GO TO 106
      WRITE (2,137)
      WRITE (2,138)
      ERROR = 1
  106 WRITE (2,140) HIVEN
      GO TO 102
C
C     THE SUMMATION WITHIN EACH SPECIFIC VENEER CLASSIFICATION
C          NOW TAKES PLACE WITH THE AREAS BEING CONVERTED FROM
C          A COMMON SQ.FT. TO A COMMON CUBIC BASIS.  THIS DATA
C          IS USED TO CREATE A LOCAL FILE CALLED 'VENOUT'.
C
  107 IF (MIL.NE.J.OR.DIA.NE.K.OR.BLK.NE.L) GO TO 109
```

```
108 IF (CODE.EQ.1.) THEN
    FULLT = FULLT + AREA
    FULLC = FULLC+AREA*VENTHK(MIL)/12.0
    FULLS = FULLS+AREA**2
    FULLK = FULLK+1
    GO TO 102
    ELSE IF(CODE.EQ.2.)THEN
    HALFT = HALFT + AREA
    HALFC = HALFC+AREA*VENTHK(MIL)/12.0
    HALFS = HALFS+AREA**2
    HALFK = HALFK+1
    GO TO 102
    ELSE IF(CODE.EQ.3.)THEN
    RANT = RANT+AREA*VENTHK(MIL)/12.0
    GO TO 102
    ELSE IF(CODE.EQ.4.)THEN
    UTFTT = UTFTT+AREA*VENTHK(MIL)/12.0
    GO TO 102
    ELSE IF(CODE.EQ.5.)THEN
    TFTT = TFTT+AREA*VENTHK(MIL)/12.0
    GO TO 102
    ELSE IF(CODE.EQ.6.)THEN
    REJT = REJT+AREA*VENTHK(MIL)/12.0
    GO TO 102
    ELSE IF(CODE.EQ.7.)THEN
    IACRT = IACRT+AREA*VENTHK(MIL)/12.0
    GO TO 102
    ELSE IF(CODE.EQ.8.)THEN
    ACRT = ACRT+AREA*VENTHK(MIL)/12.0
    GO TO 102
    ELSE IF(CODE.EQ.9.)THEN
    CLPRUP = CLPRUP+AREA*VENTHK(MIL)/12.0
    END IF
    GO TO 102
C
C   FOR A SPECIFIC FACTOR CLASSIFICATION,THE SUMMED CUBIC
C        VOLUMES ARE LOADED INTO ARRAY 'TBLOCK'.  A
C        PRELIMINARY OUTPUT OF THIS VENEER DATA WILL BE
C        PROVIDED IF DESIRED.
C
```

CLPLOSS Computer Program, continued

```
 109  TBLOCK(J,K,L,14) = FULLT
      TBLOCK(J,K,L,15) = FULLS
      TBLOCK(J,K,L,16) = FULLK
      TBLOCK(J,K,L,17) = HALFT
      TBLOCK(J,K,L,18) = HALFS
      TBLOCK(J,K,L,19) = HALFK
      TBLOCK(J,K,L,20) = RANT
      TBLOCK(J,K,L,21) = UTFTT
      TBLOCK(J,K,L,22) = TFTT
      TBLOCK(J,K,L,23) = REJT
      TBLOCK(J,K,L,24) = IACRT
      TBLOCK(J,K,L,25) = ACRT
      TBLOCK(J,K,L,26) = CLPRUP
      TBLOCK(J,K,L,27) = FULLC
      TBLOCK(J,K,L,28) = HALFC
      J = MIL
      K = DIA
      L = BLK
      HIBLK = HIBLK+1
C
C     THE ACCUMULATION VARIABLES ARE NOW REINITIALIZED TO
C          ZERO AND THE PROGRAM CONTINUES TO THE NEXT BLOCK
C          OF VENEER DATA.
C
C
      CALL ZEROA
      IF (MIL.NE.9999) GO TO 108
      PRINT *,'THE VENEER SUMMATION IS NOW COMPLETE'
      IF (ERROR.EQ.0) WRITE (2,141)
      WRITE (2,142) HIVEN
      WRITE (2,143) HIBLK
      WRITE (2,144) HIGHM,HIGHD,HIGHB
C
C      IT IS DETERMINED WHETHER OR NOT THE USER
C           DESIRES A VENEER VOLUME OUTPUT ON A
C           BLOCK BY BLOCK BASIS.
C
      PRINT*,'DO YOU WANT A COPY OF THE VENEER VOLUMES'
      PRINT*,'ON A BLOCK BY BLOCK BASIS ?'
      PRINT*,'  (ENTER 1 FOR YES, 0 FOR NO)'
      READ(*,'(I1)')I
      IF(I.NE.1) GO TO 240
      WRITE (2,145)
      WRITE (2,146)
      WRITE (2,147)
```

```
      I = 0
      DO 110 J=1,HIGHM
         DO 110 K=1,HIGHD
            DO 110 L=1,HIGHB
               I = I+1
               WRITE (2,148) I,(TBLOCK(J,K,L,M),M=14,19)
 110  CONTINUE
      WRITE (2,149)
      WRITE (2,150)
      WRITE (2,151)
      WRITE (2,152)
      WRITE (2,153)
      WRITE (2,154)
      I = 0
      DO 111 J=1,HIGHM
         DO 111 K=1,HIGHD
            DO 111 L=1,HIGHB
               I = I+1
               WRITE (2,155) I,(TBLOCK(J,K,L,M),M=20,26)
 111  CONTINUE
C
C     **********************************
C     ************ SECTION 2 ************
C     **********************************
C
C     THE FOLLOWING CALCULATIONS EMPLOY THE TWO END CONIC
C          FORMULA AND ARE NECESSARY PRIOR TO LOADING THE
C          INPUT DATA INTO ARRAY 'TBLOCK'.  THIS FIRST
C          READ SECTION READS THE SCALED BLOCK DATA FROM
C          THE INPUT FILE 'BLOCKS', TO MAKE THE NECESSARY
C          CALCULATIONS.
C
 240  CLOSE(1)
      OPEN(1,FILE='BLOCKS')
      HIBLK = 0
C
C
C     THE FOLLOWING READ STATEMENT, READS ONLY THE VENEER
C          DATA FROM THE INPUT FILE CALLED 'BLOCKS'.  THE
C          DATA IS THEN LOADED INTO THE ARRAY 'TBLOCK'.
C
C
```

CLPLOSS Computer Program, continued

```
 112  READ(1,136 ,END=218)MIL,DIA,REP,DMAJA,DMAJB,DMINA,DMINB,
     1        BLEN,COR1,COR3,COR5,SCBVG,SCBVN
      HIBLK = HIBLK+1
      IF (MIL.EQ.0) GO TO 218
      DMAJ = (DMAJA+DMAJB)/2.0
      DMIN = (DMINA+DMINB)/2.0
      ABCVOL = (PI*BLEN/20736.0)*(DMAJ**2+DMIN**2+DMAJ*DMIN)
      CORVOL = (PI*BLEN/41472.0)*(COR1**2+2.0*COR3**2+COR5**2.0+COR1*
     1COR3+COR3*COR5)
      COR2 = COR1+(COR3-COR1)*(1.0-VENLEN(MIL)/BLEN)
      COR4 = COR5+(COR3-COR5)*(1.0-VENLEN(MIL)/BLEN)
      SPRVOL = (PI*(BLEN-VENLEN(MIL))/6912.0)*(DMIN**2-((COR1**2+COR2**2
     1+COR4**2+COR5**2+COR1*COR2+COR4*COR5)/6.0))
      THVOL = ((PI*VENLEN(MIL))/6912.0)*(DMIN**2-((COR2**2.0+2.0*COR3**2
     1+COR4**2+COR2*COR3+COR3*COR4)/(6.0)))
      TBLOCK(MIL,DIA,REP,1) = BLEN
      TBLOCK(MIL,DIA,REP,2) = VENTHK(MIL)
      TBLOCK(MIL,DIA,REP,3) = DMAJ
      TBLOCK(MIL,DIA,REP,4) = DMIN
      TBLOCK(MIL,DIA,REP,5) = ABCVOL
      TBLOCK(MIL,DIA,REP,6) = SCBVG
      TBLOCK(MIL,DIA,REP,7) = SCBVN
      TBLOCK(MIL,DIA,REP,8) = COR1
      TBLOCK(MIL,DIA,REP,9) = COR3
      TBLOCK(MIL,DIA,REP,10) = COR5
      TBLOCK(MIL,DIA,REP,11) = CORVOL
      TBLOCK(MIL,DIA,REP,12) = SPRVOL
      TBLOCK(MIL,DIA,REP,13) = THVOL
      GO TO 112
 218  PRINT *,'ALL BLOCK DATA HAS NOW BEEN CALCULATED'
      PRINT *,'THE SPLIT PLOT SORTING WILL NOW TAKE PLACE'
C
C     *************CLASSIFICATION BY MILL*************
C
      DO 114 J=1,HIGHM
         CALL ZEROB
         DO 113 K=1,HIGHD
            DO 113 L=1,HIGHB
               CALL SUM (J,K,L)
 113     CONTINUE
         CALL CALC (J)
         TEMP(J,3) = VENTHK(J)
 114  CONTINUE
```

CLPLOSS Computer Program, continued

```
C
C     *************CLASSIFICATION BY DIAMETER************
C
      DO 116 K=1,HIGHD
         CALL ZEROB
         DO 115 J=1,HIGHM
            DO 115 L=1,HIGHB
               CALL SUM (J,K,L)
 115     CONTINUE
         I = K+HIGHM
         CALL CALC (I)
         TEMP(I,3) = 0
 116  CONTINUE
C
C     *************CLASSIFICATION BY MILL AND DIAMETER*************
C
      DO 119 J=1,HIGHM
         DO 118 K=1,HIGHD
            CALL ZEROB
            DO 117 L=1,HIGHB
               CALL SUM (J,K,L)
 117        CONTINUE
            I = HIGHM+HIGHD*J+K
            CALL CALC (I)
            TEMP(I,3) = VENTHK(J)
 118     CONTINUE
 119  CONTINUE
C
C     PRINT SPECIAL 'ALL' LABELS
C
      DO 120 J=1,HIGHM
         WRITE (LABS(J) , '(I2,8X,''ALL'')')J
 120  CONTINUE
      I = HIGHM+1
      DO 121 J=1,HIGHD
         WRITE (LABS(J+HIGHM) , '(''ALL'',8X,I1,1X)')J
 121  CONTINUE
      DO 122 I=1,HIGHM
         DO 122 J=1,HIGHD
            WRITE (LABS(HIGHM+HIGHD*I+J) , '(I2,8X,I2,1X)')I,J
 122  CONTINUE
      J = HIGHM+HIGHD+(HIGHM*HIGHD)
```

CLPLOSS Computer Program, continued

```
      OPEN(6,FILE='TEXT2')
  250 READ(6,'(A)',END=251)LINE
      WRITE(2,'(A)')LINE
          GO TO 250
  251 WRITE (2,156)
      WRITE (2,157)
      WRITE (2,158)
      WRITE (2,159)
      WRITE (2,160)
      DO 123 I=1,J
        WRITE (2,161) LABS(I),TEMP(I,1),TEMP(I,2),TEMP(I,3),TEMP(I,4),
     1  TEMP(I,5),TEMP(I,6),TEMP(I,7),TEMP(I,8)
  123 CONTINUE
      WRITE (2,162)
      WRITE (2,163)
      WRITE (2,164)
      WRITE (2,165)
      WRITE (2,166)
      WRITE (2,167)
      DO 124 I=1,J
        WRITE (2,168) LABS(I),TEMP(I,1),TEMP(I,9),TEMP(I,10),TEMP(I,11)
     1  ,TEMP(I,12),TEMP(I,13),TEMP(I,14),TEMP(I,15)
  124 CONTINUE
      WRITE (2,169)
      WRITE (2,170)
      WRITE (2,171)
      WRITE (2,172)
      WRITE (2,173)
      DO 125 I=1,J
        WRITE (2,174) LABS(I),TEMP(I,1),TEMP(I,16),TEMP(I,17),TEMP(I,18
     1  ),TEMP(I,19),TEMP(I,20),TEMP(I,21)
  125 CONTINUE
      WRITE (2,175)
      WRITE (2,176)
      WRITE (2,177)
      WRITE (2,178)
      DO 126 I=1,J
        WRITE (2,179) LABS(I),TEMP(I,1),TEMP(I,22),TEMP(I,23),TEMP(I,24
     1  ),TEMP(I,25),TEMP(I,26),TEMP(I,27),TEMP(I,28),TEMP(I,29)
  126 CONTINUE
      WRITE (2,180)
      WRITE (2,181)
      WRITE (2,182)
```

CLPLOSS Computer Program, continued

```
      WRITE (2,183)
      DO 127 I=1,J
         WRITE (2,184) LABS(I),TEMP(I,1),TEMP(I,30),TEMP(I,31),TEMP(I,32
     1   ),TEMP(I,33),TEMP(I,34),TEMP(I,35)
127   CONTINUE
      WRITE (2,185)
      WRITE (2,186)
      WRITE (2,187)
      WRITE (2,188)
      DO 128 I=1,J
         WRITE (2,189) LABS(I),TEMP(I,1),TEMP(I,36),TEMP(I,37),TEMP(I,38
     1   ),TEMP(I,39),TEMP(I,40),TEMP(I,41)
128   CONTINUE
      WRITE (2,190)
      WRITE (2,191)
      WRITE (2,192)
      WRITE (2,193)
      WRITE (2,194)
      DO 129 I=1,J
         WRITE (2,195) LABS(I),TEMP(I,1),TEMP(I,42),TEMP(I,43),TEMP(I,44
     1   ),TEMP(I,45),TEMP(I,46)
129   CONTINUE
      WRITE (2,196)
      WRITE (2,197)
      WRITE (2,198)
      WRITE (2,199)
      WRITE (2,200)
      DO 130 I=1,J
         WRITE (2,201) LABS(I),TEMP(I,1),TEMP(I,47),TEMP(I,48),TEMP(I,49
     1   ),TEMP(I,50),TEMP(I,51)
130   CONTINUE
      WRITE (2,202)
      WRITE (2,203)
      WRITE (2,204)
      WRITE (2,205)
      DO 131 I=1,J
         WRITE (2,206) LABS(I),TEMP(I,1),TEMP(I,52),TEMP(I,53),TEMP(I,54
     1   )
131   CONTINUE
```

CLPLOSS Computer Program, continued

```
      WRITE (2,207)
      WRITE (2,208)
      WRITE (2,209)
      WRITE (2,210)
      DO 132 I=1,J
         WRITE (2,211) LABS(I),TEMP(I,1),TEMP(I,55),TEMP(I,56),TEMP(I,57
     1   ),TEMP(I,58),TEMP(I,59),TEMP(I,60)
  132 CONTINUE
      WRITE (2,212)
      WRITE (2,213)
      WRITE (2,214)
      WRITE (2,215)
      DO 133 I=1,J
         WRITE (2,216) LABS(I),TEMP(I,1),TEMP(I,61),TEMP(I,62),TEMP(I,63
     1   ),TEMP(I,64)
  133 CONTINUE
      STOP
C
C
C
C      SECTION 1 AND 2 INPUT FORMAT STATEMENTS
C
C
C
  134 FORMAT(5F13.9)
  135 FORMAT(4(I6,4X),F10.3)
  136 FORMAT(I1,I1,I2,1X,4(F7.4,2X),F9.5,3(F8.5),F4.0,F5.0)
C
C
C
C     SECTION 1 OUTPUT FORMAT STATEMENTS
C
C
C
  137 FORMAT(3(/),T53,'****** VENEER FILE CODE ERROR LISTING ******')
  138 FORMAT('-',T 10,'CODING ERRORS HAVE BEEN DETECTED ',
     * 'IN THE FOLLOWING LINES OF YOUR VENEER DATA FILE:')
  139 FORMAT('0',T20,'********** CODE ERROR IN LINE   ',I8)
  140 FORMAT('0',T20,'********** ZERO ERROR IN LINE   ',I8)
  141 FORMAT(3(/),T20,'NO CODING ERRORS HAVE BEEN DETECTED IN YOUR ',
     * 'RAW DATA FILE')
  142 FORMAT(3(/),T10,'THE TOTAL NUMBER OF DIGITIZING ',
     *'OPERATIONS BEING CONSIDERED HERE ARE =',T80,I8)
  143 FORMAT(3(/),T10,'THE TOTAL NUMBER OF PEELER BLOCKS ',
     *'BEING CONSIDERED HERE ARE =',T73,I8)
  144 FORMAT(3(/),T10,'CONSISTING OF ',I4,'   FACILITIES ',
```

CLPLOSS Computer Program, continued

```
     *I4,'   DIAMETERS, AND ',I4,'   BLOCKS IN EACH')
C
C
  145 FORMAT('1',T4,'BLOCK',T17,'TOTAL FULL SHEET AREA',T47,
     *'TOTAL COUNT',T77,'TOTAL HALF SHEET AREA',T107,
     *'TOTAL COUNT')
  146 FORMAT(T3,'NUMBER',T15,'(CUBIC FEET)      (SUM OF',T48,
     *'OF FULLS',T75,'(CUBIC FEET)      (SUM OF',T108,'OF HALVES')
  147 FORMAT(T33,'SQUARES',T93,'SQUARES')
  148 FORMAT(T4,I4,T14,F12.3,T31,F12.3,T50,F6.0,T74,
     *F12.3,T91,F12.3,T110,F6.0)
C
C
  149 FORMAT('1',T4,'BLOCK',T12,'TOTAL RANDOM   TOTAL UNTRIMMED',
     *T45,'TOTAL TRIMMED      TOTAL REJECT   TOTAL ACCURATELY',
     * T98,'TOTAL INACCURATELY      TOTAL')
  150 FORMAT(T3,'NUMBER    STRIP AREA    FISH-TAIL AREA',T45,
     *'FISH-TAIL AREA',T66,'AREA',T81,'CLIPPED',T102,
     *'CLIPPED',T121,'CLIPPED')
  151 FORMAT(T14,'SQ.FT.',T30,'(SQ.FT.',T48,'(SQ.FT.',T65,'(SQ.FT.',
     *T79,'RECOVERABLE AREA    RECOVERABLE AREA',T120,'ROUND-UP')
  152 FORMAT(T12,'ACTUAL THICK.)  ACTUAL THICK.)   ACTUAL THICK.)',
     *T63,'ACTUAL THICK.)',T81,'(SQ.FT.',T103,'(SQ.FT.',T120,
     *'(SQ.FT.')
  153 FORMAT(T80,'ACTUAL THICK.)',T101,'ACTUAL THICK.)',
     *T121,'ACTUAL')
  154 FORMAT(T121,'THICK.)')
  155 FORMAT(T4,I4,T13,F9.3,T30,F9.3,T47,F9.3,T63,F9.3,T81,F9.3,
     *T103,F9.3,T119,F9.3)
C
C
C
C       SECTION 2 OUTPUT FORMAT STATEMENTS
C
C
C
```

CLPLOSS Computer Program, continued

```
  156 FORMAT('1',T54,'****** BLOCK DATA ******')
  157 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T38,
     *     'AVERAGE',T50,'AVERAGE',T62,'AVERAGE',T75,'AVERAGE',
     *     T91,'GROSS',T107,'NET',T120,'CUBIC BLOCK')
  158 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T39,'BLOCK',T50,
     *     'VENEER',T61,'LARGE END',T74,'SMALL END',T90,
     *     'SCRIBNER',T105,'SCRIBNER',T123,'VOLUME')
  159 FORMAT(T28,'BLOCKS',T38,'LENGTH',T49,'THICKNESS',T62,
     *     'DIAMETER',T75,'DIAMETER',T91,'SCALE',T106,
     *     'SCALE',T122,'(CU.FT.)')
  160 FORMAT(T39,'(IN.)',T51,'(IN.)',T63,'(IN.)',
     *     T76,'(IN.)',T89,'(BD.FT.)',T104,
     *     '(BD.FT.)')
  161 FORMAT('0',T7,A13,T29,F5.0,T39,F5.1,T51,F6.4,
     *     T63,F5.1,T76,F5.1,T90,F8.1,T105,F8.1,
     *     T121,F8.1)
  162 FORMAT('-','INVALID THICKNESSES ARE INDICATED BY ZEROS')
C
C
  163 FORMAT('1',T50,'****** CORE AND SPUR DATA ******')
  164 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T38,
     *     'AVERAGE CORE DIAMETERS (IN.)',T70,'TOTAL CORE',T84,
     *     '% OF TOTAL',T98,'TOTAL SPUR',T112,'% OF TOTAL')
  165 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T72,'VOLUME',T86,
     *     T85,'BLOCK',T100,'VOLUME',T114,'BLOCK')
  166 FORMAT(T28,'BLOCKS',T39,'OPERATOR',T71,
     *     '(CU.FT.)',T84,'VOLUME',T99,'(CU.FT.)',
     *     T113,'VOLUME')
  167 FORMAT(T41,'END',T50,'CENTER',T61,'END')
  168 FORMAT('0',T8,A13,T29,F5.0,T40,F5.2,T51,F5.2,T60,F5.2,
     *     T72,F6.1,T86,F4.1,T99,F6.1,T114,F4.1)
C
C
  169 FORMAT('1',T51,'****** ROUND-UP DATA ******')
  170 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T38,
     *     'TOTAL ROUND-UP',T55,'% OF TOTAL',T69,'TRASH-GATE',
     *     T83,'% OF TOTAL',T97,'CLIPPED',T108,'%OF TOTAL')
  171 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T41,'VOLUME',T57,
     *     'BLOCK',T70,'ROUND-UP',T85,'BLOCK',T97,'ROUND-UP',
     *     T109,'BLOCK')
  172 FORMAT(T28,'BLOCKS',T40,'(CU.FT.)',T56,'VOLUME',T71,
     *     'VOLUME',T98,'VOLUME',T109,'VOLUME')
  173 FORMAT(T70,'(CU.FT.)',T97,'(CU.FT.)')
  174 FORMAT('0',T8,A13,T29,F5.0,T40,F8.1,T57,F4.1,T70,F8.1,
     *     T85,F4.1,T97,F8.1,T110,F4.1)
C
C
  175 FORMAT('1',T50,'****** VENEER VOLUME DATA ******')
  176 FORMAT('-',T7,'MILL',T14,'DIAMETER',T26,'NUMBER',T36,
```

CLPLOSS Computer Program, continued

```
     *    'TOTAL VENEER VOLUME',T58,'% OF TOTAL',T72,
     *    'THEORETICAL VENEER VOLUME',T99,'% OF TOTAL',T113,
     *    'CUBIC',T122,'VENEER')
  177 FORMAT(T7,'CLASS',T16,'CLASS',T28,'OF',T40,'PRODUCED',
     *    T61,'BLOCK',T101,'BLOCK',T111,'RECOVERY',T121,'RECOVERY')
  178 FORMAT(T26,'BLOCKS',T34,'(CU.FT.)',T44,'(SQ.FT.3/8 IN.)',
     *     T61,'VOLUME',T72,'(CU.FT.)',T83,'(SQ.FT.3/8 IN.)',
     *     T100,'VOLUME',T113,'RATIO',T122,'FACTOR')
  179 FORMAT('0',T7,A13,T25,F5.0,T33,F8.1,T45,F12.1,T63,F4.1,
     *    T72,F8.1,T85,F12.1,T103,F4.1,T112,F5.3,T122,F5.3)
C
C
  180 FORMAT('1',T50,'****** CLIPPING LOSS DATA ******')
  181 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T40,
     *    'TOTAL CLIPPING LOSS',T65,'% OF TOTAL',T79,
     *    'TOTAL REJECT VOLUME',T104,'% OF TOTAL')
  182 FORMAT(T7,'CLASS',T18,'CLASS',T30,'OF',T67,'BLOCK',
     *    T106,'BLOCK')
  183 FORMAT(T28,'BLOCKS',T38,'(CU.FT.)',T49,'(SQ.FT.3/8 IN.)',
     *    T67,'VOLUME',T77,'(CU.FT.)',T88,'(SQ.FT.3/8 IN.)',
     *    T105,'VOLUME')
  184 FORMAT('0',T7,A13,T29,F5.0,T38,F8.1,T51,F8.1,T67,F4.1,
     *    T77,F8.1,T90,F8.1,T106,F4.1)
C
C
  185 FORMAT('1',T47,'****** CLIPPING LOSS DATA ******')
  186 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T39,
     *    'ACCURATELY CLIPPED',T63,'% OF TOTAL',T78,
     *    'INACCURATELY CLIPPED',T104,'% OF TOTAL')
  187 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T39,
     *    'RECOVERABLE VENEER',T65,'BLOCK',T79,
     *    'RECOVERABLE VENEER',T106,'BLOCK')
  188 FORMAT(T28,'BLOCKS',T37,'(CU.FT.)',T47,'(SQ.FT.3/8 IN.)',
     *    T64,'VOLUME',T76,'(CU.FT.)',T87,'(SQ.FT.3/8 IN.)',
     *    T105,'VOLUME')
  189 FORMAT('0',T7,A13,T29,F5.0,T37,F8.1,T50,F8.1,T65,F4.1,
     *    T76,F8.1,T90,F8.1,T106,F4.1)
C
C
```

CLPLOSS Computer Program, continued

```
  190 FORMAT('1',T48,'****** FULL SHEET SIZE AND VOLUME DATA ******')
  191 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T38,
     *     'INDIVIDUAL FULL SHEET AREA',T72,'TOTAL SHEET VOLUME',
     *     T97,'% OF TOTAL')
  192 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T41,'(ACTUAL THICKNESS)',
     *     T99,'BLOCK')
  193 FORMAT(T28,'BLOCKS',T39,'AVERAGE',T55,'STANDARD',T68,
     *     '(CU.FT.)',T80,'(SQ.FT.3/8 IN.)',T98,'VOLUME')
  194 FORMAT(T55,'DEVIATION')
  195 FORMAT('0',T7,A13,T29,F5.0,T39,F7.3,T54,F7.3,T68,F8.1,
     *     T83,F8.1,T99,F4.1)
C
C
  196 FORMAT('1',T44,'****** HALF SHEET SIZE AND VOLUME DATA ******')
  197 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',
     *     T38,'INDIVIDUAL HALF SHEET AREA',T72,
     *     'TOTAL SHEET VOLUME',T96,'% OF TOTAL')
  198 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T43,'(ACTUAL THICKNESS)',
     *     T99,'BLOCK')
  199 FORMAT(T28,'BLOCKS',T39,'AVERAGE',T55,'STANDARD',T67,
     *     '(CU.FT.)',T80,'(SQ.FT.3/8 IN.)',T98,'VOLUME')
  200 FORMAT(T55,'DEVIATION')
  201 FORMAT('0',T7,A13,T29,F5.0,T39,F7.3,T55,F7.3,T67,F8.1,
     *     T82,F8.1,T98,F4.1)
C
C
  202 FORMAT('1',T49,'****** RANDOM STRIP DATA ******')
  203 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T42,
     *     'TOTAL RANDOM STRIP',T67,'% OF TOTAL')
  204 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T48,'VOLUME',
     *     T69,'BLOCK')
  205 FORMAT(T28,'BLOCKS',T39,'(CU.FT.)',T50,'(SQ.FT.3/8 IN.)',
     *     T69,'VOLUME')
  206 FORMAT('0',T7,A13,T29,F5.0,T38,F8.1,T53,F8.1,T70,F4.1)
C
C
  207 FORMAT('1',T50,'****** FISH-TAIL DATA ******')
  208 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T41,
     *     'TOTAL UNTRIMMED F/T',T67,'% OF TOTAL',T84,
     *     'TOTAL TRIMMED F/T',T107,'% OF TOTAL')
  209 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T46,'VOLUME',T69,
     *     'BLOCK',T88,'VOLUME',T109,'BLOCK')
  210 FORMAT(T28,'BLOCKS',T39,'(CU.FT.)',T51,'(SQ.FT.3/8 IN.)',
     *     T69,'VOLUME',T81,'(CU.FT.)',T92,'(SQ.FT.3/8 IN.)',
     *     T109,'VOLUME')
  211 FORMAT('0',T7,A13,T29,F5.0,T37,F9.1,T52,F9.1,T70,
```

```
     *    F4.1,T79,F9.1,T94,F9.1,T110,F4.1)
C
C
  212 FORMAT('1',T42,'****** DATA ON A % MERCHANTABLE BASIS ******')
  213 FORMAT('-',T7,'MILL',T16,'DIAMETER',T28,'NUMBER',T38,
     *    'FULLS',T47,'HALVES',T57,'RANDOMS',T68,'TRIMMED')
  214 FORMAT(T7,'CLASS',T17,'CLASS',T30,'OF',T67,'FISH-TAILS')
  215 FORMAT(T28,'BLOCKS')
  216 FORMAT('0',T7,A13,T29,F5.0,T38,F5.1,T47,F5.1,
     *    T58,F5.1,T68,F5.1)
      END
C
C     ***********************************
C     ************ SUBROUTINES ***********
C     ***********************************
C
C
C     THIS SHORT ROUTINE REINITIALIZES ALL VARIABLES
C         FOR THE SUMMATION BY VENEER CODE ROUTINE.
C
C
      SUBROUTINE ZEROA
      COMMON/FIRST/A(15)
      DO 1 I=1,15
         A(I) = 0.0
    1 CONTINUE
      RETURN
      END
C     THIS ROUTINE REINITIALIZES ALL SUMMING VARIABLES
C          IN THE SPLIT-PLOT CLASSIFICATION PROCEDURE
C         IN THE SPLIT-PLOT CLASSIFICATION PROCEDURE.
C
      SUBROUTINE ZEROB
      DIMENSION TBLOCK(5,4,30,28)
      COMMON/SECOND/TBLOCK,B(85)
      DO 1 I=1,85
         B(I) = 0.0
    1 CONTINUE
      RETURN
      END
C     THIS SUMMATION ROUTINE TOTALS ALL NECESSARY VARIABLES
C         FOR EACH FACTOR CLASSIFICATION.
```

CLPLOSS Computer Program, continued

```
C
C
      SUBROUTINE SUM (J,K,L)
      DIMENSION TBLOCK(5,4,30,28)
      COMMON/SECOND/  TBLOCK,BLKS,STHK,SBLEN,SDMAJ,SDMIN,SSCBVG,SSCBVN,
     1     SCOR1,SCOR3,SCOR5,SCORVO,SSPRVO,STHVOL,SFULLT,SFULLS,
     2     SFULLK,SHALFT,SHALFS,SHALFK,SRANT, SUTFTT,STFTT,SREJT,
     3     SACRT,SABCVO,SCORVP,SSPRVOP,SIACRT,SCLPRU,
     4     BLENAV,DMAJAV,DMINAV,COR1AV,COR3AV,COR5AV,
     5     TOVOLA,TOVOLB,TOVOLP,THVOLA,THVOLB,THVOLP,CRR,
     6     VRF,CLLOSA,CLLOSB,CLLOSP,ACRTA,ACRTB,ACRTP,REJA,REJB,
     7     REJP,IACRTA,IACRTB,IACRTP,FULLAV,FULLSD,FULLA,FULLB,
     8     FULLP,HALFAV,HALFSD,HALFA,HALFB,HALFP, RANA,
     9     RANB,RANP,UTFTA,UTFTB,UTFTP,
     A     TFTA,TFTB,TFTP,TGRUP,TGRUPP,CLRUPP,RUPVOL,RUVOLP,
     B     FULLM,HALFM,RANM,TFTM,SFULLC,SHALFC
      BLKS = BLKS+1
      SBLEN = SBLEN+TBLOCK(J,K,L,1)
      STHK = STHK+TBLOCK(J,K,L,2)
      SDMAJ = SDMAJ+TBLOCK(J,K,L,3)
      SDMIN = SDMIN+TBLOCK(J,K,L,4)
      SABCVO = SABCVO+TBLOCK(J,K,L,5)
      SSCBVG = SSCBVG+TBLOCK(J,K,L,6)
      SSCBVN = SSCBVN+TBLOCK(J,K,L,7)
      SCOR1 = SCOR1+TBLOCK(J,K,L,8)
      SCOR3 = SCOR3+TBLOCK(J,K,L,9)
      SCOR5 = SCOR5+TBLOCK(J,K,L,10)
      SCORVO = SCORVO+TBLOCK(J,K,L,11)
      SSPRVO = SSPRVO+TBLOCK(J,K,L,12)
      STHVOL = STHVOL+TBLOCK(J,K,L,13)
      SFULLT = SFULLT+TBLOCK(J,K,L,14)
      SFULLS = SFULLS+TBLOCK(J,K,L,15)
      SFULLK = SFULLK+TBLOCK(J,K,L,16)
      SHALFT = SHALFT+TBLOCK(J,K,L,17)
      SHALFS = SHALFS+TBLOCK(J,K,L,18)
      SHALFK = SHALFK+TBLOCK(J,K,L,19)
      SRANT = SRANT+TBLOCK(J,K,L,20)
      SUTFTT = SUTFTT+TBLOCK(J,K,L,21)
      STFTT = STFTT+TBLOCK(J,K,L,22)
      SREJT = SREJT+TBLOCK(J,K,L,23)
      SACRT = SACRT+TBLOCK(J,K,L,24)
      SIACRT = SIACRT+TBLOCK(J,K,L,25)
      SCLPRU = SCLPRU+TBLOCK(J,K,L,26)
```

CLPLOSS Computer Program, continued

```
      SFULLC = SFULLC + TBLOCK(J,K,L,27)
      SHALFC = SHALFC + TBLOCK(J,K,L,28)
      RETURN
      END
C     THIS ROUTINE TAKES ALL ACCUMULATED VALUES FOR A
C          PARTICULAR FACTOR CLASSIFICATION AND CALCULATES
C          AVERAGES, STANDARD DEVIATIONS, CUBIC VOLUMES,
C          BOARD FEET VOLUMES, AND PERCENTAGE VOLUMES FOR
C          FULL AND HALF SHEET CATAGORIES.  FOR THE REMAINING
C          SEVEN VENEER CATAGORIES, ONLY AREAS AND PERCENT
C          VOLUMES ARE CALCULATED.  THESE CALCULATED VALUES
C          ARE THEN STORED INTO A TEMPORARY ARRAY CALLED
C          'TEMP' TO AWAIT FINAL OUTPUT.
C
C
      SUBROUTINE CALC (I)
      REAL IACRTA,IACRTB,IACRTP,MERCH
      DIMENSION TBLOCK(5,4,30,28)
      COMMON/FIRST/ FULLT,FULLS,FULLK,HALFT,HALFS,HALFK,RANT,
     1     UTFTT,TFTT,REJT,ACRT,IACRT,CLPRUP
      COMMON/SECOND/  TBLOCK,BLKS,STHK,SBLEN,SDMAJ,SDMIN,SSCBVG,SSCBVN,
     1     SCOR1,SCOR3,SCOR5,SCORVO,SSPRVO,STHVOL,SFULLT,SFULLS,
     2     SFULLK,SHALFT,SHALFS,SHALFK,SRANT, SUTFTT,STFTT,SREJT,
     3     SACRT,SABCVO,SCORVP,SSPRVOP,SIACRT,SCLPRU,
     4     BLENAV,DMAJAV,DMINAV,COR1AV,COR3AV,COR5AV,
     5     TOVOLA,TOVOLB,TOVOLP,THVOLA,THVOLB,THVOLP,CRR,
     6     VRF,CLLOSA,CLLOSB,CLLOSP,ACRTA,ACRTB,ACRTP,REJA,REJB,
     7     REJP,IACRTA,IACRTB,IACRTP,FULLAV,FULLSD,FULLA,FULLB,
     8     FULLP,HALFAV,HALFSD,HALFA,HALFB,HALFP, RANA,
     9     RANB,RANP,UTFTA,UTFTB,UTFTP,
     A     TFTA,TFTB,TFTP,TGRUP,TGRUPP,CLRUPP,RUPVOL,RUVOLP,
     B     FULLM,HALFM,RANM,TFTM,SFULLC,SHALFC
      COMMON /THIRD/ TEMP(29,64)
      BLENAV = SBLEN/BLKS
      DMAJAV = SDMAJ/BLKS
      DMINAV = SDMIN/BLKS
      COR1AV = SCOR1/BLKS
      COR3AV = SCOR3/BLKS
      COR5AV = SCOR5/BLKS
      SCORVP = SCORVO/SABCVO*100.0
      SSPRVOP = SSPRVO/SABCVO*100.0
      TOVOLA = SFULLC+SHALFC+SRANT+STFTT
```

CLPLOSS Computer Program, continued

```
TOVOLB = TOVOLA*32.
TOVOLP = TOVOLA/SABCVO*100.0
THVOLA = STHVOL
THVOLB = THVOLA*32.
THVOLP = THVOLA/SABCVO*100.0
CRR = TOVOLA/SABCVO
VRF = TOVOLB/SSCBVN
CLLOSA = SREJT+SCLPRU
CLLOSB = CLLOSA*32.
CLLOSP = CLLOSA/SABCVO*100.0
ACRTA = SACRT
ACRTB = ACRTA*32.
ACRTP = ACRTA/SABCVO*100.0
REJA = SREJT
REJB = REJA*32.
REJP = REJA/SABCVO*100.0
IACRTA = SIACRT
IACRTB = IACRTA*32.
IACRTP = IACRTA/SABCVO*100.0
FULLAV = SFULLT/SFULLK
FULLSD = ((SFULLS-(SFULLT**2)/SFULLK)/(SFULLK-1.0))**0.5
FULLA = SFULLC
FULLB = FULLA*32.
FULLP = FULLA/SABCVO*100.0
HALFAV = SHALFT/SHALFK
HALFSD = ((SHALFS-(SHALFT**2)/SHALFK)/(SHALFK-1.0))**0.5
HALFA = SHALFC
HALFB = HALFA*32.
HALFP = HALFA/SABCVO*100.0
RANA = SRANT
RANB = RANA*32.
RANP = RANA/SABCVO*100.0
UTFTA = SUTFTT
UTFTB = UTFTA*32.
UTFTP = UTFTA/SABCVO*100.0
TFTA = STFTT
TFTB = TFTA*32.
TFTP = TFTA/SABCVO*100.0
TGRUP = SABCVO-(SSPRVO+SCORVO+SFULLC+SHALFC+SRANT+SUTFTT+SCLPRU+
1SREJT)
TGRUPP = TGRUP/SABCVO*100.0
CLPRUP = SCLPRU
CLRUPP = CLPRUP/SABCVO*100.0
```

CLPLOSS Computer Program, continued

```
RUPVOL = TGRUP+CLPRUP
RUVOLP = RUPVOL/SABCVO*100.0
MERCH = FULLB+HALFB+RANB+TFTB
FULLM = FULLB/MERCH*100.0
HALFM = HALFB/MERCH*100.0
RANM = RANB/MERCH*100.0
TFTM = TFTB/MERCH*100.0
TEMP(I,1) = BLKS
TEMP(I,2) = BLENAV
TEMP(I,4) = DMAJAV
TEMP(I,5) = DMINAV
TEMP(I,6) = SSCBVG
TEMP(I,7) = SSCBVN
TEMP(I,8) = SABCVO
TEMP(I,9) = COR1AV
TEMP(I,10) = COR3AV
TEMP(I,11) = COR5AV
TEMP(I,12) = SCORVO
TEMP(I,13) = SCORVP
TEMP(I,14) = SSPRVO
TEMP(I,15) = SSPRVOP
TEMP(I,16) = RUPVOL
TEMP(I,17) = RUVOLP
TEMP(I,18) = TGRUP
TEMP(I,19) = TGRUPP
TEMP(I,20) = CLPRUP
TEMP(I,21) = CLRUPP
TEMP(I,22) = TOVOLA
TEMP(I,23) = TOVOLB
TEMP(I,24) = TOVOLP
TEMP(I,25) = THVOLA
TEMP(I,26) = THVOLB
TEMP(I,27) = THVOLP
TEMP(I,28) = CRR
TEMP(I,29) = VRF
TEMP(I,30) = CLLOSA
```

CLPLOSS Computer Program, continued

```
      TEMP(I,31) = CLLOSB
      TEMP(I,32) = CLLOSP
      TEMP(I,33) = REJA
      TEMP(I,34) = REJB
      TEMP(I,35) = REJP
      TEMP(I,36) = IACRTA
      TEMP(I,37) = IACRTB
      TEMP(I,38) = IACRTP
      TEMP(I,39) = ACRTA
      TEMP(I,40) = ACRTB
      TEMP(I,41) = ACRTP
      TEMP(I,42) = FULLAV
      TEMP(I,43) = FULLSD
      TEMP(I,44) = FULLA
      TEMP(I,45) = FULLB
      TEMP(I,46) = FULLP
      TEMP(I,47) = HALFAV
      TEMP(I,48) = HALFSD
      TEMP(I,49) = HALFA
      TEMP(I,50) = HALFB
      TEMP(I,51) = HALFP
      TEMP(I,52) = RANA
      TEMP(I,53) = RANB
      TEMP(I,54) = RANP
      TEMP(I,55) = UTFTA
      TEMP(I,56) = UTFTB
      TEMP(I,57) = UTFTP
      TEMP(I,58) = TFTA
      TEMP(I,59) = TFTB
      TEMP(I,60) = TFTP
      TEMP(I,61) = FULLM
      TEMP(I,62) = HALFM
      TEMP(I,63) = RANM
      TEMP(I,64) = TFTM
      RETURN
      END
 EOI ENCOUNTERED.
/
```

APPENDIX C

Micro-computer Programs

HP Digitizing Program

```
0: "PROGRAM #1       NEW DIGITIZING PROGRAM       ":
1: "TRK1,FILE0":
2: "THIS DIGITIZING PORTION OF THE VENEER RECOVERY STUDY PROGRAM.":
3: "  COMPUTES THE AREA,IN SQ.IN., OF INDIVIDUAL PIECES OF VENEER.":
4: "  X&Y COORDINATES ARE OBTAINED WHEN MOVIE FILM OF DOUGLAS FIR VENEER":
5: "  IS PROJECTED ONTO THE DIGITIZER SURFACE AND THE IMAGE IS CORRECTLY":
6: "  DIGITIZED. THE AREA IN SQ IN. IS THEN CONVERTED TO ACTUAL SQ.FT.":
7: "  DIMENSIONS. THIS PROGRAM PROVIDES RAW DATA ON INDIVIDUAL SHEET":
8: "  AREAS.":
9:
10: PRT "DIGITIZING"
11: PRT "PROGRAM";SPC
12: PRT "SPECIAL"
13: PRT "FUNCTIONS";SPC
14: PRT "DIRECTIONS...";SPC
15: PRT "1. HIT 'FETCH'"
16: PRT "2. HIT 'F0'"
17: PRT "3. TYPE IN"
18: PRT "  INSTRUCTIONS"
19: PRT "4. HIT 'STORE'"
20: PRT "5. REPEAT FOR"
21: PRT "  EACH SPECIAL"
22: PRT "  FUNCTION";SPC ;SPC ;BEEP
23: BEEP
24: PRT "ENTER......";SPC ;SPC
25: PRT "F0= *CONT 106"
26: PRT "F1= *CONT 101"
27: PRT "F2= *CONT 95"
28: PRT "F3= *CONT 192"
29: PRT "F4= *CONT 35"
30: SPC ;SPC
31: PRT "WHEN FINISHED...";SPC ;SPC
32: PRT "  HIT F4";SPC ;SPC
33: DSP "ENTER SPECIAL FUNCTIONS NOW!";BEEP;STP
34:
35: PRT "START A NEW"
36: PRT " FILE FOR EACH"
37: PRT " NEW BLOCK";SPC
38: PRT "TO DO SO....."
39: PRT "HIT 'FULL' AFTER"
40: PRT "COMPLETING"
41: PRT "EACH BLOCK";SPC ;SPC
42: DSP "TURN DIGITIZER ON";BEEP;STP
43: DSP "TURN LINE PRINTER ON";BEEP;STP
44: DSP "LINE PRINTER SW IN 'N' POSITION";BEEP;STP
```

HP Digitizing Program, continued

```
45:
46: "ARRAY W RECORDS BLOCK CODES AND AREA DATA":
47: "ARRAY Q RECORDS COORDINATE DATA FOR AREA CALCULATIONS":
48: DIM W[100,5],Q[4,2]
49:
50: BEEP
51: ENT "ENTER NEXT SERIAL NUMBER",S;BEEP
52: ENT "ENTER NEXT DATA FILE NUMBER",R0;BEEP
53:
54:
55:
56:
57: "THE X-Y SCALAR FACTOR AND MILL NUMBER MUST BE ENTERED HERE":
58: .582→R
59:
60: "MILL":
61: 4→A
62:
63: "BLOCK":
64: DSP "MARK YOUR TALLY SHEET";BEEP;WAIT 300;BEEP;STP
65: ENT "BLOCK#=?",B;BEEP
66: IF B<1;CLL 'INPUT ERROR';GTO -1
67: IF B>32;CLL 'INPUT ERROR';GTO -2
68:
69: "DIAMETER":
70: ENT "DIAMETER CLASS#=?",C;BEEP
71: IF C<1;CLL 'INPUT ERROR';GTO -1
72: IF C>4;CLL 'INPUT ERROR';GTO -2
73: "CORRECT":
74: BEEP
75: ENT "ALL INPUTS CORRECT? 1=YES,0=NO",R2
76: IF R2>1;CLL 'INPUT ERROR';GTO -1
77: IF R2=0;GTO +2
78: IF R2=1;GTO +7
79: BEEP
80: ENT "WANT TO TRY AGAIN?,1=YES,0=NO",R3;BEEP
81: IF R3>1;CLL 'INPUT ERROR';GTO -1
82: IF R3=1;GTO "MILL"
83: IF R3=0;GTO "END"
84:
85: "NEW FILE":
86: DSP "DATA TRACK COMING UP";BEEP;WAIT 1000
87: INA W
88: TRK 0
```

HP Digitizing Program, continued

```
89: FDF R0;WAIT 1000
90: 1→I
91: "THE FIRST LINE OF EACH FILE IS MARKED WITH A SERIAL NUMBER (S)":
92: S→M[I,5]
93: I+1→I
94:
95: "VENEER":
96: BEEP
97: ENT "VENEER CODE#=?",D;BEEP
98: IF D<1;CLL 'INPUT ERROR';GTO -1
99: IF D>9;CLL 'INPUT ERROR';GTO -2
100:
101: "TYPE":
102: ENT "DIGITIZING TYPE#=?",R1;BEEP
103: IF R1<1;CLL 'INPUT ERROR';GTO -1
104: IF R1>2;CLL 'INPUT ERROR';GTO -2
105:
106: "SKEW":
107: GSB "SKEW CORRECTION"
108: IF R1=1;GTO "QUADRALATERAL"
109: IF R1=2;GTO "TRAPAZOIDAL OR CONVOLUTED"
110:
111: "QUADRALATERAL":
112: BEEP
113: DSP "READ TOP LEFT CORNER";BEEP
114: RED 4,X,Y;BEEP
115: DSP "READ TOP RIGHT CORNER"
116: RED 4,W,Z;BEEP
117: GSB "COORDINATE 3&4 CORRECTION"
118:
119: "THE TRUE LENGTH CALCULATIONS CORRECT THE QUADRALATERAL SHAPED ":
120: "   PIECES (MEASUREMENTS) FOR BEING OUT OF SQUARE":
121: "8 FOOT TRUE LENGTH":
122: \((Q[2,1]-Q[1,1])^2+(Q[2,2]-Q[1,2])^2)→E
123: \((Q[4,1]-Q[3,1])^2+(Q[4,2]-Q[3,2])^2)→O
124: "4 FOOT TRUE LENGTH":
125: \((Q[3,1]-Q[1,1])^2+(Q[3,2]-Q[1,2])^2)→T
126: \((Q[4,1]-Q[2,1])^2+(Q[4,2]-Q[2,2])^2)→U
127: "AVERAGE OF SIDES":
128: (E+O)/2→M
129: (T+U)/2→N
130: M*R*N*R→P
131: GTO "CHECK"
132:
```

HP Digitizing Program, continued

```
133: "TRAPAZOIDAL OR CONVOLUTED":
134: 0→V→T
135: DSP "BEGIN CONTINOUS DIGITIZING";BEEP
136: RED 4,X,Y;BEEP
137: "READ":
138: RED 4,W,Z;BEEP
139: GSB "COORDINATE 3&4 CORRECTION"
140: ABS(Q[3,1]-Q[4,1])→M
141: IF Q[3,2]>Q[4,2];GTO +3
142: ABS(Q[3,2]-Q[4,2])/2+Q[3,2]→N
143: GTO +2
144: ABS(Q[3,2]-Q[4,2])/2+Q[4,2]→N
145: M*R*N*R→P
146: IF Q[3,1]<Q[4,1];P+V→V;GTO +4
147: "POSITIVE AREA NOW SUMMED":
148: P+T→T
149: "NEGATIVE AREA NOW SUMMED":
150: W→X
151: Z→Y
152:
153: "CONTINUOUS CUT-OFF":
154: IF Q[4,2]<0;GTO "SHEET AREA"
155: GTO "READ"
156:
157: "SHEET AREA":
158: IF V>T;V-T→P;GTO "CHECK"
159: DSP "THIS AREA IS INCORRECT";BEEP;WAIT 200;BEEP;WAIT 200;BEEP;WAIT 1500
160: DSP "DO IT OVER";BEEP;WAIT 1500;BEEP;GTO "SKEW"
161:
162: "CHECK":
163: "THE AREA IS PRINTED ON THE INTERNAL PRINTER":
164: "FOR A PRELIMINARY VISUAL CHECK":
165: FXD 1;PRT D
166: FXD 3;PRT P;SPC ;SPC
167: ENT "CORRECTLY DIGITIZED? 1=YES,0=NO",R4;BEEP
168: IF R4>1;CLL 'INPUT ERROR';GTO -1
169: IF R4=1;GTO +6
170: IF R4=0;DSP "THEN LETS DO IT OVER!";BEEP;WAIT 2000;BEEP
171: GTO "SKEW"
172: "IF THE AREA IS VISUALLY CHECKED TO BE CORRECT, ALL INPUTS ARE":
173: "SENT TO THE LINE PRINTER AND ARE THEN RECORDED ON TAPE":
174:
175: "STORE":
176: IF I>2;GTO +5
```

HP Digitizing Program, continued

```
177: FMT 1,40X,"FILE#=",F4.0,5X,"SERIAL#=",F4.0
178: WRT 10.1,R0,S
179: FMT 2,1X,"MILL",2X,"BLOCK",2X,"DIAMETER",2X,"VENEER",3X,"AREA"
180: WRT 10.2
181: FMT 3,2X,F1.0,5X,F2.0,7X,F1.0,9X,F1.0,3X,F7.3
182: WRT 10.3,A,B,C,D,P
183: A→W[I,1]
184: B→W[I,2]
185: C→W[I,3]
186: D→W[I,4]
187: P→W[I,5]
188: I+1→I
189:
190: "FILE CHECK":
191: IF I<100;GTO "VENEER"
192: GSB "FILE FULL"
193:
194: "END":
195: GSB "FILE STORE"
196: GSB "FILE CHANGE"
197: DSP "ADVANCE LINE PRINTER PAPER";BEEP;STP
198: ENT "CONTINUE THIS BLOCK? 1=YES,0=NO",R10;BEEP
199: IF R10>1;CLL 'INPUT ERROR';GTO -1
200: IF R10=1;GTO "NEW FILE"
201: ENT "ANOTHER BLOCK TODAY? 1=YES,0=NO",R9;BEEP
202: IF R9>1;CLL 'INPUT ERROR';GTO -1
203: IF R9=1;GTO "BLOCK"
204:
205: "FINISHED":
206: ENT "FINISHED FOR TODAY? 1=YES,0=NO",R7;BEEP
207: IF R7>1;CLL 'INPUT ERROR';GTO -1
208: IF R7=0;GTO "VENEER"
209:
210: BEEP;WAIT 500;BEEP;WAIT 500;BEEP
211: DSP "TURN OFF DIGITIZER!!!";BEEP;STP
212: END
213:
214: "**************************":
215: "*********SUBROUTINES*******":
216: "**************************":
217:
218:
219: "SKEW CORRECTION TRIGONOMETRICALLY ALIGNS THE USER DESIGNATED":
220: "   X-Y AXIS WITH THE TRUE PLATEN X-Y AXIS.":
```

HP Digitizing Program, continued

```
221:
222: "SKEW CORRECTION":
223: INA Q
224: FXD 8
225: DSP "MARK ORIGIN & BOTTOM LEFT CORNER";BEEP
226: RED 4,F,G;BEEP
227: DSP "MARK BOTTOM RIGHT CORNER";BEEP
228: RED 4,H,J;BEEP
229: IF H=F;DSP "HIT 'C' BUTTON PLEASE";STP ;GTO +2
230: GTO +2
231: DSP "TURN IT OFF THIS TIME DUMMY";BEEP;WAIT 1500;GTO "SKEW CORRECTION"
232: ATN((J-G)/(H-F))→R8
233: COS(R8)→K
234: SIN(R8)→L
235: "COORDINATE 1&2 CORRECTION":
236: "K&L ARE SKEW CORRECTION FACTORS":
237: F*K+G*L→Q[1,1]
238: G*K-F*L→Q[1,2]
239: H*K+J*L→Q[2,1]
240: J*K-H*L→Q[2,2]
241: "FIRST TWO COORDINATES NOW SKEW CORRECTED":
242: RET
243:
244:
245:
246: "COORDINATE 3&4 CORRECTION":
247: X*K+Y*L→Q[3,1]
248: Y*K-X*L→Q[3,2]
249: W*K+Z*L→Q[4,1]
250: Z*K-W*L→Q[4,2]
251: "SECOND TWO COORDINATES NOW SKEW CORRECTED":
252: RET
253:
254:
255: "FILE FULL":
256: BEEP;WAIT 150;BEEP;WAIT 150;BEEP;WAIT 150;BEEP;WAIT 150;BEEP
257: DSP "FILE FULL!!!!";BEEP;WAIT 3000
258: RET
259:
260:
261:
262: "FILE STORE":
263: RCF R0,W[*]
264: PRT "FILE #",R0
```

HP Digitizing Program, continued

```
265: PRT "RECORDED";SPC ;SPC
266: PRT "SERIAL #",S
267: PRT "RECORDED";BEEP;SPC ;SPC ;WAIT 2000
268: RET
269:
270:
271:
272: "FILE CHANGE":
273: R0+1→R0
274: S+1→S
275: FDF R0
276: WAIT 1000
277: BEEP;WAIT 150;BEEP;WAIT 150;BEEP
278: DSP "NEW DATA FILE=",R0;WAIT 4000
279: RET
280:
281:
282:
283: "INPUT ERROR":
284: DSP "INPUT ERROR-----DO IT OVER!!!!";BEEP;WAIT 3000;BEEP
285: RET
```

HP Control Sheet Program

```
0: "PROGRAM #2          NEW CONTROL SHEET PROGRAM ":
1: "TRK1,FILE1":
2: "THIS DIGITIZING PORTION OF THE VENEER STUDY PROGRAM COMPUTES":
3: "  THE ACTUAL DIMENSIONS OF THE MILL CONTROL SHEETS. IT IS":
4: "  FROM THESE CONTROL SHEET MEASUREMENTS THAT THE X&Y SCALAR":
5: "  VALUE IS OBTAINED":
6:
7:
8: DSP "TURN ON THE LINE PRINTER!!";BEEP;STP
9: FMT 2,12X,"********** NEW CONTROL SHEET PROGRAM **********"
10: WRT 10.2
11: FMT 4
12: WRT 10
13: FMT 1,10X,"OBJECTIVE.................A SINGLE SIDE OF THE CONTROL"
14: WRT 10.1
15: FMT 2,15X,"SHEET IS DIGITIZED SEVERAL TIMES, THE VALUES ARE SUMMED,"
16: WRT 10.2
17: FMT 3,15X,"AND ARE THEN AVERAGED. THE VALUES PRINTED OUT ARE"
18: WRT 10.3
19: FMT 4,15X,"IN TERMS OF PLATTEN INCHES."
20: WRT 10.4
21: FMT 5,13X,"A. TO OPERATE, THE USER MUST FIRST KEY IN THE REQUIRED"
22: WRT 10.5
23: FMT 6,17X,"SPECIAL FUNCTIONS."
24: WRT 10.6
25: FMT 7,20X,"1.  DEPRESS 'FETCH'"
26: WRT 10.7
27: FMT 8,20X,"2.  DEPRESS SPECIAL FUNCTION KEY"
28: WRT 10.8
29: FMT 9,20X,"3.  TYPE IN INSTRUCTIONS"
30: WRT 10.9
31: FMT 1,20X,"4.  DEPRESS 'STORE'"
32: WRT 10.1
33: FMT 2,20X,"5.  REPEAT FOR EACH SPECIAL FUNCTION"
34: WRT 10.2
35: FMT 9,20X,"6.  THEN DEPRESS F0 TO CONTINUE"
36: WRT 10.9
37: FMT 3,10X,"TYPE IN....."
38: WRT 10.3
39: FMT 4,10X,"F0 = *CONT 61     THIS RESETS THE SKEW FUNCTION"
40: WRT 10.4
41: FMT 5,10X,"F1 = *CONT 92     THIS INITIATES THE AVERAGING FUNCTION"
42: WRT 10.5
43: FMT 7,13X,"B. DIGITIZE A SINGLE SIDE REPEATEDLY,DEPRESS STOP,"
44: WRT 10.7
```

HP Control Sheet Program, continued

```
45: FMT 8,16X,"THEN DEPRESS F1. WHEN ENOUGH READINGS HAVE BEEN TAKEN. THE"
46: WRT 10.8
47: FMT 9,16X,"AVERAGE VALUE FOR THAT SIDE WILL BE PROVIDED."
48: WRT 10.9
49: FMT 1,13X,"C. THEN CONTINUE ON TO THE NEXT SHEET SIDE."
50: WRT 10.1
51: DSP "STORE SPECIAL FUNCTIONS NOW!";BEEP
52: STP
53:
54:
55: "SKEW CORRECTION":
56: "IF THE ORIGIN IS LOST WHILE MARKING POINTS, DEPRESSING THE":
57: "FUNCTION KEY,F0, WILL RETURN YOU TO THE ORIGIN FOR RE-INITIALIZATION.":
58:
59: DIM Q[2,2]
60:
61: "READ":
62: BEEP;WAIT 500;BEEP
63: DSP "MARK ORIGIN AND ANY CONTROL MARK"
64: RED 4,F,G;BEEP
65: DSP "MARK ITS MATE"
66: RED 4,H,J;BEEP
67: ATN((J-G)/(H-F))→R1
68: COS(R1)→K
69: SIN(R1)→L
70: "K&L ARE SKEW CORRECTION FACTORS":
71: INA Q
72: F*K+G*L→Q[1,1]
73: G*K-F*L→Q[1,2]
74: H*K+J*L→Q[2,1]
75: J*K-H*L→Q[2,2]
76: "THESE POINTS ARE NOW SKEW CORRECTED":
77:
78: "TRUE LENGTH CORRECTION":
79: √((Q[2,1]-Q[1,1])^2+(Q[2,2]-Q[1,2])^2)→M
80: I+1→I
81: IF I>1;GTO +5
82: FMT 1,5X,"READING#",9X,"LENGTH"
83: WRT 10.1
84: FMT 5
85: WRT 10
86: FMT 2,4X,F6.0,12X,F6.3
87: WRT 10.2,I,M
88: A+M→A
```

HP Control Sheet Program, continued

```
89: BEEP
90: GTO "READ"
91:
92: "AVERAGE":
93: A/I→B
94: FMT 4
95: WRT 10
96: FMT 3,25X,"AVERAGE=",F7.3
97: WRT 10.3,B
98: DSP "I'M READY FOR A NEW SIDE!";BEEP;STP
99: 0→I
100: 0→A
101: FXD 4
102: FMT 5,40"-"
103: WRT 10.5
104: GTO "READ"
105: END
```

HP Data File Print Program

```
0: "PROGRAM #3      DATA FILE PRINT PROGRAM  ":
1: "TRK1,FILE2":
2: "THIS SHORT PROGRAM ALLOWS ONE TO OUTPUT THE CONTENTS":
3: "     OF A DATA FILE ONTO THE LINE PRINTER":
4:
5: DIM A[100,5]
6: TRK 0
7: ENT "FIRST FILE# TO PRINT OUT?",F;BEEP
8: ENT "LAST FILE# TO PRINT OUT?",G;BEEP
9: INA A
10: LDF F,A[*]
11: FMT 1,Z,F7.3
12: FOR I=1 TO 100
13: FOR J=1 TO 5
14: WRT 10.1,A[I,J]
15: NEXT J
16: WRT 10
17: NEXT I
18: DSP "ADVANCE PAPER PLEASE";BEEP;STP
19: DSP "THANK YOU";BEEP;WAIT 1000
20: F+1→F
21: IF F<=G;GTO 9
22: DSP "ALL FINISHED";BEEP;STP
```

HP 1200 BAUD Transfer Program

```
0: "PROGRAM #4      NEW 1200 BAUD TRANSFER PROGRAM    ":
1: "TRK 1, FILE 3":
2: "TRANSFER OF H/P DATA TO CYBER IS DONE ON A FILE BY FILE":
3: "   BASIS WITH THE USER SELECTING THE FIRST AND LAST FILE":
4: "   TO BE TRANSFERRED.":
5:
6:
7: "    DIRECTIONS..........":
8: "     WITH THE H/P IN THE TAPPI ROOM (RM 182),":
9: "          1. PLUG H/P INTO 110V OUTLET":
10: "         2. CONNECT INTERFACE BUSS INTO MODEM AND COMPUTER":
11: "         3. TWO SWITCHES ON BACK OF MODEM MUST BE DOWN":
12: "         4. TURN ON H/P":
13: "         5. LOAD XFER PROGRAM":
14: "         6. FETCH LINE 50":
15: "         7. ENTER FILE NAME TO BE CREATED ON CYBER":
16: "         8. DEPRESS STORE":
17: "         9. DEPRESS RESET":
18: "        10. DEPRESS RUN":
19:
20: GSB "INITIALIZE H/P"
21: GSB "INITIALIZE INTERFACE"
22: GSB "LOGON"
23: GSB "TEXT"
24: GSB "LOAD TAPE"
25: GSB "END TRANSFER"
26: GSB "LOGOFF"
27: STP
28: END
29:
30: "******************************":
31: "**********SUBROUTINES*********":
32: "******************************":
33:
34: "INITIALIZE H/P":
35: DIM U$[20],C$[15],A$[32],F$[7],W[100,5]
36: RET
37:
38: "INITIALIZE INTERFACE":
39: WTC 11,1
40: WTB 11,37
41: WTC 11,0
42: RET
43:
44: "LOGON":
```

HP 1200 BAUD Transfer Program, continued

```
45: "DY4Y5F,BARF"→U$
46: "805213,VENEER"→C$
47: "THE FILE NAME TO BE CREATED ON CYBER SHOULD BE ACTUALLY":
48: "  TYPED INTO THE PROGRAM BEFORE RUNNING":
49:
50: "HP1"→F$
51: WTB 11,"NOS",13
52: WAIT 6000
53: WTB 11,U$,13
54: PRT "1"
55: PRT "USER# SENT";SPC ;SPC
56: WAIT 4000
57: WTB 11,"CHARGE,",C$,13
58: PRT "CHARGE# SENT";SPC ;SPC
59: GSB "WAIT"
60: WTB 11,"NEW,",F$,13
61: GSB "WAIT"
62: RET
63:
64: "ALL DATA FILES FOR THIS PROJECT ARE ON TRACK 0":
65: "  OF THE H/P CASSETTE TAPE":
66:
67: "LOAD TAPE":
68: DSP "LOAD DATA TAPE NOW";BEEP;STP
69: TRK 0
70: ENT "FIRST FILE TO XFER",R1;BEEP
71: ENT "LAST FILE TO XFER",R2
72: FOR I=R1 TO R2
73: LDF I,W[*]
74: GSB "TRANSFER"
75: NEXT I
76: PRT "ALL FILES XFERED"
77: RET
78:
79: "THIS SECTION TRANSFERS FROM ARRAY W, ONE FIVE ELEMENT LINE OF DATA":
80: "  AT A TIME, SENDS A CARRIAGE RETURN (WTB 11,13), ANDTHEN WAITS":
81: "  FOR A LINE FEED (LF) RETURN FROM CYBER BEFORE GOING ON TO THE":
82: "  NEXT LINE OF DATA":
83:
84: "TRANSFER":
85: WTB 11,"FILE",I,13
86: GSB "LF WAIT"
87: FOR J=1 TO 100
88: FMT 1,Z,5F10.3
```

HP 1200 BAUD Transfer Program, continued

```
89: IF W[J,5]=0;JMP 4
90: WRT 11.1,W[J,1],W[J,2],W[J,3],W[J,4],W[J,5]
91: WTB 11,13
92: GSB "LF WAIT"
93: NEXT J
94: PRT "FILE ",I," XFERED"
95: RET
96:
97: "END TRANSFER":
98: WTC 11,1
99: WTB 11,8
100: WAIT 1000
101: WTB 11,37
102: WTC 11,0
103: PRT "BREAK CHAR SENT"
104: GSB "WAIT"
105: WTB 11,"SAVE",13
106: GSB "WAIT"
107: PRT "DATA SAVED"
108: PRT "DATA TRANSFER"
109: PRT "COMPLETE";SPC ;SPC
110: RET
111:
112: "LOGOFF":
113: WTB 11,"BYE",13
114: IF 'INPUT'#84;GTO +0
115: IF 'INPUT'#83;GTO +0
116: PRT "LOGOFF COMPLETE";SPC ;SPC
117: RET
118:
119: "INPUT":
120: "SCANS THE INPUT FROM CYBER":
121: "USE IT AS A FUNCTION":
122: BAND(127,RDB(11))→B
123: IF K>=32;0→K
124: K+1→K
125: CHAR(B)→A$[K,K]
126: DSP A$[1,K]
127: RET B
128:
129: "WAIT":
130: "SCANS THE INPUT AND WAITS FOR (/)":
131: IF 'INPUT'#47;GTO +0
132: WAIT 200
```

HP 1200 BAUD Transfer Program, continued

```
133: RET
134:
135: "LF WAIT":
136: "SCANS THE INPUT AND WAITS FOR LF":
137: IF 'INPUT'#10;GTO +0
138: WAIT 200
139: RET
140:
141: "TEXT":
142: WTB 11,"TEXT",13
143: WAIT 1000
144: PRT "TEXT MODE"
145: PRT "ENTERED";SPC
146: RET
```

APPENDIX D

Mill Data Sheets

Mill Green-end Information

Mill Name	
Mill Location	
Mill Code #	1
Date	10/30/80

Plant Capacity	50 MM ft^2 (3/8 in basis)
Type of Debarker	Ring
Bucking System	--
Block Heating System	Steam Vats
Block Heating Schedule	Dia. #1 6 hrs; Dia. #2 8-9 hrs; Dia. #3 and Dia. #4 12+ hrs
Conveyer System	Direct Coupled
Scanner Make and Model	Morvue
Line Clock Manufacturer	Morvue
Blade Position Indicator	Morvue
Clipper Hold Down System	Morvue
Clipper Make and Model	Elliot Bay Semi-automatic NS 814
Clipper Infeed Speed	250 fpm
Lathe Charging System	PMI - Superior Precision X-Y Charger[a] (PDP 8E Minicomputer)
Lathe Manufacturer	Premier #VL 45-55[b]
Lathe Settings:	
Horizontal Gap	--
Vertical Gap	--
Pitch Angle	--
Bevel	--
Micro Bevel	None
Nosebar Type	Roller
Average Veneer Thickness	0.10135 in
Spur Knife Settings	100.9375 in

[a]Precision X-Y charger was inoperative at time of study--blocks were manually centered.

[b]This mill did not have retractable lathe chucks. A 5 in chuck was used to peel the #1 and #2 diameters and was replaced with 6 in chuck for the larger #3 and #4 diameter blocks.

Scanner Data

(Morvue)

Mill Name ________ Mill Code # 1

Mill Location ______ Date 10/30/80

Veneer Size
- Width
  - Full Ribbon 100 Fishtails 51.0
- Sheets
  - Ex. Large -- Full 53.0 Medium -- Half 26.6

Flaw Limits
- Normal Grade
  - Crack 36 W/Grain 2.0 A/Grain 0.6 Edge 1.2
- Low Grade
  - Crack 45 W/Grain 4.0 A/Grain 1.5 Edge 3.9
- Normal
  - Margin 0.6 Min. Strip 5.0 Flaw Centering 0.7
- Alternate
  - Margin 1.6 Min. Strip 5.0
- Sheet Addition
  - Large 0.4 Small 0.3

Tally
- No. of Sheets
  - Ex. Large -- Full -- Medium -- Half --
- Lineal Feet of Tally
  - Fishtail -- Random -- Trash --

Filming Sequence

Mill Name__________

Mill Location_______

Mill Code # 1

Date 10/30/80

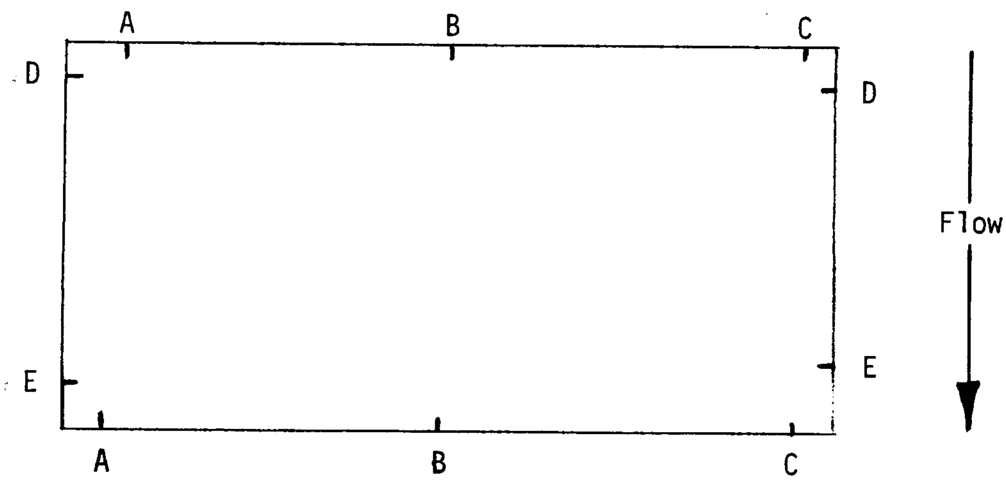
Maximum Conveyer Speed 250 fpm

Camera Height 15 ft

F. Stop Setting F 5

Scalar Factor .686

Veneer Control Sheet



A. 53.3750 in

B. 53.3125 in

C. 53.2500 in

D. 100.9375 in

E. 100.9375 in

Average Veneer Thickness

Mill Name________________ Mill Code # 1

Mill Location____________ Date 10/30/80

1	.110	.100	.109	.097	.100
2	.100	.097	.106	.098	.105
3	.111	.094	.106	.095	.096
4	.112	.103	.108	.106	.105
5	.099	.104	.105	.098	.095
6	.105	.096	.101	.103	.103
7	.106	.103	.104	.100	.093
8	.098	.098	.109	.100	.105
9	.107	.103	.102	.103	.097
10	.110	.092	.100	.105	.101
11	.099	.108	.097	.104	.101
12	.108	.105	.101	.102	.104
13	.104	.110	.101	.102	.100
14	.090	.108	.100	.103	.103
15	.097	.102	.100	.100	.094
16	.097	.105	.103	.098	.102
17	.093	.095	.095	.095	.100
18	.095	.101	.100	.104	.106
19	.110	.100	.101	.103	.098
20	.090	.101	.102	.097	.098

Total 10.135 in

n 100

Average 0.10135 in

Standard Deviation 0.0047745

Sum of Squares 1.029439

Mill Green-end Information

Mill Name	
Mill Location	
Mill Code #	2
Date	11/14/80

Plant Capacity	108 mm ft^2 (3/8 in basis)
Type of Debarker	Rosserhead
Bucking System	Chainsaw type
Block Heating System	Steam Vat
Block Heating Schedule	12 hrs - all diameters
Conveyer System	Direct Coupled
Scanner Make and Model	Morvue
Line Clock Manufacturer	Morvue
Blade Position Indicator	Morvue
Clipper Hold Down System	In-house manufacture
Clipper Make and Model	Elliot Bay Semi-Automatic NS 584
Clipper Infeed Speed	250 fpm
Lathe Charging System	Geometric Centering
Lathe Manufacturer	Coe
Lathe Settings:	
Horizontal Gap	--
Vertical Gap	--
Pitch Angle	--
Bevel	--
Micro Bevel	--
Nosebar Type	Roller
Average Veneer Thickness	0.10056 in
Spur Knife Settings	101.03125 in

Scanner Data

(Morvue)

Mill Name ____________ Mill Code # 2

Mill Location ________ Date 1/14/80

Veneer Size
Width
Full Ribbon 99/0 Fishtails 52.0
Sheets
Ex. Large -- Full 53.0 Medium -- Half 26.8

Flaw Limits
Normal Grade
Crack 30 W/Grain 2.6 A/Grain 0.9 Edge 2.0
Low Grade
Crack -- W/Grain -- A/Grain -- Edge --
Normal
Margin 0.9 Min. Strip 6.0 Flaw Centering 0.1
Alternate
Margin 0.9 Min. Strip 6.0
Sheet Addition
Large -- Small --

Tally
No. of Sheets
Ex. Large -- Full -- Medium -- Half --
Lineal Feet of Tally
Fishtail -- Random -- Trash --

Filming Sequence

Mill Name__________ Mill Code # 2

Mill Location_______ Date 11/14/80

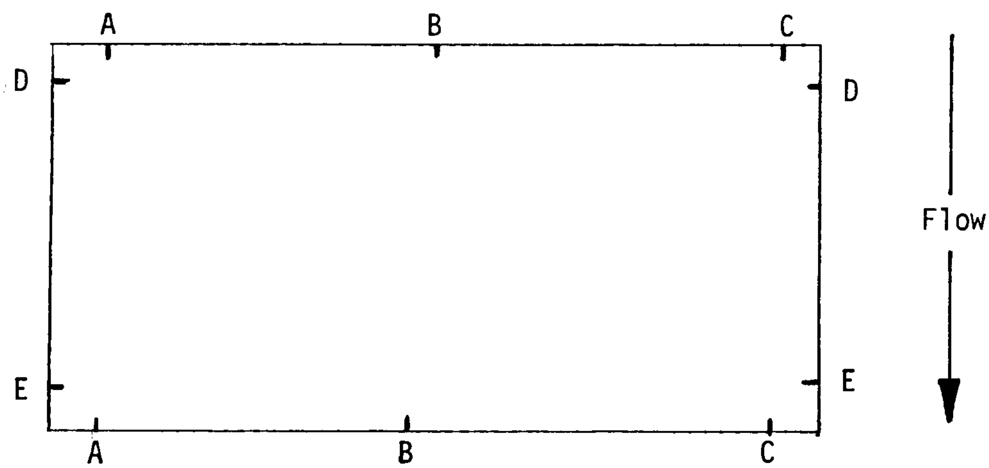
Maximum Conveyer Speed 250 fpm

Camera Height 15 ft

F. Stop Setting F 5.0

Scalar Factor .695

Veneer Control Sheet



A. 53.2500 in

B. 53.2500 in

C. 53.1875 in

D. 101.0313 in

E. 101.0313 in

Average Veneer Thickness

Mill Name ______________ Mill Code # 2

Mill Location ______________ Date 11/14/80

1	.100	.102	.100	.100	.099
2	.100	.099	.100	.096	.098
3	.099	.100	.102	.100	.101
4	.101	.101	.100	.098	.100
5	.101	.102	.105	.100	.102
6	.101	.098	.098	.098	.104
7	.102	.102	.103	.099	.097
8	.100	.102	.101	.107	.104
9	.099	.100	.095	.107	.101
10	.099	.097	.100	.103	.106
11	.100	.103	.098	.104	.099
12	.100	.102	.100	.102	.100
13	.102	.100	.108	.102	.102
14	.098	.101	.099	.103	.100
15	.098	.102	.101	.102	.094
16	.098	.102	.100	.101	.101
17	.098	.095	.103	.100	.101
18	.097	.100	.105	.101	.104
19	.100	.098	.100	.098	.101
20	.099	.096	.103	.105	.101

Total 10.056 in

n 100

Average 0.10056 in

Standard Deviation .0025359

Sum of Squares 1.011868

Mill Green-end Information

Nill Name	
Mill Location	
Mill Code #	3
Date	- 8/22/81

Plant Capacity	90 mm ft^2 (3/8 in basis)
Type of Debarker	--
Bucking System	Merchandizer
Block Heating System	none - pond
Block Heating Schedule	none - pond
Conveyer System	tray - Redco controls
Scanner Make and Model	Morvue
Line Clock Manufacturer	Morvue
Blade Position Indicator	Morvue
Clipper Hold Down System	Prentice
Clipper Make and Model	Old Prentice
Clipper Infeed Speed	220 fpm
Lathe Charging System	Coe Precision X-Y Charger
Lathe Manufacturer	Coe
Lathe Settings:	
Horizontal Gap	--
Vertical Gap	--
Pitch Angle	--
Bevel	--
Micro Bevel	--
Nosebar Type	--
Average Veneer Thickness	0.12726 in
Spur Knife Settings	101.125 in

Note: This mil had automatic veneer sheet pullers (Swedes).

Scanner Data

(Morvue)

Mill Name ________ Mill Code # 3

Mill Location ________ Date 3/22/81

Veneer Size
  Width
    Full Ribbon 100.0 Fishtails 54.0
  Sheets
    Ex. Large -- Full 52.6 Medium -- Half 25.9

Flaw Limits
  Normal Grade
    Crack 45.0 W/Grain 3.0 A/Grain 0.5 Edge --
  Low Grade
    Crack 24.0 W/Grain 5.0 A/Grain 0.9 Edge --
  Normal
    Margin 1.2 Min. Strip 5.0 Flaw Centering 0.0
  Alternate
    Margin -- Min. Strip --
  Sheet Addition
    Large -- Small --

*Note: Switch set on randoms - not panels

Tally
  No. of Sheets
    Ex. Large -- Full -- Medium -- Half --
  Lineal Feet of Tally
    Fishtail -- Random -- Trash --

Filming Sequence

Mill Name__________ Mill Code # 3

Mill Location________ Date 8/22/81

& 9/26/81

Maximum Conveyer Speed 220 fpm

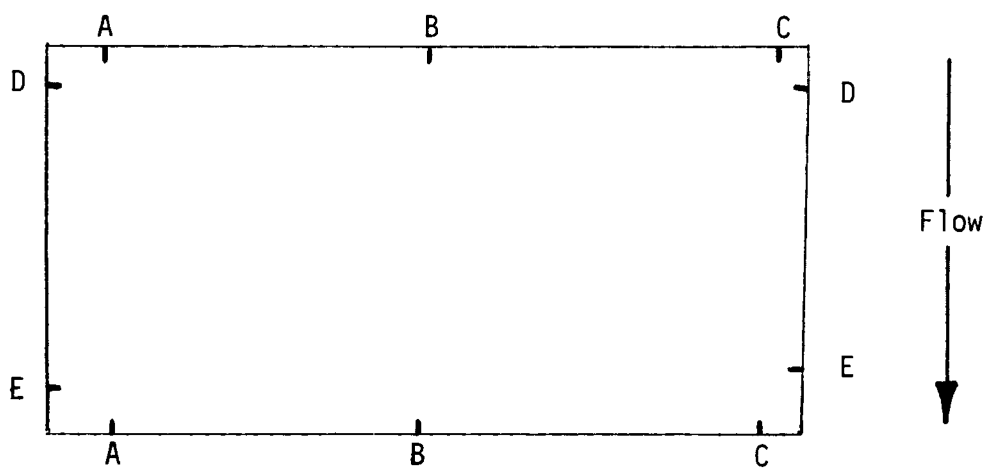
Camera Height

F. Stop Setting F 5.6 (8/22/81)

F 3.5 (9/26/81)

Scalar Factor .604

Veneer Control Sheet



A. 53.500 in

B. 53.5625 in

C. 53.6875 in

D. 101.1250 in

E. 101.1250 in

Average Veneer Thickness

Mill Name ______________ Mill Code # 3

Mill Location ______________ Date 8/22/81

1	.127	.125	.128	.128	.130
2	.130	.124	.127	.125	.129
3	.125	.130	.128	.129	.129
4	.123	.130	.126	.130	.130
5	.120	.131	.124	.128	.130
6	.125	.132	.128	.126	.125
7	.127	.130	.129	.126	.130
8	.132	.128	.129	.126	.129
9	.130	.129	.130	.125	.132
10	.128	.126	.126	.126	.125
11	.128	.13	.127	.123	.125
12	.131	.128	.127	.127	.130
13	.130	.127	.128	.125	.129
14	.131	.128	.127	.126	.130
15	.128	.120	.127	.128	.127
16	.127	.124	.126	.128	.130
17	.125	.110	.127	.129	.128
18	.131	.115	.126	.127	.130
19	.124	.130	.128	.128	.126
20	.124	.130	.124	.127	.128

Total 12.726

n 100

Average .12726 in

Standard Deviation 0.0032306

Sum of Squares 1.620544

Mill Green-end Information

Mill Name	
Mill Location	
Mill Code #	4
Date	8/27/81

Plant Capacity	125 mm ft^2 (3/8 in basis)
Type of Debarker	--
Bucking System	--
Block Heating System	Hot water
Block Heating Schedule	8-9 hrs, all diameters
Conveyer System	Tray
Scanner Make and Model	Black Clawson Acroclip
Line Clock Manufacturer	Black Clawson
Blade Position Indicator	Black Clawson
Clipper Hold Down System	Plymak
Clipper Make and Model	Plymak (rebuild Prentice)
Clipper Infeed Speed	240 fpm
Lathe Charging System	Geometric
Lathe Manufacturer	Premier
Lathe Settings:	
Horizontal Gap	--
Vertical Gap	--
Pitch Angle	--
Bevel	--
Micro Bevel	--
Nosebar Type	--
Average Veneer Thickness	0.1275 in
Spur Knife Settings	101.375 in

Note: This mill had a twin-saw fish-tail trimming operation.

Scanner Data

(Black Clawson)

Mill Name ____________ Mill Code # 4

Mill Location ________ Date 8/27/81

Veneer Size

Width

Full Ribbon -- Fishtails 51 1/8

Sheets

Ex. Large -- Full 51 3/4 Medium -- Half 25 5/8

Univ. 57 Univ. 27 7/8

Flaw Limits

Normal Grade

Crack -- W/Grain -- A/Grain -- Edge --

Low Grade

Crack -- W/Grain -- A/Grain -- Edge --

Normal

Margin 1 in Min. Strip 5 in Flaw Centering --

Alternate

Margin -- Min. Strip --

Sheet Addition

Large -- Small --

*Note: Score width = full negative

Tally

No. of Sheets

Ex. Large -- Full -- Medium -- Half --

Lineal Feet of Tally

Fishtail -- Random -- Trash --

Filming Sequence

Mill Name ________ Mill Code # 4

Mill Location ________ Date 8/27/81

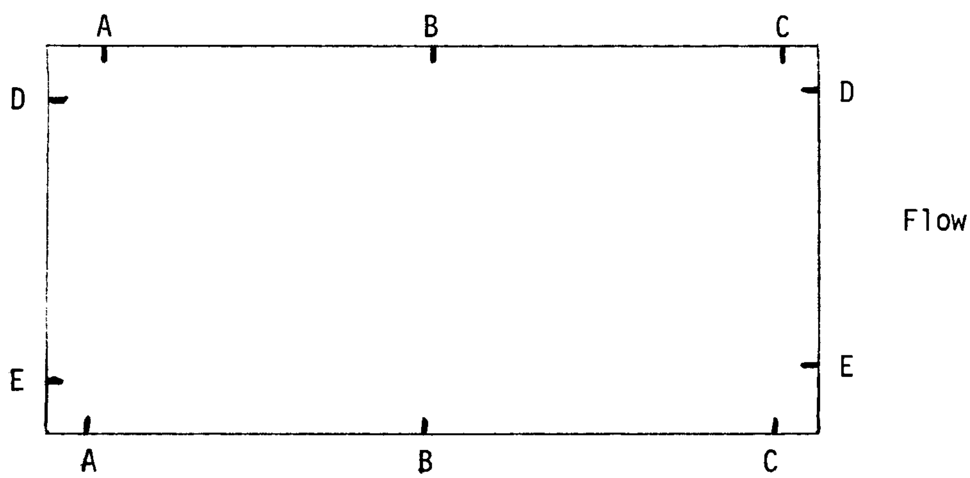
Maximum Conveyer Speed 240 fpm

Camera Height 12 ft 6 in

F. Stop Setting F 2.8

Scalar Factor .582

Veneer Control Sheet



A. 53.2500 in

B. 53.2500 in

C. 53.1875 in

D. 101.3750 in

E. 101.3750 in

Average Veneer Thickness

Mill Name________________ Mill Code # 4

Mill Location______________ Date 8/27/81

1	.128	.128	.129	.127	.131
2	.123	.127	.134	.126	.126
3	.130	.129	.125	.131	.126
4	.131	.126	.127	.130	.126
5	.127	.127	.129	.130	.130
6	.123	.127	.127	.130	.125
7	.125	.129	.128	.126	.126
8	.125	.126	.126	.127	.130
9	.128	.132	.130	.126	.127
10	.127	.130	.125	.128	.127
11	.128	.125	.127	.128	.128
12	.130	.125	.126	.130	.124
13	.126	.129	.131	.130	.130
14	.127	.125	.125	.129	.124
15	.130	.130	.124	.128	.125
16	.125	.125	.128	.129	.126
17	.128	.131	.125	.128	.126
18	.126	.127	.126	.128	.127
19	.128	.128	.131	.123	.131
20	.126	.125	.126	.128	.131

Total 12.750

n 100

Average 0.1275 in

Standard Deviation 0.0022585

Sum of Squares 1.62613

Mill Green-end Information

Mill Name	
Mill Location	
Mill Code #	5
Date	9/3/81

Plant Capacity	65 mm ft^2 (3/8 in basis)
Type of Debarker	Ring
Bucking System	Circle Saw
Block Heating System	Water Vat
Block Heating Schedule	All Blocks - 17 hrs (usually 1 hr/in radius
Conveyer System	Tray - 4 Trays
Scanner Make and Model	Morvue
Line Clock Manufacturer	Morvue
Blade Position Indicator	Morvue
Clipper Hold Down System	Prentice
Clipper Make and Model	Prentice - new Mark IV
Clipper Infeed Speed	240 fpm
Lathe Charging System	Geometric
Lathe Manufacturer	Premier
Lathe Settings:	
Horizontal Gap	--
Vertical Gap	--
Pitch Angle	--
Bevel	--
Micro Bevel	--
Nosebar Type	--
Average Veneer Thickness	0.09798 in
Spur Knife Settings	100.4375 in

Scanner Data

(Morvue)

Mill Name ________ Mill Code # 5

Mill Location ________ Date 9/3/81

Veneer Size
- Width
  - Full Ribbon 100.0 Fishtails 60.0
- Sheets
  - Ex. Large -- Full 52.6 Medium -- Half 26.6

Flaw Limits
- Normal Grade
  - Crack 27 W/Grain 5.6 A/Grain 0.6 Edge 3.5
- Low Grade
  - Crack 27 W/Grain 5.5 A/Grain 0.9 Edge 3.5
- Normal
  - Margin 2.0 Min. Strip 5.0 Flaw Centering 0.4
- Alternate
  - Margin 2.0 Min. Strip 5.2
- Sheet Addition
  - Large -- Small --

Tally
- No. of Sheets
  - Ex. Large -- Full -- Medium -- Half --
- Lineal Feet of Tally
  - Fishtail -- Random -- Trash --

Filming Sequence

Mill Name__________ Mill Code # 5

Mill Location__________ Date 9/3/81

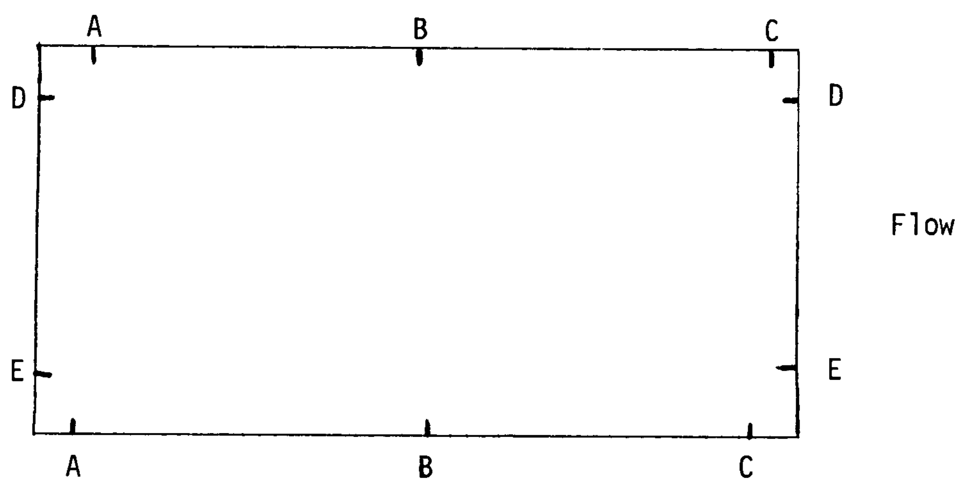
Maximum Conveyer Speed 245 fpm

Camera Height 14 ft

F. Stop Setting F 3.5

Scalar Factor .638

Veneer Control Sheet



A. 52.8750 in

B. 53.0000 in

C. 53.2500 in

D. 101.4375 in

E. 101.4375 in

Average Veneer Thickness

Mill Name________________ Mill Code # 5

Mill Location____________ Date 9/3/81

1	.100	.103	.097	.097	.095
2	.097	.102	.095	.100	.098
3	.104	.098	.097	.097	.100
4	.093	.095	.097	.099	.096
5	.094	.095	.098	.098	.099
6	.101	.096	.098	.102	.097
7	.095	.095	.098	.098	.098
8	.101	.094	.096	.098	.103
9	.097	.100	.101	.098	.099
10	.099	.099	.102	.099	.100
11	.096	.095	.096	.096	.100
12	.099	.100	.104	.098	.095
13	.101	.098	.098	.100	.096
14	.102	.100	.095	.095	.097
15	.098	.098	.097	.095	.102
16	.102	.095	.100	.099	.095
17	.105	.097	.099	.098	.093
18	.098	.098	.098	.096	.095
19	.098	.093	.096	.097	.098
20	.100	.095	.100	.099	.095

Total 9.798

n 100

Average .09798 in

Standard Deviation 0.0025819

Sum of Squares 0.960668

APPENDIX E

Formulas

Appendix E provides the mathematical derivations of the volume formulas used in the CLPLOSS computer program. The cubic volumes are based on the two-end conic method of calculating volumes [28]. All the length and diameter measurements are shown in inches in Figure 39. Calculated volumes are in cubic feet. Derivations are contained on the subsequent pages.

Symbol		Definition
L_1	=	block length, inches
L_2	=	veneer length, inches
D_1	=	average block small-end diameter, inches
D_2	=	average block large-end diameter, inches
d_1	=	average core end diameter, inches
d_2	=	average core diameter at edge of veneer length, inches
d_3	=	core mid-length diameter, inches
d_4	=	average core diameter at edge of veneer length, inches
d_5	=	average core end diameter, inches

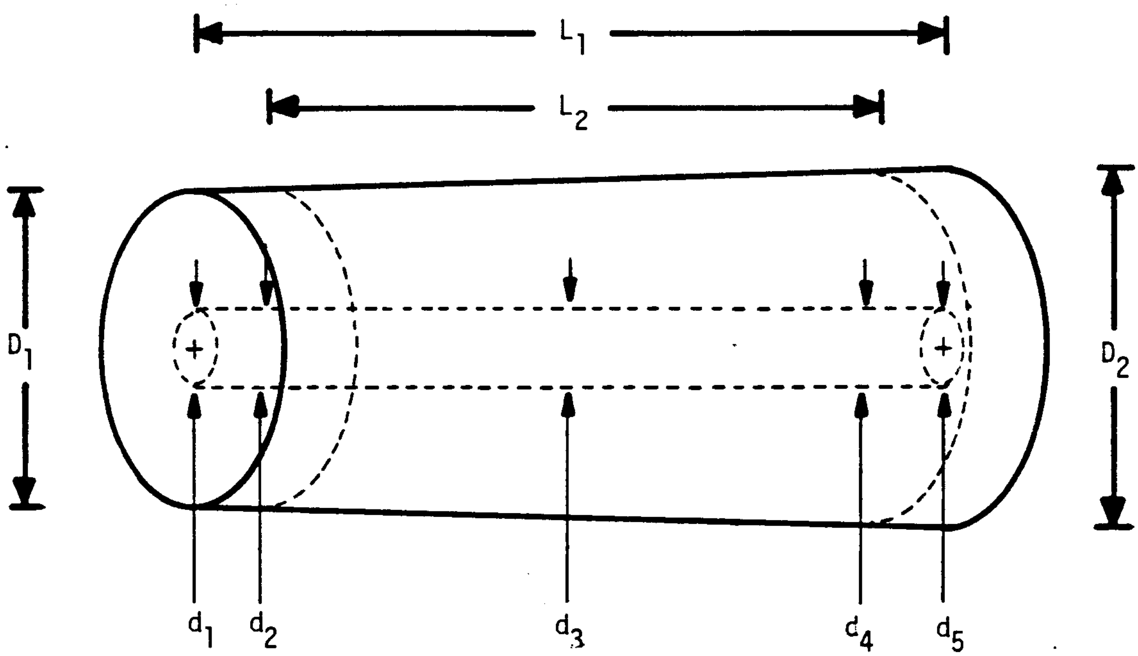


Figure 38. Diagram of block and core measurements required for various volume calculations.

Block Cubic Volume
$$\text{Block Volume} = \frac{\pi L_1}{144 \cdot 4 \cdot 3 \cdot 12} (D_1^2 + D_2^2 + D_1 D_2)$$ $$= \frac{\pi L_1}{20{,}736} (D_1^2 + D_2^2 + D_1 D_2)$$

Spur Volume

$$d_2 = d_1 + \left[\frac{d_3 - d_1}{L_1/2 \cdot 12}\right] \left[\frac{L_1 - L_2}{2 \cdot 12}\right]$$

$$= d_1 + \left[\frac{2(d_3 - d_1)}{(L_1/12)}\right] \left[\frac{L_1}{2 \cdot 12} - \frac{L_2}{2 \cdot 12}\right]$$

$$= d_1 + [(d_3 - d_1) - (L_2/L_1)(d_3 - d_1)]$$

$$= d_1 + [(d_3 - d_1)(1 - L_2/L_1)]$$

$$d_4 = d_5 + \left[\frac{d_3 - d_5}{L_1/2 \cdot 12}\right] \left[\frac{L_1 - L_2}{2 \cdot 12}\right]$$

$$= d_5 + [(d_3 - d_5)(1 - L_2/L_1)]$$

(continued)

Spur Volume, continued

$$\text{Spur Volume} = \frac{\pi D_1^2}{144 \cdot 4}\left(\frac{L_1 - L_2}{12}\right) - \frac{\pi}{144 \cdot 4 \cdot 3}\,(d_1^2 + d_2^2 + d_1 d_2)\left(\frac{L_1 - L_2}{2 \cdot 12}\right) - \frac{\pi}{144 \cdot 4 \cdot 3}\,(d_4^2 + d_5^2 + d_4 d_5)\left(\frac{L_1 - L_2}{2 \cdot 12}\right)$$

$$= \frac{\pi (L_1 - L_2)}{144 \cdot 4 \cdot 12}\left[D_1^2 - \left(\frac{d_1^2 + d_2^2 + d_1 d_2}{3 \cdot 2}\right) - \left(\frac{d_4^2 + d_5^2 + d_4 d_5}{3 \cdot 2}\right)\right]$$

$$= \frac{\pi (L_1 - L_2)}{6912}\left[D_1^2 \quad \left(\frac{d_1^2 + d_2^2 + d_4^2 + d_5^2 + d_1 d_2 + d_4 d_5}{6}\right)\right]$$

Core Volume

$$\text{Core Volume} = \frac{\pi}{144\cdot 4}\left(\frac{d_1^2 + d_3^2 + d_1 d_3}{3}\right)\left(\frac{L_1}{2\cdot 12}\right) + \frac{\pi}{144\cdot 4}\left(\frac{d_3^2 + d_5^2 + d_3 d_5}{3}\right)\left(\frac{L_1}{2\cdot 12}\right)$$

$$= \frac{\pi L_1}{144\cdot 4\cdot 3\cdot 2\cdot 12}\left[\left(d_1^2 + d_3^2 + d_1 d_3\right) + \left(d_3^2 + d_5^2 + d_3 d_5\right)\right]$$

$$= \frac{\pi L_1}{41{,}472}\left(d_1^2 + 2d_3^2 + d_5^2 + d_1 d_3 + d_3 d_5\right)$$

Theoretical Veneer Volume

$$\text{Theoretical Veneer Volume} = \frac{\pi D_1^2 L_2}{144\cdot4\cdot12} - \left[\frac{\pi}{144\cdot4}\left(\frac{d_2^2 + d_3^2 + d_2d_3}{3}\right)\left(\frac{L_2}{2\cdot12}\right)\right] - \left[\frac{\pi}{144\cdot4}\left(\frac{d_3^2 + d_4^2 + d_3d_4}{3}\right)\left(\frac{L_2}{2\cdot12}\right)\right]$$

$$= \frac{\pi L_2}{144\cdot4\cdot12}\left[D_1^2 - \left(\frac{d_2^2 + d_3^2 + d_2d_3}{3\cdot2}\right) - \left(\frac{d_3^2 + d_4^2 + d_3d_4}{3\cdot2}\right)\right]$$

$$= \frac{\pi L_2}{6912}\left[D_1^2 - \left(\frac{d_2^2 + 2d_3^2 + d_4^2 + d_2d_3 + d_3d_4}{6}\right)\right]$$