NORTHWEST SCIENCE

VOL. XXI, No. 3 — AUGUST, 1947

Published January, 1948

POSSIBILITIES IN NEW FOREST PRODUCTS INDUSTRIES IN THE NORTHWEST

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Delivered before the general session, December 27, 1946

Why are we all seeking the establishment of new industries based on wood? There are two important fundamental reasons. First, it is increasingly apparent that our supply of good wood is not as big as we had fondly imagined. Therefore, it is necessary to obtain more products from the material that we harvest. Second, it has become tragically apparent that better forestry must be practiced nation-wide, and one important tool with which to achieve the expressed goal of better forest practices is better utilization.

Perhaps that point ought to be elaborated a little. When we talk better utilization of the forest crop some people immediately become alarmed, because if close utilization were carried to its extreme it could mean simply more rapid destruction of remaining virgin stands of timber and too rapid cutting of merchantable, but immature, second growth. What we are really talking about is a diversified utilization that is properly integrated with the productive capacity of the forests with which we deal. By diversified utilization we mean practically the reverse of utilization practices that have been the rule in most of our important forest regions in the past. In general, a narrow and limited market has dictated the harvest, and the harvest has been aimed almost entirely at single products. This has led to overcutting of choice species, undercutting of species not in demand, general conversion of stands to species hitherto considered inferior, and lack of utilization of lower quality materials. If, however, our point of view is shifted from that of the high-grade market to the woods and what it can produce in the way of useful goods, the utilization industries based upon the woods must assume a widely differentiated aspect. The easiest silviculture and the cheapest will probably be that which harvests the growth of the forest, both in species, quantity, and quality, in a manner that is geared well to the way in which the forest produces trees. There are a few examples in this country of such opportunities. There may be some in the Inland Empire but the author's attention has not been called to them.

This sort of differentiation of products according to the productive capacity of the forest with which we are dealing leads logically to another type of integration in utilization that is of increasing importance. This is the use of the byproducts or offal from one industry by another. There are many examples already in the forest products industries of this sort of operation. It is developing rapidly in the Pacific Northwest where rather large industries are now being operated on the material that five years ago went into the burner.

You have been told many times that in the Inland Empire there is overcutting of white pine and ponderosa pine and undercutting of white fir, larch, Engelmann spruce, and lodgepole. You know that the life of your industries based on the two predominant lumber species of the past is limited, and that the forest products industries of the future must use to a greater degree those species that have hitherto been considered inferior for wood production. The point does not need to be further elaborated, with this exception. A part of the reduction in cut in ponderosa pine and white pine that is necessary can be made up as far as labor input is concerned by a closer utilization of those species through working up in known ways the materials now wasted.

It would be well to insert at this point a short discussion of a few of the factors that determine the establishment of a new forest products industry. We live, in the United States, in what is probably the greatest free trade market in the world. That means that there is very wide opportunity for the exchange of goods from one section of the country to the other without artificially created traffic barriers and other impediments to the free movement of goods. It is not necessary to go into all of the details of that statement because you know that to some extent this matter of the free movement of goods within our boundaries is fiction. You know about discriminatory freight rates and you know about the obstacles that are erected to the migration of capital into new territories. You know of the political obstacles that are raised in the esetablishment of new power resources, and so on. But we do, at least, *worship* the idea that we have tree opportunity to develop new industries within fundamental limitations of economics.

One result of this freedom has been the exploitation of the best and most accessible of our resources. I am reminded of the way my father used to instruct us to take apples from the bin in the cellar. We were told always to pick out a specked apple. That way we had apples pretty well on into the spring. Some of our less thrifty neighbors made no such interdiction. They picked out the good ones and ran out of apples in January. As far as our timber resources are concerned, we have been eating mostly prime apples, and we are now coming to the period when we are going to have to take the specked ones.

This may not be such a bad idea in the long run. We have large unused timber resources. Our task is to find out how to adapt them in the highest degree to our needs and produce materials from them at reasonable cost.

This matter of economics is not a subject into which this paper is designed to penetrate. Under our system, which is a good system, we put quite a premium on managerial skill and technical ability. Thus a business well situated with respect to raw material may fail because of lack of one or the other of these two qualities in its leadership, while a similar business poorly situated from the point of view of natural advantages may succeed because of the possession of these two attributes by managers. The reason for bringing this up is that the Intermountain Region is not most advantageously situated from the point of view of accessibility to markets. It has to compete against the Pacific Northwest with its available ocean transportation and against the South with shorter rail hauls to the principal markets. Therefore, all those things that are technically possible in industries based on forest products may or may not be desirable for location in the Intermountain Region. Those are matters that must be subjected to much more critical economic review than can be given here. What can be done is to call your attention to a few outstanding examples of opportunities to use the materials of the Inland Empire more efficiently and for the erection of industries not now present, always within economic limitations.

There are three major lines along which improved wood utilization has taken form. One is the fabrication of the wood itself into new or improved physical forms. Second, technicians have learned to do things to wood that will improve its properties in use and, third, they may change the whole chemical and physical make-up of the wood and derive from it new and valuable

materials. Let us develop these in order.

IMPROVEMENTS IN THE PHYSICAL FORM OF WOOD

The simplest thing you do to a sawlog is to saw it into rough lumber. The lumber may be further manufactured into various shapes and sizes for use. This is one of the glaring opportunities for improvement in the products setup in this region. Here is a significant thing. In 1940, the four Northwestern States produced 35 per cent of the total lumber production of that year but manufactured only 12 per cent of the factory products made from lumber. In the Inland Empire, 548 million board feet of lumber was cut in 1940, 152 million feet, or 28 per cent, was used in manufacture principally for matches, millwork, and boxes, but only 47 million feet was used in this region for factory products—9 per cent of the lumber production.

Actually, there is abundant opportunity to increase the remanufacture of lumber produced in the region. What forms might the increase take?

There has long been in the eastern and southern hardwood industry the so-called dimension stock industry. Dimension stock, in brief, consists of pieces of wood sawed and shaped roughly to dimensions slightly above those of the finished article. For example, the finished article might be a turned chair leg. The piece manufactured for the final turning would be square, slightly larger in diameter than the finished article, of approximately the same length, and not dressed. The chair manufacturer takes this piece of wood, turns it according to his desire, sands and finishes it, and incorporates it into his chair.

This particular form of manufacture has assumed large proportions and will probably grow. It grew in the hardwood industry largely because of the fact that so much hardwood is knotty and a considerable amount of cutting has to take place in order to obtain even small pieces of clear stock. Many mills manufacture random length oak flooring from material that people in the West regard as junk, and one plan manufacturing flooring in lengths ing from 8 inches to 16 feet and n a fine product and money.

In recent years there has been siderable development of this s manufacture in softwoods, both i region and in the Northwestern One plant in Washington, which center of manufacture for abo small plants scattered around ove gon and Washington, cuts blanks slabs that were on the way to the er. These little tributary mills c raw stock from slabs picked of chain, ship it to the central plant it is kiln dried and cut into the r sary sizes and shapes for further n facture. This plant is turning out items as mop handles, bed slats, for wooden toys, drawer ends, Ve blind tops, sides, and bottoms, a host of other items. It is even eng in the manufacture of numerous items where small sticks are side and further shaped for the consu needs.

The significant thing there is large labor input that is going into terial hitherto wasted. The second nificant matter is the potential u short lengths that have in the past of no significance to the softwoo dustry. This particular operation is suming about 100,000 board fet of ber per day.

Indicative of the value of such m facture is another operation in Or where woods waste that has us been left on the ground is the raw terial. By the use in the woods small, semi-portable sawmill tha cutting 8-foot cants and lumber, operator has recently recovered 2½ lion feet of usable lumber from 80 of fairly recent cut-over land. Mo the product is going through his remanufacture or cut-up plant for production of similar cut-up stoc that referred to before. Here are proximately 30,000 feet per acre of merly waste materials being turned manufactured goods taking a high labor input and returning real value to the enterprise. In former years the articles that are now being manufactured from this material would have been made from 16-foot lumber and unless the cut-up plant could have obtained satisfactory 16-foot lumber locally, the remanufacture would probably have been done somewhere else, possibly in the Middle West or the East. There seems to be good logic from the point of view of good forestry and from the point of view of good economics in encouraging the development of such industries in the Northwest and the Inland Empire.

A great deal has been said in various places about the approach of a period when laminated products would take the place of large timbers for construction purposes. Technically, great strides have been made in the production of timbers and shapes by the process of laminating and gluing. Great impetus was given to this industry by the necessity for its development during the war and by the formulation of new glues. It does have considerable promise in its ability to use short lengths and small dimensions to build up large members. Fortunately, industries in Oregon and Washington are developing a laminating industry. High strength wood can be placed in glued laminated timbers in portions where strength is needed, and lower grade, knotty lumber can be used where bending strength is not critical. Second-growth stands, in general, are not going to produce much clear material unless they are grown with that end in view. When needed, laminated timbers can also be produced with properties which excel those found in solid pieces cut from the tree. An interesting example is the larch mine guides which were glued with phenol-formaldehyde resins, which have now been in experimental use at the Anaconda Copper Mining Company at Butte for nearly two years. In these guides interior plies are placed to provide partial end grain on the wearing surfaces. The guide wears better and its useful life is considerably extended.

In the Inland Empire small industries are making fruit boxes from such material as white fir. There is some slicing of box shook from blocks of white fir. Slicing of box shook from Douglas-fir is now under way in Oregon. Box shook from lodgepole bolts is also manufactured by the use of a shingle saw. These are definite indications of an important trend—the use of formerly rejected species for the manufacture of a material of great importance to the Northwest. You are undoubtedly aware of the fact that the box situation in such areas as that surrounding Wenatchee is considered critical. Certainly, there appears to be good reason for the further development of industries manufacturing box and other useful lumber from white fir and lodgepole pine.

There are ample opportunities for the development of a veneer industry in this region based on larch| Recent experiments at the Forest Products Laboratory have shown that larch does cut a good rotary veneer and there seems to be no insurmountable obstacle to its use in plywood manufacture.

So much for the ways in which industries can be developed further that are based upon wood manufactured as wood.

There is one economic matter which should be considered briefly. It has to do with marketing. It has perhaps plagued the hardwood dimension stock industry as much as anything else. Here is a mill. It has waste material. Technically, it knows how to manufacture cut-up stock from its waste. Somewhere in the Middle West or the East is, shall we say, a manufacturer of toy furniture that needs just what this chap could manufacture. How could they be brought together? Usually they are not. The solution probably will be found in a marketing organization for softwood cut-up stock—an organization big enough to cover the marketing field and know where purchasers are, but also familiar with the supply situation and

with authority to allocate production to its members. This is barely touching on a very large subject, but it is important.

MODIFICATION OF WOOD PROPERTIES

Let us consider only two important, comparatively recent developments. You are all familiar with the development of "compreg" by the Forest Products Laboratory. This material was built up of thin plies of softwood that had been impregnated with the components of phenol-formaldehyde resin, then subjected to heat and pressure. It is now hard, very dense, very strong, almost completely impervious to the action of moisture and capable of taking a very beautiful finish. It is also expensive. For certain specialty uses it found wide application during the war. It will no doubt also find wide application in peace. There is a limiting factor, however. Its present cost is high because cost of the resins with which it is impregnated is high. Someday somebody is going to find how to impregnate this material with a cheap resin and come out with a product of similar properties. When that occurs there will be a great impetus given to the manufacture of this or similar material.

There is a cheaper material that can be made from white fir or larch or aspen or alder, or any other of the softer, weaker woods — wood when at the proper moisture content and heated to the proper temperature is semi-plastic and can be compressed without impregnation with resin. It can be compressed to a density of about 1.3, will be very hard, very strong, and of great use value. It is not as resistant to the action of water as compreg. In fact, it will swell and shrink in about the same ratio as would a piece of ordinary wood of the same dimension, but it does so very much more slowly. Therefore, it would seem to have quite definite usefulness for flooring or interior trim where hardness and resistance to wear are desirable properties. This product was developed at the Forest Products Laboratory. The Western Pine Association Laboratory in Portland has improved it.

Other important research on meth of stabilization of wood against the a tion of moisture is in progress at t Forest Products Laboratory. This, you can well believe, is a field of gre importance because the tendency wood to shrink and swell with chan ing moisture content has always mi tated against its usefulness in sor fields.

CHEMICAL TRANSFORMATION OF WOOD

Perhaps the most familiar products this sort of operation are in the fie of pulp and paper. Fundamentally, mc of the processes for the manufacture pulp, except those that are purely m chanical, depend upon the dissolving the lignin portion of the wood and t leaving in solid form of the cellulo portion. Depending upon the degree purification to which the cellulose po tion is subjected, the yield of pulp m vary all the way from around 40 p cent to as high as 80 per cent. In b tween the small yield of practical pure cellulose and the large yield li a heavy percentage of materials th includes the hemicelluloses, certa forms of extractive materials, and whole host of substances small in qua tity.

This region has an abundance of go pulp species. Engelmann spruce, whi fir, and lodgepole pine, are promine in our thinking. One may ask, the why pulp industries have not develope A principal deterrent has been the ma ter of stream pollution. As generally o erated, the sulfite pulp industry h discharged huge quantities of pollut water. It could not be tolerated in t Inland Empire. The sulfate industr making mostly kraft pulp, has fou cheap, easily accessible, and abunda raw materials in the South. In spi of these disadvantages considerab pulp wood has been shipped from Mo tana to pulp mills in Wisconsin a Minnesota. The question logically aris as to whether or not pulp industri ought to be established in the Northe Rocky Mountain States.

That question cannot be answer

here. Suffice it to say that the whole matter is being given thorough study. Processes of sulfite pulping are available in which stream pollution is reduced to practically nothing. Certain new pulp processes are under development at the Forest Products Laboratory and elsewhere that appear promising from this point of view. Very probably within a few years there will be pulp mills in these States.

Before leaving the pulp field, we should discuss briefly two interesting developments. First, there is a rather new material for construction and engineering developed from paper during the war. It is called papreg. It is made of sheets of paper impregnated with phenol-formaldehyde resin, then subjected to heat and pressure. This forms a tough, hard, strong sheet that can be molded into many shapes and machined into many others. Again, this is not a cheap product but it is a very promising specialty. One present use is as flooring in house-trailer construction where high-strength, light-weight material is the primary requirement.

Generally speaking, wallboards, whether for construction purposes or for use as insulating board, have some desirable properties and some not so desirable. If they are soft enough to be of any value as insulation, they are usually too soft to hold a nail or contribute much in the way of strength to the structure. Also, they have been just a little bit selective with respect to the kind of wood that could be incorporated in them. But there is a new type of board. The process by which it is made is pretty old. Patents covering it were taken out over 20 years ago. Technicians at the Forest Products Laboratory recently reexamined these old patents and developed this board which is made from hogged fuel. Similar boards are made from straight sawdust or other wood waste. The binding material is a highly hydrated wood pulp, nothing else. It has what appear to be good properties. We have not yet finished the testing of the various types of boards that can be made this way. The process seems to be promising, and it is hoped that there will be no patent restrictions on its use.

An interesting feature of this board is the possibility that it can be produced in quite small plants. It is also adapted to manufacture in large plants. We cannot tell at this point which sort of operation will be most feasible. Certainly, there appears to be the possibility that the small manufacturer can set up extra labor cost against the high equipment cost of the large manufacturer and maybe hold on even terms. We don't know. Time will tell.

In discussing the widely varied field of chemical transformation of wood, let us mention an interesting process for seasoning lumber recently developed by the Laboratory of the Western Pine Association. This process depends upon the extraction of the water from pine lumber by the use of acetone or alcohol. In this process of drying the solvent removes considerable quantities of the usual mixture of fats and resins that comprise the class of materials referred to earlier, namely, a part of the fraction known as extractives. Apparently, in some cases and with some species of pine the value of extracted material will more than pay the extra cost of the seasoning process.

More recently this laboratory has also experimented with the extraction of the larger amounts of these materials present in the stumps of ponderosa pine and will undoubtedly also do similar work on white pine. In the latter cases the material for extraction will probably be chipped or hogged and placed in large vertical extraction vessels within a perforated basket and in this condition should be, after extraction, in excellent shape for further chemical work.

One of the things that might be done to such wood after the removal of the fats and resins would be to subject it to acid hydrolysis along the same line as that employed at the new Springfield plant of the Willamette Valley Wood Chemical Company.

This Springfield plant is designed to operate on the old German Scholler process by which wood in a percolator is treated with dilute sulphuric acid under high steam pressure and the carbohydrate content of the wood is practically completely transformed into sugar, leaving a brown amorphous mass as more or less degraded lignin as the residue. The sugar solution thus obtained is a mixture of six carbon sugars and five carbon sugars. The six carbon sugars, mostly ordinary glucose, can be fermented to industrial alcohol or to any one of a number of other important chemical materials derivable by fermentation from the hexose sugars. The Springfield plant is designed to manufacture industrial alcohol by this old process, radically improved by the research staff of the Forest Products Laboratory.

During the process of hydrolysis a part of the five carbon sugar content is transformed to furfural. This is recovered during subsequent stages of the process. Also, small quantities of acetic acid and methyl alcohol are formed. The latter is recovered during the rectification of the ethyl alcohol.

In the process, as it will be operated at Springfield, the still bottoms from the distillation of the fermented sugar solution will contain the five carbon sugars that have not been fermented to alcohol. Under the present setup these will have to be discharged and mostly removed by specially arranged filter beds in order to avoid contamination of the Willamette River. It is hoped that within the near future it will be possible to make installations that will avoid this wasteful procedure and transform this rather large quantity of pentose sugars into protein feed consisting of a certain species of yeast. The technique for so doing has been thoroughly developed through the laboratory stage. The plant as at present designed should produce about 15 or 16 thousand gallons of alcohol per day and when facilities are available 10 or 12 tons of high-protein yeast.

It is of interest, also, to recognize that in the process of fermentation to alcohol approximately 45 or 50 tons per day of carbon dioxide gas will be evolved from the fermenters. The installation at Springfield has been so handled as to permit the collection of this gas and its compression and formation into dry ice if that procedure is found economically desirable. The availability of this large quantity of carbon dioxide has already attracted considerable interest among concerns that engage in the packing and shipping of fresh fruits, vegetables, and fish from the West Coast. The rapid development of air transport of perishable freight may lead to the rapid utilization of this raw waste material.

It should be recognized that the primary raw product from such a process of wood hydrolysis is a crude solution of sugar. The further elaboration of this industrial raw material can take any one of numerous courses. It can, for example, all be transformed into high-protein yeast as well as can that fraction not fermentable to alcohol. In this case, of course, the production of protein feed from a plant of the size of the Springfield plant would probably reach the magnitude of 50 or 60 tons per day of dry yeast. It is hoped that pilot-plant facilities for yeast production can be installed soon at Springfield so that semi-commercial procedures for this process can be thoroughly developed, the economics of the process thoroughly analyzed, and sufficient material produced for the carrying out of adequate feeding experiments by the various State Colleges of the Western States. The aim is to develop plans for much smaller plants than the one at Springfield; for example, a single percolator unit instead of the five-percolator unit at Springfield with a yeast plant geared to that amount of production. Such a plant would probably consume in the neighborhood of 50 or 60 tons of wood waste per day and produce in the neighborhood of 12 tons of dry yeast. Because of its much smaller capacity, it could be installed at mills with comparatively small cut or in a community where there were several small mills from which wood waste could be made available.

In the long run it may be that this sort of development will be of the utmost importance to the West because, as you are all aware, this is an area of chronic protein deficiency. The turkey industry in Oregon and Washington alone is capable of consuming 100,000 tons per year of protein feed.

One more possibility that should be discussed, especially in the Northern Rocky Mountain States, is the possibility of industries founded upon a peculiar property of Western larch. This wood contains up to 20 per cent of a substance known as galactan, a water-soluble carbohydrate that is composed almost entirely of the sugar galactose. Galactose can be oxidized to mucic acid for which some market has existed in the past and for which a greater market could probably be created. A small industry was attempted some years ago in Montana for the extraction of this material and its oxidation to mucic acid. Perhaps such an industry will be more profitable if adequate provision is made for integration of other forms of byproduct utilization with mucic acid production. For example, it is conceivable that hogged larch could be packed in percolators similar to those in use at Springfield, the preliminary extraction with hot water being given to remove the galactan and then the residue subsequently hydrolyzed by the same process in use at Springfield for the production of a crude sugar solution. No pilot-plant installations known to the writer are at present using such a combination of processes.

In all these hydrolytic processes solid lignin is the residue. For the present no higher uses for it are available than as a mulch in nurseries and truck gardens or other purposes in which its physical form and general chemical make-up are satisfactory. Considerable work is in progress at the Forest Products Laboratory and elsewhere on the utilization of this material, and it is hoped that in the long run production from this source may become sufficiently profitable to help defray the general cost of operation. For the present, with alcohol prices at extremely high levels and supplies of other raw materials for alcohol at extremely low levels, the economic success of the Springfield plant does not seem to be much in doubt. What the future price of alcohol may be is anyone's guess, but our best calculations indicate that the Springfield plant will be able to hold its own in whatever may turn out to be normal conditions. If the byproducts of the plant come along as well as expected, it will do very well. Neither can one forecast the requirements for alcohol in this country very accurately.

These are only a few of what seem to be the most important possibilities for the establishment of wood-using industries in the Inland Empire. Waste utilization, as far as wood is concerned, cannot develop except upon the basis of primary wood-using industries that produce waste. This means that if a wood-using economy is to develop to its fullest extent in this or any other region, it must be based upon the production of quality lumber and similar products such as plywood and, on some lands, pulp. These primary products must carry the costs of growing trees, building access roads, and harvesting. The waste produced in growing, logging, and manufacturing will be far more than enough to provide the raw materials for many of the industries capable of using them.

Fundamentally, sustained yield of high-grade primary forest products should be our aim. There will be plenty of low-grade material upon which to base byproducts manufacture.

FOREST PROTECTION IN THE SILVICULTURE OF WESTERN WHITE PINE FORESTS

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Until about twenty years ago, forest protection was considered an integral part of silviculture. But in more recent years, with increasing specialization in fire, insects, and disease control, there has been a tendency to consider protection as a separate phase of forest management. This trend, unfortunately, has occurred at a time when silvicultural practices have become more intensive. Only by a correlation and integration of protection, economics, and silvics can a sound practice of silviculture result. The purpose of this paper is to show how important forest protection is in the silviculture of Western white pine forests.

Control of Forest Insects

Under an extensive type of silviculture, insect control must be direct. It has been demonstrated that timely and adequate application of insect control measures will usually keep infestations in check and reduce losses. The aim in direct control is to keep infestations endemic and to prevent the development of epidemics, which once under way are largely uncontrollable. This is the type of insect control we have had in white pine forests in the past.

Meanwhile, the forest entomologists have been insisting that the most promising form of control is through prevention of forest conditions favorable to the starting of epidemics. James C. Evenden of the Forest Insects Laboratory at Coeur d'Alene has told us many times that Western white pine becomes more susceptible to bark beetle attack as the result of overstocking which taxes the wood producing capacity of the soil. He believes that the overcrowding of stands is generally responsible for the development of bark beetle epidemics. When a general infestation of bark beetles develops, differences in individual tree susceptibility largely disappear. Hence, the most promising method of control consists of preventive measures aimed at keeping stands vigorous. This points to the use of partial cuttings which remove low-vigor trees, free thrifty trees from competition, and maintain stand vigor.

Partial cutting is a relatively intensive silvicultural measure. Because of economic reasons, it has not been practicable in the past in the Western white pine type. But recent developments such as truck logging and the greater utilization of mixed species make these cuttings economically possible.

Some measure of the practicability of partial cuttings as a means of harvesting trees which would otherwise be lost to insects and disease is given by results of three of our tests of very light cuttings. Two of these tests are located in 180-year-old stands on the Deception Creek Experimental Forest and one in a 130-year-old stand on Rapid Lightning Creek on the Kaniksu National Forest. The average five-year loss by insects, windthrow, suppression, etc., in comparable uncut stands has been ninety board feet per acre per year. In the lightly-cut stands, which averaged fifteen per cent volume removed in cutting, the loss has been fifty board feet per acre per year. Of the trees twelve inches and larger which have died on these test areas during the last five years, sixty-five per cent have been trees of poor and fair vigor. These re-