Shaping-Lathe Roundup Machine Is Key to Profitable Manufacture of Composite Sheathing Panels in Massachusetts or Maine

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Abstract

A process is described in which a shaping-lathe headrig produces flakes of optimum geometry while rounding 8-foot peeler bolts to their maximum cylindrical diameter. The cylinders are then passed, at a rate of 5 to 7 per minute, to a veneer lathe for production of continuous veneer, which is subsequently clipped into 4- by 8-foot sheets. Veneer cores are flaked in a separate operation; these flakes, mixed with the flakes resulting from roundup, veneer residue, and panel trim, are pressed into 4- by 8-foot core sheets 9/32 to 13/32 inch thick. In a separate pressing operation, the flake cores are faced with 1/8-inch veneer to yield structural exterior composite sheathing of superior quality. By this process, a ton of bark-free peeler bolts should yield more than .9 ton of sheathing (OD basis); less than .1 ton (mostly sanderdust) ends as fuel. All other residue, except bark, is incorporated in the sheathing. The proposed plant will consume 5,000 to 6,000 peeler bolts per 3-shift day. Based on an average log diameter (small end, inside bark) of 10 inches, annual production during 240 3-shift operating days should be 100,000,000 square feet of 17/32-inch panel (1/2-inch nominal). Plant cost plus operating capital is estimated at $23,000,000. When sited in western Massachusetts or in central Maine, the operation should return a before-tax profit of about 36 percent (and an after tax profit of 18-1/2%) of the entire investment; cash flow should be about 28-1/2 percent, or $6,520,000 annually, after taxes.

Record numbers of housing starts are anticipated in North America during the 1980s. Demand for sheathing and subfloor materials to satisfy this market, together with anticipated high industrial demand for structural panel product, will likely cause North American mills to run short of veneer for structural products. Fortunately, technology is on hand to significantly increase the output of structural panels from available supplies of veneer logs.

STRUCTURAL PANELS with flake cores and veneer faces can be manufactured to compete in price and function with conventional sheathing plywood (2, 3, 7). Use of the shaping-lathe headrig (5, 6) to roundup 8-foot peeler bolts before rotary peeling, and then flaking the veneer cores, yields quality flakes from which to manufacture cores (4, 8). Continuous veneer peeled from the resultant perfectly cylindrical bolts can be dried and clipped into 4- by 8-foot sheets for use as faces and backs in panels of veneer and flakes. Spur trim from the veneer lathe, underthickness veneer produced on the first revolution of the veneer lathe, miscellaneous clippings, and panel trim can be flaked and added to the core finish. Only dust from sanding the flakeboard cores to thickness gage need be burned as fuel.

By this process, more than 90 percent of the dry tonnage of each peeler log becomes high-value structural panel. By contrast, a conventional plywood operation converts only 50 percent of bark-free log tonnage into sized sheathing (1).

The Roundup Lathe

The shaping-lathe headrig is central to the concept. This machine has been under development since 1963 and has progressed through a series of prototypes (6). A commercial version designed for bolts 40 to 54 inches in length is now installed in a West Virginia plant where it produces cants which are resawed into pallet lumber (5).

As a continuation of this development work, one manufacturer has designed a 108-inch roundup lathe for use in composite sheathing plants (Fig. 1); it is similar in principle to their 54-inch machine. The roundup process begins when debarked and cut-to-length logs arrive on the infeed deck where they are delivered one at a time to a charger (not illustrated) of the type commonly used ahead of veneer lathes. When the log is centered in the charger its diameter is sensed by the centering arms; this diameter data is used by an analog minicomputer to

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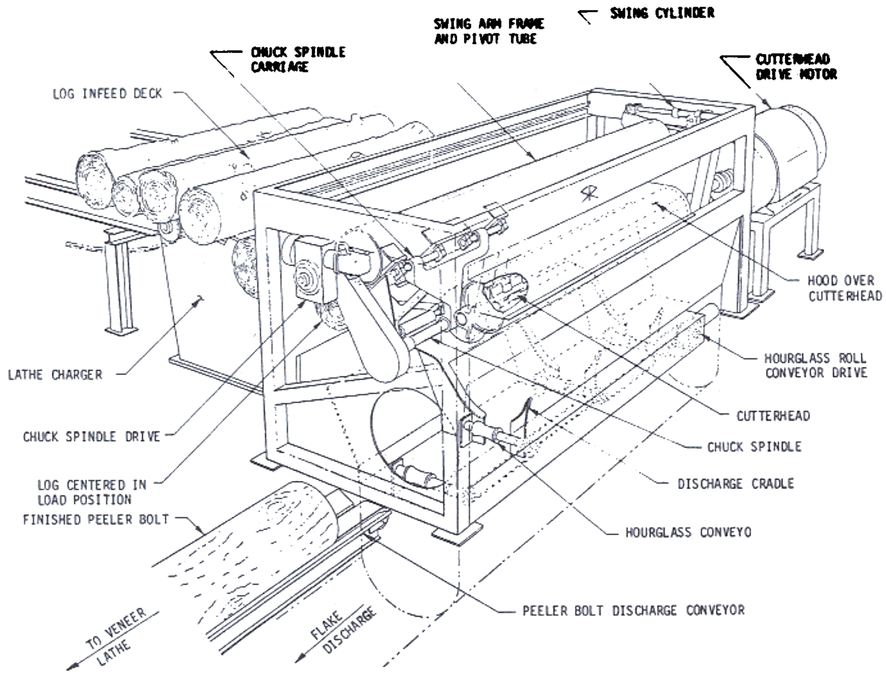
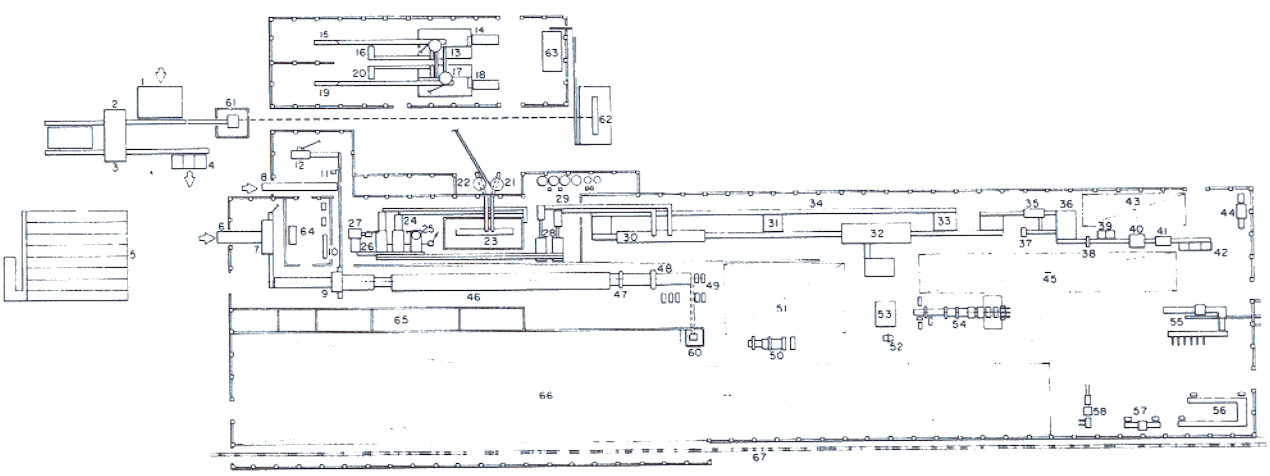


Figure 1. — Roundup shaping lathe for logs 8-1/2 feet long and 8 to 30 inches in diameter. The lathe yields cylindrical peeler bolts and flakes for panel cores. Throughput is 5 to 7 logs per minute.

direct the lathe to machine the maximum-size cylinder within each log.

Log chucks close axially, grip the ends of the centered log, and the charger then releases its grip. The arms carrying the log chucks and log swing downward at high speed toward the rapidly rotating cutterhead until the log is within a few inches of the knives; the stopping point is prescribed by the minicomputer. The swing-rate then slows and flaking begins. When the log centerline is at a distance from the knife cutting circle just half the intended diameter of the cylindrical peeler bolt to be generated (computer determined), the swing



1	LOG INFEED DECK	18	CORE FLAKE DRYER	35	SKINNER SAW	52	LOAD TURNER
2	BARKER	19	CORE FLAKE STORAGE	36	CROSS CUT SAW	53	GLUE PREPARATION
3	CUT-OFF SAWS	20	CORE FLAKE HOPPER	37	SCRAP HOG	54	LAY-UP & PRESSING LINE
4	BLOCK BUNKS	21	FIRE DUMP (NO 14 DRYER)	38	BLOW DETECTOR	55	TRIM & GRADING LINE
5	CONDITIONING CHESTS	22	FIRE DUMP (NO 18 DRYER)	39	AUXILIARY STACKER-LOADER	56	PLASTIC PATCH LINE
6	ROUND-UP LATHE INFEED CONVEYOR	23	MILLER HOFT FLAKE BIN	40	SANDER	57	TOUCH SANDER
7	ROUND-UP LATHE	24	FLAKE SCREENS	41	GRADING	58	STRAPPING LINE
8	TREE TOPS - BLOCK INFEED	25	TRIM - SCREEN	42	STACKER	59	TRIM HOG
9	VENEER LATHE	26	METERING BIN	43	IN-PROCESS STORAGE	60	VENEER CHIPPER
10	CORE CONVEYOR	27	FLAKER	44	PANEL SAW	61	BARK HOG
11	CUT-OFF SAW	28	METERING BINS & BLENDING	45	IN-PROCESS CORE BOARD STORAGE	62	HOG FUEL BIN
12	FLAKER	29	RESIN & WAX STORAGE	46	VENEER DRYER	63	BOILER
13	ROUND-UP LATHE FLAKE METERING BIN	30	FORMING STATION	47	MOISTURE DETECTOR	64	GRINDING ROOM
14	ROUND-UP LATHE FLAKE DRYER	31	MAT REJECT	48	CLIPPER	65	SERVICE AREA
15	ROUND-UP LATHE FLAKE STORAGE	32	PRESS	49	VENEER STACKER	66	WAREHOUSE
16	ROUND-UP LATHE FLAKE HOPPER	33	CAUL SEPARATION	50	VENEER EDGE GLUER	67	RAIL SPUR
17	CORE FLAKE METERING BIN	34	CAUL RETURN LINE	51	VENEER STORAGE AREA		

Figure 2. — Layout of plant to manufacture composite panels. Enumerated elements are identified in the text.

motion stops, and the log is rotated one full revolution counterclockwise; speed of rotation is computer controlled to yield flakes of desired thickness. As viewed in Figure 1, the cutterhead also rotates counterclockwise, thereby yielding up-milled flakes.

When machining is complete, the chuck arms swing away from the cutterhead, chucks retract, and the cylindrical bolt is released to be gently caught in a cradle and carried away from the lathe on hourglass rolls. The flakes—produced in 3 to 10 seconds—drop through the hourglass rolls before the log is released and are discharged to a metering system before being dried.

The roundup lathe processes up to seven logs per minute, will handle logs to 30 inches in diameter, and can produce cylinders as small as 8 inches in diameter. The machine will accept logs measuring 8 feet 3 inches to 8 feet 9 inches in length.

Plant Layout

Panel manufacturing sequence is best explained by reference to the plant layout; key operations and equipment are numbered and shown in Figure 2. In this section, numbers in parentheses refer to numbers in Figure 2. First, long logs move from a log deck (1) through a ring debarker (2), are bucked to peeler-bolt length (3), and discharged into receiving cradles or bunks (4) for transport into heating chests (5) that are designed to condition the bolts for flaking and peeling.

Heated bolts pass over an infeed deck (6) enroute to the roundup shaping lathe (7) from which cylindrical peeler blocks pass to the veneer lathe (9). Because blocks are cylindrical (and sapwood-free if desired), the veneer lathe feeds continuous veneer into a dryer (46). The emerging dry continuous veneer passes through a moisture sensor (47) and is clipped (48) to sizes appropriate for overlaying flakeboard cores.

Flakes from the shaping-lathe roundup machine (7) are conveyed to a metering system (13), fed to a flash dryer (14), and discharged to flake storage (15). Fire dumps (21, 22) are provided for the flash dryers in case of emergency.

The spent core from the veneer lathe (9) travels into a cutoff saw (11) and then through a drum flaker (12). The system also has provision (8) to admit debarked tops or pulpwood to the drum flaker system (11, 12). The drum flaker delivers flakes via metering system (17) and flash dryer (18) to the storage area (19). Flake handling and storage equipment are designed to accommodate flakes that have very low bulk density when dry and a high propensity to interknit and form bridges.

Bark from the debarker deck (2) is conveyed to a fuel bin (62) that feeds the boiler plant (63), which in turn produces part of the heat required for dryers, hot presses, and conditioning vats.

Dry flakes are delivered to a storage bin, from which they are fed through a screening system (24). Oversize particles are flaked again (27) and the acceptable fraction is blended with binder (28) delivered from a wax and resin storage area (29). Resin-spread flakes are conveyed to mat-forming heads (30) that are equipped to align them in the 4-foot direction; i.e., at right angles to the grain of subsequent veneer overlays.

Underweight mats are rejected for recycling (31) and acceptable mats proceed to a 4- by 16-foot hot press (32) which is equipped with a conventional caul return system (33). Pressed core panels emerge from the hot press and are trimmed (35, 36); trimmed edges are recycled into mat furnish. Core panels pass through a blow detector (38) that has provision for recycling defective ones (39) before they are sanded to thickness gage (40), graded (41), and delivered to bins (42) preparatory to overlaying. Defective panels can probably be salvaged by defect removal (44), and usable 4- by 8-foot core panels can be assembled from resulting smaller pieces. Core panel storage area adjoins the hot press (45).

In the veneer flow line, veneer that is too thin or otherwise defective is removed by clipping (48), then chipped (60), and flaked (27) for incorporation into core panels. Narrow veneer resulting from defect removal is assembled into full sheets at an edge-gluing station (50). Veneer, sized for overlaying, is stored (51) preparatory to glue application, layup with flakeboard core panels, and hot-pressing into three-ply panels (54). A glue preparation area (53) and load turner (52) are provided.

After hot pressing, the composite panels are trimmed to market size (55); edging trim is hogged (59) and then screened and flaked (25, 27) for incorporation in core panel furnish. Selected panels can be upgraded by plug-patching (56) and touch sanding (57). Finally, panels are steel strapped into bundles (58) and stored (66) prior to shipping by railroad (67) or truck. A mill service area (65) is located adjacent to the veneer line, and the grinding room (64) is centrally located between roundup machine and veneer lathe.

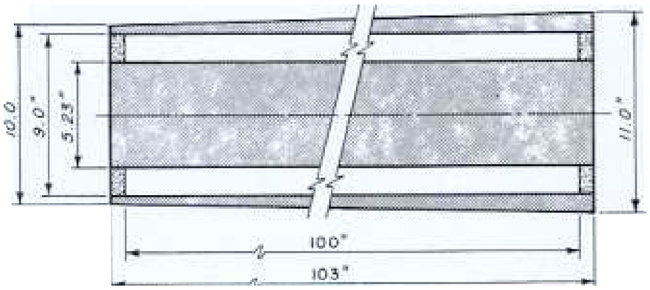
The plant that we have described permits conversion of virtually the entire bark-free log into sheathing panels; the principal material loss is the sanderdust resulting from sizing flakeboard core panels to gage thickness. This sanderdust is burned to generate process heat.

Material Balance

In computing material balances for nominal 1/2-inch-thick sheathing, we have assumed that the average log measures 10 inches in diameter inside bark at the small end and tapers 1 inch in 103 inches (Fig. 3). In Figure 3, the outer shaded volume is removed by the roundup shaping lathe as flakes. The inner shaded volume ends as flakes cut from the veneer core. Shaded volume depicted on the ends of the log is removed by scribe knives during rotary peeling; the resulting ribbons of veneer are subsequently flaked. The unshaded area represents green rotary-cut veneer amounting to 2.438 cubic feet. Total flake volume exceeds veneer volume by 12.2 percent and is 2.735 cubic feet (solid wood basis).

During drying and manufacture, these volumes per log are reduced as shown in Table 1. Thus, the volume ratio of dry, pressed flakes to dry, pressed veneer obtained from a 10-inch log (Fig. 3) is 1.906/1.694=1.125.

This analysis is based on using a variety of eastern spruces, pines, and hemlock. According to U.S. Product Standard PS 1-74 (11), plywood sheathing panels of such woods, made to compete with Douglas-fir (*Pseudotsuga*



VOLUME COMPONENT (SOLID WOOD, GREEN)	CUBIC FEET
GROSS WOOD VOLUME IN LOG	5.173
9-INCH-DIAMETER CYLINDER 103 INCHES LONG	3.792
ROUNDUP FLAKES	1.381
FLAKES FROM 103-INCH-LONG 5.23-INCH-DIAMETER CORE AND FROM SIDE TRIM OF 9-INCH CYLINDER REDUCED TO 100-INCH LENGTH.	1.354
TOTAL FLAKE VOLUME	2.735
100-INCH VENEER PEELED FROM 9-INCH CYLINDER TO 5.23-INCH CORE	2.438

Figure 3. — Roundup and peeling diagram of a log 10 inches in diameter inside bark at the small end.

TABLE 1. — *Volume reduction of veneer and flakes from a 10-inch log during composite panel manufacture.*

Product and cause of volume change		Volume (ft.^{3})
Gross volume of green veneer (solid wood)		
Radial shrinkage and compression in press	-.112	
Tangential shrinkage	-.172	
Veneer breakage, 15% (diverted to flakes)	-.323	
Trim of oversize veneer sheets (to flakes)	-.137	
Net volume of dry pressed veneer		1.694
Initial gross volume of green flakes (solid wood)		2.735
Volumetric shrinkage (10%)	-.274	
Veneer breakage (see above)	+.323	
Trim of oversize veneer (see above)	+.137	
Compression to 40 pounds per cubic foot (a loss of 26.5%)	-.774	
Volume of resin and wax	+.086	
Sanding loss (14 or 15%)	-.327	
Net volume of dry pressed flakes		1.906

menziesii (Mirb.) Franco) or southern pine, must be thicker than nominal. For example, a composite panel with 1/8-inch faces of red pine (*Pinus resinosa* Ait.) or red spruce (*Picea rubens* Sarg.) might measure 17/32 inch thick to attain approximate equivalency with 1/2-inch Dóuglas-fir or southern pine plywood. Accordingly, if composite panels 17/32 inch thick are constructed with 1/8-inch veneers on face and back and 9/32-inch flake cores, the ratio of pressed flake volume to pressed veneer volume will be 9/8 or 1.125, the identical ratio to that yielded from a 10-inch log.

A 10-inch log yielding a net dry, pressed panel volume of 3.600 cubic feet (1.694 ft.^{3} of veneer and 1.906 ft.^{3} of flakes) will yield 81.32 square feet of panel 17/32 inch thick. Thus, each cubic foot of log will yield 15.72 square feet of panel 17/32 inch thick.

Although little of the total dry log weight is lost in the manufacturing operation (principally sanderdust),

TABLE 2. — ***Volume yield of 1/2-inch composite panel per 10-inch log, as a percentage of gross log volume inside bark.***

Volume component		Volume (%)
Product		
Veneer in panel, net	32.7	
Flakes in core, net	36.9	
		69.6
Visible loss as sanderdust from core		6.3
Invisible losses		
Veneer shrinkage and compression	5.5	
Flake shrinkage and compression (adjusted for addition of chemicals)	18.6	
		24.1
		100.0

net panel volume produced amounts to only 70 percent of log volume (Table 2).

Balanced production of flakes and veneer for nominal 5/8-inch composite panels can be based on logs measuring only 9 inches in diameter inside bark at the small end and 10 inches at the large end. Such logs, which contain a gross green volume of 4.237 cubic feet, rounded up to 8.0-inch cylinders and peeled to 5.42-inch core diameter, will yield 1.089 cubic feet of dry, pressed veneer in panels and 1.770 cubic feet of dry, pressed flakes in panels for a flake-to-veneer ratio of 1.625:1. A composite panel 21/32 inch thick with 1/8-inch-thick faces of red pine or red spruce veneer and 13/32-inch flakeboard core (approximately equivalent to 5/8-in. Douglas-fir or southern pine plywood) has a flake-to-veneer ratio of 13/8 or 1.625:1. With this log size and cutting pattern, 1 cubic foot of log will yield 12.34 square feet of sized panel 21/32 inch thick. Volume distribution will be as shown in Table 3.

Economics

To illustrate feasibility of the composite-panel plant, two locations (western Massachusetts and central Maine) have been considered (9, 10). Tree species available at the Massachusetts location include eastern white pine (*Pinus strobus* L.), red pine, and eastern hemlock (*Tsuga canadensis* (L.) Carr.). In central Maine, available species are red spruce and white spruce (*Picea glauca* (Moench) Voss). As previously explained, composite panels of these species should perhaps be

TABLE 3. — *Volume yield of 5/8-inch composite panel per 9-inch log as a percentage of gross log volume inside bark.*

Volume component		Volume (%)
Product		
Veneer in panel, net	25.7	
Flakes in core, net	41.8	
		67.5
Visible loss (as sanderdust)		6.9
Invisible losses		
Veneer shrinkage and compression		
Flake shrinkage and compression (adjusted for addition of chemicals)	21.3	
		25.6
		100.0

made thicker than the thicknesses appropriate for Douglas-fir and southern pine; e.g., 17/32 inch instead of 1/2 inch, and 21/32 inch instead of 5/8 inch. These adjustments have been made in the tabular data and discussions that follow.

TABLE 4. — *Some key assumptions underlying profit analyses of composite-panel plant in northeastern United States.*

Factor	Assumption: Western Massachusetts	Assumption: Central Maine
Production costs		
Delivered log price, $/Mfbm International 1/4 scale	$ 115.00	$ 102.00
Cost of resin and wax, $/M ft.[2] of panel		
1/2 inch nominal	23.35	24.90
5/8 inch nominal	30.90	32.96
Average hourly wage for mill and maintenance crew, $, incl. fringe benefits	7.09	6.38
Power cost, $ annually	285,246.00	171,725.00
Natural gas (Mass.) or oil (Maine), $ annually	573,779.00	573,779.00
Property taxes, $ annually	352,400.00	527,175.00
Federal and state income taxes, %	48%	50%
Revenue and freight charges		
Net sales price f.o.b. mill after discounts and commissions, $/M ft.[2]		
1/2 inch (nominal)	211.95	209.13
5/8 inch (nominal)	260.87	257.27
Freight-to-market, $/M ft.[2]		
1/2 inch (nominal)	18.05	20.87
5/8 inch (nominal)	23.13	26.73

TABLE 5. — *Annual profit and loss statements for production of two thicknesses of composite panel in northeastern United States.*[1,2]

Class of entry and element of cost	Western Massachusetts	Central Maine
	—Thousands of dollars—	
1/2-inch panels (nominal thickness)		
Variable costs		
Chemicals, utilities, and supplies	3,852	3,894
Labor	2,041	1,837
Wood	4,440	3,938
Fixed costs		
Administration	978	1,153
Depreciation	2,300	2,300
Total variable and fixed costs	13,611	13,122
Sales revenue (after discounts and commissions)	21,195	20,913
Profit before income taxes	7,584	7,791
After-tax profit	3,944	3,895
Cash flow after taxes	6,244	6,195
5/8-inch panels (nominal thickness)		
Variable costs		
Chemicals, utilities, and supplies	4,294	4,364
Labor	2,041	1,837
Wood	5,101	4,524
Fixed costs		
Administration	978	1,153
Depreciation	2,300	2,300
Total variable and fixed costs	14,714	14,178
Sales revenue (after discounts and commissions)	23,478	23,154
Profit before income taxes	8,764	8,976
After-tax profit	4,557	4,488
Cash flow after taxes	6,857	6,788

[1]Assumes 100 percent equity and 240 operating days of 3 shifts each.
[2]Annual production of 1/2-inch panel is assumed to be 100,000,000 square feet, while that of 5/8-inch panel is 90,000,000 square feet.

TABLE 6. — *Return on investment for composite panel manufacture in two locations.*[1,2]

Statistic	Western Massachusetts (%)	Central Maine (%)
Profit before income tax	35.5	
After-tax profit	18.5	
Cash flow after income taxes	28.5	

[1]Assumes that production is evenly divided between 1/2- and 5/8-inch-thick panels (nominal).
[2]With 100 percent equity in $23,000,000 capital requirement.

Operating costs computed for the two locations are remarkably similar; low costs for freight, resin, and taxes in Massachusetts are offset by low wood, labor, and power costs in Maine (Tables 4, 5, and 6).

For both locations, 100 percent internal financing, that is, 100 percent equity, was assumed. Depreciation was over 10 years on a straight-line basis. In both locations, a mill crew of 115 is required plus a crew of 35 for maintenance, boiler operation, and guard service, for a total of 150 hourly rated employees. A salaried staff of 17 is required with annual salaries and fringe benefits totaling $414,000. Annual office expenses including communications, travel, and advertising are $120,000 for both locations, and annual insurance premiums are estimated at $92,000. Production and maintenance supplies are estimated to be $6.50 per thousand square feet of 1/2-inch panel and $7.35 per thousand square feet of 5/8-inch panel. At both locations, connected motors total 6,700 horsepower, with maximum demand load of 3,747 kilovoltamperes and average monthly power consumption of 1,348,840 kilowatthours when producing 1/2-inch (nominal) panels.

Composite panels with aligned flake cores should bring the same price per thousand square feet as plywood sheathing. Net plywood prices (May 1977) delivered to wholesale warehouses in the Boston area are about as follows:

Product purpose	Price/M ft.[2]
1/2-inch CDX for subflooring and roof sheathing	230-235
5/8-inch CDX for subflooring	284-290

The assumed net sales price of composite panel, f.o.b. mill, added to the freight rates assumed (Table 4) equals the lower values in the above tabulation. Sales distribution is estimated to be as follows: New York area, 55 percent; Boston area, 25 percent; and Cleveland area, 20 percent.

Conclusions

Use of the shaping-lathe roundup machine appears to be a key to economic conversion of small northeastern softwood logs (i.e., logs of several species measuring 9 to 10 in. in diameter inside bark at the small end) into composite structural panels competitive to CDX plywood. An investment of $23,000,000 should yield after-tax annual profits of about $4,220,000 and after-tax cash flow of about $6,520,000. Mill and office employment would total 167 jobs; supporting woods operations would provide many more jobs.

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