RESUME OF SOME OF THE NEWER PRODUCTS IN WOOD UTILIZATION

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Any account of wood utilization possibilities today must recognize products and processes that had hardly been heard of a few years ago. Because so many of these new forms of wood or wood-base materials have come into existence, there is a definite urge among those interested in timber to inform themselves whether their timber is being utilized to best advantage and whether there is now a good outlet for material formerly thought useless. This report is for use in answering inquiries received at the Forest Products Laboratory requesting such information.

The switch from high-grade virgin timber to lower grade and second growth has made new developments necessary; basic improvements in fiberizing, bonding, and laminating have made them possible. Much as the passing of the large, clear lumber products of the past is bemoaned, the new forms are sometimes better and relatively less costly than the old.

The newer developments involve fiber products, veneer products, and solid wood products, but the first more than the others. The fact that many of the major developments have occurred in the field of fiber utilization is significant to all regions because much of the available timber in all regions is well adapted to utilization as fiber, and the national trend in forest utilization is toward greater expansion in the manufacture of fiber products. There are undoubtedly limits to what markets can absorb in fiber products, but these limits are certainly not visible at present.

Fiber utilization usually means relatively large production units and substantial investments for equipment. Substantial expenditures for technical supervision and control are also involved, and great emphasis must be attached to distribution and sales, which often prove much bigger factors than they appear at first.

Along with the new products and methods of processing, new descriptive terms and new or different meanings for old accustomed terms have come into use. Different branches of the forest products industries sometimes use the same
term with different meaning. Hence, nomenclature and definitions have become something of an industry problem. Definitions that the Forest Products Laboratory considers effective are included at the end of this report. The reader is urged to check these definitions so that he does not misinterpret some of the statements made in the report.

Pulp and Paper Products

The new developments in this field involve highly technical matters primarily of concern to specialized technologists and need not be dealt with in any detail. There are certain broad phases of the subject, however, that can well be mentioned in their relation to the utilization situation in most regions.

An important element in recent developments is the increased use of paperboard by the packaging industry. Public recognition of the many virtues of paperboard containers, and the rapid introduction of new uses for them, have been responsible for this increase. Striking examples are containers for milk and frozen foods.

In addition to paperboards, a new use having considerable impact on industry is that of paper and boards for building construction. These building products are saturating felts for asphalt roofing and insulating boards and high density boards for house construction. Production of building board products increased more than tenfold from 1939 to 1951.

Long-fibered softwoods, such as the spruces, hemlocks, pines, and firs, will always be prized pulp species in almost any region. But the hardwoods, such as aspen, cottonwood, gum, and several others, already important, give promise of playing an increasingly important role, partly because they are of major volume in many areas close to large consuming markets, and partly because they are inherently well adapted to products of the greatest recent increase in consumer demand.

Hardwoods are particularly suited for pulping by the soda process to produce soft, opaque, bulky pulps that are ideally fitted for use in book and magazine papers. Roughly 25 percent of the present hardwood pulpwood consumption is for soda pulp. The relatively low strength of the hardwood soda pulp, however, will probably limit any appreciable expansion in the future.

Lightweight hardwoods like aspen, cottonwood, and gum make good-quality groundwood pulps having most of the uses of softwood groundwood. But the dense hardwoods, such as oak and maple, which are more abundant than the others, make poor strength groundwood pulps by known commercial practices, and hence have only limited use as filler pulp. The groundwood industry now consumes about 18 percent of the hardwoods, but any great expansion by present methods does not appear promising. Chemical pretreatment of wood bolts, followed by conventional grinding, has been indicated by experiments as a method of producing serviceable pulps from the dense hardwoods, although the pulps tend to differ in properties from customary groundwood pulp.

Sulfite pulp takes about 18 percent of the hardwoods utilized by the pulp industry. These pulps generally supplement or are substitutes for soda pulp.
in printing paper, or they are used in white papers of moderate strength and in purified pulp. Because of the relatively low strength of most of the hardwood sulfite pulps and the unsatisfactory pulping of certain woods, no great increase in production is expected.

Hardwood sulfate pulp is increasing in production and now consumes about 13 percent of the total U.S. hardwood pulpwood consumption. This pulp has properties that compare favorably with softwood sulfite pulp and it has many of the same uses. It should have extensive use in many products where high strength is not the paramount consideration and as part of the furnish in products of moderate strength. Special hardwood sulfate pulps are also used in the chemical conversion industry. When such difficulties as barking and separate processing are overcome, it is expected that production of hardwood sulfate pulps will expand greatly.

The semichemical and coarse-fiber industries are outstanding in their application of hardwoods. Most of the growth has taken place during the last 10 years, chiefly for the manufacture of corrugating board and building products and, more recently, bleached papers from semichemical pulp. The facts that hardwoods are highly suitable for processing by the semichemical process, that exceptionally high yields are obtained from this process (an important factor now at a time of high wood costs), and that high-quality white papers and boards can be made from the bleached pulps, presage an interesting future for this newest of the major pulping processes.

The semichemical pulping process, with its advantages of high yield and its applicability to hardwoods, has become of great interest to the pulp industry in the last few years. The particular suitability of semichemical pulps for high-quality corrugating board for use in the rapidly expanding packaging industry gave the process a needed start, and other natural quality values are being discovered. The growth of the semichemical industry has been remarkable. Productive capacity in the United States has increased from 465 tons daily in 1940 to 1,490 tons in 1947 and to 2,750 tons in 1951. There are now 26 semichemical pulp mills located in all of the major pulping areas except the Pacific Northwest.

Hardwood semichemical pulps are characterized by relatively high strength, rapid development of strength, short fibers, and high hemicellulose content. The fully bleached pulps are appreciably stronger than the unbleached, and, except for relatively low folding endurance, they are as strong or stronger than bleached softwood sulfite pulp. The bleached pulps are softer, more absorbent, and have more flexible fibers than the unbleached pulp.

Paper and boards made from hardwood semichemical pulp are hard, stiff, and low in opacity. When desired, however, these properties can be offset by blending the pulp with softer, more opaque pulps. Unbleached semichemical pulps are used mainly in corrugating board to take advantage of the stiffness of the fibers, in specialty boards, such as book, match, and bottle cap, and in certain grades of wrapping paper. These pulps have also been used in insulating board, hardboard, and roofing felt. The bleached pulps are used in coated book, magazine cover, bond, and greaseproof papers.
Trials have indicated strong possibilities for use of bleached hardwood semichemical pulps in book, waxing, carbonizing, and towel papers.

An entirely different field in which aspen pulp has special advantages is that of purified pulp, also frequently called alpha pulp or dissolving pulp. This kind of pulp is used for the production of regenerated cellulose yarns and fabrics, and for lacquers, plastics, and explosives. Nearly all of the alpha pulp now produced is made from the long-fibered softwoods. It is probable, however, that the increasing demand for alpha pulp will provide the incentive for a more extensive use of short-fibered hardwoods. Because of its high cellulose content and ease of pulping, aspen is an attractive material for the production of purified pulp. When techniques are developed that permit the more general use of short-fibered pulps, purified aspen pulp is likely to find ready acceptance. The wood could be digested by the conventional sulfite process or by a modified sulfate process and the pulp purified by conventional methods. The digesting of aspen with nitric acid has received considerable attention as a possible method of producing pulp for subsequent purification. The possibility of obtaining a high yield of alpha pulp by the purification of neutral sulfite semichemical pulp is a factor in favor of the consideration of that process.

Hardboards

One of the more significant developments in recent years is the growth of the hardboard industry. Some 12 plants in the United States have been built or planned since 1948, with a daily productive capacity of about 2,000 tons. Most of them are in the West, but the original plant was in the South. Hardboard is made from low-grade logs and mill waste, usually barked but not always, from both softwoods and hardwoods. Hardboard is coming to be used for purposes that previously were served only by material from high-grade timber.

Hardboard is a medium-cost product when manufactured under conditions of high-volume production. Plant equipment costs vary widely according to the process used. They are relatively high when production is geared to minimum production costs.

There is considerable confusion in the industry at present as to what classifies as hardboard, although it is a term in very wide use. Generally, hardboard is described as dense, relatively stiff fiberboard, usually manufactured in thicknesses of 1/8 to 5/16 inch. In this report it is taken as a product having a specific gravity of 0.80 or more to distinguish it from softer insulation boards and intermediate board products. Individual manufacturers make hardboard of varying qualities under a wide variety of brand names, some of which are Masonite, Armorboard, Superwood, Pres-pine, Resin Wood, Structoboard, Weldboard, Lebanite, Oregonbord, Forest Hardboard, Foron, Presdirood, All Wood, and Duron.

Hardboard is most commonly made from a pulped or partially pulped fiber, but in a few instances it is made from nonfelted finely divided raw wood.
particles. Most of the boards made from wood particles, however, are not
densified to the point where they classify as hardboards under the pre-
ferred definition. Thus they are referred to as resin-bonded particle
boards.

To make pulped-fiber hardboard, the wood is first chipped then reduced to
fibers in a digester, defibrator, or attrition mill. The fibers are
refined and deposited on a screen for felting. After the felts or mats
are cut to size, they are pressed in a multiplaten hot press for densifi-
cation and curing. For tempered hardboard, water repellents and other
treatments are added.

If the fibers are carried in a slurry of water and deposited on the screen
as in paper manufacture, it is referred to as the wet-form process. If
the fibers are deposited on the screen by air or other means, it is an
air-felted or dry-formed process. When the pulp is felted by certain
patented methods with less water than is used in wet forming, it is called
the semidry process.

If the screen travels as the fibers are deposited, the process is called
continuous; if the screen does not travel, it is called a batch process.

In the nonfelted type of fiberboard meeting the stated definition of hard-
board, the wood particles are produced from dry sawdust, shavings, and
clippings reduced to small size by hammer mills and other grinders. The
particles are mixed with synthetic resins, properly dispersed on screens
or trays, and hot pressed. Equipment is relatively simple compared with
a pulp-fiber operation. Machines for mixing wood particles with the resins
are fairly simple, but it is necessary to use automatic or semiautomatic
tray loaders that are capable of loading the trays with a uniform weight
and thickness of the mixture. Particle size, shape, and distribution are
of critical importance. The resin component determines the cost and
properties of this type of board.

The equipment cost for the continuous wet-formed process is $20,000 to
$40,000 per ton of daily capacity, with a minimum capacity for economic
operation of 60 tons per 24 hours. The semidry process involves a lower
investment cost per ton capacity. For the wet-formed batch process, the
investment cost per ton of daily capacity is about 25 percent lower than
continuous wet form, with a minimum for economic operation of approximately
25 to 50 tons per 24 hours. For the nonfelted type of hardboard, the
equipment cost is about $15,000 per ton daily capacity with a minimum
economic unit being about 10 tons per 24 hours.

With the higher per ton investment cost and with the larger capacity
units, the manufacturing costs per thousand square feet is correspondingly
reduced. In 1951, the manufacturing costs for 1/8-inch hardboard were
estimated to vary from $21.70 to $30 per thousand square feet depending
upon the process; for 1/4-inch board by the batch processes the cost
varied from about $37 to $44.
It is reported that raw materials constitute only about one-fourth of the cost of hardboard. In some processes, this is mainly wood costs; in others, largely resin cost. In the nonfelted type of hardboard where resin is an important component, the cost of resin at current prices per thousand square feet of 3/16-inch material is approximately $15.

Because hardboards rate high in moisture resistance, hardness, and stiffness, their market channels are diverse, with about one-half of the production being subjected to some remanufacture before reaching the ultimate consumer. This portion of production is for the industrial market, while the remainder is for the retail market. Material for the retail market finds an outlet through lumber yards in 4- by 4- to 4- by 16-foot panels, with the 4- by 8-foot panel being most common. Common thicknesses are 1/8, 3/16, 1/4, and 5/16 inch.

Generally, hardboard has many of the same uses as thin plywood except where weight is of paramount importance, such as in some packaging. In some fields, hardboards have uses where plywood is not a strong competitor. A list of about 300 uses is said to have been compiled in the industry.

Many of the present uses for hardboards have service records that clearly demonstrate the advantages of the material. In the furniture industry, hardboards are used for mirror backs, drawer bottoms, desk tops, and insert panels and backs for chests of drawers and wardrobes. In the appliance field, hardboards find an outlet in backs for radios and television sets and as liners and backs for refrigerators and freezers. They are used extensively in templates and jigs for manufacturing operations, and some of the special dense hardboards are used to a limited extent in dies and forms for working metals and for electrical-control panels. In household furnishings, they are used for facings for flush doors, and as backs, doors, and counter tops for kitchen cabinets and storage units. In the transportation field, increasing amounts of hardboards are being used for panels, liners, and partitions in truck, bus, trailer, and Pullman car bodies.

In buildings and houses, hardboards may be used for siding, paneling, counter faces and tops, facing for concrete forms, linoleum underlayment, exterior wall covering, and to a limited extent, as floor surfacing. They are used considerably in advertising displays, signs, and toys.

At least one producer manufactures hardboard strictly for in-plant use. This is a significant point as sales costs and marketing difficulties are eliminated.

Among the newer prospects for utilizing increasingly large amounts of hardboard are (1) as stress-cover material, (2) as facing for plywood core panels, (3) as base for plastic overlays, and (4) as core material for plywood faced panels.

Several plywood mills are presently manufacturing hardboard-faced plywood. When Douglas-fir crossbands and cores are used, the composite conforms to standards set up and maintained by the Douglas Fir Plywood Association. Other softwoods also are being used.

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Hardboards provide an excellent base for the thin, highly decorative plastic overlays that are used so extensively for counter, table, and bar tops in homes, restaurants, stores, and taverns. Hardboards have been used to a limited extent as stress-cover material for prefabricated house panels. As the prefabricated housing industry grows, larger amounts can be used.

The future of hardboard seems assured. The extent to which it will grow will depend to a considerable degree on such factors as the number of new uses that can be developed, the amount of buyer confidence that can be built up, the continuation of low-cost production, freight, and merchandising which will keep hardboards competitive with other materials. Improvement and modification of the product to meet special requirements will be important factors. It seems to be the consensus of many of the people working in this phase of forest products that a substantial part of the future lies not in flat sheets but in specially molded shapes.

Distribution and marketing difficulties and costs have proved to be tougher than many producers initially expected. Distribution through regular lumber trade channels has not worked out well because many of the users are industrial fabricators not largely reached through lumber retail channels. Sales tend to be by brand names, and often the product must be tailored to specific use requirements. Much of the new production is on the West Coast where nearby large industrial users are not as plentiful as in the Midwest and East. Shipping West Coast hardboard to Midwest markets costs from $9 to $10 per thousand square feet of 1/8-inch board and about $14 per thousand square feet for 1/4-inch board, which partly offsets the lower production costs of West Coast plants.

Resin-Bonded Particle Boards

Nonfelted boards in certain instances may classify as hardboards, as indicated previously, but typically should be classified as resin-bonded particle boards. The wood component is of distinctly separate particles, and densification is not carried out to a high degree. Normally they are produced in heavier thickness than hardboards. For bonding, resins are relied on even more than pressure. Material smaller than pulp chips is the starting point. Particle board is a type of product that laymen sometimes think of as the ready answer to the sawdust and shavings disposal problem. It is not that simple. However, for specially prepared forms of material from waste and with special attention to methods of layering and bonding, this type of product holds promise of a substantial future.

Some commercial production of particle boards in the United States is under way, and a good deal of research and experimentation is going on in connection with it. In addition to use as core material for furniture parts, there are certain recognized forms in commercial production for open-market sales, as covered by commercial patents relating either to a particular formulation, or to special equipment or methods of facilitating manufacture. A product of this type has a low-density core of wood particles prepared from veneer mill waste and outer face plies made from special
shavings sliced from veneer log cores. Compressing, glue-bonding, and curing are done in hot presses. The output, at least in part, is offered to the trade for use without any surface overlay because of its distinctive textured appearance, which designers favor for certain purposes.

Commercial exploitation of this type of board has thus far developed more extensively in Germany, Switzerland, and France than in the United States. It is reported that there are at least a dozen plants in Germany making what they term "shaving boards" or "chip boards" about 3/4 inch thick for furniture core and building panel material. There are also several such plants in other European countries, and active experimentation is taking place in southeastern Asian countries.

The terms "shaving board," "chip board," and "chip core" are borrowed from European terminology, and should not be applied to materials normally thought of in the United States as shavings or chips. In Europe, as in the United States, there is a preference for making most of the material from solid waste wood by converting it into thin flakes or special shavings. Europeans and Americans recognize the pronounced effect of particle shape and size, and generally agree that thin material gives the highest strength to the board. It is also agreed that ordinary planer shavings are not satisfactory for the better types of board. If ordinary shavings are used, they are pulverized in a hammer mill and used in combination with specially cut material.

The opinion of an American engineer, who has seen European producing plants and consuming factories, is that use of wood waste of this type as core stock in lieu of solid wood core stock is destined for rapid growth in this country. Substantial developments in the particle-board field will probably involve use of the product as core stock overlayed with veneer, plastic, and other face materials.

Resistance to moisture, strength, and appearance characteristics, as well as production costs, vary greatly according to the kind and amount of resins used for bonding, the form of raw material used, and how the production procedures are carried out.

Elmendorf estimates capital requirements for a board plant in the United States producing 1 ton per hour of 3/4-inch board from special shavings from corewood would be $500,000, without boiler or power plant; a similar plant using sawdust would cost $250,000.

Elmendorf, A. Furniture Core Panels of Wood Waste. Paper No. 52-F-44, American Society of Mechanical Engineers.
Molded Products

Wood base-materials are now being formed and pressed to finished contours and shapes for specific industrial products. These processes may become much more important in the future as molded wood products of various types can be made from plywood, veneer, pulp, fiberboards, and particle boards.

Contoured pressing and bonding of veneer into molded plywood products is a well-established practice for various military applications and for furniture and other industrial products.

Molded pulp products, such as egg trays and paper plates, are well recognized lines of manufacture.

Hardboard formulation to curved forms rather than flat sheets is not carried out at present, but may be an important factor in the future. It is significant that production is getting under way in the West to supply wood-fiber mats for further processing by fabricators who will impregnate them with suitable resins and compress them to their own molded forms.

The use of wood particles of or processed from sawdust and shavings for molding finished products has had strong appeal as a possible means of converting waste in ordinary operations to merchantable commodities. There are distinct limitations but also distinct present and future applications. Many toilet seats, croquet balls, and the like are now manufactured from fragmented wood molded with synthetic resins. Bowls and similar utensils, some chair backs, and containers with molded-in depressions for tools and other similar articles are also produced.

Extrusion molding of a mixture of wood fibers and suitable resins has received considerable attention but with relatively little commercial development thus far, although it is reported that at least two plants are in commercial production.

Various molded plastic products make use of wood flour as an important component, but more as a filler or extender than a visible part of the product. These products and the wood material they embody warrant due recognition, but they fall somewhat outside the category of molded products considered here.

In this field, the material is tailored to a specific use rather than a use being found for the material.

Veneer, Plywood, and Overlays

Veneer is, of course, standard facing material for wood panels, whether all veneer or in combination with core material. The use of veneer in panels is supplemented by other facing materials, such as resin-impregnated sheets of glass, fabric, cloth, and paper, and thin metals. All these facing materials are used over plywood, hardboards, particle boards, or other
built-up cores. Or the reverse may occur -- thin plywood may be used as the face material over other built-up cores. Or as indicated previously, hardboards may be used as the facing for plywood core material. In other words, stemming from what all-veneer plywood originally exemplified, there is now a great variety of combinations being used and every indication that this development will continue. It extends opportunities to utilize wood waste and wood of lower qualities, and gives consuming industries an ever-widening choice of materials to meet specific requirements. In a sense, the trend acts as an equalizing force among forest regions in the matter of timber qualities. Of course, it does not mean that good, large timbers are not easier and cheaper to operate with than low-grade small timbers, but one type and quality of timber now has no insuperable monopoly over another, if other conditions compensate.

Papreg, Compreg, and Impreg

Changing the normal properties of paper and veneer by special impregnation with suitable synthetic resins and subsequent variable treatments is the basis of substantial developments in the last few years. The dimensional changes caused by changes in moisture content are greatly reduced. Impregnation followed by hot-plate pressing, usually incident to simultaneously bonding numerous layers together in fairly thick large panels, imparts high density, hardness, and smoothness of surface as well as moisture resistance.

When special high-strength papers are used as the base, a product called papreg is formed. Papreg has found many commercial and military uses where high-class material is required. Table and counter-top material typifies one field of commercial use and flooring another.

When veneer is used as the base, the product is called compreg. This material has also found several military and commercial applications. In the latter, the maintenance or enhancement of the beauty of the grain of the wood is an important feature.

When veneer or somewhat thicker wood is impregnated with suitable resins but not followed by hot pressing the product is called impreg. This material maintains more or less the normal density and hardness of the original wood but has high resistance to dimensional changes. It holds commercial interest for certain applications where easy machining or cutting to shape combined with high stability are required, as for example in mock-up work.

Sandwich Material

One of the newest forms of engineering material is what is called sandwich material. This may be wholly or partly wood-base material, or of nonwood base, such as fiber glass, metal, rubber, or synthetics. In this respect, it is a common meeting ground for several radically different base materials. A sandwich construction is low-density core to which are bonded high-density, high-strength faces to give a total effect of high stiffness and shear.
resistance combined with light weight. The core may be a lightweight solid material, such as balsa wood, or an open formation like honeycomb. A typical all-wood form is of resin-impregnated paper honeycomb construction; the faces are high-strength plates of plywood or compressed resin-impregnated paper. The core and faces are bonded with synthetic-resin glues. The thicknesses may be 1 inch or less, but in structural forms are usually up to 3 or 4 inches. Currently, the uses are for specialty purposes, such as aircraft parts, and movable office partitions. A number of experimental houses have been constructed, but use in housing is on the horizon for the future.

Sandwich material from wood or fiber is not extensively produced as yet, but wood-product concerns are watching its development. Ultimately it may be a form into which much paper and veneer products go. It cannot be ignored in long-range viewing of forest-utilization trends in any region; neither can it be definitely evaluated at present. It is one of those things that may greatly change present conceptions of forest-products utilization.

Cement-Fiber Boards

The use of wood fiber combined with minerals as a cementing agent has been the objective of several research and commercial projects over a considerable period of time. Where ordinary sawdust and Portland cement have been used, the results have not been generally satisfactory. Where especially prepared fibrous wood and special cements have been used with technical understanding of the chemical and other reactions that are involved, some commercial success has been realized.

A product of this type, which has been in commercial use for several years, consists of excelsiorlike ribbons of wood cemented together under mild pressure with a magnesite formulation to form thick sheets or blocks of material some 2 to 3 inches in thickness. One of its important uses is as a structural insulating material for factory roofs.

More recently, other forms of the product are reported to be in fairly heavy production; one by a company in New Jersey makes use of a finely shredded wood fiber, and another by a company in Ohio uses an excelsior-type fiber.

A third form, exhibited recently under the term of "embedded fiberboard," is made of a finely shredded fiber produced by a special machine, the use of which is leasable on a royalty basis. The fiber is cemented with a special formulation of gypsumlike minerals. It is used in standard thicknesses as wallboard material and is said to provide a low cost, strong wallboard. The plant equipment cost for economic production is said to be about $250,000.
"Making big ones out of little ones" is the way laminating is often facetiously described. A glued lamination is defined as built up of plies joined with an adhesive so that the grain of all plies is essentially parallel. Laminating has developed substantially during recent years, with the switch from large to small logs and with improved gluing techniques. Its most conspicuous advances have been with relatively large, structural members, such as roof arches and ship framing, but smaller products, such as bowling pins, ball bats, and furniture parts are also being made. Inch or thicker lumber is usually the starting point for the heavier members, but veneer may be the initial material for some products.

It is to be expected that laminating will develop more and more as time goes on both for building purposes and for smaller fabricated products.

Technical know-how and skill are determining factors in this line of enterprise. Equipment costs for suitable plants are by no means negligible, but it is not a type of processing that inherently calls for large investments. Large, medium, or relatively small plants are possible if the know-how and equipment are at hand.

Standard wood-shop machines, dry kilns, equipment for gluing, temperature controls for curing, and presses are prerequisites. End-scarfing techniques for joining lengths within a ply or lamination are often critical factors.

Technical advantages of laminated products are that they (1) permit fabrication to various shapes, (2) permit the use of smaller material, (3) decrease the time required to produce thoroughly dry products, (4) decrease splitting, checking, and loosening of fastenings, and (5) often reduce the time in final erections or assemblies.

Economic limitations are (1) that the cost is often above that of a solid-lumber product if the latter is suitable and available, and (2) that proper equipment and skills are required in engineering and fabricating the product.

Gluing must be done so as to provide uniform and adequate bond strength and selection of glues must be geared to service requirements. Severe service may require decay-resistant species or preservative treatment that may be accomplished before or after gluing.

Container Material

With the great changes taking place in the packaging field, box lumber, an important use for low-grade lumber at many sawmills, is subject to increasing competition from new container materials. Some of the loss of markets for rough box lumber may be compensated for by other container products that can be made from low-grade timber. A component of one of the newer types of containers is cleat stock, a lumber product that is now being produced by some mills. The so-called cleated box (reinforcing cleats glued to...
fiberboard or plywood panels) is coming into wide commercial use, especially for shipment of home appliances. The fabricators of these boxes require cut-to-size stock, nominal 1 inch, 1-1/4 to 2-1/2 inches wide, and in varied lengths up to about 6 feet. Thorough seasoning is a must because the cleats are to be glued to fiberboard panels and defects are limited. Thus, it is a more refined product than many sawmills now produce, and steady, year-around delivery in a specified variety of sizes is required. The use of dry kilns to assure steady delivery of seasoned material seems essential.

Another type of container coming into prominence is a thin sheet material consisting of facings of kraft paper glued to a single ply of veneer. It is produced by at least one large company in the South and another in the West. Commercial patents cover the products or processes as now produced. The materials go under such trade names as "Craveneer," "Tecwood," and "Fly-veneer," and the finished packages sometimes as "Wood-kraft-veneer." The potential use of this type of material in the shipment of foods and other products appears to be large.

**Briquettes and Charcoal**

Fuel products of wood are usually thought of as passing out of the technological and economic picture because of the great expansion in the use of gas, oil, and other easily handled fuels. To a large degree this is true, but -- although former volumes have fallen off -- new fuel specialties of wood are now being produced and marketed.

The largest commercial use for sawdust and shavings, for example, is the production of fuel briquettes. One method of briquetting practiced by 60 companies accounts for an annual output of about 200,000 tons of so-called pressed logs. Most of these companies are in the West, but there are one each in the Lake States, the South, and the East.

In addition to the pressed logs, which are usually of stove-wood size, a stoker briquette is also made. Its production is limited, however, and channels of distribution are not firmly established.

Although many companies in Europe follow a briquetting process that does not require material of low moisture content, it is doubtful that the quality would be acceptable here. Therefore, the only process used successfully in this country requires a dry sawdust and shavings. A substantial and steady supply of these materials -- about 20 to 24 tons daily for the large briquette and from 5 to 8 tons a day for the stoker size -- is essential to successful operation.

Charcoal is another specialty that has wide use as picnic, barbecue, and industrial fuel. Much of it is now made by relatively small companies, in which it is the main product rather than a by-product of wood distillation. Although it may be a somewhat temporary vogue, it is one that many small companies have catered to, and it now provides a market for forest material in almost all parts of the country.

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Pallets

Pallets and fork-lift trucks are Siamese twins in the package-handling field in all branches of American industry; born during World War II and growing lustily since. Pallets are portable wood platforms upon which packages are placed for use with fork-lift trucks in all stages of handling and storage. They may be one-use expendable items, or built for reuse and long life. Many small factories as well as large industries are turning to this method of materials handling, which creates a current and potentially large demand for lumber.

For the country as a whole, about 221 million board feet were used for pallets in 1948, which means that their manufacture is one of the important industrial uses for lumber, about one-tenth that for millwork or for furniture.

Most pallets are made of hardwoods -- oak, gum, beech, aspen, maple, birch, about in the order given.

Different lines of business use different types of pallets, therefore they are often manufactured for a particular buyer. Many pallets are made by companies that specialize in that business; some by sawmills that do it as a sideline. Pallets are sometimes handled through brokers who take the orders from industrial buyers and farm out the manufacture to producing mills.

Because pallets were made of common lumber, were easily fabricated, and were in very strong demand at the beginning of their use, their manufacture was reported to be very profitable. More recently, the competition has greatly stiffened and some suppliers have apparently been dissatisfied with returns and abandoned production. Pallets remain an important lumber product, however, and their manufacture promises to continue on a substantial basis.

Air-dried or kiln-dried lumber is generally used, although some pallets are made of green stock. Grades No. 2 Common and lower are generally used, but some consumers are requesting a higher grade product. Planing and some other machine work is required on most types. Deck boards may be 3/4- to 2-inch lumber, while skids, stringers, and uprights may be dimension lumber. Parts are fastened together with nails, screws, and, in some cases, gluing. The size, number, and location of fasteners are very important in most pallet construction.

Feed Molasses and Wood Sugars

Chemical hydrolysis -- subjecting hogged wood or sawdust to acid solutions under pressure to change the cellulose to sugars -- is an old process that has undergone much development in recent years. Extensive animal-feeding tests by agricultural colleges in various parts of the country have established the acceptability and value of the feed products that can be produced from wood sugar. The economics of production and use have posed the main
difficulties. Under current prices for competing feed materials, notably blackstrap molasses, the manufacture of feed molasses from wood may be marginal or submarginal. Relatively large, constant concentrations of wood waste at low cost (50 tons daily) are prerequisites at present to any economic consideration. Heavy equipment costs and experienced skills are required.

The conversion of logging and manufacturing wastes into wood-sugar solutions suitable for further processing offers one of the best potential possibilities for the use of large quantities of waste material. Since no commercial plant has been operated as yet, much work still remains, including the development of markets. Feed molasses is only one product that can be produced from wood sugars fermented into industrial alcohol, glycerine, or fats, or they can be chemically processed into glycerine, glycols, furfural, and acetic and levulinic acids. In other words, these sugars will produce the same products that can be manufactured from corn, beet, or cane sugar. Much remains to be done in the development of uses for the lignin residue, which is a key problem in the economic application of hydrolysis.
DEFINITIONS USED BY FOREST PRODUCTS LABORATORY

Trade and other recognized definitions are used in this list when considered adequate; in certain cases with some modification.

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**Briquette**

Wood.--A mass of fine wood particles highly compressed to cylindrical or cake form, usually without external or internal binder.

Charcoal.--A mass of powdered charcoal compressed to cake form, with the addition of a binding agent.

**Built-Up Timbers**

An assembly made by joining layers of lumber together with mechanical fastenings so that the grain of all laminations is essentially parallel.

**Chips**

Wood cut into small pieces of substantial thickness and more or less uniform size, usually for specific requirements such as pulping. (In European terminology the term also refers to shavings.)

**Chipboard**

A relatively low strength, low density board made from waste paper, often used as the inner ply in shipping container and carton boards.

**Compreg**

Wood in which the cell walls have been impregnated with synthetic resin and compressed so as to give it reduced swelling and shrinking characteristics and increased density and strength properties.

**Container Board**

Corrugated or solid fiberboard used for the manufacture of shipping containers.

**Core Stock**

A term usually applying to edge-glued lumber that is used for cores or center plies in lumber-core plywood; sometimes extended to include resin-bonded particle boards, resawn laminated veneer, resin-impregnated paper honeycomb or other forms used for center plies in panel construction.
Corrugated Board

Paperboard composed of wood pulp (or straw pulp) usually about 0.009 inch in thickness after it has been passed through a corrugating machine. Usually single or double faced with flat sheets of paperboard called liners.

Cut Stock

In the softwood lumber industry a term comparable to dimension stock in the hardwood industry. It is softwood stock processed to a point where the maximum waste is left at a cut-stock mill and the maximum utility delivered to the user. It is stock of specified thickness, width, and length, or multiples thereof. According to specification, it may be solid or glued up, rough or surfaced, partially or fully machined for fabrication.

Dimension Stock

A term largely superseded by the term hardwood dimension lumber. It is hardwood stock processed to a point where the maximum waste is left at a dimension mill and the maximum utility delivered to the user. It is stock of specified thickness, width, and length, or multiples thereof. According to specification, it may be solid or glued up, rough or surfaced, partially or fully machined for fabrication.

Dissolving Pulp

Highly purified, high-alpha pulp used for the manufacture of cellophane, rayon, and cellulose derivatives.

Excelsior

Long strands of wood of such controlled thickness and width that they will curl and pack without breakage. They are produced by knife cutters operating longitudinally of the fiber length. Although the strands are usually approximately square in cross section, they may be flat or ribbon-like. In European usage, the term is synonymous with wood wool, but in the United States the latter term refers to excelsior of extra fineness.

Fiberboard

See Fiber Building Board and Container Board. (A confusing term sometimes applied to Fiber Building Board and Container Board.)
Fiber Building Board

A broad generic term inclusive of sheet materials of widely varying densities manufactured of refined or partially refined wood (or other vegetable) fibers. Bonding agents and other materials may be added to increase strength, resistance to moisture, fire, or decay, or to improve some other property.

Flaked Wood

A term descriptive of uniformly thin, flat, or easily flattened fragments of wood which are cut to minimize fiber damage and the cross grain, short-fiber material which characterizes ordinary shavings from planer operation.

Hardboard

A fiber building board (see) having a specific gravity of 0.80 to 1.15.

Superhardboard.—A board having a specific gravity of 1.35 to 1.45.

Hogged Wood

Wood cut or broken into relatively coarse pieces primarily to facilitate handling and to control size, shape, or quality of fiber. This material is prepared often for use as fuel.

Hollow-Core Construction

A panel construction with faces of plywood, hardboard, or similar material bonded to a framed-core assembly of wood lattice, paperboard rings, or the like which support the facing at spaced intervals.

Honeycomb

A construction of thin sheet material, such as resin-impregnated paper or fabric, which has been corrugated and bonded, each sheet in opposite phase to the phases of adjacent sheets, to form a core material whose cross section is a series of mutually continuous cells similar to natural honeycomb.

Impreg

Wood in which the cell walls have been impregnated with synthetic resin so as to reduce materially its swelling and shrinking. Impreg is not compressed.
Insulation Board

Semirigid.--A fiber building board (see) manufactured primarily for insulation, having insufficient strength for structural use but sufficient stiffness and strength to maintain position and form without attachment to the structure proper. Specific gravity 0.02 to 0.15.

Rigid.--A fiber building board (see) manufactured for insulation, strength, and sound absorbent qualities, having a specific gravity of 0.15 to 0.40.

Intermediate density.--Often called wallboard, having a specific gravity of 0.40 to 0.80.

Laminated Paper Board

Paperboard laminated either by (a) combining two or more plies of board with adhesive or resin or (b) combining with adhesive or resin a thin paper with specific properties to one or both sides of a sheet of paperboard.

Laminated Paper

A paper built up to a desired thickness or given a desired surface by joining two or more webs or sheets with adhesive or resin. The papers thus joined may be alike or different, or a totally different material like metal foil may be joined with paper.

Laminated Paper Plastic

Laminae of resin-treated paper molded under heat and pressure into a coherent structure made in the form of sheets, tubes, rods, or other forms of simple curvature. See papreg. (Also termed paper-base laminate.)

Laminated Wood

An assembly made by bonding with an adhesive layers of veneer or lumber so that the grain of all laminations is essentially parallel.

Modified Wood

Wood processed to impart properties quite different from those of the original wood by means of chemical treatment, compression, or treatment with or without heat. (Relates to the wood component only and not to the method of assembly. European terminology relates also to the latter to include such products as plywood.)
Molded Pulp Products

Products such as egg trays, pie plates, and the like, which are made by pressing or by sucking a fairly thick mixture of pulp fiber in water against or into a wire mold of the shape and size desired, removing a large amount of the water by vacuum and the rest by drying.

Overlaid Veneer

A single sheet of veneer overlaid and bonded on both sides with paper, resin-impregnated paper, or metal.

Pallet

A low portable platform of wood, metal, fiberboard, or combinations, to facilitate handling, storage, and transportation of materials as a unit.

Paper

In general, all kinds of matted or felted sheets of fiber of any origin; formed on a fine wire screen from water suspension.

Specifically, one of two broad subdivisions of the general term, paper, the other being board. The distinction between paper and board is not sharp but generally speaking paper is lighter in basis weight, thinner, and more flexible than board. Almost all types of fibrous material 0.012 inch or more in thickness are boards. Blotting paper, felts, and some drawing papers are exceptions. Practically all types less than 0.006 inch in thickness are paper. Most types ranging from 0.006 to 0.012 inch in thickness are paper; 9 point (0.009 inch) corrugating board, chipboard, some linerboards, and tag board are examples of exceptions.

Paperboard

A general term descriptive of a sheet made of fibrous material, that is, wood pulp, straw, waste paper, or a combination of these, mostly 0.012 inch or more in thickness. Also included in this term are certain types between 0.006 and 0.012 inch in thickness, such as corrugating material, lightweight chipboard, etc.

Paper-Plastic Overlay

One or more sheets of paper impregnated with resin and used as face material usually for plywood, but sometimes for lumber or other products. The paper-plastic material when properly molded to the surface of the other material forms an integral part of the whole and cannot be peeled off. Overlays can be classified as masking, decorative, or structural, depending on their purpose.
Papreg

Any of various paper products made by impregnating sheets of specifically manufactured high-strength paper with synthetic resin and laminating the sheets to form a dense moisture-resistant product.

Plywood

A crossbanded assembly made of layers of veneer or of veneer in combination with a lumber core or plies joined with an adhesive. Two types of plywood are recognized, namely, (1) veneer plywood and (2) lumber core plywood. The grain of adjoining plies is usually laid at right angles and almost always an odd number of plies are used to obtain balanced construction.

Molded plywood.--Plywood that is glued to the desired shape either between curved forms or more commonly by gluing pressure applied with flexible bags or blankets (bag molding) or other means.

Postformed plywood.--The product formed by reshaping, by means of steaming or other plasticizing agent, flat plywood into a curved shape.

Overlaid plywood.--Plywood overlaid on one or both sides with a material other than veneer, such as resin-impregnated paper, decorative plastic, or metal.

Pulp

Distintegrated fibrous material produced either chemically or mechanically for the making of paper, boards, rayon, plastics, the like. It may be sulphite, sulfate, soda, semichemical, groundwood, defiberated, or exploded.

Resin-Bonded Particle Board

A building board having a specific gravity of 0.40 to 1.15 manufactured by blending separate wood particles with various resins and consolidating the mixture under heat and pressure.

Roofing Felt (Saturating Felt)

A very porous soft paper made largely from old rags, waste paper, and coarse wood fiber, used as a base for saturating with asphaltum, tars, and other waterproofing compounds in the manufacture of roofing paper and shingles.
Sandwich Construction

A layered construction comprising a combination of relatively high-strength facing materials intimately bonded to and acting integrally with a low-density core material.

Sawdust

Small fragments of wood produced by the cutting of a saw where, whether ripping or cross cutting, the fibers are severed predominantly across the grain and form granular particles. Sawdust is distinguished from shingle tow and similar offal where, due to side cutting, the fibers are severed largely with the grain to form strands rather than granular fragments.

Shredded Wood

A term occasionally used to describe wood broken down into coarse fiber form consisting of bundles rather than separate fibers; not disintegrated to the point of being pulp fiber yet more fibrous than fine excelsior.

Shavings (Planer)

Fragments of wood removed by a planing machine in dressing lumber or timbers to smooth surface and uniform size. Although strands removed in hand planing lumber and in sizing poles and posts are traditional forms of shavings, in modern woodworking and utilization practice the restricted definition is preferred. In European usage, shavings are called chips and are sometimes so termed in the United States.

Staypak

Wood that is compressed in its natural state (without resin or other chemical treatment) under controlled conditions of moisture, temperature, and pressure that practically eliminate spring-back or recovery from compression.

Veneer

A thin sheet of wood of uniform thickness cut on a veneer machine.

Rotary-cut.--Veneer cut in a lathe which rotates a log or bolt, chucked in the center, against a knife.

Sliced.--Veneer that is sliced off a log, bolt, or flitch with a knife.

Sawed.--Veneer produced by sawing.
Wood Flour

Wood reduced to finely divided particles approximating those of cereal flours in size, appearance, and texture, and passing a 40-100 mesh screen.