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R. Bruce Etheridge, Director

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A POSTWAR PROGRAM

For

NORTH CAROLINA'S FOREST INDUSTRIES

Survey by

EGON GLESINGER

Divisions of
COMMERCE AND INDUSTRY
AND
FORESTRY

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FOREWORD

by

GOVERNOR J. MELVILLE BROUGHTON

North Carolina ranks close to the top among the states of the nation in the volume and value of its forest products. Unfortunately, the State also ranks close to the top in the amount of waste and unnecessary destruction of its forest resources.

Leading manufacturers of lumber and pulpwood, officials of forestry associations and representatives of colleges and universities having forestry departments have given their wholehearted cooperation toward planning for a better program of forest utilization and conservation in North Carolina. Under the general supervision of the Forestry and Parks Committee of the State Board of Conservation and Development, a committee composed of manufacturers and forestry organizations appointed by the Governor has actively conducted a thorough survey and study of the State's resources.

This special committee was fortunate in being able to secure for the purpose of such survey the services of Dr. Egon Glesinger, of Washington, D. C., a noted expert in this field. Dr. Glesinger has a background of intimate knowledge and experience with the program of utilization of wood resources in European countries, particularly in Sweden, where perhaps the best rounded program in the world exists. On the basis of this experience and background and with the fullest cooperation on the part of interested and informed individuals and groups in North Carolina Dr. Glesinger has made a thorough study of our resources and has made specific recommendations to the committee.

Dr. Glesinger's report does not purport to be the last word on the subject nor do his recommendations come with any degree of finality. They are rather set forth as suggestions worthy of consideration. As such, I commend this report wholeheartedly for the careful consideration of all in our State who are interested in the conservation, utilization and manufacture of the forest resources of the State.

J. MELVILLE BROUGHTON
Governor of North Carolina

Author's Preface

This is a foreigner's report. I came to this country only three years ago. When I received Governor Broughton's invitation to make a survey of wood utilization in North Carolina, I had to reach for a map to find out just where I was supposed to go. Only months later did I discover, to my great surprise, that annual wood growth in North Carolina equals that of my native Poland, and that North Carolina's forest industries present an economic issue comparable in magnitude, and in fact somewhat larger than the forest industries of France or Czechoslovakia.

Since then, my ignorance has been somewhat corrected. In the course of my studies I have received the most generous cooperation, help and advice from

1. various agencies of the State of North Carolina
2. the staff of the Experiment Station of the U. S. Forest Service, Asheville, North Carolina
3. local forest owners, lumbermen and other forest industrialists
4. and a great number of foresters, chemists, administrators and businessmen.

I wish to express my heart-felt thanks to all these wonderful Americans and above all to my far-sighted friend, Henry Wilson, and the Drexel Furniture Corporation for having rendered this survey possible. I feel also deeply indebted to J. E. Coad, State War Industries Coordinator, for his enthusiastic efficiency in promoting new ideas.

Between October 1943 and December 1944, I have toured all parts of the State, so that there is scarcely a county where I did not set foot. I have also made a comparative study of forest industries in other Southern States. From these visits I have retained such a profound impression of the wealth of North Carolina's resources, the diversity of its industries, the beauty of its countryside, the pioneer spirit and the human kindness of its citizens, that I like to think of North Carolina as my second home. And yet it would be presumptuous to expect that a few months background could enable me to recommend changes of practices established by the work of generations, without sometimes missing a point or underestimating the importance of certain local factors.

On the other hand, the fact of being a stranger enabled me to approach my task unprejudiced by local custom. Familiar with the solutions applied to similar problems in Europe, I was particularly impressed whenever I found fundamental differences, and was more sensitive to the wastefulness of certain methods than a person who has grown up with them.

Compared to the dullness of qualified suggestions, the risk of being criticized for sweeping statements has impressed me as the minor of two evils. I have presented my conclusions as a series of recommendations, adding up to a postwar program for North Carolina's forest industries. But despite this ambitious title, my main purpose was to draw attention to situations which in my opinion should be corrected and to suggest along what lines the solution might be sought. I have not tried to be new and original; on the contrary, since I wanted to arrive at a

practical program, it is obvious that many of my proposals have been thought of before. Nor did I intend to tell the people of North Carolina how to run their business, but merely to acquaint them with the reactions and impression of an outside observer. It will now be up to them to put my recommendations to a practical test.

In that connection, there are already a few encouraging signs. In March 1944, a first draft of this report was circulated for comments. The response was in no way unanimous, frequently critical but remarkably active. By the end of 1944, information had reached both the author and North Carolina's Department of Conservation and Development showing that Governor Broughton's untiring efforts are beginning to bear fruit and that developments are shaping up along the lines recommended in this report.

In the course of 1944, one of the State's pulp mills has raised its output by 25 per cent; three out of four have announced plans for expansion as soon as war restrictions are lifted. A new pulp mill is planned. Several fiberboard concerns have started to search the State for suitable plant locations. In the summer of 1944, the U. S. Forest Service conducted an investigation which showed that enough sawdust could be concentrated in each of two areas to support three one-million-gallon woodsugar factories. Lumbermen are beginning to take steps designed to reduce or to salvage manufacturing waste. Mechanical logging equipment is being introduced to a growing number of pulpwood cutting operations. A large banking concern has advised the Department of Conservation and Development that it is prepared to take a financial part in the different projects suggested in this report. The trend toward an improvement and an expansion of North Carolina's forest industries has taken tangible forms; it is growing stronger every day.

Upon the initiative of the Forestry and Parks Committee of the State Board of Conservation and Development, and of the North Carolina Forestry Association, the Association's President (Dr. Clarence F. Korstian) called a conference on November 14 and 15 of this year in Asheville. It was attended by a representative group of State and Federal forest officials and by delegates of the major forest industries. The conference, called to explore the possibilities of group agreement on some measure of public direction of cutting practices on private forest lands, reached a common accord. It approved the text of a Bill which it felt deserving of general support in the State Legislature in the event its introduction should seem timely. In keeping with the purpose of the conference, its findings were transmitted to the Forestry Committee of the State Board of Conservation and Development and to the Executive Committee of the Forestry Association. No matter whether or not the details of the Bill meet all hopes and requirements, its presentation by all interested parties is certainly a great step forward. If such State direction were adopted and enforced it would build up the growing stock of North Carolina's forests to a point where their permanent yield would be sufficient to meet the requirements of a substantially enlarged industry. It would remove any possible doubt in the minds of investors as to the advisability of selecting North Carolina for the erection of new wood using plants.

Highly important among recent developments is the creation of regional forest products units by the U. S. Forest Service under a program designed to facilitate the practical application of research results obtained in the Central Laboratory at Madison, Wisconsin. Two such units—one in Philadelphia for New England and the East and one in New Orleans for the Deep South—have already been set up. Further units are contemplated. Their purpose is similar to the objectives of this report. But by being able to devote sufficient time to specific problems in given locations, to call on Madison for additional research and to arrange for the erection of pilot plants whenever necessary, these units will be able to go several steps further.

Forest conditions in North Carolina are distinctly different from those of the Northeast or even the Deep South. Yet it is my considered opinion that North Carolina is as full of attractive prospects for new forest industries as any State. It would therefore seem urgent to create a forest products unit, specializing in the study of problems common to North Carolina and to the neighboring States of the Mid-south and the Appalachian region.

If the evidence assembled in this report were able to start the ball rolling and to convince competent authorities of the need for such a forest products unit, a major practical result would have been obtained. Indeed, nothing less than a full fledged forest products unit would be qualified to carry on the crusade for better forest untilization initiated in North Carolina by the administration of Governor Broughton, a crusade of which this report is proud of having been a modest part.

EGON GLESINGER

Asheville, December 1944.

THE GOAL

From the tidewater swamps of the Atlantic to the ridges of the Great Smoky Mountains, there stretches a huge forest, the State of North Carolina. Centuries ago this forest attracted the first white settlers to the State. Their descendents cleared some 40 percent of the land for crops and industrial settlements and drew on the tree substance to build up, among other forest industries, one of the world's finest and largest furniture centers. At the end of the XIXth Century, the same forest induced George W. Vanderbilt to acquire the Biltmore estate and to established on its grounds America's first school of forestry.

Today the forest of North Carolina continues to provide its inhabitants with natural beauty, watershed protection for important hydro-electric power resources, employment for over 50,000 workers, fuel and raw material for a sizable wood industry. Yet wasteful practices and lack of integration have prevented this industry from achieving the results that could be expected. North Carolina's forest is still full of opportunities for new industrial ventures, more employment and higher output. The time is here for North Carolina to make another bold step forward, to lead the Nation toward a New Age of Wood.

With commercial forests covering 58 percent of the State territory, (U. S. average forest cover only 23.6%) North Carolina is as thickly forested as Sweden. Favorable climate and soil make trees grow fifty percent faster than in Scandinavia. Thus, on 18 million acres—one-third of Sweden's forest area—North Carolina raises annually half of Sweden's tree crop. Properly protected and managed, the State's forests could match Sweden's annual wood production.

Forests, Sweden's green gold, have constituted since time immemorial the economic backbone of one of the world's most prosperous and advanced nations. But in North Carolina forest industries rank merely as a poor third among the State's manufacturing groups. Tobacco and cotton each support an annual output of more than 500 million dollars. In 1938 forest products accounted for not quite 110 million dollars,[1/] half of which came from furniture,[2/] a secondary industry, while primary forest products aggregated altogether 55 million dollars, namely:

Lumber and other woodwork: 1.5 billion board feet, worth	$27.2 million
Pulp: 240,000 tons, worth	7.1 million
Veneer: 110 million board feet, worth	5.1 million
Tanning Extract: worth	2.5 million
Misc. Products: 5.8 million cords; worth	1.5 million
Fuelwood: worth	11.6 million
Total Primary Forest Products, worth	$55.0 million

1/ In this report, most of the statistical material concerning forests and forest industries was taken from: "North Carolina Forest Resources and Industries," a recent publication by the U. S. Forest Service.

2/ The production value of furniture includes the cost of lumber used in making it. To the extent to which this lumber came from within the State, its value (maybe $3 million) is contained twice in the forest production total of $110 million.

War requirements have pushed up annual sawmill output to 1.7 billion board feet and pulp production to some 400,000 tons. But even these figures fall far short of what could be derived from an annual growth of almost 10 million cords of sound wood. To achieve a more adequate utilization of the forest resource, *here is the postwar goal I propose for North Carolina* (for details see Section II):

Lumber	1 billion bd. ft., worth	$18.2 million (1)
Fiberboard	200,000 tons, worth	10.0 million
Pulp	1,500,000 tons, worth	45.0 million
Sawdust Plastics	10,000 tons, worth	0.5 million
50,000 Woodgas generators, using 600,000 cords at $20		12.0 million
1 Wood Distillation Plant producing 1 million bu. of charcoal and byproducts, worth		0.3 million
1 Woodsugar Plant—making 3½ million gallons of alcohol and byproducts, worth		0.7 million
Veneer, Tanning, etc., unchanged		9.0 million
Fuelwood—5 million cords for homes and tobacco curing, worth		10.0 million
Total		$105.7 million

The essence of the program is a considerable expansion of pulp production and the establishment of a number of waste-using wood industries, coupled with a substantial curtailment of lumber output. It would result in doubling the prewar value of primary forest production and provide 10,000 to 15,000 new jobs in high wage paying plants. It seems reasonable to expect that these developments would be followed by a corresponding expansion of secondary forest industries, especially in the field of pulp and paper products. The total value derived annually from North Carolina's forest crop might then hit the 200 million dollar mark.

The proposed program is based entirely on the conditions and resources which I have found in North Carolina. Its effects would be to raise the efficiency of North Carolina's forest industries, to the level actually achieved in Sweden. This choosing of a foreign country as yardstick for an American production goal will obviously raise many eyebrows. Yet I was anxious to mention the Swedish parallel to protect my proposals against being dismissed as "theoretical speculation" or "something that has never been done before." There is indeed no technical reason why North Carolina should produce less pulp, lumber, and other goods from an annual wood crop of ten million cords, than Sweden would be getting from an equal amount of wood. Moreover, Swedish production methods lend themselves far better to comparisons with American conditions than is generally realized, since wages are high, raw material prices low. (Prewar wages: 25 cents per hour of forest work, the same wages as paid then in North Carolina. Prewar log prices at Swedish factory: $24 per 1000 board feet of saw logs, 5-7 dollars per cord of pulpwood).

(1) All values are based on 1938 prices.

The program is in line with the general trend toward increased chemical and reduced mechanical wood utilization. It is based on the fact that one ton of dry wood produces alternatively:

Fuel: yielding 8 billion B. T. U. = ½ ton of coal worth		$ 3.50
Lumber: 400 board feet	"	16.00
Pulp: ½ ton	"	30.00
Wallboard: 2000 square feet of hard board	"	80.00

But is there enough wood in North Carolina for multiplying pulp production (incl. fiberboard) by four? According to pulp operators, who have the greatest trouble in rounding up enough wood for present war requirements, the State's pulp capacity has already been reached, maybe exceeded. How then could one expect to find the additional 2 million cords, which our program calls for?

Above all it should be understood that the goal is to be achieved gradually. New uses, such as generators, should first be tested on a modest scale. Not all the additional factories need to be started simultaneously. I would indeed not advise to raise pulpwood processing capacity beyond 1 million cords at first (70,000 tons fiberboard, 600,000 tons of pulp) and this would only add some 400,000 cords to the latest pulpwood consumption figures. Yet the final goal should never be lost sight of; its achievement around 1960 should be the joint ambition of all concerned.

To my mind there will be no difficulty to secure all the wood needed for the program, provided the fifteen years of its gradual application are used for a thorough reorganization of forest practices, the restoration of growing stock and the general introduction of mechanical logging equipment. Moreover the program should be accompanied by a campaign designed to create more waste mindedness among forest industries and result in the integration of now separated forest and manufacturing operations, which in turn should make important wood quantities available for chemical conversion. Further, the anticipated curtailment in lumber production would reduce annual drain by 1½ million cords.

Sections III and IV of this report are devoted to a discussion of how all this should be done. The following table summarizes these proposals and shows what results—i.e. how much additional wood supplies—they should be expected to yield:

	Additional annual supplies
Forest Regulation (resulting in removal of unused hardwoods)	500,000 cords
Fire Protection	500,000 cords
Better Logging Practices	1,000,000 cords
Partial Use of Manufacturing Waste	1,000,000 cords
Salvaging of sawlogs and pulpwood now used as fuel	1,000,000 cords
Total	4,000,000 cords

1/ All values in this estimate are based on 1938 prices, which of course renders them less impressive.

SECTION I.

WHAT IS WRONG?

The potential supplies just listed represent over forty percent of North Carolina's annual wood increment, enough for raising the State's pulp output to six times the present size. Of course, I do not believe that every one of these new sources could be relied upon one hundred percent, nor would that be needed, since all the new uses listed in our program only call for 2½ million cords. But the margin of unused resources shown in the preceding tabulation is so large that it suggests one of two conclusions. Either my assumptions are irrealistic to the point of incompetence—a demonstration which I must leave to others—or else something is wrong with North Carolina's forest industries. And indeed, to my mind, it is.

Drive some 6000 miles through North Carolina's countryside as I did in the past year and you cannot fail to be impressed by the waste piles that mark the locations where the State's 3800 portable sawmills have worked and left.

Or visit a logging operation, not just on private lands but even in the National Forest, and the mess that faces you is bound to inspire the question whether forests are an exception to the rule, invented and demonstrated by American industry, that order and proper organization are the prerequisites of success. As a matter of fact, substantial amounts of pulpwood and other valuable materials remain on the ground and rot, after the loggers have left; under the law of practically every European country the removal of these leftovers has long been compulsory.

Add to these leftovers the chestnut giants of the Western mountains, killed by the blight, which should also have been salvaged long ago and you could scarcely conceive of a more fertile breeding ground for insect pests nor of a better tinder for the thousands of fires that destroy every year trees to the extent of 1 1/3 million dollars. Indeed a sad sight and an embarrassing monument of human negligence.

The discovery that much wood is wasted in North Carolina is, of course, by no means original. Nor are attempts to change that situation entirely new. Back in 1929 Axel H. Oxholm, then director of the National Committee on Wood Utilization (U. S. Department of Commerce), published a "Survey of Nonutilized Wood in North Carolina" which contains an excellent appraisal of lumber practices in the State together with a lot of sound proposals how to improve these practices. Yet today, fifteen years later, North Carolina's waste wood problem is still serious. Let us review then, what causes so much wood waste and what makes the salvaging of that waste so difficult.

Definition of Waste

The logical way to start this discussion would be to define the term "waste in forest industries". This however raises a host of theoretical arguments which are best avoided. The important point to make is that only around twenty percent of the tree crop reaches the consumer, and the rest is wastefully burned or lost in the course of logging, manufacturing and finishing operations. Few, if any, industries are working with yields that low; obviously there is an enormous field for improvement. Moreover, unlike other raw materials, practically all the wood that makes a tree is equally good raw material. There is nothing wrong with the 80 percent of the tree content that is discarded, except that accidents of manufacturing operations make them too small or too narrow for traditional mechanical uses. A large portion of all waste wood—if properly salvaged—could still be used for chemical conversion. There are also many technical devices for reducing manufacturing waste substantially below present American figures. Of course they all cost money and, for that reason, the right degree of wood utilization is not a stable rule but varies according to economic and technical conditions.

Hunch or Calculation?

It would probably not pay to use American forests as intensely as war conditions have compelled the Germans to use theirs. But just where to draw the line between use and waste cannot be left to hunch. It calls for careful calculations for each case and locality, repeated at frequent intervals and making due allowance for the indirect losses—such as increased fire hazard for instance—resulting from insufficient forest utilization.

Frankly, I have found few operators in North Carolina taking the trouble of figuring out whether they wouldn't be better off by being less wasteful. Take just one example. There are some thirty veneer plants in a radius of 100 miles from the North Carolina Pulp Company's mill at Plymouth. The owner of the most distant mill has recently installed a coal stoker and is selling all his veneer cores for pulp. Results: From 5 million board feet of veneer logs

1,400 cords of cores selling at $10	$14,000
Less replacement cost: 700 tons of coal at $7	4,900
Net Profit	$ 9,100

which represents probably an increase of 30% over the plant's average operating profit.

Despite smaller freight distances to the pulpmill and the present pulpwood squeeze, few of the other veneer plants have started to save their cores for pulp. The operators whom I questioned confess that they never thought of it or else explain at length that they need all their waste for fuel—both in the plant and as stovewood for the employees. Suggestions to use coal instead are brushed aside.

There is no end to examples showing how the myth of America's abundance serves as pretext for inertia. The amazing part about it is that not even dwindling profits have produced their usual effect. During the depression, lumber companies were among the heaviest losers. Since 1936 the profits in the lumber industry never recovered beyond half the average profit rate of U. S. manufacturing industries. Maybe it isn't so economic after all to waste three-fourths of the raw material in the forest and at the mill?

Measuring Systems

In all fairness it needs to be said that the measuring systems universally employed in American wood industries have not rendered the task of operators any more easy.

Saw timber is measured in board feet, pulp wood in units of varying size, fuel-wood in cords. One thousand board feet of heavy saw timber logs selling for say $25 correspond to 1½ units of pulp wood worth $18. One thousand board feet of small sawlogs may be equivalent to 3 units of pulpwood selling for $36. To determine these equivalents calls for rather involved calculations. The average forest owner has no easy way of knowing and comparing. His decision whether to sell a stick of wood for lumber, for pulp, or to leave it lying on the ground is just a hit or miss proposition.

Even worse is the American custom of handling sawlogs according to their hypothetical lumber yield and to disregard their actual volume contents. Many years ago when the log rules were established, their authors assumed that all logs are sawn into 1" boards and that 4" are lost in the course of the operation, which amounts to a waste allowance running from 35 to 70 percent. Since then, manufacturing methods and lumber sizes have changed, all waste is not necessarily useless, but the log rules tend to freeze the yields at this XIXth century level.

In Europe it is always the foremost concern of every lumberman to keep his waste coefficient below 40—sometimes below 35 percent; to watch his yields and to work for their gradual improvement. The American lumberman rarely knows his exact yields. In some of them the log rules even create illusions of perfect efficiency. Time and again, I was told by sawmill superintendents: "If you are looking for waste, there is nothing you will find here. From every 1000 board feet of logs, we are making 1100 feet of lumber. No Sir, we have no waste!"

Industrial Organization

The disregard for waste and an exaggerated idea of independence have resulted in industrial patterns which set a further obstacle in the way of closer utilization.

In Europe, every forest owner insists that certain cutting practices be observed and refuses to sell unless he is paid for the variety of products which his trees can yield. Forest laws protect the owner in these demands. Hence the lumberman, who usually handles the logging, keeps the sawlogs for himself and sells the rest—i.e. cull logs, thinnings and upper stems—to pulpmills, mines or fuel merchants, obviously at a profit. Most pulpmills in Central Europe get all their wood that way

and run no wood operations of their own. If they do, they arrange with lumber firms to receive, say, twice as much pulpwood as the cubic volume of the sawlogs which they give in exchange.

In North Carolina, the conflict between pulp and lumber industries is mistakenly looked upon as an inevitable feature. Few lumbermen realize that by confining their logging operations to sawlogs, they leave annually more pulpwood in the forest than the requirements of the State's four pulp factories. If these lumbermen made pulpwood, they would be far less disturbed by the competition of pulpmills for logs. Moreover the drain on North Carolina's young forests would be greatly reduced.

Technology

Of course it would be wrong to overlook in this discussion that the technology of closer wood utilization is a very young art.

Some fifty years ago, sawmills were the only large forest industry. What they couldn't use was good for fuel only. Gradually the pulpmills emerged as an outlet for logs too thin or too short for making lumber. For a long time, however, the pulp industry confined its interest to a few species and grades. It is only quite recently that pulp, fiberboard, plastics and a rapidly growing wood chemical industry have created uses for almost everything that composes a tree.

Lack of Markets

However, the knowledge of new wood uses is not enough. There must be factories applying these processes on a sufficient scale to offer a market for all the wood hitherto wasted. So far, the capacity of such outlets available in North Carolina is very insufficient.

This lack of outlets for low grade woods is taken by many observers as an expression of America's abundance. They interpret this situation as showing that there still is more wood available than needed and therefore dismiss it with such proud statements as "waste is the companion of abundance" or "there are many economies which we cannot afford to make". In my opinion, this has nothing to do with abundance but reflects an alarming industrial maladjustment, which has already resulted in a great dispersion of operations, typified by the State's several thousand portable sawmills. This dispersion means, however, that a factory, interested in rounding up substantial amounts of wood waste, would find it difficult to get what it needs. It might then happen, either that the factory is built elsewhere, or, that it organizes itself to use fresh logs instead of waste. In both cases, an opportunity for securing a waste outlet would be lost. And hence, there is waste because there are no outlets. And there are no waste outlets because the waste is not available.

This self aggravating process has reached serious proportions. Despite all appearances of abundance, the desirable grades are being overcut in North Carolina's forests; much forest land is poorly stocked and degraded. Let this pattern consolidate itself for another twenty years and no large-scale operator, who can help it, will go near the State border.

The New Approach

There is still time to stem that tide. Especially the reconversion era offers a unique opportunity for a bold new start. I therefore propose a three pronged attack:

Creation of new outlets .
Mobilization of additional wood supplies by better forest and factory practices.
Rationalization of existing wood industries.

In discussing my program, I will start with the new outlets because existing practices cannot be improved without their help. Moreover it is necessary to know the requirements before determining what kind of additional wood supplies should be made available and how much. Yet I am anxious to stress that, like in a military operation of that kind, each of the three attacks can only succeed if proper support is received from the two other fronts. This applies particularly to the need for better forest and factory practices. Indeed, unless additional wood supplies are made available by better utilization of the tree crop, the new outlets could easily render a bad situation worse. All proposals contained in Section II. of this report are made, therefore, under the explicit assumption that the measures advocated in Sections III. and IV. will be adopted simultaneously.

SECTION II.

NEW OUTLETS

Improved waste utilization stands and falls with the establishment of plants capable of using waste products. Since the waste quantities in question are large by every criterion, the plant program will have to be on a corresponding scale.

Almost everybody is likely to agree with such a general statement. But when it comes to practical application, I can see the enthusiasm of a good many people quickly fading away.

Foresters may well have a case for concern. Experience shows that industries initiated as waste users often finish up as additional consumers of regular logs and pulpwood.

Also, existing industries may consider the prospect of new plants with divided feelings. New factories mean new competitors for raw materials and markets alike, none of which makes business any easier.

Both hesitations are overruled by the undisputable fact that *relative scarcity is the only road that leads to intensified utilization.* Intensified utilization, in turn, means more money per acre of forest land. It renders conservation more necessary and more possible. Also, to make sure that this result is actually obtained, I am proposing public regulation of forest practices as a corollary to the industrial expansion program. (See Section III.).

Increased competition, on the other hand, forces industrial management to think and to work harder. Ultimately it results in greater efficiency. Moreover, if established industries wish to forestall excessive outside competition, they can do so by taking matters into their own hands. Indeed, every facility should be granted to induce business organizations established in the State, either to build the new factories themselves or at least to take a major interest in them.

It would be easy, but untruthful, to defend my expansion program by emphasizing that the new plants are to employ lowgrade materials for which the existing ones have no use. To be sure, my selection of new plants was determined by their ability to use hardwoods, cull logs, topwood and mill waste. But these plants will doubtless want to sweeten their pie with a certain percentage of higher grade woods and thus invade the hunting grounds of the older concerns. The outcome will be that old and new factories alike will use a mixture of first-grade cordwood and other less popular qualities and shapes. This is precisely the goal we are shooting for.

The war has demonstrated how exaggerated prewar specifications have been. Not all the wartime concessions with regard to raw material quality should be retained. But a full return to earlier extravagance is equally unnecessary.

One more preliminary remark. I have assumed for all my proposals that postwar America will be geared toward an expanding economy and reasonably full employment. In selecting the type of industries that

should be built, I have based myself on generally available information about the consumption trends for different commodities. It is clear however that a report of this kind could not include a detailed market analysis for each of the many items which it has to deal with. Nor would it have been feasible to discuss investment, equipment, cost of production and prospective sales receipts for every suggested plant and for a series of alternative locations; it is even questionable whether it would be proper to include such business details in a printed report of this kind.

I have tried of course to indicate as far as possible the general economic prospects of my proposals. It should also be remembered throughout the following pages, that North Carolina is favored by particularly good labor, water and soil conditions, that State taxes are low and large markets within easy reach. I have attempted to demonstrate that plenty of cheap wood could be made available for new industrial operations. It would seem therefore that economic circumstances are sufficiently attractive in North Carolina to warrant the undertaking of such surveys and investigations as prospective investors will want to make before going ahead. The State's Department of Conservation and Development is in a position to supply additional information with regard to processes, resources and locations.

A. Fiberboard Plants.

Synthetic boards are in value and quantity the most important plastic yet developed from wood. This fact is frequently overlooked because the public has not been taught to look upon these products as plastics. Yet hardboards and to some extent even insulating boards are ligno-cellulose plastics and to my mind lumber's heir apparent in tomorrow's world.

The exceptional success of fiberboard plants here and abroad confirms that belief. Essentially this industry offers the following attractions:

a) *High yields:* Around 80 percent of the wood contents are retained in the end product.

b) *Low raw material specifications:* Some processes can use a high percentage (50% and more) of lowgrade wood and mill waste and still produce good boards. Even bark is tolerated.

c) *A custom made homogeneous product:* Density, strength properties, finish and size can be adapted to the consumer's needs.

d) *Large profit margin:* The qualities of the product are such that it sells substantially above manufacturing cost, leaving a comfortable margin for plant improvements, advertising, research and profit.[1]

The rapid growth of this industry has led some people to wonder whether present capacity has not reached the U. S. market's saturation point. Output aggregates not quite 3000 tons a day, almost twice as much as in 1937, enough for an annual consumption of 20 square

1. One equipment maker, for instance, claims that hardboard now selling at $65 per 1,000 sq. ft., is being produced by his clients at a cost of less than $25.

feet per inhabitant. With heavy competition from rockwool and other insulating materials made of glass, gypsum, bagasse etc., would it be wise to expand capacity still further?

To my mind this industry has so far only scatched the surface. Latest figures from Sweden show an annual consumption of 60 square feet per inhabitant. American manufacturers are finding every day new uses for synthetic boards. Experts agree that a slight price reduction could win hardboards many new markets. Present demand for all types of synthetic boards is far in excess of supply. If postwar building comes any way near housing requirements, there is no reason why the market for structural materials should fall below present levels. Moreover, recent research has demonstrated that optimum insulation and heating cost economy call for several times the customary thickness of insulating panels.

There are several standard methods for making synthetic boards. The most successful process, so far, has been developed by the Masonite Corporation. Twenty years ago their plant at Laurel (Mississippi) started with a daily capacity of 150,000 square feet; by now it makes almost 2,000,000 feet a day. Masonite plants in Australia, Sweden, Italy and Canada have carried the success to the four corners of the earth. The gun explosion process in which this company specializes is more than a good method for making fiberboard. Recent tests have demonstrated that it is a fundamental wood chemical approach which holds great possibilities for the separation of industrially useful lignin, and probably a great many other chemical derivatives.

Another process is the semi-chemical separation of the fibers by the Asplund Defibrator, a method adopted by over 150 plants in the United States, Sweden and other European countries. The principal attraction of the Defibrator is the opportunity it provides for using slabs with bark and other sawmill waste. It can absorb up to 30 percent furniture waste.

A number of American manufacturers make their fibers by mechanical grinding. This process is cheaper than the more chemical approaches, but it can only employ full sized cordwood.

There exists yet no fiberboard factory in North Carolina.[1] Nearest is the Johns Manville plant at Jarratt (Virginia) which draws some of its wood supplies from the State. Fiberboard plants being ideally suited for using the hardwoods and the mill waste of which there is so much in the State, I believe that two factories should be planned. Special emphasis should be placed on hardboard best suited for using short fiber hardwoods and offering the brightest selling prospects.

One plant to be located on the Coast between Washington and Wilmington (probably near New Bern) could start with a yearly capacity of not less than 40,000 tons of boards, calling for an investment of three million dollars or more and requiring some 30,000 cords of raw material. Although pine cordwood is still available in that area, the new plant should base its program primarily on the 300,000 cords of

1. The containerboard manufactured at Sylva from spent chestnut chips is not a fiberboard.

black and tupelo gum growing annually in that section, on 3,000,000 cords sound cull logs, and on the surrounding saw mills which cut over 200 million board feet of lumber in 1942, offering a potential waste supply of some 80,000 cords. The new factory could thus be sure of finding ample raw materials for successive expansions up to many times its initial capacity.

The other plant could be established near the center of furniture industries and look to them both as a source of raw material and as a market for its products. Located somewhere between Hickory, Statesville, Lenoir and Morganton it could expect to find an annual supply of 75,000 cords of solid furniture waste, and at least another 25,000 cords of solid sawmill waste. In addition, the forests of Western North Carolina produce large amounts of sound hard and soft woods now burned for fuel. Starting with an annual capacity of 30,000 tons (cost around 2,000,000 dollars) the plant should be planned for using 10,000 cords of furniture and sawmill waste, plus 10 to 15,000 cords of hardwoods. It could be gradually expanded, with the growth of its markets, and endeavor to absorb ultimately some 50,000 cords of various manufacturing waste.

B. Sawdust Plastics.

The conversion of sawdust into plastics that sell for 50 cents a pound is the postwar dream of every furniture and lumber man. Few of them are aware that sawdust plastics are confined so far to the lower price brackets around 10 cents a pound and that the high-grade plastics which will dominate postwar markets—insofar as they will use a wood base—are likely to be made from acetate and other expensive cellulose derivatives rather than from the cut and degraded sawdust fibers. Moreover, the plastics industry is still working on a fairly small scale. A factory using 10,000 tons of sawdust a year is already a fair-sized proposition. The total U. S. production of phenolic molding powders in 1943 was only about 50,000 tons. North Carolina's annual sawdust pile holds almost 1,000,000 tons. The solution of the mill waste problem must be expected to come from pulp and synthetic board projects, with units operating in terms of hundred thousands of tons, from new chemical ventures such as woodsugar factories and only to a minor extent from molded sawdust plastics.

Despite these qualifications, individual departments in the field of sawdust plastics are desirable and promising. A plastics plant can be started with a capital investment of 20,000 dollars (although the most economical factories cost ten times as much). For a lumber or a furniture concern it may constitute a first step towards chemical wood utilization and facilitate subsequent bolder moves in that direction. Frequently the plastics—made from waste—could be used in connection with the company's regular line of products (on furniture or millwork for instance), their marketing handled through established sales channels. Nor are molded gadgets the only end product. Allied processes supply coatings, finishing materials, the stuff that goes into acid and flame resistant tabletops. I therefore recommend the installation of one of several plastics units.

Fundamentally, there are two ways for making sawdust plastics:

1). *Woodfilled plastics.*

Sawdust or other mill waste is ground into woodflour that serves as a plastics filler. This method, used for many years in the manufacture of linoleum, was adopted by the makers of Bakelite and other dark colored, thermosetting plastics. Woodflour accounts for 50 percent or less of the end product's weight and commands a rather low price. The rest consists of phenol-formaldehyde or similar synthetic resin binders, which have to be purchased from the large chemical concerns and are fairly expensive.

2. *Lignin bonded plastics.*

Lignin, a material still shrouded in mystery that makes up one fourth of all tree substance, has been found capable of acting as a plastics binder, if properly treated. A number of processes are drawing on lignin's resinous properties to reduce or eliminate the need for extraneous chemical binders. From the wood industries' angle such "selfcontained lignin plastics" are obviously a very attractive approach.

The Forest Products Laboratory at Madison, (Wisconsin) has developed Hydroxylin, a sawdust lignin plastic, and claims that commercial quantities could be produced at 3 cents a pound. The present sales price for phenolic molding powders is ten cents a pound or more. The Marathon Paper Company makes plastics from waste sulfite liquor lignin and waste pulp; so does Kimberley Clark in cooperation with U. S. Plywood. Many more pulp companies have developed processes of their own; every major research laboratory of pulp, lumber, plastics and fiberboard companies has a special crew working on lignin and plastics. Almost every day individual inventors and universities discover some new processes; dozens of patent applications are pending all the time.

The question is no longer whether sawdust plastics can be made but how to pick the right process. It is as safe to predict that a lot of money will be made with plastics as it is to bet that quite a lot of money will be lost in connection with anything but the most efficient processes. It seems logical for makers of furniture to go into the plastics field. But they should not do so without having secured beforehand the assistance of an experienced, well-staffed research outfit. Maybe the plastics unit could be set up in connection with some large fiberboard or wood chemical corporation?

C. Woodgas Generators for Trucks and Tractors.

Some twenty percent of North Carolina's standing timber is of the "heavy hardwoods" type. The butt logs of the very finest oaks, maple and hickory have an excellent market as highgrade sawtimber. But pulpmills are usually reluctant to buy these species, claiming that they don't make good paper. A large portion of the 2 million cords of heavy hardwoods that grow annually in this state is just fuelwood. Consequently, every year from 500,000 to 1,000,000 cords that ought to be removed, remain in the forests. *Markets for non-sawtimber hardwoods is the most urgent single measure needed for improving the value of North Carolina's timber stand.*

It can be hoped that a substantial expansion of the State's pulp industries (wallboard included) would be accompanied by an inclusion of heavy hardwoods in the specifications of pulpmills. For wallboard it makes little defference. The Champion Fiber pulp factory at Houston (Texas) has been making paper from oak for some time and so have a few others, more recently. It will be long, however, before pulp will come close to absorbing the available surplus of heavy hardwoods. To offer a more immediate outlet on a large scale, I suggest the introduction of woodgas generators.

Past American experiences with generators have not demonstrated their economy. Most of the models used so far were not up to modern standards. The charcoal generator developed by Champion at Canton (N. C.) weighs 900 lbs.; recent Swedish models have been reduced to as low as 100 lbs. Automatic gas-air mixers, electric fans and other accessories developed in Europe since 1940 but little known in this country have greatly raised the efficiency of generators. Moreover, most American, Canadian, British, and Australian ventures in the generator field, have been confined to the charcoal burning types. Swedish large scale experiences have shown that generators running on wood are in most cases more economical. Recently the U. S. Forest Products Laboratory has developed a generator using green (i.e. not dried) sawdust. This sounds very promising, but still has to be tested.[1]

Twenty pounds of wood motor fuel perform the same effect as one gallon of gasoline. If, to take care of hauling and handling charges, the average price of firewood were raised to 15 dollars a cord, twenty pounds would sell for 7 cents. Compared to a gasoline price of 20 cents a gallon, the theoretical economy would be 3 to 1.

Nevertheless, American passenger cars are not likely to use any solid fuel in the near future. Generators require attendance for which the ordinary driver has no time. The distribution of wood fuel by filling stations would call for an elaborate organization, increase the fuel cost, narrow down the margin of economy.

But for tractors and other farm machinery, for woodworking equipment (small sawmills included), and for wood-hauling trucks the argument runs in the opposite direction. It costs a lot of money to bring gasoline to remote farms and forest operations. Wood fuel is available right on the spot. Farmers and woodworkers will not mind attending their generator equipment, if by so doing they can reduce their fuel bill to the cost of cutting and storing a few cords of low grade hardwoods.

An average truck or farm tractor requires annually some 1200 gallons of gasoline. Instead it could run on 12 cords of heavy hardwoods and save the owner a cash payment of some $250 a year, i.e. almost the installation cost of a generator, which now runs around $300 for tractor units. If 50,000 generators were operating in the State, they would offer a market for at least 600,000 cords of generator fuel a year and provide the economic basis for the removal of heavy hardwoods in accordance with sound forestry practices.

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1 For details regarding the construction and price of Swedish and American generators write to: Dept. of Conservation & Development, Raleigh.

To encourage such a development it would seem advisable for branch experiment farms, prison farms and extension services to acquire generator driven tractors and trucks for demonstration purposes. State and federal authorities should also purchase the machanical equipment, recently developed in Europe for felling and cutting up generator wood to the required sizes, and arrange to rent this equipment to individual farmers and to logging crews.

D. Destructive Distillation and Charcoal Generators.

Heavy hardwoods are the traditional raw-material for destructive hardwood distillation. Just beyond the State border, the Tennessee Eastman Corporation runs at Kingsport one of the largest destructive distillation plants in the country and has built around that operation a wood chemical industry as big and impressive as any of the modern chemical giants. Kingsport buys a fair amount of so called "chemical wood" in North Carolina; but these purchases are fairly irregular. Moreover, as the only industrial market for the State's heavy hardwoods, Kingsport enjoys a practical monopoly in setting the price—and up to 1940 this price was far from satisfactory. Should distillation plants be included in North Carolina's postwar program?

Before the war, destructive hardwood distillation was described by those engaged in that industry as a dying proposition. Even now they never fail to stress that there is no room for new plants. Facts contradict such pessimism. To be sure, the peacetime markets for charcoal are limited. Synthetic methanol and acetic acid, made from oil or coal, are very cheap and serious competitors for the same chemicals, distilled from wood. Yet, the 4 modern hardwood distilleries I have visited in the South have all been in permanent operation for many years, have made good profiits and show much less concern for their own future than for the fate of potential new competitors.

The question whether or not to promote destructive distillation plants in North Carolina should be answered in the light of two considerations:

(a) Will pulp industries and woodgas generators provide a sufficient market for heavy hardwoods?

(b) Have new processes reduced the production cost of methanol, acetic acid and wood tar derivatives to a competative level?

If the answer is yes in the first case and no in the second, then there is no reason for pressing the issue. Otherwise, I believe that one modern destructive distillation plant at least should be contemplated in the State's western hardwood area or in the central Piedmont, east of the Southern Railroad. Such a plant should be built for a minimum capacity of 100 tons of charcoal a day—20,000 cords a year—calling for an investment of $500,000. With ample supplies of cheap raw-materials, reasonable wage levels, good water and other facilities, the plant should be able to operate under favorable prospects. However, to overcome prejudices against the expansion of that industry a further incentive may be required. This could be provided by a State guarantee to buy the plant's charcoal output for School and other State-owned bus-lines running with charcoal generators.

The principle of these generators is the same as for those burning wood. Wood fuel is cheaper than charcoal, more economical, requires no processing and therefore preferable in remote, forest districts. Charcoal is a more concentrated fuel, calls for smaller generators, smaller fuel hoppers, and is therefore better suited for buses and other vehicles driving along the highways.

A bus, using 10 gallons of gasoline per 100 miles and running 20,000 miles a year burns 2000 gallons, costing at 20¢, $400.

Equipped with a charcoal generator, the same bus would need 1000 bushels of charcoal, costing at 20¢, $200.

(Equivalents: 1 gallon = 10 pounds of charcoal = 20 pounds of wood.)

School buses being chauffeur driven, the cost of additional care and attendance would be negligible. A fleet of 1000 buses would offer a guaranteed outlet for all the charcoal made in one modern distillation plant. The chemical by-products could then be sold at competitive prices with synthetics.

The cost of the generator is one of the decisive questions, both with regard to the introduction of woodgas and charcoal generators. European experience shows that it depends essentially on the scale at which the equipment is manufactured. Semi-mass production has reduced the Swedish cost from $1000 to $300 per unit. Certainly American manufacturing methods could reduce the cost still further. But in this country there is yet no industrial manufacture of generators, and it is doubtful whether the large automobile concerns will want to take up the making of generators. Maybe some medium concerns could be induced to try. They might even acquire a license for Swedish designs and set up their operations in North Carolina. Otherwise it might be best to import the equipment from Sweden.

I am well aware that the economics of this entire recommendation could be questioned. However, account should also be taken of what it would be worth to the State, if, thanks to the systematic removal of lowgrade hardwoods, North Carolina's forest stand were greatly improved and the hardwood invasion checked. These advantages are certainly large enough for taking a chance; they might even warrant a State subsidy, under the form of charcoal driven school buses.

E. Chestnut Extraction.

Ten factories producing annually tanning extracts worth 2½ million dollars make North Carolina one of the world's largest tanning extract centers. Together with a few out-of-state mills, they consumed just over 200,000 cords of chestnut wood in 1940, plus 18,000 tons of bark from chestnut oak and hemlock.

The chestnut blight has destroyed, probably forever, the tanning industries' prospects for continued wood supply. It may therefore appear paradoxical to include chestnut wood extraction among projects for industrial expansion. However, there is a serious danger that without immediate action, more irreplaceable chestnut wood will be lost than used.

The standing volume of dead chestnut trees now amounts to 10½

million cords. Of this quantity, 2½ million cords must be set aside as sawtimber, another million cords should be deducted for trees too scattered for economic harvesting. At the present rate of consumption it would take the industry some 30 years to use up the remaining 7 million cords. But foresters believe that in another five to ten years, these trees will be so intensely attacked by decay that fire, insects and wind will harvest what will then be left. The industry would conclude this self-liquidating venture after processing less than half the potential wood supply. The loss in timber values and wages alone would be well in excess of 10 million dollars, not to mention the fact that these dead tree giants constitute an increasingly serious fire hazard for the surrounding tree stock. Sound business and sound forestry both call for the removal of these dead corpses, before it is too late.

J. W. Cruikshank and E. V. Roberts of the U. S. Forest Service (Appalachian Forest Experiment Station, Asheville, N. C.) have urged government and industry to cooperate in a big salvaging operation. In a "Southern Lumberman" article of March, 1942, they suggest the cutting of two and one-half million cords of dead chestnut (and maybe twice that much) as an immediate postwar project. According to them, the wood should be stored in centrally located yards and gradually sold to extend the lifetime of the chestnut extracting industries by 10-20 years.

Maybe an expansion of processing facilities would be an even better solution. When the chestnut operation is completed, Champion at Canton and Mead at Sylva—both combining chestnut extraction with pulp manufacture—could probably use the extracting equipment for waste liquor utilization. The price rise in tanning extract, likely to follow the exhaustion of chestnut wood, could pay for storage cost and interest charges.

Whatever solution is adopted, the problem certainly calls for immediate attention and decisions.

F. Pulpmills.

The road that leads from the old into the new age of wood is covered with pulp. Woodsugar, woodgas, sawdust plastics or wood-derived yeast may well be more spectacular. Pulp is the basic formula discovered by mankind to mobilize the forest raw material for modern civilization. Pulp products and derivatives moreover include—in addition to paper—the textiles, organic chemicals from waste liquors, explosives, plastics and many of the other modern wonders of wood.

As early as 1777 North Carolina had a paper mill although rags were its raw material. The pulp mills at Roanoke Rapids and Canton, completed almost simultaneously in 1907, were the first to make pulp from southern pine and hardwoods. In 1928 Champion at Canton became the first mill in the world to use gum and poplar for highgrade bleached pulps, years before the Germans claimed hardwood pulps as their sensational discovery.

The State's pulp industry has recently not kept up with these proud traditions. In 1940 North Carolina's four pulp mills produced not quite 400,000 tons of pulp and used some 600,000 cords of pulpwood; that is approximately 6.5 percent of the State's forest growth. The U. S.

pulp industry recently claimed 14 percent of the nation's annual wood increment. But in Sweden, pulpwood consumption outgrew the lumber industry's wood requirements in the late twenties and in 1937 Sweden's pulp industry used 31% of the forest crop. These requirements were met without any harm to sustained yield practices, and in fact greatly facilitated their continued observance.

More pulp mills are thus one of the obvious conclusions for North Carolina's forest industries program. I have nevertheless decided not to inscribe new pulp mills at the top of the list, because the two fiberboard plants deserve in my opinion an even higher priority, and also because several of the State's mills are speaking about a substantial expansion of their capacity, as soon as the war is over. To work simultaneously toward the establishment of several pulpwood converting mills might create too much commotion and easily result in an undesirable land boom. Yet, while the fiberboard mills are finding their place, it is not too early to think about the erection of two new pulpmills, preferably in connection with the plans of concerns already established in North Carolina. In the latter case it should be remembered that the experience with oversized pulpmills, such as have recently grown up in the South, is not a too happy one from the forestry point of view. It seems that a mill with a daily capacity much above 300 tons of pulp, must draw its wood from too wide a radius. The great distance frequently renders proper pulpwood logging uneconomic; also the interest of pulp operators in forest conservation has been found to decrease as the distance of a forest from the mill increases. A larger number of medium-sized mills therefore seems to present the most desirable solution.

The question, whether there will be markets to absorb additional U. S. pulp is generally answered in the affirmative. The U. S. Department of Commerce estimates that immediate postwar output of U. S. pulpmills could reach 12 million tons, which represents an increase of 1½ million tons above latest production figures. For the long run a continuous and massive upward trend in the demand for pulp products is anticipated.

But great care should be exercised in selecting the right process and product. The war has resulted both here and abroad in important advances in pulping technique. Madison Laboratory, for instance, is very hopeful about a "semi-chemical pulping method" which gives substantially higher yields per unit weight of wood than the chemical processes, is specially suited for hardwoods, and produces excellent papermaking pulps. Unbleached pulp, which sells around $70 a ton under OPA ceilings, would only cost from $22 to $25 to manufacture. Moreover economical producing units begin already with a daily capacity of 40 tons and can be built with an investment of half a million dollars.

In selecting the product, it may well be found that the capacity of Southern mills for containerboard, bags and other packaging materials is in excess of peacetime requirements. But this is less likely to be true of the high-strength papers, recently developed for making paper-base airplane parts, since they open the enormous market of structural materials to pulp products. Nor need there be much fear of excessive newsprint supplies. The U. S. has a permanent deficit in

groundwood and sulphite pulp—the two components of newsprint—which is covered by some 500,000 tons imported yearly from Canada. At Lufkin (Texas) a mill with a daily capacity of 250 tons has been in successful operation since 1937 and has demonstrated that southern woods can make good newsprint. Another plant has been under consideration for some time and seems to offer excellent prospects.

Dissolving pulps present another attractive field for expansion. Staple fiber production has only made a modest beginning in the U. S. Acetate and nitrating pulps are finding increasing use in connection with highgrade plastics and textiles. North Carolina's furniture industry offers one of the nation's largest markets for nitrocellulose lacquers and other pulp derived finishes.

Germany and other European countries have successfully developed rayon and staple fiber pulps from beech and other short fiber hardwoods; the Rayonier plant at Fernandina (Florida) has demonstrated that they can also be made from southern pine. American war experience has taught the textile and plastics trade that even the finest, high alpha pulps—formerly reserved for linters—can be made cheaper and equally good from wood. I recommend the starting of thorough investigations for the establishment of a fair-sized dissolving pulp factory, best situated in the foothills section of Western North Carolina.

With these two pulpmills and the new wallboard mills, North Carolina's pulp investment program seems to be complete. At first, these four mills would probably add only some 250,000 tons to North Carolina's yearly pulp output, raising the total to approximately 600,000 tons (1 million cords of pulpwood = 11% of natural growth). But the experience of four factories shows that pulpmills can make money and do well in North Carolina and it is a known fact that successful pulpmills are quick-growing children. Hence, wood reserves from which North Carolina's mills could multiply their capacity should be carefully safeguarded.

G. Sawdust and Woodsugar.

In popular discussion, sawdust is regarded as the number one wood waste problem. Yet because sawdust, frequently accumulated in huge piles behind the mills, is the most visible form of wood waste, it is not necessarily the most important one. The Forest Service has estimated that 13.5% of every log becomes sawdust in the course of sawmilling. Another 20-25% of what is left is turned into sawdust by planing, furniture making and other secondary operations, bringing the total sawdust up to some 25% of the saw log's content. Against that, slabs, edgings and other solid wood waste in primary and secondary manufacture account for at least 30%. Moreover, in terms of the annual wood cut, sawdust represents at best 10-12%. But fire and disease claim 11% of North Carolina's annual growth, logging waste takes as much as 28%. Thus, nothing could be more erroneous than to consider the sawdust solution as a panacea.

One further fact should be remembered. Methods for reducing fire and disease losses, and for using solid millwaste in pulp manufacture are known and well tested. A large-scale conversion of sawdust into

products competitive even under peacetime conditions is in sight; but the final answer still remains to be found.

A number of pulpmills (Bastrop, Georgetown, Plymouth) were recently induced to use sawdust for pulp. The chief disadvantage arises from the fact that the wood fibers in the sawdust are cut. This reduces the strength of the pulp by 40%. Sawdust also contains many impurities; if collected from old piles in coastal areas, it is usually full of sand which causes heavy strain on pipelines, evaporators and other pulp mill equipment. Even though the price for sawdust compares favorably with that of pulpwood, it is unlikely that its use by pulp manufacturers will be continued when the war is over. Nor is such use technically justified, as long as plenty of undamaged wood fiber material remains available.

The most promising use of sawdust is its chemical decomposition. Here the cut down fibers act as an advantage by facilitating the penetration of chemicals. The various wood hydrolysis processes look toward sawdust as their preferred raw material. Among these processes the Scholler-Schaefer method is considered the most suitable for American conditions. A first plant with an annual capacity of 100,000 tons of green sawdust (3½ million gallons of Ethyl alcohol) is under construction at Eugene (Oregon).

The treatment of sawdust in percolators with diluted sulphuric acid results in a separation of lignin from the cellulose and in a transformation of the latter into sugars which are then converted by fermentation into alcohol or yeast. Tests in an American pilot plant have confirmed that this process yields 45-60 gallons of Ethyl alcohol per ton of dry wood and that the sales price of alcohol from large scale operations could be established around 20 cents a gallon.

Compared to a current grain alcohol price averaging 90 cents a gallon, the economy is so great that the immediate construction of several plants by the government is fully justified. Indeed it can be expected that the price difference would enable the government to write off the entire plant cost after one year's operation.

To be fully competitive in a peace market the sales price per gallon of alcohol should be brought down around 10 cents. This reduction could be easily obtained and exceeded if it were possible to sell all the lignin derived from the operation at two cents a pound. The day may be near when this will be possible. So far it is not. Lignin is not good enough. There is too much of it.

The Forest Products Laboratory and a score of private research groups and industrial laboratories are hard at work to solve the lignin problem. Four main lines of attack are under consideration:

1. *Hydrogenation.*

Dr. Harris of the F.P.L., has developed the hydrogenation process in the test tube and was able to separate several resinous materials, rubberlike substances, oils and even hydrocarbons, similar to gasoline and suitable for motor fuel. But the commercial feasibility of lignin hydrogenation has still to be demonstrated.

2. *Plasticizing Lignin.*

Lignin acts as a plastics binder, especially in combination with partially hydrolyzed wood. It has also found a market as a rubber

extender, as a roadbinding material and for a number of minor chemical uses. Both here, in Sweden and in Germany these uses have been commercially tested and confirmed. But they offer only a limited outlet, not capable of absorbing the hundred thousands of tons which a large scale woodsugar industry would have to sell.

3. *Destructive Distillation.*

Some chemists believe that most of the valuable wood distillation products are derived from lignin; hence, the idea to use lignin instead of wood, in destructive distillation. But "chemical wood" was purchased before the war at 6 dollars a cord, corresponding to 0.3 cents a pound. This is way below the 2 cents a pound which the woodsugar makers expect to get.

4. *Native Lignin.*

Complete chemical utilization of lignin is regarded more and more as the final answer. As a first step in that direction, lignin must be brought back to its natural form in the tree. All waste liquor lignin is degraded, the pulping processes of which it is a by-product having destroyed its most valuable properties. Native lignin is soluble, reactive and light colored. Those who hold that theory have reason to believe that native lignin would not only be a valuable plasticizer, but also a basic raw material for a chemical industry, which might one day duplicate the success of coal tar and oil chemistry. The research laboratory of the Masonite Corporation has been able to achieve remarkable progress along that line

This discussion of lignin research is by no means exhaustive nor scientifically accurate. It is merely intended to show that much work is going on in this field and that great hopes can be held for its success in a not too distant future.

Once the lignin problem is licked, woodsugar has every chance of becoming one of the outstanding features of future industrial expansion. Alcohol can look towards an ever-growing market. To stretch the dwindling oil supplies, it may become necessary to blend gasoline with 20% alcohol. One day renewable alcohol from wood may even succeed non-renewable gasoline as the world's motor fuel. Ethyl alcohol is also a most versatile chemical substance that goes into rubber, plastics, synthetics, explosives, etc. Cheap woodsugar can produce cheap feeding yeast of high protein content. It may play a major part in connection with a world-wide expansion of livestock production, one of the most fundamental requirements of all postwar nutrition plans. The raising of beef cattle in the Coastal Plains of North Carolina could be greatly facilitated if yeast from sawdust could be drawn upon to improve the nutritive value of the cattle's diets.

Dr. J. A. Hall of the U. S. Forest Service has stated that no Scholler plant should be contemplated for less than 200 tons of dry wood waste per day (70,000 tons a year). Yielding annually 3½ million gallons of alcohol and 40 million pounds of lignin, in addition to furfural, methanol and other by-products, a plant of that size will cost over 2 million dollars to build. Its wood waste supply should come from mills located within 50 miles hauling distance.

North Carolina's present lumber production runs around 1.7 billion board feet, enough to feed 11 woodsugar plants. No single mill has a

capacity coming even near the requirements of a woodsugar plant. But acting upon the request of Governor Broughton the U. S. Forest Service has conducted three investigations in the summer of 1944, to discover a possible location for the first woodsugar plant in the mid-south. It was found that sawmills and concentration yards in the Durham-Raleigh area have an excess supply of 130,000 tons of oven-dry waste a year, which is almost twice the amount needed for a full-sized woodsugar plant. The only weak spot is a decrease in the standing tree volume, which has been going on for some time in this region. It might eventually compel the sawmills to reduce their output and this in turn would curtail the woodwaste supply of the prospective wood-sugar factory. This objection need not be taken too seriously, because the region is so densely populated that sawmills and concentration yards would continue even if logs had to be imported from other regions.

Thus North Carolina has tossed its name into the hat for a first woodsugar factory. In due course, further units might be added, especially if it should be possible to concentrate the State's woodworking industries in accordance with the recommendations of this report (see below), and to end the present trend toward dispersion in forest industries. In the Tarboro area for instance, 65,000 tons of wood waste are already available, which is theoretically enough for a second wood-sugar plant, although this supply does not contain an adequate safety margin.

H. Further Research.

The postwar program contained in this section proposes the creation of additional wood using capacity for 2½ million cords of pulpwood, sawdust and generator fuel. Installations for the first 400,000 cords of pulpwood and 200,000 cords of fuelwood should be started right away. The following two Sections will attempt to show where and how so much wood could be found.

The significance and desirability of all these measures are beyond discussion. But will they be taken? Obviously this will depend on their economic and technical feasibility.

The present report can only discuss these questions in general terms. It will now be necessary to take every single recommendation, to select several locations, and then to make all the detailed investigations that are needed to translate literature into tangible facts.

In the course of these investigations, it will be found that further advice is needed, to solve some technical details or to decide just what process to choose. It is important to provide for adequate machinery to follow up on the work of this report.

Moreover, there exists a number of unsolved technical problems, which are likely to delay progress in North Carolina's forest industries, even though they refer to apparently secondary issues. Waste pulp liquors are a typical example. With the expansion of North Carolina's pulp industry, increasing amounts of lignin and valuable chemicals will be flushed down the rivers or burned in recovery systems where their fuel value is only 0.3 cents a pound. A cheap barking method for saw-

logs, a chipper for slabs and edgings, or a good process for making plastics from furniture waste, are a few more instances of urgent solutions, not quite available yet but lying apparently just around the corner.

Many industries owe their success to the fact that they have always helped promising new inventions in getting around such corners. This is not the case with forest industries.

Pulp companies are doing some research, but most of them concentrate on control work and on efforts to improve the quality of their products. Sawmill concerns that are engaged in any research can be counted. Pulp and lumber trade associations have organized respectable efforts to make up for this deficiency; so has the Institute of Paper Chemistry at Appleton, Wisconsin. The federally financed Forest Products Laboratory at Madison, certainly the world's finest institution of its kind, is accomplishing an outstanding service to the nation. But more is needed if real progress is to be made.

Realizing the need for establishing a regular contact between local problems and the facilities of the Madison Laboratory, the U. S. Forest Service has just started to set up regional forest products units. Composed of a crew of well-trained specialists, the main function of these units will be to assist in solving the different problems of practical application just referred to.

It would not be possible at first to set up such forest products units in each State. But the idea is to create units for several regions, each comprising a group of states with similar problems. Having studied the problems facing North Carolina's forest industries, I am so deeply impressed with the spectacular results that could be achieved by just a little more applied research, that the urgent need for a forest products unit located in the Appalachian and Mid-southern area is to me beyond doubt.

Once such a unit has been established, it will be important to supply it with ample funds. Following the example of many countries, such funds could be assembled by imposing a *research tax* on all wood transactions, to be collected in equal parts from buyer and seller. Supposing the tax rate were fixed at 1%, it would provide North Carolina with an annual research fund well in excess of 1 million dollars. Forest utilization could then really make sufficient progress to match the standards of efficiency and success set by other American industries.

SECTION III.

MORE RAW MATERIALS

Because there is a lot of non-used wood in North Carolina, Section II of this report contains a set of proposals for additional industries and outlets. But is it not likely that increased consumption will result in accelerated depletion? This danger exists unless measures are taken to make sure that the new outlets serve to promote closer forest utilization and to absorb wood that is now wasted. The proposals of this Section are an attempt to indicate what these measures should be.

A. Forest Regulation.

No organized society has ever been able to rely exclusively on the farsightedness of its members to keep order. Freedom under law is the basic credo of the American way of life. But its application to America's forests has yet to come.

According to the Forest Survey, total growth in North Carolina's forests exceeded total drain by small margin. However, grand totals do not tell the whole story. In the seven year period from January 1937 to January 1944 almost 1½ million cords more pine were removed than replaced by natural growth; at the same time the average age and size of the pine stands suffered a reduction. On the other hand, 7,000,000 cords less hardwoods were harvested than grown, but even here the sawtimber stands of yellow poplar and sweet gum were overcut.

The forests of North Carolina are threatened by a process of degradation, characterized by the gradual replacement of desirable species in sawlog sizes, with less desirable hardwoods growing in understocked stands. A shift in the utilization pattern is needed, away from the species and categories now being depleted to those insufficiently used. Oversimplified, the Survey's conclusions suggest: less pine lumber, more hardwood pulp and other hardwood uses.

The new plants are to help in achieving this shift. But they will not do so all by themselves. Nor can they bring about the necessary reduction of lumber output.

Experience in all countries has demonstrated that proper forest management cannot be accomplished without some degree of public regulation and control. To be sure, the larger industrial concerns have frequently adopted conservation practices without public compulsion. This is particularly true of pulpmills, vitally interested in securing permanent raw material supplies to protect their expensive plant installations. But the farmer who has a small woodlot, the absentee owner or the man who runs a peckerwood mill—all so characteristic of North Carolina's forestry picture—scarcely know what proper forest conservation calls for, nor are they as a rule financially strong enough to do the right things unless backed up by adequate legislation. Moreover, it would be unsound and unfair to expect from any of these small firms restraint in their commercial operations unless the same rule applies to all.

Public regulation of forest practices should do more than that. Compulsory sound forest management would prevent forest owners

from cutting in excess of growth. But it would also induce them to remove at regular intervals all mature trees, instead of degrading the value of the stand by just picking the raisins. Unfortunately the latter provision, customary in Europe, is not likely to be part of North Carolina's forest code, if the proposals recently adopted in Asheville at the conference sponsored by the North Carolina Forestry Association were to become the basis of legislative action. Nor indeed is such compulsory cutting included in the current plans for federal legislation.

Since the detailed provisions are still in the stage of preliminary discussion, it is difficult to estimate the effects of prospective legislation on the timber supply of the coming years. It can be expected however that a regulation of forest practices, if adequately conceived and enforced, would result in a curtailment of sawlog supplies by at least 300 million board feet a year, and probably more in order to facilitate a rebuilding of the growing stock. The permitted sawlog cut, far in excess of 2 billion board feet, would be theoretically sufficient for maintaining present lumber output. Some sawlogs will continue however to be used for non-sawmill purposes. I believe therefore that regulation will be followed by a somewhat reduced lumber output.

The second, immediate effect of regulated forest management could well be the reduction of pine pulpwood supplies in different areas and this in turn might compel the mills to cut and use some of the hardwood surplus, which averages around 1 million cords per year. In the absence of legal compulsion—which is unlikely—this highly desirable increase in the hardwood cut will only take place if the necessary outlets are available.

The outstanding significance of regulation lies in its long range repercussions. North Carolina's forests are in a pretty run-down condition. Not much would be left by now, were it not for the excellent soil and climate, that reproduce trees in spite of man-made obstacles. If these natural facilities were supported by proper policies, foresters are sure that North Carolina's annual tree crop would soon reach twice the present figure./1

Forest regulation by public action is no longer a question of whether but merely how. It is needed to fulfill a threefold purpose. It is the prerequisite and indispensible complement of any expansion of North Carolina's forest industries. It is the basis of their future prosperity, and it will set the limits within which free competition and free enterprise can strive for ever greater progress.

B. Better Forest Protection

Fires and diseases in North Carolina's forests claim every year around 1 and one-half million cords of wood. Amounting to 15% of yearly growth, these losses are not heavier than the U. S. average. But their toll would be sufficient for supplying more than twice the present requirements of North Carolina's pulp industry.

1/ The excellence of natural conditions is illustrated by the experience of a large, commercial pine plantation, near Carthage, where average growth in twenty year old stands now amounts to 400 board feet per acre, but sometimes reaches twice that amount. Average growth for the entire State is only 131 board feet per acre.

The worst about these losses is the fact that they could be avoided. Fire prevention is largely a question of dollars and cents. Ordinary insurance technique should determine the policies.

The Forest Survey has estimated the stumpage value of North Carolina's standing forest at 188 million dollars. At present, State, County and Federal funds available for fire control on nonFederal forest lands total $350,000 a year, about 0.2 percent of the asset's value.

That this is too low is demonstrated by annual fire casualties, which a conservative estimate puts at 1.4 million dollars. W. K. Beichler, of the State Forest Service, believes that another $600,000 a year would be needed to place all the productive forests under adequate protection. This appropriation would reduce fire losses to $400,000 a year and thus save $1,000,000 worth of wood; that is nearly twice as much money as the additional expenditure involved. Mr. Beichler's assumptions are fully confirmed by European experiences. Adequate protection has reduced the average mortality in Europe's forests from fire and diseases to less than five percent. In German and Swedish forest budgets mortality drain has ceased to be an item.

It is beyond the scope of this report to discuss details of forest protection. But considering Mr. Beichler's figures, I assume that by the time all the new factories are in full operation—say ten years after the end of the war—the casualty toll in North Carolina's forests will have been reduced to 10% of annual growth. Some 500,000 cords of additional raw material would thus become available for industrial use. Moreover, the trees attacked by natural hazards may yield a lot of sound material. It is customary in Europe to provide for the accelerated removal of all trees that have suffered from fire, insects, storms or snow; in several districts of the South, salvage work has become a regular operation and is yielding good profits. If it were made a regular practice in North Carolina to salvage dying trees, they could probably add another 500,000 cords to the annual wood budget.

C. Better Logging.

In the course of my field work I have visited a number of logging operations. Almost everywhere I discovered that the upper stems of sawtimber trees, containing perfectly good pulpwood, were left on the ground. I also found that this common practice has not been very much affected by the present pulpwood shortage. Only the arguments put up in defense have changed.

Before the war, it used to be said that pulpwood prices were insufficient to warrant the cost of trimming and hauling the upper stems. Now it is argued, loggers are so rare, that they must give all their time to the cutting of sawlogs and cannot afford to fuss with small stuff.

This reasoning does not strike me as very sound. Above all it gives no consideration to the fact that these tops are a major cause of forest fires, frequently retard young growth and thus greatly reduce the value and the yields of forest lands. Moreover, sawlogs bring $25 a thousand, pulpwood brings $10 per cord. Many lumbermen do not hesitate to take even 6" top logs for lumber, since they will make two 2x4's. But the same number of small logs that go into 1000 bd. ft. of lumber under

the Doyle rule contains 3.2 cords of pulpwood and would yield $32 instead of $25. And yet most lumbermen refuse to make pulpwood.

I have found quite a few smart loggers who told me they were going to return to the forest on their own and make pulpwood from what had been left behind. One of them for instance, figured he and his crew would make 30 units (almost 40 cords) of pulpwood from the leftovers on a 25 acre lot, giving them a profit of 2-3 dollars per unit over and above the crew member's regular wages of $6.50 a day.

It is true, however, that lapwood on account of the many branches and its smaller size, is more expensive to handle than logs. To solve that difficulty it will be necessary to adopt treelength logging, instead of cutting up the trees into log length as soon as they are felled. Further, all pulpwood should henceforth be made with mechanical logging equipment. I have visited pulpwood operations where a crew of 8 men, working with rather simple equipment (1 tractor, 1 portable power saw, 1 loading crane) was able to cut and load 32 units of pulpwood a day. With due allowance for the amortization and maintenance of the equipment (price: $4000), and assuming a wage rate of 65 cents an hour, it costs only $1.65 to produce a unit of pulpwood. Without the equipment, it takes a man-day to make and load a unit and costs $5. With these advantages the general adoption of mechanical equipment must be regarded as a certainty, especially since it enables 8 men to do a job for which hitherto 32 men were needed.

Wasted pulpwood is the major but not the only shortcoming in logging operations. Most pulpmills repay the lumbermen in their own coin when they cut wood on their boundaries. Instead of separating the saw timber and the veneer logs from the rest, they haul everything to the pulp factory and feed even clear, heavy butt logs into the chipper.

Many attempts have been made to set an end to such practices. The Agricultural Extension Service, cooperating with the U. S. Forest Service has nine foresters aiding North Carolina farmers, especially by cruising their woodlots, marking their trees for selective cutting and even advising them how to market their wood.

Even wider in scope is the program of the Farmers Federation in Asheville, sponsored by the Pack Forestry Foundation. Under that scheme, the Federation offers to mark, handle and sell wood crops on a commission basis. The advantages involved are:

a). selective cutting which preserves and increases the value of the growing stock.

b). better forest utilization and higher returns per acre of forest land, since all trees are graded into veneer, saw-timber and pulpwood logs.

c). expert logging crews and modern logging equipment, both reducing logging losses and increasing the amount of timber sales.

So far the Federation has merely lined up a few landowners as test cases and has started operations on some 6000 acres of timberlands. Under usual practices, these owners would get for:

9 million board feet stumpage at $8 per M	$72,000
7000 units of pulpwood at 1 dollar and 50 cents	10,500
Total stumpage	$82,500

But working through the Farmers Federation they can now expect to receive for:

10 million board feet, delivered at $25 per M	$250,000
15,000 units of pulpwood, delivered at $10	150,000
Total receipts	$400,000

Less:

Logging and hauling sawlogs at $16 per M feet	$160,000
Logging and hauling pulpwood at $7 per unit	105,000
Balance	$135,000
Commission of Farmers Federation	30,000
Thus, net stumpage	$105,000

The owners get 25% more money for their wood. The mills receive a better handled and graded material, delivered right to their doorstep. The forests are left in a better condition than they would be after customary logging operations.

The Federation's scheme is designed to include ultimately all the small and medium wood holdings of Western North Carolina. Before expanding, both the mechanical and the commercial procedures may have to be revised somewhat and better adapted to large scale transactions. To finance the cost of logging and hauling operations, and for cash advances to farmers signing up under the program, a substantial operating fund would be needed. It still has to be found. But the advantages of the scheme are such that private concerns as well as State and Federal authorities (including the Agricultural Extension Service) would be well advised in giving this experiment every possible encouragement.

In Scandinavia, similar cooperative systems have been in successful operation for many years. The Farmers Federation's approach may well contain the germs of a new logging pattern designed to replace eventually all over America wasteful logging methods of the past.

Foresters estimate that three-quarter cords of pine and over one cord of hardwood pulpwood are left behind for every 1000 board feet of sawlogs that are harvested. Applying this ratio to North Carolina's present lumber output, it reveals a pulpwood reserve of over 300,000 cords of hardwood and of approximately 1 million cords of pine. Even after reducing these figures by a 25% safety factor, the additional pulpwood supply amounts to 1 million cords.

Unaccounted for by official statistics, here is a source which alone would be more than sufficient for supplying the initial pulpwood requirements of our industrial expansion program. Moreover, this case renders the need for such expansion particularly clear. For with or without the Farmers Federation, forest owners will only be induced to

change their practices, when mills located at short distances are prepared to pay reasonable prices for pulpwood which now remains in the forest.

D. Manufacturing Waste

Waste in North Carolina's mechanical woodworking industries (pulpmills excluded) aggregates every year some three million cords. All the wood that makes up that waste has been logged and hauled, much of it carefully graded and kiln-dried. To assume a cost value of five dollars per cord of waste is obviously theoretical, certainly conservative. But it explains why so much thought and effort have been repeatedly devoted to the salvaging of North Carolina's twelve and a half million dollar wood waste pile.

There are two fundamentally different yet mutually not exclusive solutions to the waste problem: Reduce it or use it.

Traditionally, waste reduction has been the lumberman's first and only thought. A score of resaws, gluing devices, edgers and trimmers have been developed to rework slabs and other wood pieces too small for making ordinary boards. While this is better than to throw the sticks into the waste burner, these waste reducing operations involve a lot of handling, additional machinery and usually salvage just a few percent of the log's wood contents. On the other hand, most of these solid wood pieces, if properly cleaned and chipped, could be fed into a pulp digester, since there is nothing wrong with them except their size. I therefore believe that a change of emphasis is called for. More efforts should be undertaken by wood manufacturers to render their waste suitable for chemical conversion. Mechanical waste reducing processes should not be overdone, because the reworking renders dimension stock and other custom sawn wood pieces so expensive, that they may soon lose their markets to cheaper priced pulp products, synthetic boards or other substitutes.

Another general principle should be borne in mind throughout the detailed discussion of manufacturing waste and its uses. In North Carolina coal or hydroelectric power can replace a cord of wood fuel at a cost of $3.50 or less (See page 6.) Not long ago this fuel equivalent of $3.50 per cord made wood heating as good a utilization as could be hoped for. With the development of pulp industries and other chemical wood utilizations, this situation is changing rapidly. Wood operators should therefore become conscious of the fact that whenever chemical outlets can offer more than $3.50 per cord of millwaste,1/ it pays to replace wood by some other fuel or preferably to improve the heating system in their plant.

Now let us review somewhat closer the waste situation in North Carolina's principal woodworking industries:

1.) *Sawmills.*

Tests conducted by the Forest Products Laboratory have demonstrated that the manufacture of 1000 board feet (1.32 short tons) of lumber results in the following waste products:

1/ Millwaste being less compact than logs or boards weighs accordingly less per cord. Throughout this discussion it is assumed that 1 ton of millwaste = 1 cord.

Bark:	0.36 tons)	Edgings, etc.	0.35 tons)
Sawdust:	0.37 tons)	Seasoning waste:	0.18 tons)
Slabs:	0.25 tons)	Total waste; 1.51 tons = 114% of end product.		

The waste from North Carolina's present output of 1.7 billion bd. ft. of lumber thus amounts to 2½ million tons. It is either burned (most of it wastefully) or accumulated in huge piles behind the mills.

Already before the war a small beginning was made in parts of the U. S. to use some of this waste as chemical raw material.

According to the 1939 census, 319,000 cords of slabs were used by U. S. pulpmills, representing approximately 3 percent of their raw material requirements and about the same portion of the solid wood waste from that year's lumber output. Since then, labor shortages have induced a few more pulpmills to stretch their raw material supplies by using slabs. The North Carolina Pulp Company at Plymouth cooked in 1943 some 30,000 cords of slabs and sawdust which represented not quite 20 percent of the factory's pulpwood consumption.

In Sweden, 25% of all the pulp produced in 1937 was made of sawmill waste; more than 90% of the lumber industry's solid waste (bark and sawdust excluded) thus ended up in pulp digesters. Since no pulp needs to be better than Swedish pulp, American mills should not hesitate in following that example. It may also give them a clue as to why Swedish pulp can compete in price with American products.

As a practical proposition for North Carolina, I do not think we should aim at using all the sawmill waste right away. Instead, I suggest to concentrate at first on the slabs and the larger-pieced solid waste. Accounting for roughly one-third of all sawmill waste, the supplies from that source would run around 800,000 cords a year. This is far more than pulpmills will be able to absorb—but it is worth trying. The remaining sawdust, bark and smaller waste should be used as fuel until such time as waste markets and prices will warrant further changes.

Before its slabs and solid waste could actually be converted into pulp, the lumber industry will have to solve three fundamental problems:

a.) *Remove the Bark.*

Bark affects the yields, color and strength of all pulp. Rough slabs have been reluctantly accepted by some pulp and fiberboard mills, but the bark invariably reduces the desirability and the price of the slabs. Dr. Hill, the technical director of the North Carolina Pulp Company's factory at Plymouth, has recently presented a paper, showing that the yield from unpeeled pine slabs was 37 percent lower than from regular pine logs and that the strength of the pulp suffered a reduction of 8 percent. This difference was chiefly due to bark and impurities (sand, etc.), to some extent also to the bad shape of the chips. (See below.)

The traditional way to meet that difficulty is to clean the slabs with hand knives or to hold them against the rotating knives of a so-called rosser. Both processes call for a lot of handling; are wasteful and fairly expensive.

Since all the bark has to be removed eventually from the lumber as well, I believe that it would be more efficient to bark all the logs—at least softwoods, gum and poplar—before they enter the sawmill.

In recent years this has become a general practice in Sweden. On the West coast, hydraulic and other equipment had been developed for removing bark from heavy logs.

The sawing of cleaned logs should gradually become a general practice in North Carolina, as a first step towards a general reorganization of sawmilling methods. For the second step would be to flatten the pine logs by taking off fairly thick slabs and to send these slabs on a special conveyor right into the pulpwood chipper. By resawing the squared logs into boards on a gangsaw, the sawmill's yield could probably be raised near to 70 percent.

b.) *Make good Chips.*

Slabs and other millwaste vary considerably in length and thickness; they are smaller and lighter than regular pulp logs. When sent through standard chippers or hogs, they will make chips of irregular size which do not show the shape and uniformity required for a good cook.

No doubt this is a mechanical detail that can be solved. Indeed the Swedes have an answer all worked out, tested by large scale industrial application. It is indispensible to acquaint American pulpmills with that solution. For until mill waste can be made into first-class chips, pulp mill superintendents will resist the continued use of slabs as soon as war emergencies are over.

c.) *The Waste must be available.*

At present only very little wood waste is available in North Carolina. The reason: more than 50% of the State's lumber is cut by mills making less than 5 million board feet a year; most of them are of the portable type, scattered all over the place, changing locations every two or three months.

Cutting any log that will give a 2 x 4, driving their equipment with gasoline motors and thus unable even to use their waste for fuel, working with unprecise machinery and thick circular saws, these peckerwood mills are the curse of the trade. Waste is the economic justification for their existence, for it is argued that they save transportation by moving right to the place where the trees are felled. But this dispersion is only justified as long as 50 percent of the log contents have no commercial outlet. If millwaste can be used, the situation is reversed, because it is cheaper to haul logs than to collect waste from 50 different places.

But how are better equipped mills to replace these portable sawmills? Are not the latter fairly well entrenched in North Carolina, even a part of its social structure? I believe that peckerwood mills will retain their position for supplying local wood requirements. For commercial operations, however, medium sized bandmills should have a fair chance provided they can rely on a regular pulpwood market for their slabs, enabling them to outbid their competitors for logs.

Left to itself, this replacement process may be fairly slow. I propose therefore that public authorities, farmers cooperatives, and pulpmills cooperate in establishing half a dozen permanent bandmills in different parts of the State. I recommend such action because the elimination of peckerwood mills is to my mind a "sine qua non" for most

of the other reforms. Until it is achieved, waste will accumulate in the forests and on paper in gigantic piles; it will never reach the pulp digesters.

Even the larger sawmills do not show as large a waste surplus as one might expect. Having no better use for their waste, these mills operate with inefficient heating systems. Yet it is inconceivable that 1 and one-half tons of wood fuel equalling more than 20 million B.T.U. should be required to saw, dry, dress and ship 1,000 board feet of lumber. Indeed the theoretical average, established by extensive national surveys runs only around 0.30 tons per thousand, i.e. 20 percent of what is supposedly required by North Carolina's lumbermills. Since it is only intended to convert slabs and other large pieces into pulp, approximately one ton of millwaste per 1,000 board feet of lumber would still be left with the mills for fuel. A minor modernization of the heating systems should enable North Carolina's sawmills to get along with that.

2.) *Veneer and Plywood Mills.*

With 57 plants cutting annually 110 million board feet of logs, North Carolina ranked already before the war among the nation's leading veneer producers. Since then, veneer capacity has been further expanded by some fifty percent.

Eminent experts like Professor Nelson C. Brown assert that veneer mills operate with much higher yields than sawmills, because they have neither sawdust nor slabs. This statement is not confirmed by my observations. Under the Doyle rule, sawmills cutting the heavy type of logs that goes into veneers, sometimes come out even, usually show an underrun of 10-15%. I have yet to find a veneer mill getting more than 60% board measurement from its logs; plywood mills usually show a board feet yield of 50 percent or less. It is my belief that waste in veneer mills runs around 70 percent and exceeds 80 percent in plywood plants. Figures from abroad confirm that estimate.

These high losses arise not only from the cores but chiefly from the substantial quantities that must be peeled off before the bolt gets a cylindrical shape and from scrap veneers. Thus the salvaging of veneer waste presents another worthwhile proposition.

The cores call for no special selling effort. Free from bark, round in shape, heavy, they make excellent chips and are bought by pulpmills with delight.

The same cannot be said of scrap veneers. Some pulpmen believe they are just as bad as sawdust. Others argue that scrap veneer fibers are unhurt and that the cooking liquors could easily penetrate the chips, if only the mechanical problem of making good chips were solved. Attempts are underway to crush the scrap veneers under a press, to bale them, similar to cotton or hay and to ship these bales, ready to be dumped into the digesters. If this process works, the pulpmills would save all the operations in the bark drums and the woodroom and could pay a higher price for scrap veneer chips than for regular cordwood. So far this is merely a hope.

Waste from North Carolina's veneer industry now runs up to 180,000 cords a year. Again the problem is, how to make it available. Veneer mills could probably spare their cores. But plywood mills need

all their waste for power and steam in their driers, hot presses and finishing operations. Maybe they would have to buy some coal to set their cores free for pulp. Since such a substitution is profitable they should do so. In that case, the veneer industry could contribute some 40,000 cords of veneer cores to the State's annual pulpwood budget.

Scrap veneers could add another 110,000 cords of pulpwood. They would have to be replaced by some 50,000 tons of coal. For the moment, I have decided not to include any scrap veneers in my pulpwood estimates.

3.) *Extract Plants.*

For making tanning extract, chestnut logs are cut into the same kind of chips that are used for pulp. The spent chips are free from bark and availiable in fairly large amounts at a few extraction plants, all located within a small radius. More than thirty years ago Champion Fiber started to convert these spent chestnut chips into pulp and has been doing so ever since. So has the Mead Corporation at Sylva, and a number of out-of-state plants.

And yet, three out of North Carolina's five chestnut extract plants dispose of their spent chips at a fuel value of $3.50 per cord, instead of processing them into pulp.

The apparent justification for these practices is the fact that it takes a lot of money to build a pulp factory, far more than the capital tied up in any one of these minor extraction plants. But this obvious truth does not explain why the spent chips are not sold to existing pulpmills of which several are within close range. That it took a war to render such arrangements possible and that even now they do not extend to all the spent chips in the State must be blamed on the inertia of pulpmills and extractors alike.

The substitution of coal, setting free annually some 70,000 cords of spent tannin chips for pulpwood is one of the most obvious steps toward better wood utilization in North Carolina.

4.) *Furniture Plants.*

Traditional investigations of the wood waste situation have usually overlooked the potential waste supplies from furniture factories. Undertaken by the Forest Service or forestry schools, such investigations have concentrated all their attention on the so-called primary wood industries. Yet in secondary industries, which include the furniture industries, as well as planing mills and concentration yards with essentially similar waste problems, the amount of wood raw material to be salvaged is by no means negligible. Nobody can walk through a furniture mill without being impressed with the sizeable chunks of clear, highgrade lumber that are dropped from cut off saws, ripsaws and edgers on the waste conveyer. In North Carolina, with its 200 furniture plants and over 150 concentration yards and planing mills, the problem deserves particular attention.

Textbooks evaluate the waste in furniture-making at 25%. To my mind this is a considerable undervaluation. In North Carolina's furniture plants the difference between the so-called gross and net footage now runs from 50-60 percent. Low quality wood supplies have raised that figure somewhat above prewar levels, but it seems safe to set the normal average at 40%. Moreover this loss is determined

only on the basis of the so-called net footage, that is, the rough measurement of wooden squares and other regular geometrical shapes of which furniture parts are built. These parts are subsequently dressed and sanded; most of them are shaped to follow some artistic design and this involves a further loss ranging from 10 to 60 percent. In all statistics these finishing losses remain completely unaccounted.

The total loss in furniture-making amounts to not less than 50% in terms of true wood volume or weight and probably exceeds that figure. One-third of that amount consists in sawdust and shavings, the rest is solid wood.

Furniture waste is similar to sawmill waste; its salvaging presents essentially the same problems. Thus one of the main difficulties in the way of chemical utilization is how to convert the waste into regular shaped chips. Another one is how to set the waste free for industrial use. Furniture factories burn this waste as industrial fuel and give the surplus away as stovewood to their employees. The waste would have to be replaced by some other fuel, before it could be sold.

In certain apparently minor technical respects, the waste problem of the furniture industry differs from that of the sawmills. Let us examine how these differences affect the waste utilization prospects.

Disadvantages.

a). Most furniture is a cocktail of several hardwood species. The mixing recipes are modified several times a day. Larger factories might be able to separate their waste by species, but this would increase collection and storage costs. If this separation is omitted, this mixture of wood species and the fact that the waste contains furniture pieces covered with various glues, may still not render the waste useless, but will certainly add to the reluctance of ordinary pulpmills to pay a fair price.

b). The process of furniture making starts in a dry kiln. Chemical wood pulp is usually made from green wood. Certain chemists believe that steam treatment affects and weakens the fiber. While this assertion remains to be proved, the use of kiln-dried wood will certainly call for modifications of the cooking liquors, maybe for other technical adaptations.

Advantages

a). All the lumber used by furniture mills is free from bark—a notable advantage, as compared to current sawmill waste.

b). The average furniture plant is as large as the largest type of North Carolina's sawmills. It is a peculiarity of the industry that where there is one furniture factory, there are several. Furniture waste is concentrated in fairly large amounts within a few miles radius.

In my opinion, the advantages of furniture waste probably outweigh the drawbacks. However, an effort is needed to solve some technical difficulties and to overcome the prejudices against the use of dried, hardwood waste, This effort needs to be made by the furniture manufacturers, since it is to their prime interest to get some money for their waste. They might find it well worthwhile to cooperate in organizing a special research fund to determine the best methods for pulping their waste. War shortages of pulpwood offer a unique oppor-

tunity for inducing pulpmills to experiment with furniture waste. The furniture industry should make a special effort not to let this opportunity pass.

In 1940 North Carolina's furniture industry, using some 220 million board feet of lumber plus 25 million board feet of veneers, accumulated 120,000 cords of waste. Of these, about 50,000 cords consist of shavings, sawdust and scrap veneers, best fit for fuel. The remaining 70,000 cords are solid wood and constitute a potential source of chemical raw materials.

5.) *Other Woodworking Plants.*

According to the 1938 census, there were 155 independent planing mills in North Carolina, producing goods worth 15 million dollars. I estimate the output of these "concentration yards" at 500 million board feet., their waste coefficient with 20%. They add some 100,000 cords to the State's annual wood waste pile.

Primary wood plants, other than sawmills and veneer cutters, numbered almost 100, their production valued at 1.35 million dollars consumed approximately 75,000 cords and resulted in at least another 30,000 cords of waste.

These last two groups of industries have thus some 120,000 cords of waste, equally divided between solid pieces and sawdust, shavings or other small waste. Their potential supply amounts to 60,000 cords of good fiber material, assuming as usual that their small waste should continue to serve as fuel for the time being.

SUMMARY

The following table lists the main components of the annual waste pile accumulated by North Carolina's mechanical wood industries:

	Annual Wood consumption	*Total waste*	*Components in M. cords*		
			Bark	*Small-solid & Sawdust*	*Large Solid*
Sawmills	1.7 billion b.f.	2,500,000 cords	600	1100	800
Veneer & Plywood mills	150 million b.f.	180,000 "	30	110	40
Extraction plants	170,000 cords	(1)90,000 "	....	20	70
Other primary plants	75,000 cords	30,000 "	....	15	15
Furniture	220 million b.f.	110,000 "	....	40	70
Concentration Yards	500 million b.f.	100,000 "	....	50	50
TOTAL.....		3,010,000 cords	630	1335	1045

Slabs and large pieced solid waste aggregate over a million cords. Since this quantity would be enough for making almost twice the State's present pulp output, I suggest to concentrate all our attention on that part of the waste pile.

Footnote 1: Approximately 80,000 cords of spent extraction chips, converted into pulp, were not included in the "waste" total.

Let us assume that 500,000 cords, that is half the theoretical supply of slabs and solid waste, could actually be mobilized. Let us further guess that chemical conversion industries will gradually accept an average of 20 percent mill waste among their raw materials. Before a market for 500,000 cords of slabs could be hoped for, North Carolina's total pulpwood consumption would thus have to hit 2½ million cords. The expansion of pulp and fiberboard output to a total of 1.6 million tons a year, as suggested by our program, is just about what would be needed to provide a market for the most valuable part of North Carolina's wood manufacturing waste.

E. Better Utilization of Fuelwood and Cull Logs.

Since time immemorial wood has been mankind's most important fuel. While less efficient, wood is always cheaper in rural districts than coal or oil, since it involves no distribution and transportation charges. For the farmer, wood is the only fuel that costs no cash.

In addition to 2½ million cords of logging and manufacturing waste, fuel claims annually one-third of North Carolina's woodcut. Five million cords are used for heating; another million serves for curing tobacco. Inasmuch as North Carolina's heavy hardwoods are excellent fuel and have no sufficient industrial markets, this high rate of fuelwood consumption is not undesirable. But a correction of existing practices could render the removal of low-grade wood from the forests more attractive and result in setting free a million cords of pulpwood. Obviously such a reform should be attempted.

Heating with wood always involves two dangers which have reached exceptional proportions in North Carolina.

1. *Wasteful Heating Practices.*

The easiest and nicest way of burning wood is to throw logs into an open fireplace and this is still done in many of North Carolina's rural homes. Their owners are scarcely aware of the fact that they indulge in a great luxury and that the heat efficiency of open fireplaces is less than ten percent of what the fuel could yield.

Even where stoves are used, most of the models are outdated and extremely wasteful. Moreover, modern insulation techniques have not yet reached the farm homes of the South.

The Forest Survey has found that North Carolina's average farm burns annually 12.2 cords of wood. Since a properly insulated house in southern Sweden can do all its heating and cooking with 8 cords of softwood per year, 6 cords of hardwood should be sufficient with North Carolina's climate. Thus 6 cords of fuelwood per farm are destroyed every year by uneconomical heating practices. Instead of consuming 4.2 million cords of fuelwood, the State's farm families could attain the same comfort with 2 million cords. And while this theoretical difference of 2.2 million cords is certainly exaggerated, it indicates the order of magnitude of what a reform of fuelwood hearvesting and burning methods could achieve.

2. *Burning of Highgrade Wood.*

Only such wood should be burned as can serve no better purpose. But in North Carolina matters look very different. Only 2½ out of 6

million cords of fuelwood consist of defective materials. The rest is sound wood, most of which would be suitable for industrial use. The Forest Survey has found that 900,000 cords of sawtimber (470 million board feet) are burned every year, as well as probably another million cords of perfectly sound pulpwood.

On the other hand, from a total stand of 44 million cords of cull trees, only 2-3 million cords are removed every year, which is far less than foresters consider necessary to make place for sound growing stock. Indeed, the need for accelerated removal of cull trees, tops and limbs, and lowgrade hardwoods is so urgent that it has prompted me to include generators and other measures among the new outlets recommended in Section II.

Thus, North Carolina's fuelwood economy is wasteful and the excessive consumption is covered from sound trees, good for industrial use, while lowgrade trees remain in the forest and obstruct improvements in forest management. Other countries have experienced similar troubles. The Nazis were the first to understand what raw material reserves were contained among their fuelwood. Pre-Hitler Germany used 40 percent of the annual cut for fuel. By 1939, some 79% of the forest crop was retained for industrial use, only 21% was burned; half of what economy-minded German foresters had considered ten years earlier as fuelwood was now salvaged for chemical conversion.

Theoretically, North Carolina's fuelwood problem lends itself to simple correction. As a practical proposition, any change in inveterate woodburning and housing habits is a tough nut to crack, since it means for rural populations almost a change in their way of life.

To succeed, the attack must be bold and come from several sides.

In the first place, pulpwood using factories must be established in different parts of the State to be as close to the forests as possible. Section II, A & D, explains how this condition is to be fulfilled.

In the second place, mechancial equipment should be introduced for cutting wood into coal-size blocks, suitable for use in automatic stokers. Such equipment has recently been developed by the Forest Products Laboratory at Madison, which announces that its use would reduce the cost of fuelwood in rural areas by $1.00 or $2.00 per ton and help to increase greatly the burning efficiency of fuelwood. Fuel-conversion units will cost from $7,000 to $7,500 and should function as an area service, somewhat like a threshing machine.

Finally, wood burning practices should be improved by the large-scale introduction of modern wood-burning stoves. The Ashley Woodstove Company has developed a downdraft woodburning stove sold by retail stores for $50.00. It is claimed that one such stove keeps a farmhouse warm for a whole winter on 3 cords of fuelwood.

Woodgas stokers, developed in the past five years in Sweden are regarded by engineers as a revolution in heating technique. They attain a thermic efficiency of 80 percent, compared to 30 percent which used to be the normal performance of wood burning stoves. Negotiations are under way to import a few model stoves from Sweden, to conclude a license agreement for the U. S. and to develop manufacturing facilities in North Carolina.1/

1/ For details write to: Department of Conservation and Development, Raleigh.

There is no lack of good stoves. The problem is only how to bring them into the farm houses. I propose that this should be done by close cooperation between the Agricultural Extension Service, farmers' organizations, and pulp companies. State and Extension foresters or farmers' organizations could handle the distribution of the stoves as well as the sale of pulpwood and sawtimber, salvaged from the fuel pile. The pulp companies might find it worthwhile to finance the scheme in order to round up additional pulpwood supplies. Why, for instance, couldn't pulp companies offer every one of their wood suppliers a modern wood stove, provided he engages himself

a). to practice selective cutting and proper conservation according to the advice of a trained forester;

b). to supply the company (through the agency of a farmer organization) over a period of ten years with a certain quantity of pulpwood to be determined by the public forester or by mutual agreement between the farmers' and the company's foresters.

The pulpwood set free in ten years from an average annual fuelwood saving of 6 cords per farm would amount to at least 60 cords. If the price of stoves were fixed at $30.00, the farmer could pay for the stove by allowing the pulp company to deduct 50 cents per cord up to a total quantity of 60 cords. I suppose that arrangements of that kind might be made with some 150,000 forest-owning farms. They would increase the pulpwood supply by 1 million cords a year.

No matter whether this or some other scheme is adopted, it should be possible to save within a reasonably short time at least twenty percent on North Carolina's fuelwood consumption for domestic purposes (tobácco curing excluded) and by reducing these requirements from 5 to 4 million cords, to set free 1 million cords of additional pulpwood. The measures just advocated should also help in setting an end to the burning of sawtimber and pulpwood as domestic fuel.

There still remains one question. The present chapter discusses at length how fuelwood should be saved. Section II, c, is devoted to proposals for increased fuelwood consumption. Can the apparent contradiction between these two proposals be reconciled? Indeed it can, since they supplement each other.

Modern stoves, by rendering woodburning more efficient, increase the value of fuelwood. This price increase in turn is the indispensable incentive for getting the lowgrade woods out of the forest. Fuelwood economies, together with mechanized harvesting of lowgrade wood, will result in setting free large amounts of high grade woods for industrial use, as well as enough heavy hardwoods to meet the requirements of the woodgas generators and the wood distillation plant, proposed earlier in this report.

At present, good wood is burned, bad wood remains uncut. In future, by the combined action of our recommendations, all the bad wood should be removed and burned, all the good wood salvaged for appropriate utilization.

SECTION IV.

RATIONALIZATION

Even if it were technically possible to salvage all wood waste for industrial use, the time is still very remote when North Carolina's wood industries could absorb several million cords of wood waste every year. Hence the significance of all measures tending to reduce waste in the forests and in wood manufacture.

In Germany, such attempts were fairly successful. Addressing a wood congress in Nazi-occupied Paris, Prof. Kollmann, Germany's leading wood technologist reported that in 1936 waste in Germany's primary wood industries (planing mills included) had claimed 32 percent of the log contents. Another 29 percent of what was left became waste in the course of secondary manufacture. Subsequent improvements in machinery, gluing techniques, etc., reduced the total primary and secondary manufacturing waste from 61 to just 40 percent. Half of that quantity consisted in sawdust and shavings.

It is a fair guess that North Carolina's corresponding waste figure reaches 75-80 percent. Thus almost twice as much wood is lost here in the course of manufacture as necessary. From 100 cubic feet of logs, selected for manufacture, German consumers get 60 cubic feet of solid wood products, the American public only 20-25 cubic feet. Some of this far-pushed waste reduction may not be economic under American conditions; but this qualification refers to just a few percent.

Measures to achieve wood waste reductions have been publicized time and again. Mr. Oxholm's earlier mentioned report on wood waste in North Carolina (see p. 8) contains an excellent summary of a few particular efficient devices. I am not going to review here innumerable details of improved wood manufacture. Indeed, every phase of wood manufacture and every single plant has its own technical problems and solutions. Frequent plant inspections by efficiency experts and machine makers are the best way yet for obtaining improvements.

What I do want to discuss here are just two suggestions, which apply to every wood working establishment individually as well as to the industry as a whole.

A. Create Waste-Mindedness.

Earlier in this report I have tried to show how the log rules used in American wood industries contribute to their wastefulness. I believe it would be desirable to replace these log rules and the confusing multiplicity of wood measurements (board feet, cords, units, pieces, tons) by a single measuring unit, accounting in comparable terms for the log volume as well as for the wood volume manufactured or wasted. The cubic foot would be well suited for that purpose.

I am aware that such a change in measuring systems is a hopeless Utopia. Instead I suggest that the contemplated Forest Products Unit should regard the systematic development of waste-mindedness among North Carolina's wood operators as one of its foremost tasks. It should cooperate in that effort with other Federal and State authorities, with schools, trade associations and magazines.

Publications, issued at regular intervals, should translate actual practices into comparable cubic foot terms. Reminding every operator that his yield is only 40 to 50 percent, they should also tell him that other operators here and abroad have achieved higher yields and how. The significance of these improvements in dollars and cents should be presented; their effect on profits shown.

Frequent investigations should also be undertaken and publicized as to the most economic size and setup of wood industries. It is my conviction that sawmills cutting less than 3 million board feet are less profitable and far more wasteful than units making 5-10 million board feet a year. Unfortunately, I have been unable to discover recent figures substantiating that belief. How then should the individual operator be expected to know?

All the figures just enumerated ought to become the stock in trade of every operator. After the war, he could benefit immensely by being as familiar with them as he has to be now with OPA and WPB rulings.

I am usually fairly skeptical about educational campaigns but here is a case where they could pay dividends. Few manufacturers like to be told how to run their businesses. Nor is it possible to establish steadfast rules whether a gang saw is preferable to a good band equipment; whether veneer cores should be cut down to 7 inches or to 4.

A good operator will figure out these things for himself. A bad operator will not bother anyway. But unless manufacturers know what to do, what to expect, and what results others have achieved, they lack the tools for their own reasoning. The suggested disseminating of efficiency statistics will create the necessary stimulus. A waste-minded wood industry can be trusted to develop the right solutions by itself.

B. Integration of Wood Industries.

There was never a real U. S. wood industry. There were chiefly a U. S. lumber industry, a U. S. pulp industry, a U. S. furniture industry. Sawmills, pulp mills, veneer plants and furniture factories have all but ignored each other. A pooling of waste piles, mutual adjustments of raw material requirements have never been tried.

Thus, for instance, furniture factories are the principal customers of hardwood sawmills. Yet few furniture men are familiar with the details of lumber production. Even fewer lumbermen have ever bothered to acquaint themselves with the techniques of furniture making.

Consequently, furniture factories buy square edged boards of high average lengths, although every board entering a furniture plant is first cut down to short pieces, then edged for a second time. Over twenty percent of selected, clear hardwoods could be saved, if the lumber mills were allowed to send unedged boards—so-called flitches—to the furniture plants; this is demonstrated by the following examples:

A board, 18 feet long, 1" thick, measuring 6" at the narrow end and 10" at the large end, contains 12 board feet.

Alternative *A:* Cut at the *sawmill* into one: 1 x 6" board, it yields 9 board feet.

Loss: 25 percent.

Alternative *B:* Cut at the *furniture plant* into 6 boards of 3 feet each and edged subsequently, the 6 boards will total 11.52 board feet.

Loss: 4 percent.

To change over from Alternative A. to B., calls for the consent of the furniture maker. He could be induced to do so if the lumber man offered to split with him the profit from the operation and reduced the price for unedged lumber by say 10 percent. A smart furniture maker who tried that might well find here a way for cutting his costs substantially below those of his competitors.

This is just one of many examples of waste reductions that could result from closer cooperation among lumber mills and furniture plants. Others are the adjustment of lumber thicknesses to the actual requirements of dressed specifications, the universal acceptance of random widths and random lengths, more readiness to take short boards, etc.

A similar situation prevails between sawmills and pulpmills as mentioned several times earlier in this report. Sawmills could make a lot of money by selling slabs and other waste to pulpmills. Production costs of pulp could be reduced by the use of millwaste, i.e. a cheaper rawmaterial. But a number of technical questions would have to be settled first, calling for close cooperation between pulpmills and lumber manufacturers. This joint approach has never really been attempted because most lumbermen regard pulp factories as raw material competitors and vice-versa.

It is high time for lumbermen to grasp that a pulpmill could become just as much of an esteemed customer as a building contractor. It is up to the lumbermen to make the necessary sales effort, by turning out waste in quantity and shape that makes it suitable for pulpmills.

A fundamental change in outlook is called for. This change is so great that I doubt whether it could be achieved just by persuasion. I have seen too many sawmills, pulpmills, veneer plants and furniture factories working within a few yards distance, with each operator proudly ignoring the other's existence. But common interest might be able to do the trick.

I believe that *prefabrication of houses* could provide a suitable center around which to group various complementary interests. While neither an industry nor essentially new, prefabrication has close ties with almost every type of forest product. Lumber, plywood, fiberboard, paper, plastics, furniture, modern heating equipment—they all form part of a comfortable house. It would therefore be logical for a variety of industries to take out stock from a concern mass-manufacturing houses and distributing them at home and aboard. It may easily happen that the contacts among the stockholders would soon lead to cooperation in other fields as well. Prefabrication could then become the first step toward the integration of forest industries.

How to Begin.

Integrated wood concerns have recently become the standard pattern in Scandinavian wood industries. Their success is convincingly summed up in these two words: Higher profits. Also in this country all those who went ahead with integrated wood operations have fared very well. But they are still too few. *I strongly recommend "integration" as the basic principle for North Carolina's forest industries program.*

To achieve real progress in a short time, I propose the immediate selection of two forest industrial centers, one on the coast, the other in the foothills section of the Western counties. Each of these centers should group the greatest possible number of complementary forest industries. The integration should be achieved possibly by common ownership and management, otherwise by a joint board of directors. The emphasis on integration in all phases of operations should be clear from the outset.

The coastal group of industries should comprise:

Forests, mechanical logging equipment, especially for culling pulpwood and firewood, modern sawmills, a fiberboard and a plywood factory, distribution of efficient wood stoves and gas generators, and an organization for the manufacture and sale of prefabricated houses. Later a newsprint mill or a factory for laminated, high strength paper could be added.

The second group, located somewhere in Western North Carolina, could have a similar setup but should include a furniture factory, a plastic molding unit and give even more emphasis to the distribution of stoves and generators, maybe to the point of taking an interest in their manufacture. The prefabrication scheme should look chiefly to the U. S. market and provide for the sale of furnished houses, complete with refrigerators, stoves, etc. In due course a dissolving pulpmill might be added.