THE SHOLO MILL:

Make Pallet Parts and Pulp Chips from Low-Grade Hardwoods

by Hugh W. Reynolds
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THE SHORT LOG PROCESS

SHOLO (from SHOrt LOg) is a new solution to the old problem of profitably converting low-grade hardwood logs into products or product parts. It does away with the traditional and often uneconomical procedure of sawing low-grade logs into standard lumber and then converting this standard lumber into product parts. Instead, the SHOLO process is used to convert low-grade logs directly into product parts. In this report we describe the SHOLO process and give a specific example of one design of a SHOLO mill.

Although other applications of the SHOLO process are possible, it is designed for the production of pallet parts for standard warehouse pallets and the production of pulp chips from the material unsuited for pallet parts. The process appears to have a good profit potential where: (1) a plentiful supply of relatively low cost raw material is available; (2) a market exists for pallet parts and pulp chips; and (3) the number of sizes of pallet parts is limited to about eight or less.[1] The SHOLO process uses factory grade 3 or poorer quality logs. The production of both pallet parts and pulp chips means that most of the raw material is converted into salable products, and little waste remains.

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[1] Reynolds, Hugh W. and Charles J. Gatchell. THE SHOLO PROCESS: RETURN ON INVESTMENT VS. MILL DESIGN. USDA Forest Serv. Res. Paper NE-187. NE, Forest Exp. Sta., Upper Darby, Pa. (In preparation for publication).

Our research indicates that the SHOLO process can be profitable as an independent operation. But, perhaps more important, the SHOLO process should be a welcome addition to any paper company's or pulp-chip producer's operation. Also, the process might be applied by timber holders interested in reforestation of low-grade hardwood stands.

The SHOLO process is used to produce parts for the standard sized warehouse pallets (fig. 1). This pallet is made with three different sizes of parts. The stringers are 48 inches long and 2 by 4 inches in cross section. The deck boards are 40 inches long and either 1 by 4 or 1 by 6 inches in cross section.

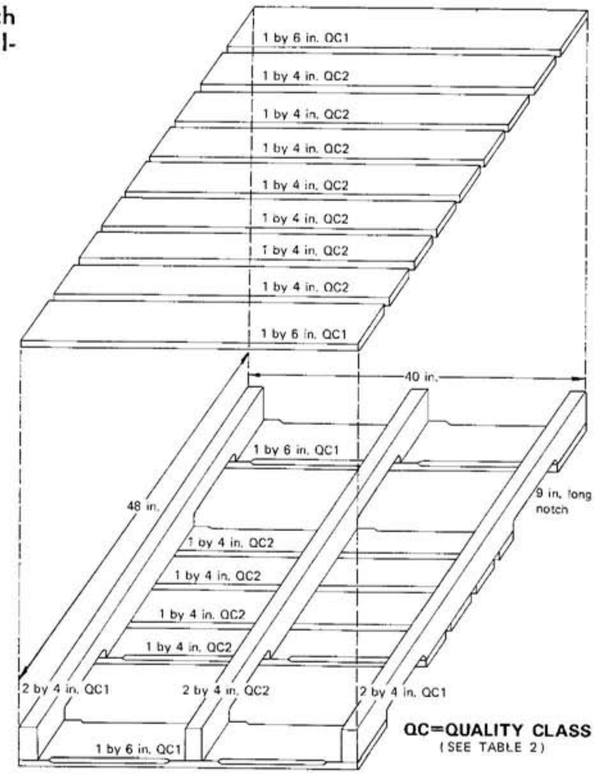
The concept behind the SHOLO process for the production of pallet parts is relatively simple. Selectively buck long, low-grade logs into SHOLO logs [2] of higher quality. Convert all round residue from the bucking operation to pulp chips. Live-saw the SHOLO logs to boards, selectively rip the boards to the proper widths, and end trim the boards to the required lengths. Convert all slabs and edgings to pulp chips. Sort the pallet parts into one of two quality classes. Package the parts on pallets and ship.

Our pilot-plant tests have shown that the actual production of pallet parts is also simple. It is simple because there are only four major decision points in the entire process, and the range of decisions is quite limited at each of these points. First, the SHOLO log maker decides whether a section of the long, low-grade log is good enough to become a SHOLO log. Second, the head sawyer decides which is the poorest face of the SHOLO log and always places the log on the saw carriage with this face towards him. Third, the ripsaw operator must decide whether a 4- or 6-inch wide cutting is to be made and whether additional cuttings are contained within each board. Fourth, the trimsaw operator must decide into which of two quality classes each pallet part falls.

To determine whether a section of long log is good enough, the SHOLO log specifications for pallet part production are fol-

[2]A SHOLO log is not "just" a short log. It is a short log of a minimum length and quality (see the specifications, table 1). The SHOLO mill can work with any low-grade log from 8 feet to tree length, as long as the minimum diameter of the small end is 8 inches.

Figure 1.—48- by 40-inch standard warehouse pallet.



lowed (table 1). The length of the SHOLO log is equal to the length of the pallet part plus end trim. For 48-inch-long parts, 52-inch SHOLO logs are bucked. For 40-inch-long parts, 44-inch SHOLO logs are bucked. For a balanced production of pallet parts, three 44-inch SHOLO logs are bucked for each 52-inch SHOLO log.

To maintain a reasonable production rate, the long log is not turned before bucking. The top face of the long log is examined for a rejection-type defect. If none is present, a SHOLO log is bucked. If there is a rejection-type defect on the top face, the front and back faces are inspected. Rejection-type defects in either of these faces means the SHOLO log cannot be bucked. Because the long log is not turned during the bucking operation, occasionally an unacceptable SHOLO log will be cut. These logs are treated as round residue and are converted into pulp chips.

Table 1.—*SHOLO log specifications for production of pallet parts*

Diameter	8 to 18 inches (small end), measured inside bark.
Length	44 inches, ± 2; or 52 inches, ± 2 inches.
Frequency	There shall be three 44-inch SHOLO logs made for each 52-inch SHOLO log.
Log faces	The top one-quarter of the log will be the top face, the bottom one-quarter will be the bottom face, and the other two faces will be the front and back faces.
Defects	A surface defect covering less than one-half the width of each face of the SHOLO log will be ignored provided that no indication of heart rot is found. A surface defect covering more than one-half of each face of the SHOLO log or a smaller defect that indicates heart rot will be considered as rejection-type defects. The SHOLO logs will be inspected for defects on the surface only.
Configuration	Rejection-type defects on adjacent faces will not be permitted. Rejection-type defects on opposite faces will be permitted. Only one such defect per face will be permitted. Both ends must be square to the log and flat. Taper exceeding one-fourth of the SHOLO log diameter (small end) will not be allowed.

The ripsaw operator must decide whether one or more cuttings are available within a board. The trimsaw operator must decide into which of two quality classes a pallet part falls. Both operators base their decisions on two pallet-part quality class specifications (table 2). While the trimsaw operator must base his decisions on a thorough knowledge of both classes, the ripsaw operator is concerned only with ripping out parts that meet or exceed the requirements of the lower grade of parts (quality class 2).

Separating the pallet parts into two quality classes is a new concept developed by Dr. Walter B. Wallin of the Forest Products Marketing Laboratory. During an extensive study of damage to pallets in industrial use, Dr. Wallin observed that the major damage occurred to the outside stringers and to the edge deckboards.

Table 2.—*Specifications for pallet parts from the SHOLO process*

	Quality class 1	Quality class 2
	High strength parts to be used in the impact areas of the pallet—the pallet sides and ends.	Normal strength parts to be used in the interior of the pallet.
Intergrown knot size	Not more than one-fourth the width of the part.	Not more than one-half the width of the part.
Number of knots	No more than one knot per 12 inches of length.	No more than one knot per 8 inches of length.
Knot location	No knots in nailing areas or edges of deck-boards. No knots in the 2-inch faces of the stringers.	Sound knots no more than one-fourth the width of the part allowed in the nailing area or on edges of the deckboards or in the 2-inch faces of the stringers.
Holes and unsound knot size	No more than one-eighth the width of the part.	No more than one-fourth the width of the part.
Wane	Not permitted.	Total wane no more than one-fourth the length, one-sixth the width, or one-half the thickness. Two-by-four stringers can have wane no more than one-fourth the thickness.
Decay	Not permitted.	Not permitted.
Splits	Not permitted.	No more than 2 inches long.
Shakes	Not permitted.	No more than 2 inches long.
Cross grain	1 inch in 12 inches minimum.	1 inch in 8 inches minimum.
Dimensions	*Nominal* — *Actual*	
Thickness	1 in. — 13/16, ± 1/32, planed two sides	Same as class 1
	2 in. — 1-5/8, ± 1/16, planed two sides	Same as class 1
Width	4 in. — 3-5/8, ± 1/16, ripped two sides	Same as class 1
	6 in. — 5-5/8, ± 1/16, ripped two sides	Same as class 1
Moisture content	Green as sawed.	Same as class 1
Species	NWPCA[1] class C, dense hardwoods: oak, beech, birch, hickory, and hard maple.	Same as class 1

[1] Anonymous. SPECIFICATIONS AND GRADES FOR HARDWOOD WAREHOUSE, PERMANENT, OR RETURNABLE PALLETS. National Wooden Pallet and Container Association, 1619 Massachusetts Avenue, NW., Washington, D. C. 1962.

By placing the best available material at these locations, a better and longer-lived pallet can be produced. The quality classes of table 2 resulted from his investigations.

All other production decisions are predetermined. For example, the 52-inch SHOLO logs are always live sawed into 2-inch-thick boards. These boards always are ripped to 4-inch-wide cuttings and trimmed to 48 inches in length. The 44-inch logs are always live sawed to 1-inch thick boards. These boards are ripped to either 4- or 6-inch width, and are always trimmed to 40 inches in length. Because of the simplicity of the SHOLO process—as compared to regular hardwood sawmilling—workers are easily trained. Skilled mechanics are required, but highly trained sawyers and lumber graders are not.

FACTORS AFFECTING SHOLO MILL DESIGN

The SHOLO mill concept is based on the use of factory grade 3 and lower quality logs. However, because of the variability within this grade, the specific design of the mill can vary and depends upon the nature of the logs used.

The quality of the raw material must be carefully determined. The most reliable and least expensive method for doing this is a pilot-plant test. Quality is measured in terms of the amount of SHOLO logs that can be bucked from a representative sample of long logs. This factor, termed the long-log potential, is determined on a weight basis. The long-log potential is obtained by dividing the total weight of SHOLO logs by the total weight of the representative sample of long logs.

How the long-log potential influences the SHOLO mill design can be understood by considering four samples of logs that we evaluated (table 3). Samples 1, 2, and 3 were all poor factory grade 3 or local-use logs. Sample 4, which averaged out to be factory grade 3, had a range of grades from factory grade 2 to local-use. About half of the factory grade 3 logs in sample 4 were below 11 inches in diameter. Had they been larger in diameter, they would have been factory grade 2 logs.

Table 3.—*Comparison of low-grade red oak log quality from two different locations*

Sample number	Log source	No. of logs	Log description	Long log potential[1] (percent)
1	Eastern Tenn. (reforestation project)	75	Random length (8 to 21 feet), poor factory grade 3 and local-use logs, 8 to 18 inches in diameter.	56
2	Eastern Tenn. (reforestation project)	121	Twenty-one feet long, lowest quality pulp logs, 8 to 18 inches in diameter.	58
3	Southern West Virginia strip-mine site	58	Random length (7 to 16 feet) top logs, poor factory grade 3 and local-use—much taper, 8 to 17 inches in diameter.	94
4	Southern West Virginia strip-mine site	28	Random length (7 to 16 feet). Average grade, factory grade 3; grade range, factory grade 2 to local-use. Eight to 14 inches in diameter.	87

[1]Long log potential = $\frac{\text{total SHOLO log weight}}{\text{total long log weight}} \times 100$

The differences between the designs of the SHOLO mill needed for samples 1 and 2 and for samples 3 and 4 are considerable. Only about half of the long logs (by weight) in samples 1 and 2 could be bucked into SHOLO logs. This means that the mill must be designed to include a whole-log chipper to convert the remainder of the long logs to pulp chips. This piece of equipment, with screens, costs about \$14,000 and requires a full-time operator. A log splitter saw, costing about \$8,000 is also necessary to convert the large diameter pieces of round residue into pieces small enough to fit into the whole-log chipper.

On the other hand, the SHOLO mill for samples 3 and 4, will not need a whole-log chipper or a log-splitter saw. In these samples, about 90 percent of the long logs (by weight) could be converted to SHOLO logs. The slabs, edgings, and end trimmings could be converted to chips by a wastewood chipper after the end-trim operation. A suitable wastewood chipper, including screens, costs about $8,500. The wastewood chipper does not require an operator and represents a savings in capital investment of around $13,500.

Another important difference between the requirements for the SHOLO mill results from differences in long-log potential. For samples 3 and 4, fewer logs (by about one-third) are required for the same output of pallet parts. This means a reduction in the output of pulp chips and thus, a lower level of activity in the mill yard. Less long-log storage capacity, less debarking capacity, and fewer bucking cuts are some of the operational benefits. Assuming the price of logs to be about the same for all samples, the SHOLO mill log costs for samples 3 and 4 will be less, because fewer logs are needed.

EXAMPLE OF A SHOLO MILL

In the following example, we describe a SHOLO mill design that we consider suitable for converting raw material, such as was found in samples 1 and 2 of table 3, into parts for standard warehouse pallets and pulp chips. This mill will require a daily input of around 200 tons (70 cords) of long logs. The daily product output is parts for about 570 standard warehouse pallets and about 110 tons of pulp chips. At about 28 board feet per pallet, the parts output is about 16,000 board feet per day. The mill yard will operate 5 days per week on a single shift. The parts plant will also operate 5 days a week, but on a double shift.

In this example, we assume that pallet parts will be shipped to a pallet assembly plant. There are cost advantages to shipping parts rather than assembled pallets.

In setting up any production process, there are few hard and fast rules. You may well decide that greater efficiency can be realized by one or more modifications to the process in this example. This is as it should be. Our attempt is to describe one realistic way to convert low-grade hardwood logs directly into pallet parts.

The Mill Yard

Log purchasing, storing, debarking, bucking, converting residue to pulp chips, and disposing of waste are performed in the mill yard. The flow chart for the mill yard is shown in figure 2. The index numbers on the flow chart and in the text correspond to the items listed in table 4.

Poor factory grade 3 and lower grade long logs are purchased by weight (1). A forklift truck (2) brings the long logs either to the storage yard (3), or to the infeed log deck (4a). Bark is removed with a ring debarker (5). A debarking capacity of about 14,000 lineal feet per day is required. Waste from the

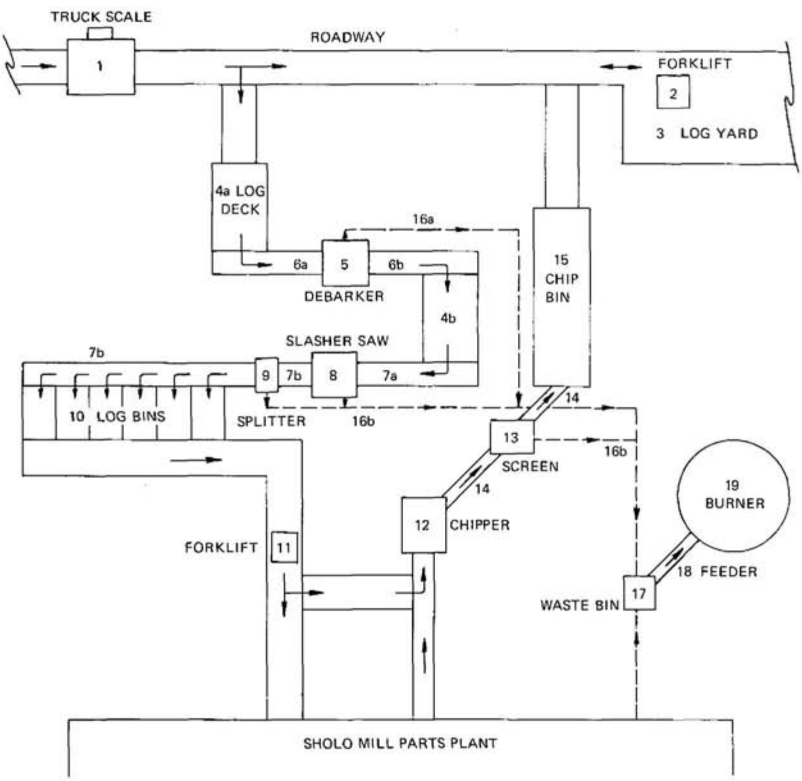


Figure 2.—Flow chart of SHOLO mill yard.

Table 4.—*Capital investment for SHOLO mill log yard*

Index No.	Description	Installed cost[1]
1	Truck scale/weight house	$ 20,000
2	Forklift truck for 21-foot-long logs	25,000
3	Log storage yard—road and fill	20,000
4a & 4b	Log deck—in and out @ $3,000	6,000
5	30-inch ring debarker and hog	25,000
6a & 6b	Debarker roll cases—in and out @ $2,000	4,000
7a & 7b	Slasher saw roll cases—in and out	4,000
8	Slasher saw, 54-inch	9,000
9	Retractable log splitter saw	8,000
10	SHOLO log bins	4,000
11	Forklift truck (4,000 pounds capacity)	6,500
12	48-inch chipper	10,000
13	Chipper screen	4,000
14	Chip bin conveyor	3,000
15	Chip bin	6,000
16a & 16b	Bark and sawdust conveyor to waste bin	5,000
17	Waste bin	3,500
18	Waste feeder, bin to burner	3,000
19	45-foot diameter waste burner, forced air control	18,000
	Total	$184,000

[1] 1969 costs determined by averaging up to three estimates for each item.

debarker is conveyed (16a) to a waste bin (17) for temporary storage before burning (19).

The debarked logs are fed to a 54-inch-diameter slasher saw (8) and bucked into 44- and 52-inch SHOLO logs and into random-length round residue. Our research has shown that an average of about five bucking cuts will be made on logs that average 20 feet in length and have a long-log potential of about 60 percent. The average time per cut is about 7 seconds. A slasher saw can easily make these cuts, and the decisions required for making the cuts according to SHOLO log specifications are simple.

All residue is ripped in half by a retractable log-splitter saw (9). This step is necessary to insure that all residue will fit easily into the throat of the 48-inch chipper(12).

The 44- and 52-inch SHOLO logs and random length residue are dumped into temporary storage bins (10). A forklift truck (11) from the SHOLO mill parts plant carries the half-round residue to the chipper (12) when not transporting SHOLO logs into the plant. The pulp chips are screened (13) and conveyed (14) to the chip bin (15) for storage. Gravity loading of open-top chip trucks is used.

The SHOLO Parts Plant

The SHOLO logs are processed into finished, ready-to-use pallet parts, which are sorted for quality and packaged for shipping, in the SHOLO parts plant. The flow chart for the parts plant is shown in figure 3. The index numbers on the flow chart and in the text correspond to the items listed in table 5.

A forklift truck carries the SHOLO logs to the live deck of the 50-inch circular saw headrig (1). For production efficiency, the SHOLO logs are grouped according to length. The headrig operator live-saws a number of 52-inch-long SHOLO logs into 2-inch-thick boards and then saws a group of 44inch long logs into 1-inch-thick boards. As the boards come from the headrig, the operator sends them to conveyor (2) for the ripsaws. Slabs and dogboards are conveyed (3) back to the mill yard for conversion into pulp chips.

Ripping boards to widths for pallet parts is the most significant operation in the parts plant. This operation is performed on pairs of ripsaws. Each pair of ripsaws is in tandem and is controlled, with the aid of a memory device, by a single operator.

Just before arrival at the ripsaws, the boards are separated onto the board decks (4) though a gate controlled by the operator of the nearest pair of ripsaws (5a and 5b). After the operator makes his decision on the number and width of pallet part cuttings, he feeds the board to the first saw and sets the memory control for the second ripsaw. Coming out of the first saw, the edging to the left of the saw blade is dumped and conveyed (3) to the chipper. The board proceeds to the second ripsaw (5b).

If the memory control has been set for only one cutting, the board is ripped and all material to the right of the second saw

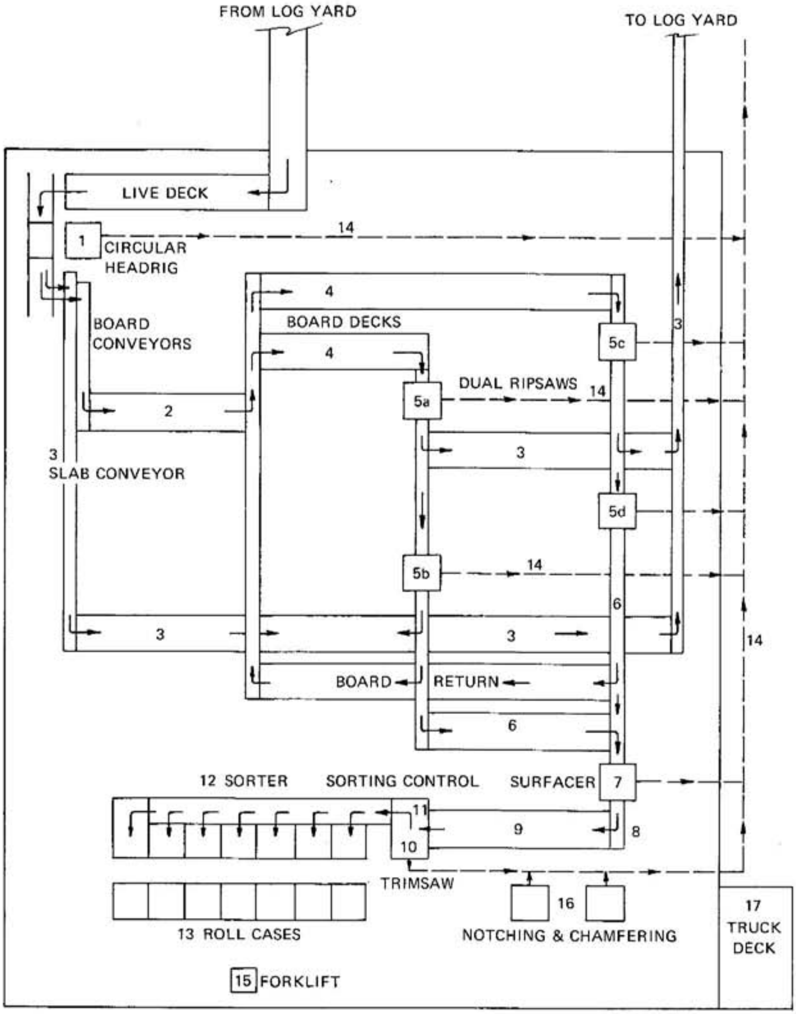


Figure 3.—Flow chart of SHOLO mill parts-plant.

blade is dumped and conveyed to the chipper. The pallet part is then conveyed (6) to the double surfacer (7). However, if another cutting is in the board, the memory control allows the cutting (pallet part) to the left of the saw blade in the second saw to be conveyed to the surfacer, but dumps the remainder of the board back onto the headrig-to-ripsaw conveyor system. The second pair of tandem ripsaws (5c and 5d) works in the same manner. Cuttings from the ripsaws are conveyed (6) to the double surfacer (7) where they are planed to thickness.

After planing, the boards are conveyed (8) to the trimsaw live deck (9) and then moved to the trimsaw (10). The trimsaws are set for lengths of either 40 inches (for 1-inch-thick stock) or 48 inches (for 2-inch-thick stock). The trimmer operator uses memory controls (11) to sort the pallet parts into one of two quality

Table 5.—Capital investment for SHOLO mill parts plant and total cost for mill and yard

Index No.	Description	Installed cost[1]
1	50-inch circular headrig w/live deck	$ 28,000
2	Conveyor—headrig to ripsaws	2,000
3	Conveyors—slabs and edging to chipper	7,500
4	Ripsaw board live deck (2 required @ $3,000)	6,000
5	Dual ripsaws with controls and returns required (2 pair)	40,000
6	Conveyors—ripsaws to surfacer	2,000
7	Double surfacer	25,000
8	Conveyor—surfacer to trimmer live deck	1,000
9	Trimsaw live deck	3,000
10	Dual trimsaw	5,000
11	Sorting control to slot sorter	2,000
12	7-place slot sorter with bins	5,000
13	Dead roll cases	3,000
14	Sawdust and planer shavings conveyor to waste bin	7,500
15	Forklift truck (4,000 pounds capacity)	6,500
16	Notching and chamfering machines	15,000
17	Truck loading dock	15,000
18	Building 150 × 60 @ $10/sq. ft. (9,000 sq. ft.)	90,000
	Total	$263,500
	Total for mill log yard	$184,000
	Total for mill parts plant	263,500
	Millwright tools—saw and knife grinders	10,000
	Subtotal	$457,500
	Contingency—20 percent of above	92,500
	Total	$550,000

[1]1969 costs determined by averaging up to three estimates per item.

classes and to separate pieces that may be below the quality class 2 specifications. The sorter (12) includes seven bins for temporary storage. Six of these bins are for the two quality classes and three sizes of parts. The seventh bin is for reject pieces. Rejects are transported by forklift to the conveyors (3) that carry slabs and edgings to the chipper. As bins fill up, they can be temporarily stored on dead rolls (13).

Finishing steps include notching (16) of all 2- by 4- by 48-inch stringers and chamfering (16) of some 1- by 4- by 40- or 1- by 6- by 40-inch deckboards. The number of boards to be chamfered will depend on the style of pallet to be made. All parts are color end coated according to quality class, piled on pallets, and strapped for shipment.

Manpower Requirements

The manpower required to operate the SHOLO mill is listed in table 6. The mill yard is run on a single shift and the parts plant is run on a double shift. A foreman is required on each shift. A millwright/maintenance man and a cleanup man can service all of the equipment and keep both the mill yard and the parts plant clean on a single shift basis.

In addition, six men are needed to operate the mill yard. A log buyer, purchasing on a weight basis, and a log forklift operator are needed to handle the long-log purchasing. A log debarker operator, a bucking operator for the slasher saw and log splitter, and an operator for the whole-log chipper are required to convert the long logs to SHOLO logs and the round residue to pulp chips. The sixth man is a forklift operator who transports SHOLO logs to the headrig and round residue to the whole-log chipper.

The parts plant is operated with seven men on the first shift and six men on the second shift. The extra man on the first shift is a notcher/chamfer operator who can process all necessary parts from both shifts. Two ripsaw operators are required to keep up with the output of the headrig operator. A trimsaw/sorter operator and two parts stacker/truck loaders complete the crew. Each of these last two men must be able to operate a forklift truck as part of the truck loading operation. They will end-coat the pallet

Table 6.—Manpower requirements

Location	Job description	Number of men	
		First shift	Second Shift
General	Foreman	1	1
	Millwright/ maintenance	1	0
	Cleanup	1	0
	Subtotal	3	1
Mill yard	Scaler/log buyer	1	0
	Long log forklift operator	1	0
	Debarker operator	1	0
	Bucking operator	1	0
	Whole log chipper operator	1	0
	SHOLO log/round residue forklift driver	1	0
	Subtotal	6	0
Parts plant	Headrig sawyer	1	1
	Ripsaw operator	2	2
	Trimsaw/sorter operator	1	1
	Parts stacker/truck loader	2	2
	Notcher/chamfer operator	1	0
	Subtotal	7	6
	Total	16	7

part according to quality, bring parts to the notching and chamfering operation, and load and strap the parts on pallets for shipment.

We recognize that modifications in the design of the SHOLO mill, local union requirements, or other factors can easily change the number of men needed. We believe, however, that we have presented a reasonable minimum for a mill of the particular design we have described.

SHOLO Mill Costs

The expected capital investment for the entire SHOLO mill is itemized in tables 4 and 5 and totalled at the bottom of table 5. All costs are based on prices available in late 1969. Costs were determined by averaging up to three estimates per item. The total cost of the mill yard, the parts plant, and all of the equipment is about $458,000. Since all values given are estimates, a 20 percent contingency fund of $92,500 is listed. This fund could be used to cover a slight rise in the prices quoted and to provide a margin for unforeseen increases in construction costs. The total cost of the SHOLO mill described is about $550,000.

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