THE ILLUSTRATIONS USED IN THIS BOOKLET
ARE WOOD ENGRAVINGS ON
THE END GRAIN OF LAMINATED MAPLE

TOWARD WISER USE OF

WOOD

A MIDCENTURY TRIBUTE

TO THE MEN AND WOMEN WHO

CONCEIVED AND FOUNDED THE

U. S. FOREST PRODUCTS LABORATORY

AND GUIDED IT THROUGH

ITS FIRST 40 YEARS

PUBLISHED BY THE
EMPLOYEES OF THE LABORATORY

FOREWORD

At the turn of the century, organized and purposeful research in forest products was practically nonexistent. What little there was consisted of scattered and largely unrelated experiments in a few university laboratories in the United States and abroad. Its results had little if any practical impact upon the wood-using industries of the day.

Fifty years later, research in forest products has become essential to modern industrial progress. In this evolutionary development, the United States has played the leading role. It was in our country that the concept of research geared to the needs of conservation on the one hand and industrial development on the other was born; and here was launched the first coordinated effort to make that concept a going reality. Thus was created the United States Forest Products Laboratory.

At midcentury, it is fitting to look back upon the progress that has been made and to retrace the steps that have been so largely responsible for that progress. It is for this reason that this booklet has been written: to tell, on the occasion of its fortieth anniversary year, the story of the Forest Products Laboratory from its beginnings to the present time.

We, the employees of the Laboratory, feel it is a proud story; and we tell it proudly.

Afterward they toss their empty plates, cups, forks, and spoons into the fading embers of the fire, and watch it perk up briefly. That's why such things were made — to be used once and thrown away. After all, they're only wood. . . . Yes, we're still having a picnic with wood.

THE PICNIC

CHAPTER I

MOST any pleasant summer Sunday you can find them, Mr. and Mrs. America and the kids, quietly enjoying their weekend freedom in the traditional American way — a family picnic.

The urge is inborn. Let's get away from the house — away from reminders of work and care — out into the open air and a shady grove of trees. Gather round the picnic table, open up the wooden lunch basket, take out the things mother fixed for the outdoor feast. . . .

Dad kindles the fire with a broken box while Sis tears the cellophane off the package of wieners. Mom spreads old newspapers over the table. Sandwiches are stripped of their wax-paper wrappings, drinks poured into paper cups, the warmed-up wieners and cold potato salad loaded onto paper plates. And with little wooden forks and spoons the whole family sets to. . . .

Afterward they toss their empty plates and cups and forks and spoons into the fading embers of the fire, and watch it perk up briefly. Likewise are the crumpled wrappings, the napkins, the newspaper table cover disposed of. If she doesn't say so out loud, Mom at least thinks:

"Thank heaven, no dishes today!"

No dishes? Of course not. The plates and cups, the forks and spoons are so cheap, they wouldn't be worth cleaning if you could. That's what they were made for — to be used once and thrown away. After all, they're only wood.

Only wood . . . It's a phrase we still use freely, of ingrained habit. Wood has been plentiful throughout our history. To the pioneer, anxious to clear his land, it was just something to be got rid of after his cabin and sheds were up; the land was needed for more valuable crops. . . . As our cities mushroomed, wood was always handy to build houses and shops and factories and schools and churches. . . . The woods were full of trees — for lumber, furniture, boxes, fence posts, wagons, freight cars, paper, fuel.

Wood — it was everywhere. A thing so plentiful, so common, there appeared no slightest reason to think twice about it.

And the habit clings. Sure, things made of wood today cost more — but doesn't everything else? Our newspapers, magazines, books are still within our easy reach pursewise. Houses are still built — and sold — by the hundreds of thousands every year. Railroads replace their wood ties with more wood ties — preservative-treated this time to last longer, but still wood.

Wood — We're using it more skillfully than ever before in peacetime, and for an infinitely wider variety of things. In some of them you mightn't recognize it offhand — pastel-colored plastics, silky synthetic cloth, flavoring extracts — but they're essentially wood. Sausage casings, speedboats, station wagons. . . .

Yes, we're still having a picnic with wood. . . .

THE LONG TRAIL

CHAPTER II

TAKE a piece of wood — what good is it?

The question is as old as inquisitive man himself. The first unremembered genius to discover wood's virtues as a war club doubtless thought he had the answer. Here was a noble extension of his own hairy arm, and it struck with amazing force; yet was light enough to swing freely and strong enough to shatter a tiger's skull.

As his descendants hit upon new uses for this stuff of trees, they learned each time a little about its properties and how one kind differed from another in usefulness.

From clubs, to spears, to bows that bent with the hunter's pull. From the branches of trees, to thatch huts, to log cabins. From logs that floated, to rafts, to canoes, to ships with wooden keels and planks and masts. From burnt-stick marks on cavern walls to hand-carved printer's type and paper on which to print. From sledges with wooden skids, to log disks that doubtless suggested the first wooden wheel to some forgotten primitive who deserves rank with the greatest of humanity's benefactors.

As man advanced through the Ages of Stone and Bronze and Iron, the utility of wood broadened steadily for him. There never was an Age of Wood simply because there never was a conceivable time when man did without it.

The dawn of modern times was heralded with implements of wood. From medieval Europe came the first printing press with its movable wood type that was to liberate man from the ignorance that had shackled his mind during the Middle Ages. Three small wooden ships traversed the Atlantic's watery wastes to blaze a trail to a new world; and another circled the globe. From the wooden decks of the Mayflower Englishmen stepped to freedom in the forests behind Plymouth Rock. . . .

Through countless generations, artisans who built the houses, temples, ships, wagons, printing presses, weapons, and other things of wood learned much about this material. They became familiar with its grain, texture, and hardness; found that some woods polished better, some were stronger, some stayed in place better, resisted rot and termites and even shipworms better than did others. And with such knowledge, handed down from father to son, they devised rules for design with wood and the essentials of carpentry, cooperage, cabinet making, carriage building, and other crafts.

Inevitably, as knowledge was passed along from master to apprentice, some of the flavor and body of experience that gave it meaning was lost. Learning was by rote, rules supplanted reasons why.

Thus today, in many modern cities, the walls of houses must be framed with studs 2 inches thick by 4 inches wide spaced 16 inches apart. Skilled metalworkers in our factories insist that only white pine will do for their patterns and mock-ups of tomorrow's machines. Gunstocks must be walnut, tool handles "white" hickory, "hopechests" aromatic cedar.

It is a rich heritage, but with strings attached. And often those strings get snarled when handicraft customs collide with machine-age demands.

HIDDEN PENALTIES

CHAPTER III

OF ALL the things on earth we need and use, wood is far and away the most versatile. Any count of its uses would reach into the thousands — and still be incomplete. Little wonder, then, that wood today ranks as one of the most important materials in world trade. Few forests remain that have not echoed to the woodsman's ax and saw. The search for fresh supplies is worldwide.

There is the nub of the dilemma confronting us: enormous and growing demand for wood in the face of shrinking supplies.

Statistics outline, illuminate, and bring the dilemma into sharp focus, but they don't provide solutions. In the Lake States, for example, those statistics tell us that total forest growth equals the drain on the forest from all causes — fire, insects, and disease, as well as man's inroads. But the ultimate fact remains that the prized white pine is gone, the prime hardwoods are going, and what is taking their place is something entirely different — mostly small, shortlived aspen. To state that aspen is growing faster than it is being cut is to utter a statistical truth, but offers no uses for it. These must be found — by expensive trial and error, or planned research.

Look at it another way. At innumerable sawmills, great mountains of sawdust inevitably collect — mostly to rot away in time. Bark, edgings, and slabs also accumulate in the inescapable process of transforming round tree trunks into square-edged lumber with saws. The percentages of the tree thus lost are interesting, but they don't tell how to reduce or eliminate that refuse or find uses for it. Something of the same situation exists at veneer mills, furniture plants, box factories, wherever wood is cut and shaped and joined.

A single statistic probably sums it up. In 1944, nearly 66 million tons of wood were lost in the course of logging and manufacturing operations in the United States, while another 43 million tons were burned as fuel at processing mills.

That statistic, standing by itself, is incomprehensible. When we translate it into terms that compare it with what we use, however, its meaning becomes almost terrifyingly clear. Suppose all those millions of tons of wood fiber were in the form of good lumber: they would represent 78 billion board feet, or well over twice as much as we use in a year's time.

We call this waste. A better name to call it would be "ignorance penalty." Because, technically or economically, we don't know how to use wood well enough, we pay that penalty.

But the losses we see and compute statistically are only part of the penalty. Hidden portions of it run the total incalculably higher.

We stick wood into the ground as posts or poles or foundation timbers, and it decays. Why? Either because a durable wood wasn't used or because it wasn't properly treated with preservative. Result: We pay a penalty.

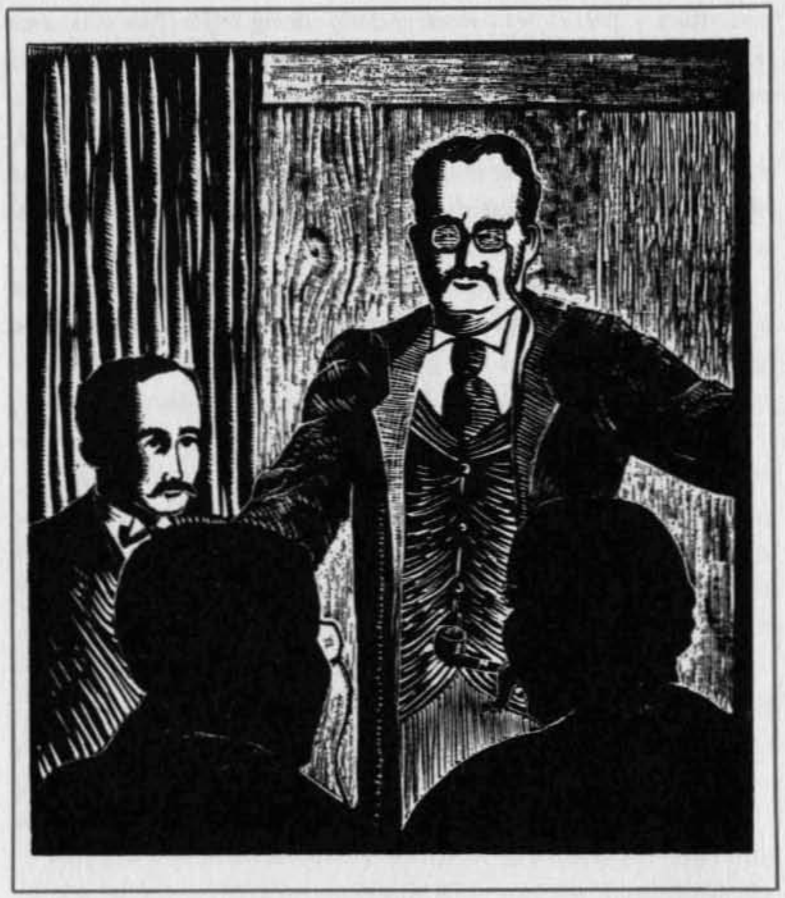
We use improperly seasoned lumber and it warps or splits. More ignorance penalties.

We build something of lumber — a house, a barn — according to custom. It serves well enough, will probably stand

for years. Yet — was it efficiently designed? No one can tell you. But the very fact that it is so sturdy hints at probable waste through overdesign. Still more ignorance penalties.

Other instances of this sort of penalty are all around us. So well hidden are some, even the most expert among us can't detect them. That they exist, however, cannot be doubted; nor that they are costing us dearly.

And those penalties we pay make it as plain as a knot in a board that we need to know better how to use the wood we have.



"Forestry is the preservation of forests by wise use." . . . We were doing anything but that when, near the turn of the century, Roosevelt in these words swung his support to conservation.

TOOLS FOR A JOB

CHAPTER IV

TEDDY Roosevelt said it:

"Forestry is the preservation of forests by wise use."

That was just around the turn of the century. The President, his fame as the Rough Rider of Spanish-American War days still fresh, had with characteristic vigor swung his support to the cause of conservation, and Gifford Pinchot was his Chief of the Bureau of Forestry. It was to a small group of men banded together as the Society of American Foresters that Roosevelt spoke those words, breaking Presidential precedent to attend a Society meeting in a private house in Washington, D. C.

But in that pioneer day those words expressed only a hope, an aspiration for better things the tools for which had yet to be forged. They summed up a need, rather than a plan of action. . . .

Wise use of our forests — we were doing anything but that. Already the East had been pretty well stripped of its prime timber. The white pine wealth of the Lake States was melting fast to meet the lumber needs of the burgeoning Middle West. The whirring saws were chewing hard at the southern pine stands from the Carolinas westward. And, by ship and train, Douglas-fir was trickling back East from the fabulous forests of Oregon and Washington. In the pellmell westward rush, the "cut out and get out" concept was rampant.

Against this Roosevelt and Pinchot spoke out. More, they were at work shaping the tools with which they hoped one day to halt, to reverse that philosophy, and rebuild the forests. With T. R.'s backing, Pinchot was hammering out the pattern of the U. S. Forest Service.

The system of national forests, already begun in the Department of the Interior, was transferred to Pinchot's bureau; and the Weeks law, providing for expansion of these forests by purchase as well as for cooperative forest fire prevention work with States and private owners, was enacted by Congress.

A chain of forest experiment stations was founded for research in tree growth and forest management.

A Branch of Forest Products was set up.

Those were the basic tools, fashioned in the first years of the new century — years that were later to become known as the Golden Decade of American conservation. Tools with which to preserve the forests, rebuild them, and work toward their better use.

"By wise use." The phrase defined the goal. Here was no fanatic's demand to halt a Nation's progress, to mummify and deify the forests. Rather, as T. R. expressed and Pinchot interpreted it, a challenge to build up, expand, and perpetuate the usefulness of the trees and their products.

And with those tools the Forest Service, before the Golden Decade ended, had taken up the challenge.

TOWARD A BEGINNING

CHAPTER V

THROUGH the port city of Charleston, S. C., in the years just after the turn of the century, funneled much of the lumber harvested from the great southern pine forests. The sawmills of the city ripped ceaselessly through the tide of logs that flowed in from the back country.

To one of these sawmills, about 1907, came two young men of the even younger Branch of Forest Products that Pinchot had created within the infant Forest Service. Specifically, their assignment was to run a series of tests on the wood of southern pines. Next to nothing was known about these woods that could be translated into the figures needed by engineers. Not that ignorance of the properties of southern yellow pine was especially noteworthy; precious little was known, engineeringwise, about any wood species. But a start had to be made somewhere.

And so McGarvey Cline and Harold S. Betts were sent to the Charleston sawmill. In a very real sense, they were trail blazers. Not only was knowledge largely lacking about the properties of wood; the means of getting such knowledge were as yet diverse and uncoordinated. Without a laboratory and with scant testing equipment, they were dependent — as explorers everywhere — on personal ingenuity and the engineering training they brought to their task. Small wonder, then, if at times they groped and stumbled.

It was, in fact, a period of probing and searching for the whole Forest Service. Cramped by meager budgets, the Branch of Products was forced to cast about for help wherever it could be found. It came largely through the device of cooperative agreements with various universities.

Several were already in effect. At Purdue University, in 1905, the Forest Service had centered its testing work on mechanical properties, but similar research was under way at Yale and the Universities of Washington, California, Oregon, and Colorado. At Yale, also, some cooperative work in wood preservation and seasoning was being done, while in Boston a small experimental pulp mill was in operation. In the South, investigations of naval stores had been started in an effort to help modernize this primitive industry, which was, cannibalwise, slowly devouring the trees on which it depended.

To the men heading the new venture, all this seemed scattered, piecemeal effort. The left hand didn't know what the right was doing. When the jobs under way were done, would there be a continuity of results — could the test findings at Yale be related to those at Purdue, at Washington, at California? And could all of them together be applied to practical engineering problems of design with wood?

Knowing the material with which they were working, these men could be forgiven some doubts. Wood wasn't like steel. You couldn't take a piece of longleaf pine, squeeze it between the jaws of a testing machine, and when it crushed take the dial reading of the machine as a final answer on the crushing strength of longleaf. No; wood, like the trees in which it grew, differed from tree to tree. How much, nobody knew.

The conclusion became inescapable that this research needed centralizing. Standard, dependable methods of test were

needed, and uniform interpretation of test results. How much better to take the wood to the testing machine rather than bring the testing work to the woods, as Cline and Betts were doing? Why not a central forest products laboratory where pine, oak, Douglas-fir, spruce, and all the rest could be tested on the same machines under the same conditions? Where engineers could exchange ideas and talk over problems with chemists, physicists, pathologists, foresters?

The idea was novel; no such laboratory existed anywhere in the world. Nevertheless, Pinchot and his Chief of the Branch of Products, William L. Hall, went to Congress with it in 1908. But the House Agriculture Committee was cold to their request for funds; what, asked the members, would be done with such a laboratory after the few months' testing work necessary to complete the job?

It was a disheartening blow to men who were just beginning to perceive the vast outlines of their task. But Cline, who had meantime left Charleston to make a tour of the laboratories where cooperative testing work was under way, came up with another idea. The purpose of his tour was to standardize testing methods. The assignment deeply impressed him, however, with the need for a central laboratory. If Congress did not see fit to give them the buildings and equipment they needed, perhaps someone else would. For instance, one of the universities that was already cooperating might be glad to have this work centralized on its campus in exchange for, say, a building and grounds.

Back in Washington, he suggested the scheme to Howard F. Weiss, a co-worker even then looking for a low-rent building in the national capital where at least some work could be centralized. After thinking it over, Weiss agreed. Together they outlined the plan to their chiefs.

The idea caught Pinchot's and Hall's approval. Feelers were sent out, and one Sunday in 1909 the two met to examine the replies. Several generous offers had come in, and a decision wasn't easy. Finally, however, the proposal of the University of Wisconsin's president, Charles R. Van Hise, was accepted. Van Hise, nationally known for his leadership in conservation, offered a new building complete with light, heat, and power. Soon afterward, Betts was sent to Madison to select the site for the building, and late the same year the vanguard of research workers began to converge on Wisconsin's capital city from Yale, California, Washington, Purdue, and elsewhere.

The building was completed early in 1910, and the world's first forest products laboratory was formally opened June 4 of that year. Although Betts left Madison shortly afterward to take up other Forest Service duties, his companion at Charleston, McGarvey Cline, became the Laboratory's first Director, and Howard F. Weiss the Assistant Director.

OUTLINE FOR A JOB

CHAPTER VI

FROM the first, it was the Forest Products Laboratory's goal to find ways of using the products of our forests better and more efficiently. The growing of trees in abundance was not the whole answer; to pay out, forestry had to produce useful things in a world that was placing an ever greater premium on efficiency and utility. That meant working toward wiser use.

There was no denying that the needs of people were shifting. In Detroit the first assembly lines were driving home the lesson of mass production. The people of the great cities were prospering and hungry for new things — from electric lights and better plumbing to new homes, more education, and the brass-bedecked autos that were churning the dust of the streets. New farm machinery was demonstrating its potency as a saver of time and muscle. At a place called Kitty Hawk, a weird contraption of bamboo, wood, and wire actually flew through the air with a man aboard.

Yes, as things were developing, it was a good time to plan for changes — a good time to set up goals. There was no predicting where all these desires and developments that were bubbling to the surface of our national life in the year 1910 would lead. But one thing was sure. They would draw heavily on our resources of timber. People would continue to need wood — in changing ways, perhaps, but lots of it. On this premise the founders of the Forest Products Laboratory planned and built.

Charting a Course

A good woodsman knows where he is, where he has been, and where he is headed. With the scientist it is much the same — with this addition: he has to know also where others have been before him.

Research in forest products cuts across many fields of basic and applied science. The chemist, the physicist, the forester, the pathologist — even the mathematician, and certainly the engineer, are key men. And each is significantly dependent upon the others for progress in much of his own work. Although each looks upon wood from the standpoint of his specialty, it is the sum of their observations that counts. Perhaps with no other material are all these branches so essential; that is because wood is used in such a variety of ways.

The men and women who gathered at Madison, Wis., to form the initial staff of the Forest Products Laboratory recognized this relationship between the various branches of their projected work as they planned the future shape and direction of the infant laboratory. Their plans were not perfect; later, new branches were to develop as the size and scope of investigations enlarged. In general, however, the original plan has been pretty well adhered to. The seedling idea planted in Madison in 1910 rapidly took root and grew.

THE SHADOW AND THE LIGHT

CHAPTER VII

SOMEONE has said that an institution is the lengthened shadow of a man. But shadows hint of darkness, superstition, and alchemists' brews. For a research laboratory, the aphorism is singularly inept; the task of such an institution is to shine rather than be shone upon. Nor can its brilliance spring from any single mind, but is compounded of the thoughts and work of many men and women.

By now the energizing light cast by the Forest Products Laboratory has been focused on all the major uses of wood, pointing the way out of the shadows of our ignorance and doubt. What it has revealed, what ideas it has stimulated, and what the galvanic shock of those ideas has produced in the way of better and wiser use of wood — these are the essence of the Laboratory's work since its founding in 1910. There is no measuring their impact upon our lives the way you measure loads and deflections in a testing machine. Its products being ideas that are public property, no sale price can be stamped on them. But in the mills, factories, and homes of the Nation these ideas have introduced new and better and cheaper products, demonstrated more effective ways of doing things. And all these carry dollar signs that aggregate many millions a year in sales, jobs, profits, and taxes.

In the Laboratory

You look at a piece of wood — a chair arm, table top, radio cabinet — and admire its soft, warm, satiny sheen. Its complex, ever-changing grain pattern intrigues you, suggesting other variations hidden under that glossy surface — variations woven about a central pattern, or theme, that is basic to its structure.

It is the same with the scientists. With their microscopes, their tricks of light and heat and chemicals, they have penetrated far into the hidden mysteries of wood's structure. They recognize annual rings, pores, ray cells, resin ducts, fibers and their hairlike fibril wrappings, and even tinier things like fusiform bodies and crystallites and micelles. They have taken this complex structure into the chemical laboratory and transformed it into many others — some of them as yet unnamed. They weigh and soak it and measure it for swelling; cut, tear, bend, and squeeze it; freeze, burn, and treat it with chemicals.

Doing all these things to wood under controlled laboratory conditions, they have learned much that sheds fresh light on our use of wood.

They have been able to do it because the Congress, in recognition of the importance of wood to each individual throughout the Nation, has provided them with the finest facilities obtainable — facilities that consist not only of machines and tools and buildings but of trained brain power and diverse essential skills. Those facilities have been gathered at the Forest Products Laboratory over the years, until today they are unsurpassed anywhere.

Research in forest products has in fact become a varied and intricate undertaking. No one man can hope to master all the details of every branch of it, for the simple reason that no one can master all the ramifications of physics, chemistry,

pathology, forestry, engineering, and mathematics needed to do so. But, fortunately, no such superhuman intellect is necessary. Forty years of experience and steady growth have proved that, working together under one roof as a team, specialists in each of these branches can achieve a pattern of unity that gains rather than loses by the interplay of many minds and thoughts and skills on any given problem.

For Instance, Houses

Through many generations, men wrestled with the problems involved in building better frame houses. Yet not until recent years have those problems been systematically attacked by the scientist. Such an attack was, in fact, impossible until men versed in the various branches of science involved were brought together and organized for it. And even then, careful preparation was necessary.

For one thing, the strength of wood had to be established; for another, its durability. And, simultaneously, the strength of various joints and fastenings, and methods of framing and sheathing, and methods of treatment and installation to eliminate fire and decay hazards. Not to mention seasoning and painting and insulation, and a multitude of other problems and practices. Here were things no journeyman carpenter could reasonably be expected to decide. They called for the specialized knowledge of the engineer, the chemist, the physicist, the pathologist.

Today, we have a lot of the answers. We know, for instance, what a joist or stud or rafter can support, and prescribe sizes and spans on that basis. We know what wind loads a conventionally built house wall will take without racking and tearing at the joints. We have odorless, paintable preservatives that fend off rot from window frames and doorways and porches, and other chemicals that can fight off flame and heat.

Housing research at the laboratory has, in fact, forged far ahead of today's building practices.

Prefabrication of houses is a case in point. Two small houses tucked in close to the Forest Products Laboratory main building tell the story. These are grandparents of a certain breed of prefabricated houses that has multiplied rapidly in recent years, until a majority of the Nation's prefabricators now build one cousin or another of the general type. With walls, floors, and roofs composed of panels of plywood glued to light wood frameworks, these houses are what engineers call "stressed-skin" construction. They represent perhaps the first successful attempt to build houses with a definite, known strength. There was no guesswork in their design; testing machines and slide rules told their engineers just what loads of furniture, people, wind, and snow they could carry even before they were erected.

Today you can buy houses fundamentally like these almost anywhere in the United States. At the Forest Products Laboratory, however, they are "old stuff." Its inquisitive researchers are now testing a radically different type of house — again one with panelized floors, walls, and roof, but built this time of plywood glued to honeycombs of paper. They call these panels "sandwiches." Light, stiff, durable, surprisingly fire-resistant, and self-insulated, these panels have been given exhaustive tests. Since 1947 Wisconsin's vigorous climate has been feeling them out for weaknesses as demonstrated in a one-story Laboratory structure about the size of a couple of boxcars.

When — and if — these paper-in-plywood sandwiches come into use for houses is strictly a speculative subject. But once again — as it did with stressed-plywood panels — the Laboratory is lighting the way for progress in housing.

. . . Or, *Paper Products*

In the eighteenth century men began to experiment with wood for paper. It wasn't until the mid-1800's, however, that they hit upon crude ways of pulping it with chemicals and grinding machines. These worked fairly well — but only with a few woods like spruce and fir, long-fibered woods that drained, matted, and dried easily into paper sheets. By the early years of the twentieth century American papermakers were running out of easily available raw material in those species, and importing more and more heavily from Canadian forests. Despite great resources in western and southern softwoods and eastern hardwoods, we were rapidly reducing our preferred pulpwood supplies. The more plentiful species simply couldn't be made into satisfactory papers.

Today we're using those southern and western softwoods in huge quantities, and mills are pulping hardwoods — even such once-despised "weed" species as the aspen that has taken over great areas of the Lake States and New England. That this has come about is due largely to concentrated research at the Forest Products Laboratory.

The resinous southern pines are furnishing everything from kraft wrapping paper and container board to fine white writing and book papers. On the West Coast, mills are pulping Douglas-fir and western hemlock along with fir and spruce. And eastern mills are finding additional resources in aspen, birch, maple, elm, beech — even blight-killed chestnut. These short-fibered woods can be made into papers of good strength, brightness, and printing quality for magazines and books; or boxboard, roofing felt, and other products.

Broadly, this has been accomplished in two ways: 1, by steady refinement of the older processes, notably sulfate and sulfite chemical treatments; and 2, through the Laboratory's development and patenting of a new process that is achieving spectacular results. It is this new process that has brought hardwoods prominently into use as pulpwoods. Called the semichemical process, it converts hardwoods into more pounds of chemical pulp per ton of wood than was long believed possible — running up to 90 percent and more of the wood as compared with around 50 percent with the older chemical processes.

. . . Or, *Better Service from Wood*

Long ago, men found out that wood needs to be seasoned to get rid of most of the sap in it before it is used; otherwise, the sap will leave of its own accord later and the wood will shrink and twist in place. But old ways of seasoning — mostly air drying — were slow and far from precise.

Today the United States leads the world in kiln drying, largely because of the Forest Products Laboratory's pioneering research. The basic patents on modern dry kilns of internal fan and blower types are public property because they cover Laboratory research achievements. Wood fresh from the forest is now dried in days, whereas it used to take months. And, for that matter, air seasoning is done better and with far less loss because the Laboratory's physicists have found out how air circulates through and among piles and have designed piles and yard layouts accordingly.

Whether it's a railroad tie, a fence post, a telephone pole, a foundation timber, or a window sill, wood is more capable of long service today than a generation ago. That's because of chemical preservatives that are cheap and effective. New preservatives, the relative merits of older ones, the suitability of different types for various kinds of service, and the quantities needed to protect wood adequately are among the de-

tails of treatment established for industry and farmers by the Laboratory's research.

Chemicals that repulse flame on wood have also been investigated. Laboratory chemists have discovered paints that help fend off fire instead of feeding it.

As clear, defect-free wood becomes scarcer, we have to learn how to use more of the more plentiful knotty and lower-grade material that comes from our smaller, new-growth forests. This has become a big field of research in recent years.

For one thing, if we are going to use knotty lumber in a building, we have to know how much strength is lost because of the knots. This calls for grading, which in turn must be based on tested information. The principles of grading structural timbers for heavy construction have been solidly established through Laboratory research. The grades used for light framing lumber, construction boards, flooring, furniture wood, and millwork have developed through the years and are not primarily based on strength requirements. Tests of lumber typical of various framing grades have, however, established in general the adequacy of each grade for particular uses. The Laboratory has published detailed ratings of the various grades of lumber for different parts of houses. These ratings take into consideration adequacy as well as quality.

When you consider that men have been gluing wood for thousands of years — the ancient Egyptians invented the art of veneering — it is something of a jolt to realize that only in our own generation has this practice come of age. Yet it is literally true that moisture was a deadly hazard of glued construction until synthetic resin glues were developed in the early thirties. Their perfection has literally torn the age-old shackles from gluing and opened a whole new world of utility for wood products.

Glue manufacturers of the United States have already de-

Every glued product represents conservation of our forest resources. A major contribution of the Forest Products Laboratory to modern living has been to remove trade secrets from gluing and devise improved techniques for the use of modern adhesives in guided missiles, ship keels, prefabricated houses, and laminated arches.

veloped scores of resin glues; so many, in fact, that the Forest Products Laboratory has become a fountainhead depended upon by the Armed Services, other Government agencies, and private industry for reliable information about the characteristics and suitability of the various new types and kinds for different uses. It is hardly surprising that users accustomed to a few long-established glues like animal, starch, blood, and casein should experience bewilderment when confronted with phenol-formaldehydes, urea-formaldehydes, resorcinols, melamines, polyvinyls, thermosetting and thermoplastic glues, and a whole host of equally strange-sounding trade names for them — not to mention fillers, hardeners, extenders, catalysts, and other adjuncts of their use. Out of this maze of developments, the Forest Products Laboratory's testing work and publications have brought some order.

Nor has the Laboratory's research with these resins stopped there. It has devised techniques for their use in aircraft, in prefabricated houses, in ships and boats. In cooperation with industry, it has developed new products with them — notably laminated wood timbers that make it possible to glue together thin, short boards into structral timbers of any length, width, and thickness for unrestricted use in buildings, ships and boats, bridges, and other heavy construction. It has investigated faster gluing methods, such as high-frequency current for the almost instantaneous curing of glues. And it has adapted synthetic-resin materials to other uses, outstanding among which is the treatment of wood with them to make it almost shrinkproof. By compressing such resin-treated wood, it has provided industry with a material for stainproof table tops, molds for metal working, and flight-deck surfaces on aircraft carriers. Impregnating paper with them, it has developed a high-strength plastic, and the decay and verminresistant cores for its paper-plywood house panels. Synthetic resins have indeed proved to be extremely versatile tools in wood research and utilization.

. . . There are many other equally intriguing facets to the Laboratory's research. For instance, the container and packaging research that, during World War II, resulted in four ships carrying the guns, explosives, and other supplies that had formerly required five. Or the seasoning and machining research that has helped cabinetmakers to use woods like sweetgum and aspen, long thought unsuitable for fine furniture — incidentally helping to keep costs down.

The Laboratory's research has even built a firm practical foundation for the adoption of good forestry practices throughout the United States. By going into the woods, cutting trees of various sizes, and showing which sizes were profitable to cut as well as which would be cut at a loss, these Laboratory men demonstrated that "selective logging" is a practical tool of forestry. Selective cutting is today a fundamental of "tree farming."

Underlying all of this "practical" development has been patient, plodding, fundamental research. The analysis of many thousands of small wood samples to get accurate strength values; the testing of equally numerous small pieces of wood glued together in order to establish the strength and durability of the glue used; the careful dissection and microscopic examination of wood to learn more about its structure and abnormalities; studies to determine how moisture passes through its extremely minute fiber structure, how it is affected by heat, how chemicals react with it, and just what its own chemical composition is. It is knowledge of this sort that enables the scientist to make wood a more useful substance to mankind. For, insofar as we lack the necessary fundamental guideposts, to that extent wood utilization continues to be incomplete and necessarily wasteful.

TODAY...

CHAPTER VIII

WOOD is inextricably woven into the fabric of our civilization. It is the oldest of antiques, the newest of pastel novelties. It is the infant's crib and the aged's cane; the draftsman's blueprint, the metalworker's pattern, the designer's mockup of tomorrow's streamlined train or ship or car or airliner. As luxuriously polished panels or rough weathered clapboards it has an equal charm. On it man lavishes his labor, his skill, his art — and, more and more, his science.

Working in the fifth largest, and probably the most diversified, group of manufacturing industries in the Nation, some 1,200,000 men and women process wood. And probably 2 or 3 million more earn their livelihoods selling, transporting, maintaining, and otherwise handling the thousands of things made of it.

. . . We've come a long way since that 1908 Congressional committee found itself unable to visualize more than a few months' testing work for scientific research in forest products. The Congress has long since discarded that view and, recognizing that money spent on forest products research continues to be returned to its taxpayer investors many times over, annually appropriates sums to keep that work going. In 1930, it provided funds for a new and larger building on land fur-

The U. S. Forest Products Laboratory, Madison, Wis., serves the fifth largest, and probably the most diversified, group of manufacturing industries in the Nation. Some 1,200,000 men and women process wood; probably 2 or 3 million more earn their livelihoods selling, transporting, maintaining, and otherwise handling the thousands of things made of it.

nished by the University of Wisconsin.

But it has not been an unguided growth. Many have contributed their thoughts and efforts to it. McGarvey Cline, the founding genius, handed the directing reins to Howard Weiss 2 years after the young institution opened its doors in 1910. Five years later Mr. Weiss in turn relinquished the directorship to a man who was to remain at the helm through the storms and stresses of two world wars and an intervening depression — all three of which took a high degree of managerial foresight and planning to keep the young and lusty organization functioning ever on a true course. To that man, Carlile P. Winslow, belongs, as much as to any other, large credit for the enduring reputation for sound, progressive research the Laboratory has earned.

With Mr. Winslow's retirement in 1946, the responsibilities of directorship have passed on to George M. Hunt, a veteran research man. During his four years of guidance there has been a remarkable expansion in the cooperative activities of the Laboratory with other agencies, both private and public, all of which serve to keep the Laboratory's research results constantly flowing into channels of specific use. One especially effective tool that has been forged is a Forest Utilization Service to bring results of the Laboratory's research directly to the lumber camp, the sawmill, and the factory. Seven branches of this Service are in operation at the headquarters of Forest Experiment Stations in Portland, Oreg., Missoula, Mont., Berkeley, Calif., New Orleans, La., Asheville, N. C., Philadelphia, Pa., and Columbus, Ohio.

. . . Nor has the Laboratory remained a thing unique in the world. Other Nations have studied it, set up their own versions of it. Some of the States, becoming increasingly aware of the need for closer study of localized problems, have established research organizations modeled upon some phase or another of its program. And various associations and companies — lumber, paper, chemicals, construction — operate laboratories of their own.

All this expansion and concentration of work have helped to illumine the essential scope and character of the job to be done. As the evidence shapes up, it is both worldwide and local. As a Nation we lean upon the forest resources of South America and Africa and Asia and Europe as well as upon our own. Likewise, as a Nation we are directly concerned with the way in which local sawmills dispose of their sawdust and slabwood. The large amounts of wood that still fail to find profitable use are at once a potential source of jobs, taxes, and income, and a challenge to the ingenuity and perseverance of the science of the Nation.

"Forestry is the preservation of forests by wise use."

The words of Teddy Roosevelt ring as clear and challenging today as ever. We must use our trees; from that there can be no turning back. That we must use them wisely is an equally compelling fact. For if we do not, we preserve neither the forests nor the magnificent enterprises that depend on their sustenance and, in turn, so greatly shape our way of life.

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