

Technological Developments In the Southern Pine Industry

By **DR. PETER KOCH**

*Chief Wood Scientist, Southern Forest Experiment Station,
U.S. Forest Service, Pineville, Louisiana*

The southern pines comprise the primary softwood timber species in the United States. Further, their importance is increasing. It is estimated that, by the year 2000, more than half (51 percent) of the softwood used in this country will come from the South.

These pines occupy about 20 percent of the 509 million acres of commercial forest in the United States. In the opinion of many foresters, the bulk of the southern pine lands are capable of growing in excess of a cord of wood per acre annually.

The southern pineries furnish the raw material for about 15 percent of the softwood plywood manufactured in the United States, 23 percent of the particleboard, 25 percent of the softwood lumber, 36 percent of the fiberboard, almost 40 percent of the market dissolving pulp, 41 percent of the groundwood pulp, a major share of the kraft pulp, over 75 percent of the poles, and nearly 100 percent of the turpentine and rosin.

Some of the commodities are also important in international markets. In 1968 the kraft mills of the South produced approximately 25 percent of the total pulps and 45 percent of the kraft pulps required in the world. The southern pines provided wood for 77 percent of this pulp. They additionally supply about one-half of the world's naval stores and three-fourths of the crude tall oil produced outside the Sino-Soviet bloc.

In the South — not including the mid-Atlantic or Central States of Delaware, Maryland, West Virginia, and Kentucky — the timber-based industry in 1958 employed about a million people and added over \$6 billion to the gross national product. Economic importance of the industry is increasing. In 1969 it was estimated that through production and distribution of wood products the 12 southern states contributed \$4 billion to the economy of the North, while adding \$10 billion to the economy of the South.

There are good reasons why the southern pines are pre-eminent as a source of raw material for industry.

First, substantial volumes of timber are available now, and the resource is rapidly renewable. The trees can be grown economically on a short rotation in pure stands over a broad range of sites throughout the South. Technologies for regenerating and managing the stands are highly developed.

Second, geography favors the growth, utilization, and marketing of the species. Mechanized harvesting and year-round woods operations are made possible by the mild climate and generally flat to rolling terrain. Labor and land costs are competitive with those of other regions. Water is abundant. Nowhere is the growing region distant from primary markets.

Third, the wood itself has an unusual combination of desirable properties. Its strength is outstanding. It is a prime material for structural plywood. Its light color and the strength of its fibers adapt it for pulping by both chemical and mechanical processes. The self-pruning attribute of the major species permits clear lumber for millwork to be produced in quantity. Further, the form of the trees favors their broad acceptance for poles and piling. The permeability of the wood enables it to be readily dried and given preservative treatment.

The southern pines, then, are an important national resource, and technological developments affecting their conversion have a substantial impact on the economy of the nation. What are some recent developments?

Tree Shears

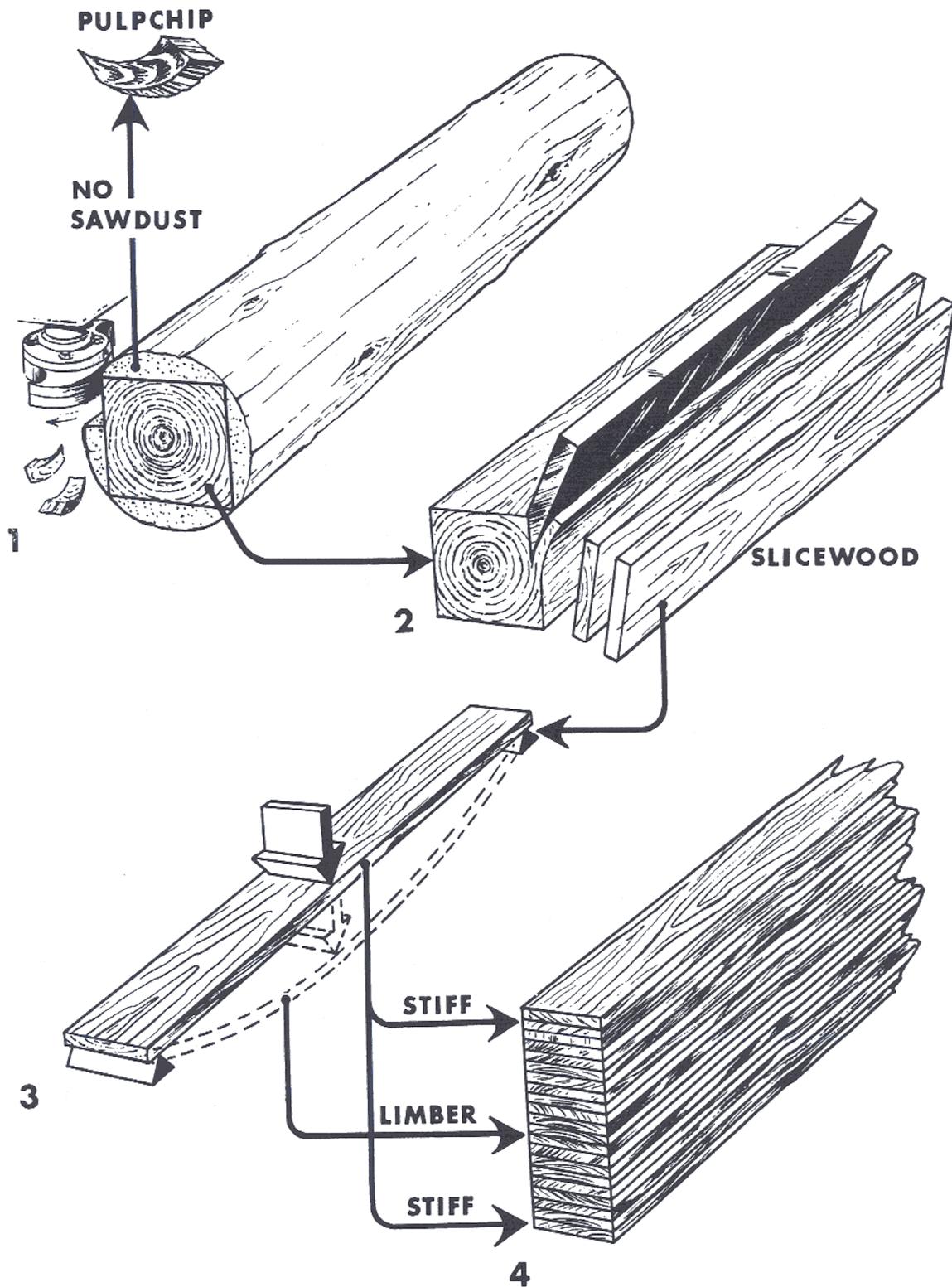
Chain saws, first introduced into the United States in the late 1930's, caused a major change in harvesting methods and virtual abandonment of the ax and crosscut felling saw. In the decade ahead, it is likely that tree shears will largely replace the chain saw, particularly for harvesting trees 12 inches in diameter and smaller. Compelling advantages of tree shears include the rapidity with which they work (up to 500 trees can be felled in 8 hours), the ease with which a stem can be severed at ground level (the low stumps not only reduce waste but also lessen cost of preparing the site for the next crop), good directional control when felling, and reduction in the physical labor required to fell trees.

Tree shears are expensive, however, and not without disadvantages. Whereas chain saws do not damage cut surfaces, shears create knife-induced splits averaging about an inch deep along each annual ring. In addition, one to several lengthy checks or splits generally develop in the butt of the stem just prior to emergence of the knife. On very small trees these splits may be minor, but on stems 20 inches in diameter they may average close to 20 inches long.

Because terrain in the South favors use of shears, however, and because of their inherent advantages, it is likely that converters of southern pine will adopt them and find ways to cope with their disadvantages.

The Chipping Headrig

Throughout the industry, increased emphasis is now given to utilization of the entire stem from ground level to top. Central to most of the new systems designed for utilization of tree-length logs is the chipping headrig — a machine that converts logs into timbers (cants or flitches) without simultaneously producing slabs or sawdust. With its companion, the chipping edger, this machine is probably the most important



This sketch illustrates four ideas that will see increasing application in the utilization of southern pines and other species of timber trees. (1)—Chipping head-rigs to machine a cant by removing peripheral wood exclusively as chips for pulping or flakeboard manufacture, that is, without slabs or sawdust. (2)—Conversion of the cant by methods that eliminate or minimize saw kerf. (3)—Non-destructive testing to separate weak pieces from strong. (4)—Methods of assembly that capitalize on the natural variability of wood.



A bark pile at a southern pine mill. Resource conservation will be advanced when research finds ways of using bark, rootwood and needles

innovation in timber conversion since invention of the mechanical ring barker.

It is having a profound effect on utilization systems. It enables logs in diameter classes from 6 to 12 inches to be profitably converted into lumber since they can be milled with little labor in a continuous end-to-end procession flowing at 100 to 300 feet per minute. Prior to invention of the chipping headrig, most logs less than a foot in diameter were destined for pulp chips — a product of less value than lumber.

Because chipping headrigs and edgers by themselves make no sawdust, yield of pulp chips is proportionately increased. Only about 5 percent of total log volume becomes sawdust in mills that convert logs to cants with chipping headrigs and cants to dimension lumber with band resaws.

In southern pine mills using older conventional methods of log breakdown, it is not uncommon for 22 percent of log volume to be converted into sawdust. Sawdust, of course, has low value in comparison to pulp chips or lumber. Less sawdust means less material going to the burner and, thus, less atmospheric pollution. With the new equipment, moreover, the labor and danger of handling slabs and edgings are eliminated. Conveyors can be simpler and, since no slab or edging space is needed behind machines, mill length can be reduced.

Logs converted into veneer and plywood generally yield higher value than if converted into lumber; however, veneer manufacturing usually is profitable only if logs are 12 inches or larger in diameter. This fact, together with the special capabilities of the chipping headrig, has resulted in a new pattern for utilization of southern pine trees. In the new tree-

processing centers, lower portions of the stem — if 12 inches in diameter or larger — are removed for conversion into veneer; tops 6 inches and smaller are chipped entire. The intermediate portion of the stem — that 6 to 12 inches in diameter — is converted into lumber via chipping headrigs. Thus, all portions of the stem are utilized to recover maximum value.

New Technology in Lumber Manufacture

In addition to the chipping headrig, other innovations in the technology of lumber manufacture are imminent. Band resaws for conversion of cants into lumber may be due for redesign. In the conventional saw, the blade is stretched over the wheels with the total force, or "strain," separating the wheels equal to about 10,000 times the cross-sectional area of the saw in square inches. Bandsaws carrying much higher strains are in successful operation in Canada; as yet, however, none have been tried in the southern pine region. Because saws with high strain cut a straight line even though thinner than normal, kerf can be reduced proportionately. It is likely, therefore, that high-strain bandsaws will be used in the decade ahead to saw southern pine.

Much needed behind fast chipping headrigs is a single-arbor edger carrying $\frac{1}{8}$ -inch-kerf circular saws capable of gang-ripping 12-inch cants into lumber at a lineal feed rate of 250 feet per minute. The problem is difficult, to say the least, but invention of such a machine would simplify both layout and operation of southern pine sawmills.

Dry kilns are also in the process of evolution. Mills cutting upper grades of structural lumber from large trees will

perhaps continue to use 4- to 7-day kiln schedules and dry bulb temperatures not in excess of 180° F.

Mills primarily interested in high-speed production of lower grade dimension lumber from very small logs, however, will likely tend toward high-velocity, high-temperature kilns. Recent research has shown that in 21 hours under mechanical restraint and with cross-circulation velocity of 1,000 feet per minute at dry- and wet-bulb temperatures of 240 and 160° F., followed by 3 hours at 195 and 185° F., southern pine 2 by 4 studs can be steam-straightened and kiln-dried to 9 percent moisture content. Compared to studs dried at temperatures not in excess of 180° F., the high-temperature studs were substantially straighter (crook, bow, and twist averaged 0.12, 0.21, and 0.09 inch), of higher grade (91 percent of the studs were Southern Pine Inspection Bureau Grades 1, 2, and Stud), and not significantly weaker. The high-temperature schedule took less than one-fourth the time and only about one-half the total energy required by the low-temperature schedule.

This research showed that southern pine lumber — particularly in the new thinner sizes — dries so rapidly at high temperature that a continuous dryer can be designed to accept lumber direct from the green chain; it might operate somewhat in the manner of current veneer dryers. Such continuous drying would eliminate the cost of kiln stick placement and removal and the cost of the sticks themselves.

Recent research also has shown conclusively that southern pine lumber can be most efficiently used in structures and laminated beams if it is first graded according to strength and stiffness. The next decade should see application of equipment to accurately and nondestructively make this classification.

A process has been developed whereby southern pine 2 by 4's cut from small logs can be dried in one-fourth the time and with half the energy conventionally required

which will increase the value of the lumber to producer and consumer alike.

Plywood Manufacturing Techniques

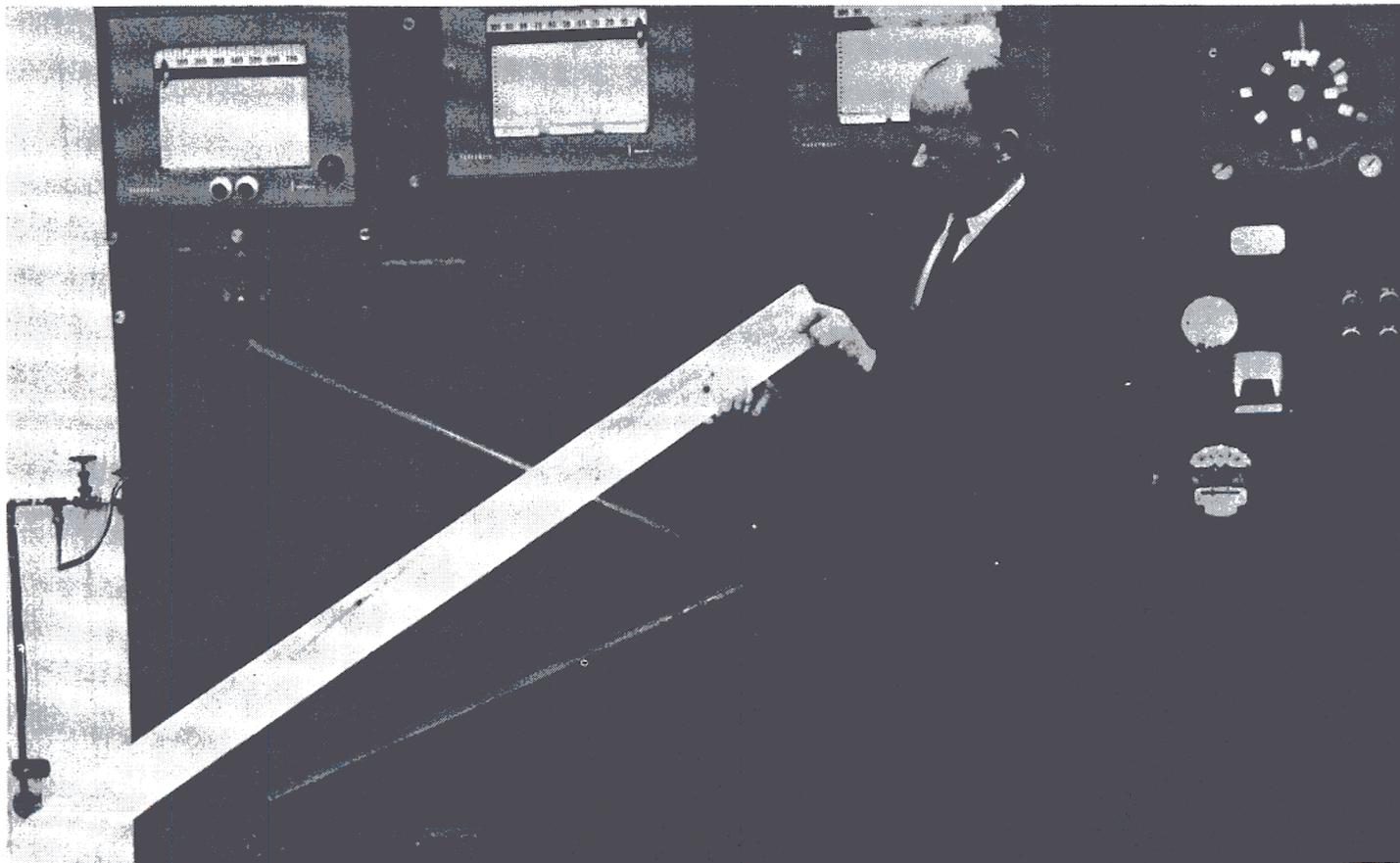
The southern pine plywood industry, able to borrow heavily from the well-developed technology of the West Coast, has achieved great manufacturing efficiency in the last 8 years. Recently, mechanization of layup equipment has further reduced the manpower required to make 1,000 square feet of plywood.

Perhaps the foremost manufacturing problem of the industry is that southern pine veneer requires about one-fourth more phenol-formaldehyde adhesive to achieve good bonds than does the Douglas-fir veneer with which it competes. Numerous laboratories have programs of research designed to achieve adhesive formulations that will give good bonds with spreads comparable to those used on Douglas-fir. Possibly in the decade ahead, these efforts will be successful.

Fortunately for the southern manufacturers, their nearness to major markets in the Midwest, Northeast, and South gives them a substantial advantage in cost of transport over western competitors, and therefore they can afford a bit more for glue.

Pulp Manufacture

The southern pineries supply wood for substantial tonnages of groundwood pulp. Most is stone ground from roundwood. Although yield from the process is near 100 percent, paper from such pulp is weaker and less flexible than kraft



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paper. For this reason, vastly more wood goes into the manufacture of kraft pulp, even though yields are much lower.

A challenge for the next decade is to develop a mechanical process for making a pulp that can be manufactured into paper sufficiently strong and flexible to compete with kraft for some applications. Such a process, yielding a ton of pulp for each ton of wood, would be a major step toward more complete utilization of the southern pine resource. Some researchers believe that success will come through invention of a method of unwinding individual pine fibers into flat ribbons (visualize unwinding a paper soda straw into the flat strip from which it was formed).

Whole-Tree Utilization

As demands on the southern pine resource increase, converters will examine ways of increasing the degree of utilization of each tree. The opportunities are numerous. Over broad areas of the region, southern pine forests grow about 1.5 cords per acre per year in stemwood — i.e., about 114 cubic feet of wood or approximately 3,600 pounds oven-dry. It is of interest that the annual needle fall per acre (dry weight basis) is not much different from the annual wood production. Southern pine needles contain a variety of oils and have fiber-like cells 1.2 to 3 mm. long, with occasional cells more than 5 mm. long. Perhaps it is time to examine the possibilities for utilization of this enormous tonnage of raw material.

Also largely unutilized is southern pine bark, which in the average tree exceeds 10 percent of the dry weight of stemwood. Because it has a fairly high heat value (about 8,900 b.t.u. per oven-dry pound, as compared to 8,600 for wood), is readily available throughout the South, and has no sulfur content, it might be considered as a fuel for electric utility plants. Bark not burned as fuel will, in the next 10 years, likely find increased use in particleboards and in agricultural mulches. Moreover, further research should facilitate utilization of the extractives in bark.

Should demand for fiber require it, techniques could prob-

ably be developed for harvesting the central mass of root systems from currently plentiful 20- to 30-year-old pines. The stem provides a convenient handle whereby small trees can be uprooted by sheer force; vibration of the stem — as in piling withdrawn by machinery — might reduce forces required, and would perhaps shake soil and bark from much of the root system. Alternatively, stems could first be sheared near ground level; in a secondary operation, lateral roots in the top 30 inches of soil could be severed by mechanically routing a narrow trench concentric to the stem at a radius of perhaps 3 feet. Then the root system could be plucked from the ground with grappling tongs.

There is little information on the weight of below-ground parts of southern pines. It is likely, however, that recoverable root systems comprise 10 percent or more of the total weight (dry basis) of 25-year-old trees.

Southern pine rootwood tracheids are about one-third longer and one-third larger in diameter, and have walls about 18 percent thinner, than stemwood tracheids sampled at stump height. Efforts to chemically pulp extractive-free rootwood of old-growth longleaf pine have been largely unsuccessful; it is possible, however, that roots of younger pines of the other major species might be utilized — if suitably mixed with stemwood — in some fiberboards or pulps.

Branchwood and topwood comprise another significant fraction of total tree weight that is largely unutilized; both are potential sources of fiber.

To summarize briefly, the chipping headrig has greatly increased value recovered from southern pine tree stems. If an improved mechanical pulping process can be invented, another significant gain in recovery will be accomplished. Further, it is likely that tree shears coupled with stump pulling equipment, and yet-to-be-developed utilization processes for needles and bark, will substantially increase the tonnage harvested from each tree. Considering all factors, it is quite possible that the tonnage of merchantable products made from the average southern pine tree in 1980 will be double that possible in 1960.

