Shaping-Lathe Headrig Yields Solid and Molded-Flake Hardwood Products

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Abstract

A shaping-lathe headrig, operated one shift daily, can be used to manufacture hardwood cants to be resawed into pallet shook, one-piece and dowel-laminated crossties, posts and rails, and other solid wood products in lengths from 6 to 9 feet. Residual flakes machined by the headrig supply a three-shift operation in which molded pallets and 4- by 8-foot sheets of structural exterior flakeboard are manufactured. The proposed plant will process about 68 cords (5,100 ft.^{3}) of mixed-species hardwood daily. On net annual sales of $2,947,536, profit before income taxes is estimated at $872,410 or 30.3 percent of the required $2,880,000 investment (100% equity) required for plant construction, startup, and operating capital. The complex is to employ 49 people in plant and office; supporting woods operations would provide additional jobs. The technology of molding pallets from flakes is developing rapidly; but as yet, no data on product performance in service are available.

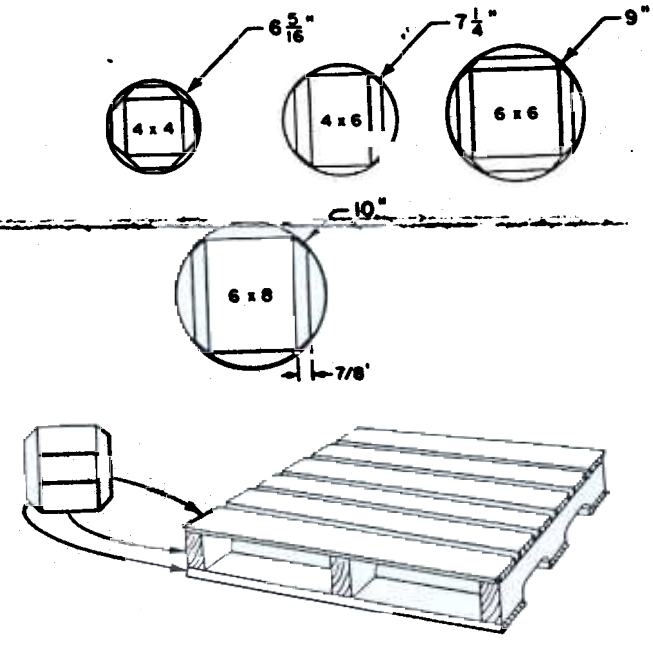

Figure 1. — A selection of cutting patterns yielding lumber for pallets.

IN THE SOUTHERN AND EASTERN regions of the United States hardwoods of lower than sawtimber grade are in excess supply; i.e., growth exceeds consumption. This paper explains a concept whereby tree-length mixed hardwoods of small diameter—yielding 6- to 9-foot-long bolts 6 to 13 inches in diameter inside bark (DIB) at the small end—can supply a plant manufacturing solid-wood products plus pallets and structural panels hot-pressed from residual flakes.

Concept

A shaping-lathe headrig (4) will be utilized to convert hardwood bolts to cants for a range of solid wood products such as nailed wood pallets (Fig. 1) and dowel-laminated crossties (3). Residues from the headrig are flakes which will be combined with urea resin to yield molded pallets (Fig. 2).

The technology of molding and pressing products from flake-resin mixtures has been the subject of intensive study in numerous laboratories for years (1, 2, 6, 7, 8, 9, 12). Many wood technologists are convinced that a molded-flake pallet can be useful and competitive in the materials handling industry. As yet, no data are published on service performance of pallets molded from flakes. This paper, however, is written on the assumption that molded-flake pallets will be successful. In one design, such pallets are pressed with dimpled decks (visualize a muffin tin with nine recesses) to form integral feet in such a configuration that the pallets nest for shipping. Pallet decks in this design will probably be about 5/8 inch thick with feet 1-1/2 to 3-1/2 inches high.

The flakes also can be blended with a phenolic resin to yield 1/2-inch-thick exterior structural flakeboard

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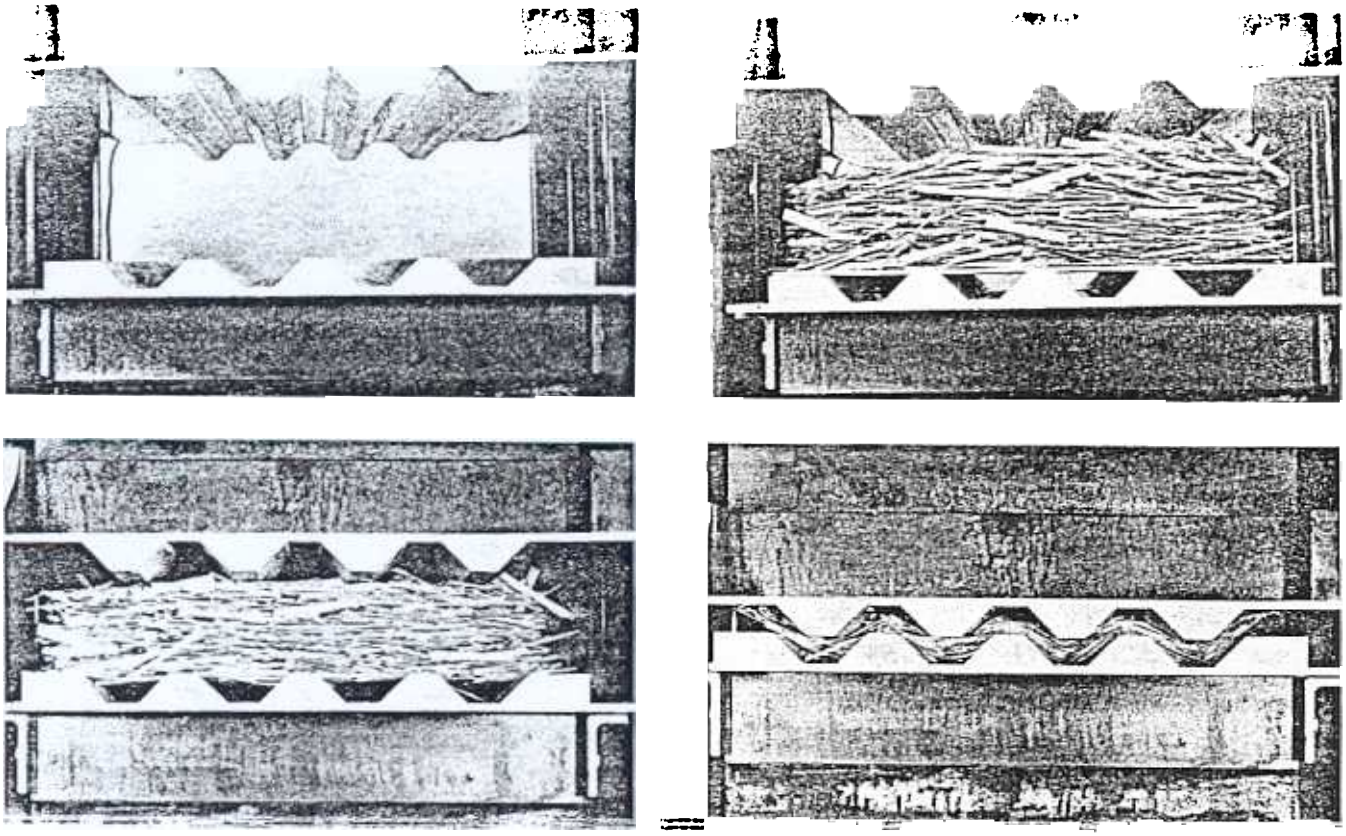

Figure 2. — Molded flakeboard fabrication process. (Top left) Mold attached to press. (Top right) Formed mat resting on caul. (Bottom left) Mat resting on mold. (Bottom right) Mold almost to stops. (11)

panels intended to compete in price and function with sheathing grades of softwood plywood. The sheathing panels will be formed from a single-layer mat, have random flake orientation, and use flakes 3 inches long and about 0.020-inch thick cut from a controlled mix of species. Board density will be about 50 pounds per cubic foot on emergence from the hot press at 3 percent moisture content (MC). Based on data from Price and Lehmann (11), such panels should have about the following properties:

Modulus of elasticity	700,000 psi
Modulus of rupture	5,500 psi
Internal bond strength	80 psi
Linear expansion (30% to 90% RH)	0.20%
Drop height to failure under 30-pound impact test over 24-inch span; load applied 6 inches from an unsupported edge	
1/2-inch thickness	51 in.
5/8-inch thickness	58 in.

Machine Selection

A shaping-lathe headrig (Fig. 3) with capacity to machine mixed-species logs from 6 feet to 9 feet long, and 5 inches to 15 inches in diameter, can turn out a variety of rough green or air-dry products for a range of markets, as follows:

Industrial market

Cants to be resawed into pallet shook
Cants to be resawed into container shook
Light timbers to 9 feet in length
Industrial blocking of odd cross section; e.g., round, hexagonal, or octagonal
Hexagonal cants to be crosscut into industrial block flooring

Railroad and highway market

One-piece crossties to 9 feet in length
Dowel-laminated crossties to 9 feet in length
Highway posts (round or square) in lengths from 4-1/2 to 9 feet

Consumer market (via retail lumber yards)

Fence posts (4-1/2 to 9 ft. long)
Fence rails (6 to 9 ft. long)
Cants for resawing into 8-foot studs or 4 by 4's
Cabin logs
Architectural crossties for use in landscaping

Furniture market

Cants in 6- to 9-foot lengths for conversion to furniture dimension stock
Rounded-up veneer bolts, or cants for slicing
Crosstie side lumber

Four single-opening, 600-psi presses, each measuring 4-1/2 by 8-1/2 feet and equipped with mat-forming and resin-blending equipment that can use urea or phenolic resins can produce molded-flake pallets for the industrial market or 4- by 8-foot exterior structural flakeboard sheathing for the housing market. Four

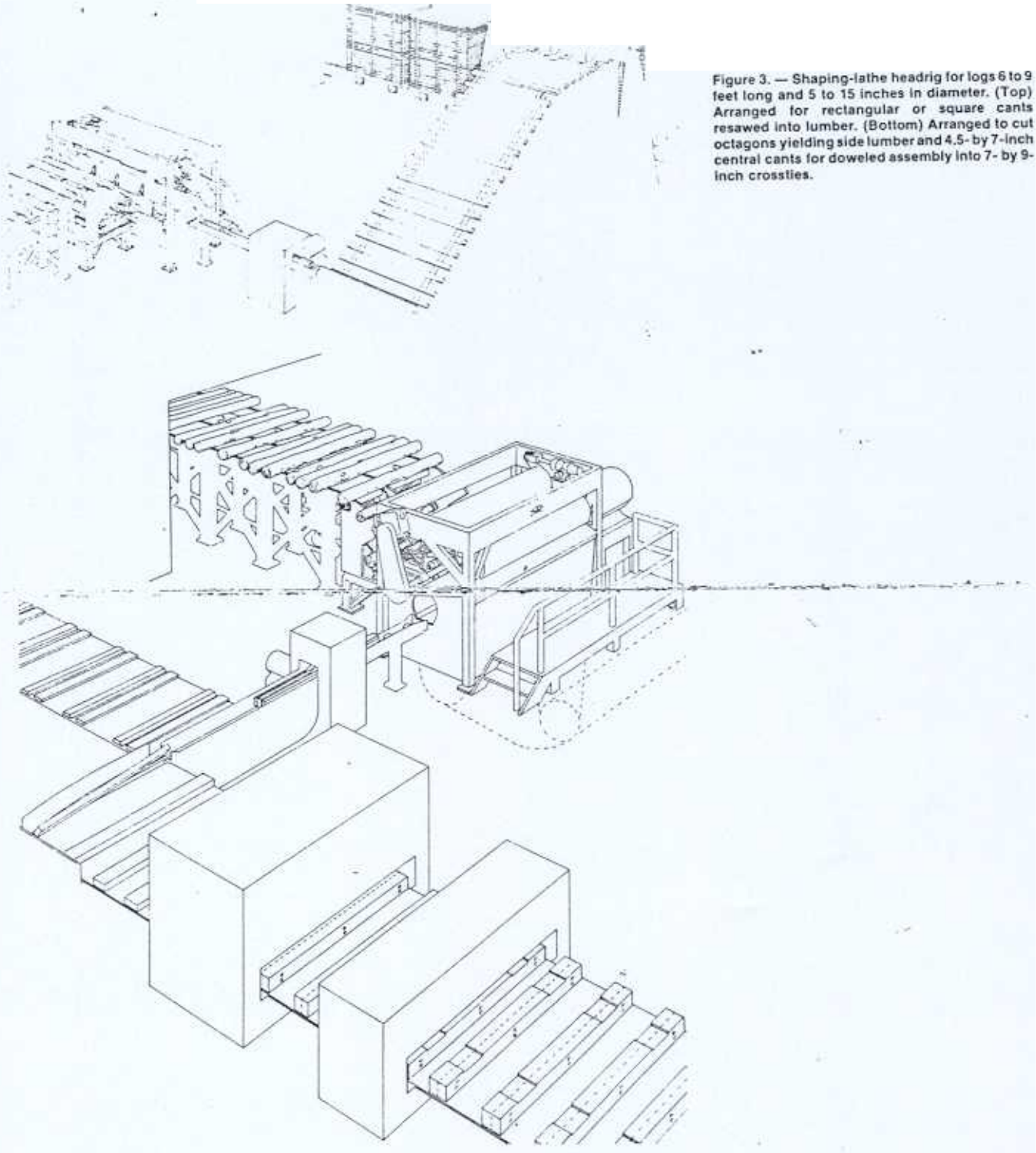

Figure 3. — Shaping-lathe headrig for logs 6 to 9 feet long and 5 to 15 inches in diameter. (Top) Arranged for rectangular or square cants resawed into lumber. (Bottom) Arranged to cut octagons yielding side lumber and 4.5- by 7-inch central cants for doweled assembly into 7- by 9-inch crossties.

single-opening presses are proposed, rather than one 4-opening press, to give floor-level access to manipulate pallet molds, to accommodate thick mats and molds, and to permit sequential closing on the assembled mats.

In this operation, raw material balance between headrig and press is crucial. The headrig should supply flakes in an amount adequate for the pressing operation, and the pressing operation should use all the flakes produced by the headrig.

The material balance between the headrig and the presses is complicated by their differing modes of operation. The headrig need operate only 8 hours to supply the pressing operation for 24 hours. Therefore, substantial storage capacity is needed between headrig

and pressing plant. Green-flake storage facilities must be comprised of two chambers or silos so that a constant blend of 40 percent soft hardwoods (e.g., sweetgum, yellow-poplar, or red maple) and 60 percent dense hardwoods (e.g., oaks and hickory) can be maintained in the furnish going to the hot presses.

Additionally, a mechanism must be provided for disposition of flakes manufactured in excess of the pressing plant's requirements; conversely, an alternative flake source is required in the event of an unscheduled shutdown of the headrig.

Flake Requirements

A logical starting place for plant design is determination of flake tonnage required by the pressing operation each 24 hours. This requirement will differ according to product. Molded-pallet manufacture with the short cycles typical of furnishes using urea resins (5-min. cycle sustained for 22.5 hr.) will use more flakes than sheathing manufacture, which calls for phenolic resins and cycle times of about 7 minutes.

Molded Pallets

The four single-opening presses will produce eight 42- by 48-inch pallets (trimmed dimension) at each closing. On a 5-minute cycle, production per 24 hours (22.5 effective) will be 2,160 pallets

$$\left(\text{i.e.,}\frac{22.5\times60}{5}\times8\right).$$

If pallets, before trimming to final size, measure 44 by 50 inches by 5/8-inch thick, and are pressed to a density of 50 pounds per cubic foot at 7 percent MC, each untrimmed pallet will weigh 39.8 pounds

$$\left(\text{i.e.,}\frac{44\times50}{144}\times\frac{.625}{12}\times50\right).$$

Ovendry (OD) weight of each untrimmed pallet will therefore be 37.2 pounds (i.e., 39.8/1.07).

If furnish (flakes plus resin) is supplied at 11 percent MC, then furnish for each untrimmed pallet will weigh 41.3 pounds (i.e., 37.2×1.11).

The components that yield 100 pounds of furnish at about 11 percent MC are about as follows:

86 pounds of flakes at 5 percent MC	
14 pounds of urea resin at 50 percent MC	
100 pounds	

This mix contains 81.9 pounds of OD flakes and 7.0 pounds of dry resin. Therefore, on an OD weight basis, resin solids amounting to 7.9 percent of furnish weight are required

$$\left(\text{i.e.,}\frac{7.0}{81.9+7.0}\times100\right);$$

flakes make up 92.1 percent of the dry furnish.

OD flakes needed per 24 hours will be:

37.2 pounds per pallet×2,160 pallets ×.921/2000 = 37.00 tons

Resin solids consumption per 24 hours will be:

37.2×2,160×.079/2000 = 3.17 tons

Total furnish per 24 hours (OD) 40.17 tons

Exterior Structural Flakeboard Sheathing

The four single-opening presses also will produce four 4- by 8-foot panels at each closing. On a 7-minute cycle (5 min. press time, 1 min. closing, 10-sec. charging, 50-sec. forming), production per 24 hours (22.5 effective) will therefore be 771 panels

$$\left(\text{i.e.,}\frac{22.5\times60}{7}\times4\right).$$

If panels, before being trimmed to final size, measure 52 by 100 inches by 1/2-inch thick, and are pressed to 50 pounds per cubic foot at 3 percent MC, then each untrimmed panel will weigh 75.2 pounds

$$\left(\text{i.e.,}\frac{52\times100}{144}\times\frac{.5}{12}\times50\right).$$

The OD weight of each untrimmed panel will be 73.0 pounds

$$\left(\text{i.e.,}\frac{75.2}{1.03}\right).$$

Supplying furnish (flakes plus resin) at 9 percent MC gives each untrimmed panel a weight of 79.6 pounds (i.e., 73.0×1.09). Components necessary for 100 pounds of furnish at 9 percent MC are:

Dry components (100/1.09)=	91.7 pounds
Wood flakes, dry=	86.5 pounds
Resin solids, dry=.06×86.5=	5.2
	91.7 pounds
Water (flakes at 2% MC; resin at 42% solids)	
Water in flakes=.02×86.5=1.7	1.7
Water in resin=5.2×58/42=7.2	7.2
	8.9 pounds
	100±

On an OD basis, resin solids amount to 5.7 percent of furnish weight

$$\left(\text{i.e.,}\frac{5.2}{86.5+5.2}\times100\right);$$

flakes make up 94.3 percent.

Flake consumption (OD) per 24 hours of panel manufacture will be:

73.0 pounds per panel × 771 panels × .943/2000 = 26.54 tons

Resin solids consumption per 24 hours will be:

73.0 × 771 × .057/2000 = 1.60 tons

28.14 tons

Thus, each 24 hours usable flakes (OD) ranging from 26.5 tons for 1/2-inch sheathing to 37.0 tons for 5/8-inch-thick pallets must be supplied by the shaping-lathe headrig and from cull wood entering the log deck. Assuming that 10 percent of the gross tonnage of flakes delivered to the pressing plant is screened out as fines and diverted to the fuel pile, gross 24-hour tonnage required will be 29.4 to 41.1 tons of unscreened flakes. At the outset, it is assumed that 10 percent of the bark-free wood reaching the log deck is unsuitable for the headrig because of small size, excessive crook, or rot. Thus, about 9.1 tons daily of bark-free wood will bypass the headrig and proceed directly to a small flaker supplying the pressing plant (Figs. 4 and 5). If the headrig is inoperative on a scheduled shift, this roundwood flaker could temporarily supply sufficient flakes to operate the pressing plant.

Materials Balance

From 20.3 (i.e., 29.4–9.1) to 32 (41.1–9.1) OD tons of flakes are due from the headrig daily. Because the

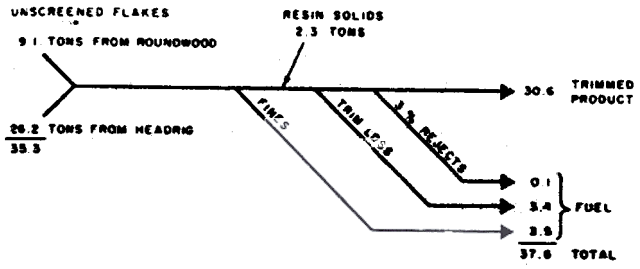

Figure 4. — Average daily (24-hr.) material balance in the pressing plant. All weights are on an OD basis. Tonnages will be greater when molding pallets with urea resin, and less with phenolic resin.

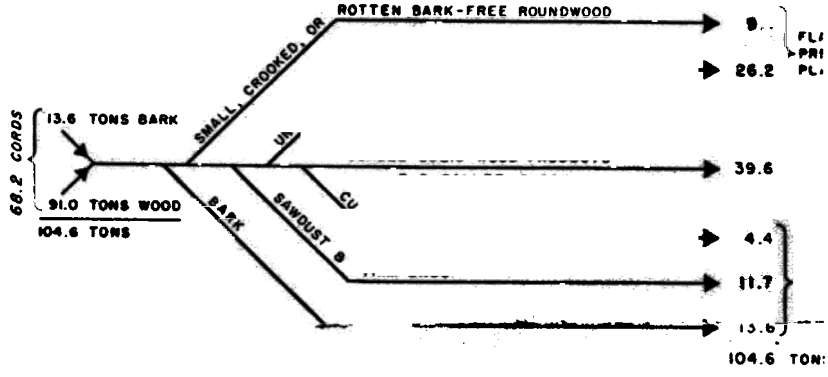

Figure 5. — Sawmill material balance, daily per single 8-hour shift. All weights are on an OD basis.

number of bolts run through the headrig each day is fairly constant at 1,440 pieces (i.e., 4 bolts per min. × 360 min.), the range in flake output must be accomplished by varying the flake to solid wood ratio of the headrig output.

If the average cant produced on the headrig has an untrimmed length of 92 inches and its cross section is octagonal so that it contains a 4- by 6-inch rectangular central cant with two 1-inch beveled-edge sideboards (Fig. 6), then it will contain about 1.81 cubic feet

$$\left(\text{i.e.,}\frac{4\times6+2\times5}{144}\times\frac{92}{12}\right).$$

With average specific gravity (SG) of 0.57 (green volume and OD weight), such a cant has an OD weight of 35.6 pounds per cubic foot or 64.4 pounds (OD).

A cant of these dimensions can be cut from a cylinder 7.2 inches in diameter or from a normally tapered bolt having a midpoint diameter close to 8 inches. A 92-inch bolt with midpoint diameter of 8 inches contains 2.68 cubic feet

$$\left(\text{i.e.,}\frac{4^2\pi}{144}\times\frac{92}{12}\right).$$

Such a bolt would, if cut to the pattern of Figure 6, yield 0.48 pound of dry flakes for each pound of dry cant, or 30.9 pounds of flakes.

A 6- by 6-inch cant squared from a 92-inch log with midpoint diameter of 9.5 inches would yield 65.9 pounds of dry flakes.

To supply 20.3 to 32.0 tons of unscreened dry flakes from 1,440 bolts daily requires an average flake yield per bolt of 28.2 to 44.4 pounds (OD). Thus, the average log

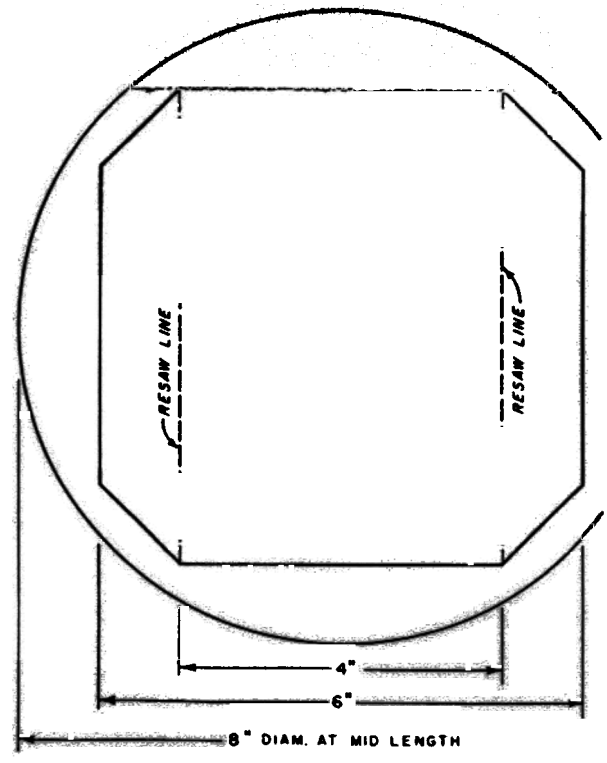

Figure 6. — Octagonal cant machined from a bolt measurin 8 inches in diameter inside bark at midlength.

processed must be from 8 to 9.5 inches in diameter; cants should have average cross sections of 32 to 36 square inches, and untrimmed lengths of about 92 inches. Because some cants will have wany edges, edging equipment must be used after cant ripsaws to yield wane-free pallet shook.

Lumber yield per day on one 8-hour shift should range from 28,800 board feet

$$\left(\frac{4\times6+2\times4}{12}\times\frac{92-2}{12}\times1440\right)$$

to 32,400 board feet

$$\left(\frac{6\times6}{12}\times\frac{92-2}{12}\times1440\right).$$

Assuming an average midpoint bolt diameter of 8.75 inches inside bark, and an untrimmed length of 92 inches, average inside-bark volume of each bolt will be about 3.20 cubic feet; 1,440 of such bolts will contain about 4,608 cubic feet, or 61.4 cords at 75 cubic feet of bark-free wood per cord.

Because about 10 percent of wood received on the merchandising deck will be routed directly to a flaker and bypass the headrig (because of excessive crook, rot, or small diameter), total wood crossing the merchandising deck should total about 68.2 cords, i.e., 61.4/0.9 (Fig. 5).

Sawdust and hog fuel produced in bucking the bolts and in processing 1,440 cants per day through ripsaws, edgers, and end trim saws, will amount to about 11.7 tons (OD).

Bark yield from 68.2 cords of mixed species (containing 5,115 ft.^{3} of bark-free wood having an OD weight of 91.0 tons) will amount to about 13.6 tons (OD) per day (Fig. 5).

Cull pallet shook, crossties, posts, and other solid-wood products will total about 10 percent of total solid product volume (5). Thus, of the 44.0 tons (dry) of solid-wood products, 4.4 tons will end as fuel (Fig. 5).

Economic Analysis

The total operation has three centers: the log deck and sawmill, the pressing plant, and the nailed-pallet fabrication plant. In this discussion, these three operations are combined to simplify analysis.

The plant will run 5 days per week 48 weeks of the year; that is, 10 days will be for paid holidays and another 10 days for annual vacations, during which time the plant will be shut down for maintenance. The yard, log deck, sawmill, and nailed-pallet plant will operate one 8-hour shift 5 days per week; the pressing plant will operate 24 hours 5 days per week.

Sales

Net sales prices (after all discounts and commissions) of the plant's products are estimated to range from $106 to $205 per ton of OD commodity (Table 1). Tonnage output of the pressing plant is assumed equally divided between molded pallets made with urea resins and 1/2-inch structural flakeboard made with phenolic resins. Fifty percent of the solid-wood output from the sawmill will go to the nailed pallet plant as usable, square-edged, cut-to-length shook; the remaining 50 percent of the solid wood will be sold as rough green untreated crossties, posts, rails, and light timbers.

TABLE 1. — *Net f.o.b.-mill sales price, after discounts and, for proposed products, and unit weight.*

Product	Sales price per OD ton ($)	OD weight of one unit (lb.)	Net sales price per unit ($)
Molded pallet 42 by 48 in.	205	34.1[1]	3.50
1,000 ft.^{2} of 1/2-inch exterior structural flakeboard	200	2,000[1]	200.00
Nailed pallet containing 25 fbm of lumber	193	64.9[2]	6.25
A 7- by 9-in., 8-1/2-ft. rough green crosstie	106	132.4[2]	7.00
A 5-in.-diameter, 6-ft.-long post	106	29.1[3]	1.55

[1]Assumes a product density of 50 pounds per cubic foot at the MC at which sold (3 to 7%).
[2]Assumes an OD weight of 35.6 pounds per cubic foot of green product. This is based on a species mix with average SG of 0.57 as follows: 20 percent each of true hickory, white oak, southern red oak, red maple, and sweet gum at specific gravities (OD weight and volume when green) of .62, .67, .61, .49, and .45.

TABLE 2. — *Net annual sales.*

Product	Daily output (net after rejects) (tons, OD)	Annual output (48 wk.) (tons, OD)	F.o.b. mill net sales per OD ton ($)	Annual sales ($)
Solid wood products other than pallet shook	19.8	4,752	106	503,712
Nailed pallets	19.2[1]	4,608	193	889,344
Molded pallets	15.3[2]	3,672	205	752,760
1/2-inch exterior structural flakeboard in 4- by 8-foot sheets	15.3[2]	3,672	200	734,400
Fuel sold[3] to outside users	18.7	4,488	15	67,320
	Total net annual sales f.o.b. mill after all discounts and commissions			2,947,536

[1]Assumes 3 percent of pallets are rejects in the nailing plant.
[2]Assumes 3 percent of pallets and sheathing panels from the molding plant are rejects and end as fuel.
[3]Half of fuel generated is used internally, and half sold to outside users. Total fuel is 29.7 tons from the sawmill, 0.6 from the nailed-pallet plant, and 7.0 from the molding plant.

Net annual sales should total $2,947,536 (Table 2). Three percent of the nailed pallets, molded pallets, and flakeboard panels are assumed to be rejects that are converted to fuel.

Raw Material Cost

Of a total raw material cost of $746,126, cordwood amounts to $433,797 or 58 percent; resin costs of $227,520 are 30 percent. Nails for solid-wood pallets, steel dowels for dowel-laminated crossties (3), and fungicide account for the remaining 12 percent (Table 3).

LE 3. — *Annu*

Mat	Daily quantity (tons, OD)	Annual quantity (tons, OD)	Cost per ton, OD ($)	Annual cost ($)
arky mixed-species cordwood in long lengths	104.6	25,104		
Urea resin	1.35	324	280.00	90,720
Phenolic resin	.95	228	600.00	136,800
Nails @ $.30/pallet	(146,395 pallets of 25 fbm each)			43,918
Steel dowels @ $1/assembled crosstie	(Assumes half of solid-wood product other than pallet shook goes into doweled ties)			35,891
Fungicide	(for selected solid-wood products)			5,000
				746,126

[1]Equivalent to about $26.50 per cord of mixed-species hardwoods, or to about $10 per green ton.

Capital and Personnel Required

Capital required is as follows:

Facilities (Table 4)	$2,180,000
Startup contingency fund	200,000
Working capital	500,000
Total	$2,880,000

The complex would employ 49 people and have a payroll, including fringe benefits, of $900,000 (Table 5).

Other Expenses

In addition to raw materials and manpower, other expense items include:

Item		Annual cost (dollars)
Depreciation of investment (land excluded) over 10 years on a straight-line basis, i.e., $2,100,000/10		$210,000
Other		
Supplies and maintenance (includes molds for pallet pressing operation)	$110,000	
Operation of three automobiles	10,000	
Other travel expense	6,000	
Telephone, taxes, insurance, and other overhead	74,000	
Power and other utilities	50,000	
		250,000
	Annual total	$460,000

Projected Annual Operating Statement

On annual sales of $2,947,536 profit before income taxes is projected at $872,410 or 29.6 percent. Profit, as a proportion of invested capital, is projected to be 30.3 percent (Table 6).

Discussion

Some of the assumptions underlying this analysis may be open to question. An effort to anticipate and answer the questions seems useful.

TABLE 4. — *Capital requirement for facilit*

Item		
YARD, LOG DECK, AND SAWMILL		
40 acres of land on railroad siding	40,000	
Yard improvement	10,000	
Weight scale for tree-length logs	20,000	
Yard forklift	50,000	
Log deck and debarker	75,000	
Bucking station and multi-pocket log sorter for length, diameter, and species class	75,000	
Drum flaker for unacceptable wood of small diameter or with excessive rot or crook	25,000	
Fuel bin for outside sales with conveyors to it	30,000	
Fork to bring bolts to sawmill and to remove solid-wood products	15,000	
9-foot shaping lathe with infeed and outfeed decks	150,000	
Flake conveyor to pressing plant	10,000	
Fuel conveyor to pressing plant	10,000	
Remanufacturing line with resaw, cut-to-length saws, edger, and stackers	40,000	
Doweling machine for crossties	15,000	
Building (60 by 200 ft. at $15/ft.[2])	180,000	
Utilities	15,000	
Wiring	20,000	
Filing room for entire complex (incl. spare heads and saws)	75,000	
Contingency	25,000	
Total		880,000
PRESSING PLANT FOR MOLDED PALLETS AND STRUCTURAL FLAKEBOARD		
Land (20 acres at $1,000/acre)	20,000	
Building (60 by 200 ft. complete with power and lights @ $15/ft.[2])	180,000	
Two flake silos for green flakes	44,000	
Station to blend green flakes by species group	4,000	
Dryer for flakes	20,000	
Dry surge bin and screen to eliminate fines	9,000	
Blender for resin and flakes	8,000	
Former	16,000	
Four presses 4-1/2 by 8-1/2 feet with 600 psi specific pressure, single opening for operation in sequence, complete with hydraulic pumping equipment	500,000	
Pallet and panel trimmer, incl. conveyor to fuel storage	20,000	
Fork lift	15,000	
Fuel storage	15,000	
Boiler house	70,000	
Resin mixer, storage, wax facility, etc	10,000	
Quality control equipment	5,000	
Contingency	25,000	
Total		961,000
NAILED-PALLET ASSEMBLY PLANT[1]		
Land (20 acres @ $1,000/acre)	20,000	
Building with electrical service and utilities ($10,000 ft.[2] @ $15/ft.[2])	150,000	
Fork lift	15,000	
Block-cutting machine	7,000	
Chamfering machine	7,000	
Notching machine	8,000	
Cyclone and piping to fuel house at sawmill	12,000	
Saws, knives, and cutterheads	5,000	
Pallet assembly line for layup and nailing	100,000	
Contingency	15,000	
Total		339,000
Grand Total		$2,180,000

[1]Geared for shipment of about 610 pallets in a daily single shift of 8 hours. Cut-to-length square-edge shook is supplied by the sawmill.

Wood Cost and Quality

The cost of sound, rot-free wood was estimated at $26.50 per cord of tree-length mixed species (60% dense hardwoods and 40% soft hardwoods) with minimum DIB of 6 inches. The "sound" specification is required because the shaping-lathe headrig requires sound

TABLE — *Personnel requirements.*

Function	Annual salary including fringe benefits ($)	
OFFICE MANAGEMENT, PURCHASING, SALES, AND ACCOUNTING (One shift per day)		
General manager	57,000	
Production manager	35,000	
Wood buyer	30,000	
Chief accountant	30,000	
Pallet salesperson	30,000	
Solid-wood salesperson	30,000	
Clerk	12,000	
Clerk	12,000	
Clerk	12,000	
Total		248,000
YARD, LOG DECK, AND SAWMILL		
Superintendent	25,000	
Weight scaler, fork-lift unloader	14,000	
Log debarker operator	14,000	
Log bucker and sorter	14,000	
Fork-lift offbearer of bolts and feeder of headrig	14,000	
Operator of shaping-lathe headrig	14,000	
Feeder of ripsaw and length-cut line	14,000	
Offbearer of ripsaw and length-cut line	14,000	
No. 1 fill-in man[1]	14,000	
No. 2 fill-in man[1]	14,000	
Mechanic (serves entire complex)	15,000	
Electrician (serves entire complex)	15,000	
Filer (serves entire complex)	15,000	
Filer No. 2	14,000	
Total		310,000
PRESSING PLANT (Three shifts per day)		
Foreman[2]	60,000	
Material handler[3]	42,000	
Press operator No. 1	45,000	
Press operator No. 2	42,000	
Trimmer operator to cut panels and pallets, to size and package them	42,000	
Fill-in and clean-up man	42,000	
Overtime for placement of molds, and for maintenance	20,000	
Total		293,000
NAILED PALLET ASSEMBLY PLANT (One shift per day)		
Foreman	20,000	
Materials handler to drive fork lift, load trucks, spot loads	14,000	
Feeder for notching machine, chamfer machine, and block cutter	14,000	
Offbearer for above	14,000	
Operator No. 1 of assembly line	14,000	
Operator No. 2 of assembly line	14,000	
Inspector (also runs stacker offbearing assembly line)	14,000	
Extra for fill-in and cleanup	14,000	
Total		118,000
Grand total		$869,000

[1]Occasionally operates dowel-lamination equipment and reclaim edger.
[2]Responsible for quality control.
[3]Operates fuel house and boiler, mixes adhesive, and loads pallets on trucks.

TABLE — *Projected annual operating statement.*

Net sales (after all discounts and commissions — see Table 2)		$2,947,536
Expenses		
Raw material (Table 3)	$746,126	
Manpower (Table 5)	869,000	
Depreciation	210,000	
Other expenses	250,000	
Total expenses		2,075,126
Profit (30.3% of $2,880,000 investment)		872,410[1]

centers for chucking. Since only "sound" wood is to be bought, our estimate of only 10 percent of total wood tonnage bypassing the headrig direct to flaking is probably correct. In some locations (e.g., north Arkansas) virtually all of the hardwoods are dense, i.e., oaks and hickory. Such a situation can be tolerated, but the molded products will weigh more per cubic foot (51 or 52 lb.); increased product weight should not inhibit sales of molded pallets but is a disadvantage in flakeboard sheathing panels. Carpenters routinely handle 1/2-inch-thick gypsum boards which weigh about 50 pounds per cubic foot, so perhaps sheathing panels of comparable weight will be acceptable. Machine nailing of high-density flakeboard panels may be necessary, however.

Lumber Quality and Product Reject Rate

We have assumed that cants cut from sound bolts will yield 90 percent usable pallet shook, ties, and posts, an estimate supported by Large and Frost (5). Our assumed 3 percent reject rate, with no salvage except for fuel, in nailed pallets, molded pallets, and flakeboard sheathing panels may be too conservative; a 1 or 2 percent reject rate might be more realistic.

Product Sales Prices

Accurate assessment of achievable net sales prices is critical to this analysis. We believe that the prices listed (Table 1) are attainable, but recognize that prevailing sales prices for the planned commodities can fluctuate, and may periodically drop below tabulated values.

Equipment Costs and Maintenance

An assumption that many equipment buyers may challenge is our estimate that four single-opening 4-1/2- by 8-1/2-foot, 600-psi presses can be built (with necessary pumping equipment) and installed for $500,000. Our conviction is based on the fact that one of the authors is currently (1977) building similar presses at a comparable price and is prepared to build additional presses and auxiliary equipment.

Other equipment in the yard and mill, the nailing plant, and the molding plant is also modestly priced according to our belief that the investment in depreciable plant and equipment need total no more than $2,100,000.

The personnel requirements call for one mechanic and one electrician on the day shift. Possibly a mechanic should be on duty the second and third shifts as well; such an addition would reduce pre-tax profit by about $30,000 annually.

Molded Pallets

Since the molded-flake pallet is a product not yet tested in service, industrialists considering this utilization concept might prefer to divert the tonnage of flakes dedicated to pallets (Table 2) to 5/8-inch sheathing instead. Both products should sell for $200 to $205 per ton (OD basis), but press cycle time for 5/8-inch phenolic

pallets is nearly double that of pallets made with urea-formaldehyde resin. This halving of output, i.e., 3,672 tons of molded pallets annually compared to 1,836 tons of 5/8-inch structural panels, would alter material balances and reduce pre-tax income even though both products sell for about the same price per ton.

Despite these reservations and uncertainties, it is believed that the manufacturing concept has merit, and deserves futher economic analyses specific to site and regional market. For sustained operations, sites appropriate for the proposed enterprise should encompass within reasonable transport distance about 32,000 acres of hardwood woodlands continuously available to loggers supplying the plant.

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