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FOREST PRODUCTS LABORATORY

In cooperation with the University of Wisconsin

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FIFTY YEARS AHEAD - A Research Viewpoint

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FIFTY YEARS AHEAD -- A RESEARCH VIEWPOINT[1]

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Mr. President, members and guests of the Pacific Logging Congress:

It is said that a prophet is not without honor save in his own country; in other words, the farther away from the home base, the bigger and better the pronouncements a speaker is allowed to get away with. So today as I stand here on Canadian soil, meeting old and new friends, and enjoying the wonderful hospitality of our neighbor country, I want you to know that I appreciate this license to prognosticate freely and to forecast coming events as they appear to a United States Forest Service research man.

But in assuming the robes of a soothsayer, which I am wearing this afternoon through your courtesy and indulgence, let me excuse myself in advance from any attempt to foretell exact occurrences, to predict categorical happenings, or to prophecy by the calendar. Such "propheteering" as I may attempt I ask that you understand only as a presentation of some broader trends that seem inevitable and some factors related to them that in all probability will significantly affect developments fifty or more years hence.

The West Coast logging and lumbering industry represents a gigantic development in capital invested and labor employed, with contacts and ramifications in every economic activity of the region. Broadly speaking, your problem for the long-range future is, how can your forest resources be handled and your wood industries developed to support permanently and to enlarge such an economic structure? If, in step with expected trends, the population of the

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[1]Address delivered before Pacific Logging Congress, Vancouver, B.C., Oct. 25, 1935.

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Pacific Coast as a whole materially increases, what quota of employment can the forest resources be made to support?

Changes Are Inevitable

Probably the safest prediction that I could make this afternoon is that fundamental changes lie ahead of the logging, lumbering, and other wood industries of the West Coast — changes not necessarily different in kind from those confronting other regions, but more dramatically focused and more sharply defined.

The first and most obvious factor operating in this direction is the changing character of the forest stand. Past and present cutting methods are changing radically the diameter composition of the future stand. In the Pacific Coast forest of the future, small-sized trees will predominate. A few decades will largely see the end of the big stuff, and the western industry will have to join the rest of the country in realizing on what nature has supplied in the way of regrowth.

The second factor is that the available forest resources can be made to sustain an annual growth which at least in volume may equal or even exceed the predepression cut. It would seem to be well within the power of the region to provide itself with a permanent and adequate supply of forest material for the maintenance of large forest industries, even though this supply must be different in size and quality from what has been available in the past.

A third main factor that will affect future operations will be continuing competition in the wood products market. Of course, as population grows and a more widely distributed prosperity is achieved, we may look forward to a more bountiful use of wood products, along with other commodities.

But, on the other hand, if other regions nearer to the large consuming markets succeed in rehabilitating their depleted forest resources, while simultaneously your large-size high-quality timber disappears, you may find this regional competition, particularly in the structural field, more acute than in the past; and it hardly seems likely that there will be a cessation of development and competition in the case of so-called substitutes for wood.

Basically, it is final cost and serviceability to the ultimate user that will determine the success of industry in the face of all kinds of competition; and while serviceability, or quality, is largely subject to technical control and development, low cost hinges in a critical degree on CHEAP AND ABUNDANT RAW MATERIALS AND PERMANENCY AND STABILITY OF OPERATIONS.

Abundance of raw materials has given the Pacific Coast's wood industries marked advantages in the past. Whatever the form or the volume of production in the future, the pressure of competition will necessitate the maintenance of the lowest possible level of raw wood costs, and stable rather than migrating operations. It is easy to see that these factors will work somewhat against the private ownership of great bodies of valuable stumpage.

The fourth factor, which arises directly from the preceding one, is the trend toward public ownership of forest lands and public aid to private owners. Regardless of our individual views and of shifts in political currents, the impact of economic and social factors seems headed, through one process or another, in that direction. While there is a great variety of influences involved in this tendency, if public cooperation in land ownership is once accomplished in a large way, and if adequate administration of the holdings is provided, it would have the distinct advantages of easing

the land situation, of ending migration and giving stability to the utilization industries, and of insuring them a continuing wood supply at the lowest possible cost.

The trend to shorter hours and higher wages for labor presents a fifth factor which we can hardly expect to diminish in the future. A man-day of work promises to become more expensive as time goes on; the question the industries must face is whether the labor cost per unit of product is going to increase also. The answer depends on two things — what the product is, and how the product is made. From a recent publication of the West Coast Lumbermen's Association it appears that the lumber dollar last year lacked 25 cents of being big enough to go around, while at the same time the labor share of that dollar was just over fifty cents.

Is the workman taking too much, or are we somehow handicapping him with inefficient means of production? If the trend toward greater man-per-hour production is a fundamental element in higher wages and higher standards of living, what does that mean for the future of logging and lumbering? Output per man in the lumber industry was not materially higher just before the depression than it was in 1899, whereas there was a gain of 24 percent in the iron and steel industries, 58 percent in stone, clay, and glass, 62 percent in paper and printing, 120 percent in nonferrous metals, and over 1,000 percent in motor vehicles. It is a known fact that labor absorbs a larger proportion of the total production costs of lumber than it does for other basic materials that compete with lumber in the construction field. All this points to the need for greater mechanization in the

wood-utilization industries, from tree to finished product; also, along with efforts to rationalize lumber production methods, there is need for a conscious development of other products, in which improved mechanization and technical methods may count more heavily and more effectively.

Finally, we must take account of a sixth and closely allied factor — the greater economic and social values arising from the production of refined rather than simple or crude products. Number of employees and wages paid are a better guide to the importance of an industry than the mere bulk of material used; and while the normal lumber industry still ranks first among the wood-using industries in number of wage earners, that does not tell the whole story. For example, a given quantity of wood, if converted into paper, will provide employment for nearly three times as many wage earners as when converted into rough lumber; and if converted into rayon there will be nearly sixty times as much employment.

Forest-Utilizing Operations of the Future

Let us now try to visualize the kind of operations that offer the greatest promise of continuing success in the era ahead.

First, it seems likely that the economic benefits of concentrated operation on a limited area will be realized more fully then in the past. With migratory tendencies reduced or eliminated, and with governmental encouragement of sustained-yield practice, the trend toward stabilization should be marked.

Secondly, since the time and cost of growing a crop of timber will be clearly recognized, there will be a definite trend toward salvaging all values possible from parts of the tree that now fall to waste in woods

and mill.. Utilization should become more intensive in many lines. Forest industry should become more broadly diversified and yet more closely integrated, with the sawmill, the veneer mill, the fabricating works, the pulping plant, and the chemical factory forming a multiple hook-up centered on realizing maximum values from timber of the size, quality, and cost that will be available. Generally speaking, large capital investments released from timber holdings may be advantageously applied to conversion plants of even higher mechanization and technical organization than are now common.

Stabilization! That means that the utilization industries will make themselves at home with the trees. The growth, development, and harvesting of a forest crop will be as much a part of the day's work as raising corn is to a farmer. Considerations of quality and rate of growth of young timber will begin to take on importance of the same order as measuring a ripe stand for cutting. Better utilization will tend toward the removal of restrictions as to species, and questions such as the proper adaptation of species to site will assume serious practical interest. Experimental findings relative to wood growth and quality will pass into realistic application, and it is quite possible that blocks of timber will be grown under controlled conditions to meet particular quality requirements -- Block "A" close grown for high summerwood content, density, and strength; Block "B" in open stand for rapid diameter increase on a pulpwood rotation; Blocks "X," "Y," and "Z" given over to special biological strains or varieties developing certain types of grain, figure, extractive content, and the like.

Silviculture will step out of the textbooks and into active life, because the forest will no longer stand waiting simply for the faller's ax but will be young growth subject at all stages to intelligent management. The work of woods crews will begin to pay for itself as thinnings find their way into profitable conversion products and as the timber stand responds to its care in terms of improved growth and properties. An activity that is inconceivable today will become widespread practice: namely, pruning. The fruitless decades spent waiting for stubborn growing stock to shed its spikes and get down to the business of putting on merchantable wood will be short-cut by the direct action of men with power-driven pole saws getting results worth dollars per hour from their work in the final value of the tree.

With a forest stand very different in character from that seen in the past, and with the sustained-yield objective in the ascendant, logging methods are due for radical changes. Permanent rather than temporary operations, quick regrowth, and the shortest practicable cutting cycle will be required; hence logging practice will have to provide both for removal from the forest area of the material that should be taken and for the protection of the growing stock that must be left. Perhaps further developments in tractor and ground-line logging or a combination of the two will offer solutions.

In the milling of the logs also important changes may be expected. There will be an evolution away from the very big mill geared for maximum production from old-growth logs and the development of a larger number of units to operate on small logs to be cut not only for lumber but for dimension and other parts adapted to built-up structural processes.

I believe there will even be a definite place for a truly efficient small portable mill to be readily moved and operated to handle scattered lots of raw material that will be available.

Laminated and Composite Material

To those nurtured in the tradition of great forest timber of unlimited size and prime quality there may be something inherently unattractive in the conception of structural members built up more or less laboriously from small stuff. Yet smaller sizes of trees in the future will mean just that. With logs too small to furnish one-piece structural parts of the dimensions required, economical ways and means will have to be found to cut and build large members from small material. This is not a new principle by any means; it has been the automatic trend in construction ever since men learned the use of tools and grasped the elements of practical engineering. The concept of this development which looms more and more important and necessary for the future visualizes built-up posts and columns, glued laminated beams, glued laminated arches of varied forms and sizes, chords and web members of heavy trusses made up of several pieces assembled not with glue but with modern mechanical devices, and, finally, entirely new types of frame buildings, towers, and bridges utilizing relatively small dimension material and made possible through the use of modern connectors and more efficiently nailed and bolted joints.

Closely allied to the foregoing is the growing trend in the development and use of plywood as a structural material. Factors in its favor are its strength and nail-holding ability, the uniformity of its

properties, the large light-weight units in which it can be used, and the relatively small waste attendant upon its manufacture. The Pacific Coast is already doing much in the development of plywood for the structural field, but there is an increasing need to determine scientifically all the properties of plywood as an engineering material and how they are affected by the quality and dimensions of veneer, the number of plies, manufacturing technique, and other variables. Back of all this and of vital significance to the future is the need to determine the limiting factors in the cutting of veneer from logs of the smallest size and poorest quality possible. Little is really to be gained, from the long-range viewpoint, by the development of a greatly enlarged plywood industry if it can only survive on the large-size high-quality logs which, as a class, will not be available in the future.

Wood Prefabricated Construction

A large part of our lumber production now finds a market in the housing field, and it is safe to say that we hope to enjoy that market in the future. We are faced today, however, with a distinct trend toward the mass production of prefabricated homes and other small buildings. Throughout the country there is an increasing recognition that if home building could be developed in a manner comparable with what has happened in the last generation with automobiles, it would largely solve the big problem of better homes at greatly reduced costs. Units or panels, shop fabricated, light enough to be readily handled, transported, and easily assembled at the site, well insulated and weather-tight, are the order of the day.

Other materials are pressing into the market through the development of such building units, and it is only through well-directed, intelligent effort that wood can hold an important place in this inevitable evolution.

Aside from its relation to the volume of future markets for timber products, the mass production of houses has an important bearing upon the character of the material that will be availalbe in the future. Present tendencies would indicate that small-dimension stock and sheet materials such as plywood will be very much in the picture. As the prefabricating idea grows and develops, it will necessitate improvements in glues and gluing, in painting, fireproofing, heat and sound insulation, and the prevention of moisture infiltration and transfusion through the walls, roofs, and floors.

Wood Chemicals

In the chemical utilization field it is the composition rather than the physical properties of the wood that determines its value as a raw material, and size is of much less importance than in the lumber and structural field. All woods may be roughly described as composed of 25 to 30 percent lignin, about 45 percent cellulose, and the rest mostly cellulose-like carbohydrates, with a few odd chemical groups like methyl alcohol -- acetic acid sticking to them. The cellulose is the main constituent of value in making the chemical pulps that go into papers and the various modern products such as rayon, cellophane, films, lacquers, and explosives. The cellulose-like carbohydrates are the main source of methyl alcohol and acetic acid as obtained by destructive distillation. Lignin remains a chemical mystery; little is known of its composition, and few and only unimportant chemical wood products have in the past been made from it.

There are other diversified chemical wood products such as oxalic acid, acetic acid, methyl alcohol, ethyl alcohol, medicinal creosote, tanning extracts, dyes, wood preservatives, baking powder, guaiacol, toothpaste, and charcoal. Most of them are now being made commercially, although in a small way; others, such as furfural, protocatechuic acid, pyrocatechin, butyl alcohol, cresol, pyrogallol, glucose, mannose, and xylose, either can be made cheaper from other raw materials or there is no market for them. It must be admitted that from the point of view of large-quantity utilization of wood such products as these are not especially important.

There are, however, certain products from wood employing chemical processes in manufacture that give promise of future large-scale utilization. Among these, pulp products take first rank.

Pulp and Paper

Everything points to a greatly increased future demand for pulp and paper. Approximately 95 percent of the production now comes from wood; there is no agricultural crop that looms as a serious competitor; there has been a consistent and striking increase in consumption aggregating 300 percent in the past generation; and the forces which have produced this expansion seem destined to remain for a long time fully operative in force and effect -- increase of the reading public, increasing use of disposable service goods of all kinds, increasing use of package merchandise, and similar expansions in other directions.

In terms of pulpwood, the United States at present consumes annually from 12 to 15 million cords for its pulp and paper requirements. The Forest Service has recently indicated a probable future requirement of 25 million cords, with a suggested ultimate production quota assigned

to the Pacific Coast, including Alaska, aggregating 7 million cords. In round numbers, this would mean employment for some 70,000 people -- more than sufficient to replace curtailed employment likely to occur in the logging and lumber industry because of depletion of large saw timber.

The striking growth of the pulp and paper industry on the West Coast in recent years is in itself a strong indication that this potential use of your future forest resources will not be overlooked.

Rayon

The striking growth of rayon production, which has shot up in the last 25 years from practically nothing to about 100,000 tons, annually, has caused considerable speculation as to its possible future significance to forest industrial developments. Let me briefly clarify the situation.

About 75 percent of the present production is made by the "viscose" process from high-quality alpha-cellulose wood pulp, which is dissolved and then turned into silk-like threads adapted for textiles. About 200,000 cords of wood are required for this current production. The cost of the alpha-cellulose pulp is around 5 cents a pound.

The remaining 25 percent is made from cotton linters by a different process which similarly dissolves the cotton cellulose and turns it into threads for textiles. Staple cotton is neither needed nor cheap enough for this purpose. The southern cotton growers are having hard sledding even with cotton at 12 cents a pound; obviously staple cotton for rayon cannot compete with alpha-cellulose from wood at 5 cents.

Since the supply of cotton linters is limited, amounting to 3 to 4 percent of the cotton production, and since there are other uses

requiring it, it seems clear that unless the future should bring an extensive enlargement of cotton production, a continued expansion of rayon will require increasing amounts of wood pulp. However, were present production all from wood, it would require only about 4 percent of the wood now used for pulp and paper production in the United States. While present tendencies seem to point to a considerably larger requirement in the future, they are reflected in the estimates of the Forest Service for future pulp and paper as noted previously.

Of even greater economic significance than the volume of production is the fact that the conversion of a cord of wood into rayon will provide 50 times as much employment as its conversion into pulp. Let us hope that in the inevitable expansion of production that is coming the Pacific Coast may get its full share.

Plastics

One outstanding hope for the economic utilization of small-size, low-grade, and waste wood is the possible development of low-cost molded products by mass production methods. While in recent years there has been a very active development of molded products from plastic materials of one kind or another, as yet none are commercially utilizing wood in any considerable quantity as a basic raw material, nor are the costs low enough to permit their use in large tonnage in the structural and building field. Recently, however, research has created within the laboratory such a product from wood waste by a simple hydrolysis process, followed by pressing in molds under heat.

The raw material costs range from $50 to $70 per ton ($30 to $60 per thousand square feet) for higher quality products and from $20 to $30 per ton ($12 to $18 per thousand square feet) for lower qualities. Even with reasonable allowance for other manufacturing costs, this development holds out much promise for future large tonnage utilization.

Ethyl Alcohol

There is one other chemical product that may at some time in the future prove of tremendous significance to the whole problem of small-material utilization. I refer to the possibilities of ethyl alcohol for gas engine purposes.

Ethyl alcohol compares favorably with gasoline as a motor fuel; it can be produced today by known processes from cheap coniferous wood, with a yield of 20 gallons per cord and at a cost not exceeding 20 cents a gallon. Current consumption of gasoline in the United States alone aggregates some 17 billion gallons annually. Those conversant with the oil situation predict for the not too distant future a depletion of our petroleum supplies, with a resulting materially increased cost for gasoline. Some authorities have stated that we will come ultimately to production costs alone, for gas engine fuel, of at least 15 cents per gallon -- possibly more. If these trends prove reasonably correct, and if research can improve the technique of ethyl alcohol production from wood to meet such production costs, there would be a potential alcohol market that would require more than 800 million cords of wood annually to supply!

Research a Vital Factor

I have enumerated some of the developments which seem to lie ahead if you are to make permanent and enlarge the great economic structure which you now have in your forest resources and logging and wood industries. But if such developments are to come about -- if the potentialities are to be converted into realities -- it will be through adequate research. That is what has brought expansion to other industries, including many of your competitors; it is the tool that you must increasingly utilize to keep pace with modern changing conditions. You can not afford to overlook it. I hope that you will recognize its importance and give to it your wholehearted support.