REDUCTION OF WASTE IN THE VENEER AND PLYWOOD INDUSTRY

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The Occurrence of Waste

All stages in the conversion of wood from the standing tree to the final veneer or plywood product are accompanied by incidental waste in some form or other. This report deals with that portion of the waste that occurs at veneer and plywood plants. Waste occurring in the woods is discussed in another Forest Products Laboratory report.[2]

Contrary to popular opinion, the waste that occurs in converting a log into veneer is considerable. In a study conducted by the Forest Products Laboratory[3] it was found that the average yield of veneer from a yellow birch log is only about 47 percent of the cubic volume of the log. The conversion of veneer into plywood entails additional wastes that probably average about 50 percent in the typical hardwood plywood plant, so that the yield in terms of veneer actually made into plywood often is as low as 20 to 25 percent of the log volume.

In the Douglas-fir plywood industry the relative volume of waste is lower because larger logs are involved and the plywood product is such that a large percentage of the veneer produced can be used in panels. The yield in terms of plywood is considered average if the square footage of the 3/8-inch plywood obtained equals 2 to 2-1/2 times the board-foot volume of the log. On the basis of a log with an average diameter of 40 inches, this yield amounts to about 55 to 68 percent of the cubic-foot volume of the log. These yield figures do not lend themselves to direct comparison with lumber-yield figures because the finished plywood product is generally of such size and quality as to be ready for final application without much trimming, whereas lumber often requires a great deal of trimming, resurfacing, and the like by the consumer. Also, plywood goes further because it is generally used in thinner sheets than lumber for similar applications.

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[1] Maintained at Madison 5, Wis., in cooperation with the University of Wisconsin.

[2] "Woods Waste," FPL Report No. R1666-3.

[3] "Waste in Veneer Manufacture," FPL Report No. R1493.

Waste can occur in many ways. In its most obvious form it consists of log ends, veneer and plywood scraps and trimmings, cores, reject panels, and the like, that often find their way to the scrap box. Sometimes it exists in the form of a low-grade product that might have been a high-grade product were it not degraded because of improper cutting, handling, drying, gluing, and other improper operations. Sometimes it exists in the form of brash veneer, compression wood, or other naturally occurring defects that result in an inferior product.

Some forms of waste in the primary operation are unavoidable, such as veneer roundings and trimmings and veneer cores, but these wastes can often be reduced by refining the production operation. Other forms of waste can be eliminated entirely or reduced considerably within the limits of economy. Finally, the reduction of waste can be brought about by salvaging what might be considered waste in the primary operation and utilizing it for some secondary product.

Reduction of Waste in the Primary Operation

The first and most important step in a waste-reduction program is to adopt measures that will prevent the occurrence or reduce the volume of material that is normally considered waste. The operator should therefore analyze each step in the production process with this in mind. The following discussion presents examples of how other operators have attacked this problem.

The selection of logs by grades suited to the product to be cut from them is an important step in reducing waste. Many high-grade logs are "butchered" into low-grade veneer under conditions that do not justify the practice. On the other hand, the cutting of low-grade logs in an operation geared to the production of high-grade veneer may mean a financial loss to the operator. The veneer operator who is cutting woods-run logs into veneer would do well to give some thought to costs, yields, and the selection of logs to suit his particular operation. He should examine the possible outlets for logs not handled to best advantage in this plant.

Unwarranted waste might occur in logs that had been stored in a yard improperly or for too long a time. End checking and rot occurring under these conditions are preventable either by providing underwater storage for logs, or by using end coatings to prevent checking[4] and chemicals to prevent stain and decay.[5]

A certain amount of loss may result from the handling of logs with cant hooks, pike poles, and axes. Time taken to train men handling logs and peeling bark to wield their tools carefully so as to avoid damage to the outer portions of

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[4] Forest Products Laboratory Report No. R1435.

[5] Forest Products Laboratory Technical Note No. 225.

logs, from which the highest quality veneer is normally cut, will certainly pay for itself in the reduction of waste. When bucking the logs into bolts, due attention should be given to taper, sweep, knots, and other defects, so that the veneer produced will be of the highest grade possible. In a study conducted by the Forest Products Laboratory[6] the importance of sweep on the final veneer yield, both in quantity and in quality, was analyzed. It was found that sweep was one of the more important controllable factors affecting yields; its effect can be minimized by carefully selecting logs so as to provide the long bolts required from the straight logs and cutting the logs having excessive sweep into short bolts. Greater care should be used in the woods to eliminate excessive sweep by proper bucking practices. Bolts should not be so long that an excessive amount of veneer will be lost in the form of end trimmings or in the spurring operation.

The heat-conditioning of veneer bolts for cutting is a process that requires careful control to prevent excessive waste in the form of degrade. Overheating of some species results in excessive end checking of the bolts and in poorly cut veneer. Underheating may result in loose veneer that is not suitable for a high-grade product. The practice of heating various species of wood and logs of different diameters together, on the same schedule and possibly in the same tank, will sometimes result in some avoidable degrade because of improper temperatures for some of the species and diameters. The practice of heating wood in log length instead of bolt length, as is commonly done in Europe and occasionally in this country, is one that can be used to reduce the amount of split veneer obtained because of end checks in the bolts.

The part of the lathe operator in reducing waste in veneer and plywood manufacture is a most important one. His technique in handling the lathe determines to a large extent the use for which the veneer is suitable. Improper lathe settings may result in veneer that is too loose, too rough, or too variable in thickness to be used for high-quality products. The condition of the lathe -- whether it is in proper working order or whether it is worn and subject to vibration -- and the condition of the knife and nose bar are all critical items.

In rotary cutting, a reduction in core diameter is often thought of as being a desirable method of reducing waste. It is not so important, however, as it might at first appear. To cut to core diameters smaller than the conventional diameter requires the addition of special lathes having small spindles and the rehandling of partially cut bolts, and in addition wood cut from the central portions of logs is generally of low quality. Consequently, cutting the cores to small diameters has not usually been found economically feasible. Where long lathes are used so that it is not practical to cut to a 6-inch core because of the deflection of the bolt in the lathe, some operators have nevertheless installed a shorter, lighter lathe, cut the long cores in half, and turned them down to smaller diameters on the small lathe.

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[6] J. Harry Rich, "Effects of sweep in the bolt on rotary cut veneer yields," 1944.

A certain amount of avoidable waste occurs in the handling of green veneer from the lathe to the clipper. In large operations where it is possible to handle the green veneer mechanically through automatic clippers the utilization is at its best, for tears in the veneer do not commonly occur and single sheets are clipped to best advantage so as to eliminate defects. The minimum width of veneer clipped by present-day automatic clippers is 2 inches. This minimum results in a certain amount of waste, since many defects could be eliminated by clipping out only a 1-inch width. In smaller operations where expensive automatic conveying and clipping equipment is not justified, the veneer is often torn into sheets and then clipped to standard widths in multiple. This results in a certain amount of waste at each tear, in the introduction of additional splits because of manual handling, and in sheets that are not clipped to best advantage from the standpoint of eliminating defects. A method of winding the green veneer on reels directly from the lathe, which is now used to some extent in hardwood plants, is one that can be used in smaller plants to reduce veneer waste. Clipping sheets singly to random widths so as to eliminate defects, even if manual handling is necessary, is a practice that will reduce waste because it results in a higher percentage of high quality veneer.

A practice that is doubly wasteful is the clipping of veneer from spiral-grained or interlocked-grained woods without regard for grain direction. When veneer of such woods is torn at the lathe into sheets for handling and then clipped perpendicular to the ends, large triangular sections are inevitably clipped at each tear and are wasted. Furthermore, the grain direction of the clipped sheets is not perpendicular to the edges and plywood made from such veneer usually warps. If, on the other hand, the veneer is clipped along the grain direction and then squared by trimming at the ends, the quality of the veneer is improved and the amount of waste incurred in producing it is reduced, especially if the veneer is clipped to fairly narrow pieces. When green veneer is handled on reels, it is easy to provide for setting the reel at an angle to the clipper knife so that veneer cut from spiral-grained bolts is clipped parallel to the grain.

The process of drying veneer sometimes results in waste because of degrade that occurs in the form of splitting, honeycombing (in thick veneers), and buckling (especially at ends). When veneer is dried in a kiln, special precautions should be taken to pile it so that it is free to shrink during drying. If this is not done many of the veneer sheets may split. In all types of veneer driers it is necessary to use drying schedules adapted to the type of veneer being dried so as to avoid degrade during drying. The storage of dry veneer, its subsequent handling, and its redrying may result in further losses, many of which can be reduced. It is sometimes desirable to store veneer and veneered products in humidity-controlled rooms to prevent development of defects related to dimensional changes that occur with changes in humidity. The adequate control of humidity in plants and in storage sheds is not difficult.[7]

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[7] Forest Products Laboratory Reports Nos. R1140 and R1612.

Much opportunity for the reduction of waste exists also in making plywood. Good gluing practice is necessary to produce good plywood and to reduce to a minimum the number of reject panels.[8] Much of the warping that causes rejection of plywood panels can be eliminated by careful control of veneer quality and gluing conditions.[9] In the production of diagonal-grained panels and panels having matched-face veneers, there is necessarily a great deal of waste in cutting the veneer to size. Waste-reduction practices in this case would require the utilization of narrow widths and small pieces of veneers. When clipping veneers to size for matching, it is desirable, from the standpoint of waste reduction, to clip in small piles instead of large piles, so that the veneer can be arranged to best advantage. Waste occurring in clipping a large portion of a single flitch to uniform width can occasionally amount to one-third of the volume of the veneer being handled. By clipping this same veneer in two piles instead of one, this volume of waste veneer could be reduced to one-half that occurring before, or to one-sixth of the total volume of veneer.

The Reduction of Waste Through Secondary Utilization Within the Plant

The universally accepted method of utilizing veneer and plywood waste is for fuel. This method has the advantage that all wastes, bark, veneer, cores, and plywood, green and dry, can be used.[10] In many cases the use of wastes for this purpose may be justified, but most operators are, nevertheless, constantly casting about for more profitable outlets.

A reduction in veneer waste is often made possible by the application of a certain amount of ingenuity and the introduction of new machinery. In one plywood plant a reduction in the proportion of veneer that normally went to fire the boiler was brought about by construction of a machine, called a "veneer retrieve," for rapidly cutting to size smaller pieces of veneer. The veneer passes rapidly on a conveyor through this machine, in which a 12-foot clipper knife cuts it to width. A series of undercut saws at 1-foot intervals, under push-button control, cuts the veneer to lengths determined by the operator. Veneer pieces down to 24 by 4 inches in size are salvaged in this way, and the machine is said to salvage a quantity of veneer per 8-hour shift equivalent to 5,000 board feet (log scale).

The introduction of various types of edge splicers, such as one incorporating a large heated drum about 5 feet in diameter about which the veneer passes and from which it emerges as a continuous sheet made up of edge-glued pieces, has made it possible to produce economically core and cross-banded veneer

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[8] USDA Bulletin No. 1500, "The gluing of wood."

[9] Forest Products Laboratory Report No. R1252.

[10] Forest Products Laboratory Report No. R1666-13.

sheets from a large number of narrow widths. Other types of edge-jointing and splicing equipment are available for rapidly and continuously edge-splicing veneers of various thicknesses and grades.

Patching equipment is available for cutting out knots and other defects in veneer or on plywood faces and for replacing them with patches. Cracks in face plies can be patched with shims. Plastic-wood compounds are being used in some instances to fill defects in plywood faces and for plugging core skips appearing on plywood edges. Plywood panels having large defects that cannot be patched, are generally cut back to a smaller standard size.

In many instances it is possible to reduce waste in a plant by increasing the number and widening the variety of products produced in the plant. A plant making bushel baskets may produce a large number of "shorts," or pieces of veneer not large enough for the standard bushel. If, however, 1/2 bushel baskets or other containers of a smaller measure are also made, many of the shorts can be used profitably. The theory of diversification of products, of which this is a very simple example, and the theory of integrating the wood-utilization practices of several types of plants, as between a sawmill, a veneer plant, and a pulp or a chemical conversion plant, should be considered by every operator who has any volume of waste wood on his hands.

During recent years the use of paper and paper plastics as surfacing materials for veneer and plywood has been developed and affords a method of using waste veneers. One panel product is made by edge splicing many narrow strips of defective veneer, that are normally clipped out as waste, and bonding a heavy kraft paper to each panel surface. The product is used for shipping containers, luggage, toys, cabinet backs, and the like. Another similar product is made by gluing waste veneer strips together with faces parallel to each other to form a two-ply laminate, but overlapping each other so that a continuous wood panel is obtained, and by bonding resin-treated paper to each surface to add stiffness and to cover the defects. Operations of this kind are generally set up on a large scale and require a continuous large supply of waste pieces to maintain operation.

A very common method of using veneer cores in the veneer plant is to saw them into crating lumber for use by the plant itself. In the southern container industry cores obtained from cutting basket and container veneer are often sawed into lumber for use as head sticks and hamper bottoms. Special small circular or sash gang saws for rapidly cutting veneer cores are obtainable and are commonly used for this purpose. In the southern container industry it is also common to cut yellow pine and hardwood cores into excelsior.

Sale of Waste

Under favorable market conditions it is possible to dispose of large quantities of veneer cores (and sometimes trimmings) for use in the manufacture of wood flour, mechanical fiber for boards, roofing felt, and the like,

and for use in pulp production, in distillation and extraction, in charcoal production, and as fuel.[11]

The sale of veneer cores for sawing into lumber is not uncommon. A small West Coast sawmill is currently buying the entire output of cores from a veneer plant and sawing them into dimension lumber. It is reported that the daily output of the mill is 16,000 feet, 80 percent of which is in the form of 2 by 4's 8 feet long.

Veneer cores can be used as rollers for moving houses, heavy machinery, and the like, but this outlet is somewhat limited as to volume.

Cores of certain lengths can readily be used for fence posts, markers, and the like, for which purposes their smoothness and general appearance is an asset. Cores of larger diameters can be quartered for use as posts. Many species of wood used for veneer, however, are not particularly durable when in contact with the ground. Preservative treatment of the heartwood of some species is very difficult. Buyer preference for woods of certain species and the adherence to specifications on the part of large consumers, that in many cases would rule out the use of cores because of cracks, knots, and other defects, are other obstacles.

Veneer cores are sometimes used in the construction of log cabins, either in the round or after sawing in half. In this case considerations concerning the durability of the wood are not so important.

The use of veneer waste for the manufacture of containers, such as baskets and berry boxes, is a good one. The container industry, however, is one that requires specialized equipment and is generally built around its own veneer supplies, since it is often cheaper to cut low-grade veneer for the purpose than to try to handle veneer scraps from another plant. The container industry is also somewhat localized at points where the containers are required and, consequently, is not a suitable outlet for veneer waste from other regions.

Hardwood veneer waste is used, especially in the Northeast, in the production of small novelties, such as cards, greenhouse and nursery labels, ice-cream spoons, surgical splints, tongue depressors, candy sticks, and cocktail mixers. Most of these items are stamped out. They are often made of white birch and are a byproduct of the toothpick industry. Other species, however, such as yellow birch, hard maple, yellow-poplar, black tupelo, and sap sweetgum, also possess the qualities desired in these products, namely, light color, freedom from taste and odor, ease of manufacture, and ease of polishing.

Plywood waste in the form of panel edgings is usually burned. One West Coast firm, however, has equipped its panel skinner with two saw blades, instead of one, at each side, so that panel trimmings are equalized as to width. These trimmings are bundled and sold to woodworking plants that can use the narrow stock in making small items or as trim or framing on larger items.

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[11] Forest Products Laboratory Reports Nos. R1666-6, R1666-9, R1666-10, R1666-11, and R1666-13.

Another possible use for plywood trimmings is the gluing of such trimmings together flatwise so that the sawed surfaces are exposed and furnish a surface that may be well-adapted for a use such as flooring. One West Coast plant is exploring the possibility of using high-frequency equipment in a machine designed for continuous production of flooring from plywood trimmings. The trimmings are to be set on edge, one behind the other, and fed through the gluing machine continuously to cure the resin glue.

Panels rejected because of pressing difficulties or other serious defects are often sold for uses whose requirements are less exacting, such as crating. Reject portions of cut-back panels can be made to serve a similar use.

Small segments of panels remaining after cutting out circles or irregular shapes find their most acceptable outlet among manufacturers of novelties, toys, and small articles. They can also be glued together to furnish blocks for turning into pulleys or other articles.

Limitations on the Use of Waste

Once the decision has been made to undertake a program of waste reduction, elimination, and utilization in a plant, the next consideration is the economic factor. In many cases waste wood is used as fuel, and as such it has a real economic value in the plant. The return to be obtained from diverting waste wood to other uses must, therefore, be sufficient to cover at least the added cost of its rehandling and the cost of fuel that must be bought to replace it.

The various examples cited show what can be done to reduce or utilize wood waste. Certain limitations should, however, be pointed out. Veneer cores represent the least problem. They are easy to handle in the form of cordwood, and handling and shipping them to considerable distances, as is now done with pulpwood, is justified.

Veneer scraps, however, are not easy to handle. The majority of all waste veneer is green, so that a large part of its weight is water, and it is generally not in standard shapes and sizes that lend themselves to stacking and handling. Because of its high moisture content, it is subject to rapid deterioration because of stain and mold. The most practical place for handling it is in the parent plant, or perhaps at an adjoining plant so located that mechanical conveying is possible.

Plywood scraps may be of various shapes and sizes, or they may be somewhat uniform in pattern and size. In the first case, they can be used economically only by the operator who can afford to spend time in sorting, handling, and devising uses for small pieces. In the second case, the scraps can be bundled, shipped some distance, and handled on a production basis provided a customer is found who has a quantity use for the particular shapes and sizes

Table 1.--Uses for waste wood from veneer and plywood plants

Use	Type of material	Species	Remarks
Cards	Veneer	High-grade hardwoods	Not a large outlet; often produced as a novelty item by the parent plant
Charcoal	Cores 6 inches or more in diameter	Denser species are preferred	See FPL Report No. R1666-11
Container panels, 2- and 3-ply	Veneer	Many	Container plywood plants can use low-grade veneers for this product
Containers: baskets, hampers, light crates	Veneer	Many	The container industry is a specialized industry generally producing its own veneer. Veneer, dry or partially dry, 1/32 to 1/4 inch thick, in various sizes, can be used
Distillation	Cores	Mostly beech, birch, maple, oak, and southern yellow pine	Potentially a large outlet. See FPL Report No. R1666-10
Excelsior	Cores	Basswood, aspen, southern yellow pine, and cottonwood preferred	Excelsior plants are often operated in connection with veneer-cutting operations. Bolt lengths of 18 inches, free of knots, are preferred
Fiber, mechanical	Cores, veneer	Maple, birch, and aspen preferred	Used by manufacturers of roofing felt and the like. Veneer, if used, should be hogged, free of dirt and bark. See FPL Report No. R1666-6
Flooring, edge-grain	Plywood	Douglas-fir	Panel edgings, trimmed to uniform width, are glued together to form edge-grain flooring
Fuel	Cores, veneer, plywood, log ends, sawdust, slabs, bark	Many	Generally used in parent plant. Sometimes sold locally. See FPL Report No. R1666-13
Lumber: Boxes, headsticks, and hamper bottoms	Cores	Many	Generally used in parent plant. See FPL Report No. R1666-8
Dimension	Cores	Chiefly Douglas-fir	Material should be 8 feet long or longer. Entire output of one Douglas-fir mill going to a small sawmill located nearby. At present the lumber produced has an excellent market. See FPL Report No. R1666-8
Lath and snowfence	Cores	Many	
Posts, stakes, and markers	Cores	Preferably durable and treatable	Use of cores for posts varies with the locality. They are sometimes quartered for small posts
Pulp	Cores, veneer	Many	Cores can be used by pulp mills located at some distance, as shipping is same as for pulpwood. Veneer is being used by pulp mills located very near to veneer mills, but it must be hogged to chips of uniform size. See FPL Report No. R1666-6
Plastics filler	Sander dust	Many	Sander dust is sometimes preferred to wood flour as a filler for plastic molding resins
Rollers for moving houses, machinery, and the like	Cores	Preferably hard wood	No large market. Cores free of cracks would be preferred
Seed flats	Veneer	Hardwoods	Veneer 1/32-inch or thicker, to be creased so as to fold into bottomless squares
Siding, log-cabin	Cores	Many	Long cores of uniform size would be preferred. They would most likely be sawed in two. There is no established market at present
Stamped items: greenhouse and nursery labels, ice-cream spoons, surgical splints, tongue depressors, candy sticks, cocktail mixers, and the like	Veneer	Chiefly white birch. Could probably use hard maple, yellow birch, yellow-poplar, black tupelo, and sap sweetgum	These items are generally produced at the parent veneer plant. Veneer scraps can be used in thicknesses of approximately 1/16-inch
Toys, novelties, and hobbies	Veneer, plywood	Many	Trimmings of high-grade panels are preferred. Sold in unassorted bundles through retailers of craftsmen's and hobbyist's supplies
Wall covering, fabric-wood	Plywood	Many	Unselected plywood, but uniform in thickness, is glued to fabric. The plywood is jewel-cut into 1-inch squares so that the product is flexible and can be glued to curved wall surfaces
Woodworking articles	Plywood	Douglas-fir (at present)	Panel edgings, trimmed to uniform width, are used for various small articles

available. The species and grade of the plywood are an important consideration. If the grade is of high quality, considerable expense in handling is justified; if it is of low quality, the user might find it to his advantage to buy full-sized plywood sheets rather than to handle many small pieces.

Uses for Waste Wood from Veneer and Plywood Plants

Table 1 lists possible uses for waste wood from veneer and plywood plants in a manner to permit individual analysis with respect to local conditions. It contains the chief outlets that are known at present. It is subject to revision as more information becomes available.

Copies of the Forest Products Laboratory reports referred to in the table and elsewhere may be had upon request to the Forest Products Laboratory, Madison 5, Wis.