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Plywood, its History, Manufacture, and Use in Specific Industrial Arts Areas

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PLYWOOD, ITS HISTORY, MANUFACTURE, AND USE IN SPECIFIC INDUSTRIAL ARTS AREAS

By

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INTRODUCTION

Plywood, a recently developed word used to replace the term veneer, has in the last century become one of our most important wood products.

Plywood is defined in the dictionary as "a material consisting of an odd number of thin sheets or strips of wood glued together with the grains (usually) at right angles..."[1] A more conplete definition might be:

> Plywood is an assembled product, made of layers of veneer and/or lumber and adhesive, the chief characteristic of which is the alternate cross layers, distributing the longitudinal wood strength. This product can not be split and shrinking and swelling under the influence of moisture is reduced to a minimum.[2]

Because of its strength, its ability to withstand the strains and stresses of warp and wind, and the improved bonding agents used in its manufacture, plywood has replaced solid stock for many purposes. As a result of its growth in popularity, plywood is being used more and more in school shops, both in the woodworking area and in the crafts laboratory. Industrial Arts

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1. Barnhart, Charles L., Ed., The American College Dictionary, New York: Random House, 1952, p. 934.

2. Perry, Thomas C., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 11.

instructors aware of this fact will want to acquaint themselves with the history, manufacture, and uses of the product. It is with this aim in mind that this paper is written.

HISTORY OF PLYWOOD

The history of plywood can be traced back to the time of Thothmes III of ancient Egypt. (about 1500 B. C.) Picture writing found on the walls of the Sculptures of Thebes and deciphered by Sir Gardner Wilkinson of Britain, tell the story of the manufacturing and use of veneering.

> It is quite evident that the rudiments of woodworking and the practical use of glue were well understood at that far-distant date. The thin sheets of veneer were hand hewn from contrasting colored woods, were spread with glue and superimposed upon each other and weighted down with sandbags, in lieu of clamps or presses. The glue was broken up from flakes or lumps, and softened by heating over the fire. It was undoubtedly a primitive kind of what is now known as animal glue. Only a few pieces of early Egyptian furniture are now extant, mostly rescued during the last century from sealed tombs. These few give ample and irrefutable evidence of overlaying and inlaying with veneer, ivory, metals, and precious stones.[1]

Some evidence of the use of veneers on Greacian furniture can be found in the book, Studies in Ancient Furniture, by Caroline Louise Ransom. She states, "Wooden couches were... sometimes beautified by veneers of finer woods, such as box."

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1. Perry, Thomas D., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 21.

During the time of the Roman Empire, the use of veneer became more important. Caesar, it is said, valued very highly a beautifully veneered table. About the time of Augustus (63 B. C. to 14 A. D.), one historian writes:

> Veneers were cut and applied, not as some have supposed for the purpose of economy, but because by this means, the most beautifully marked or figured specimens of the woods could be chosen, and a much richer and more decorative effect produced than would be possible when only solid timber was used.[1]

The middle ages produced very little in the way of constructive creativeness. It was not until the 17th century that the use of veneer became historically important. In 1760, King Louis XV of France designed and started construction of a piece of furniture known as "Bureau du Roi." It was finished and signed by Riesener in 1769. It has been called the plywood masterpiece of all times.[2] The once popular roll-top desk was patterned after this piece. Napoleon in his campaigns throughout Europe carried with him his desk called the "Bureau de Campagne," which was veneered completely with rosewood. It was the predecessor of the modern knee-hole desk.[3]

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1. Perry, Thomas D., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 21.

2. Ibid., p. 21.

3. Ibid., p. 25.

Early production of veneer was very costly because the veneer had to be cut by hand. Only the very rich could afford to have the beauty of color and figure possible with veneers. It was not until the development of powered tools with which to cut the veneers, that their use became popular in furniture construction.

The first curcular saw was patented in England on August 5, 1777, by Samuel Miller. However, use of the circular saw was not practical until about 1805, after the invention of the steam engine. Circular saws are very wasteful when used for cutting veneers. Often they waste more stock with their wide kerf than there is in the resulting product. It was not long before William Newberry developed the band saw. It was patented in 1808, but was used very little until the 1870's.

One of the more important contributors to the development of power machinery and influential in the plywood development was Sir Samuel Bentham, an Englishman. Bentham was educated at Westminster, and was inspector general of the naval works of England. His brother Jeremy Bentham, was in charge of several industrial prisons where woodworking was the chief trade. Sir Samuel supposed that it would be easier for the men to learn to operate a machine than to learn woodcrafts by attempting to copy methods of skilled woodworkers. So Bentham

undertook to develop machines which would duplicate operations of artisans skilled in the trade. Some of the machines credited to Sir Samuel Bentham are; the jig saw, metal working planer, molders and shapers, single bits, double-end boring and multiple spindle drills, and the mortiser.

In the field of plywood or veneer, Bentham developed a machine called the Bentham planer, which was a large power-drawn plane that sliced off thin sections of the wood suitable for use as veneer. He suggested winding veneers in a spiral to form a hollow tube, a procedure only recently developed for practical application. He also receives credit for the process of building up thick sections of thin plies, making the piece easier to bend.[1]

The first machine designed primarily for cutting veneers was a modification of a turning lathe. An American patent was taken out by John Dresser of Stockbridge, Massachusetts. His patent No. 1758, dated September 3, 1840, described his machine as "consisting of a strong wood or iron frame, upon which rest two ironstands, supporting an arbor or mandrel, turning against a knife, and

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1. Perry, Thomas D., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 25.

cutting veneer in a continuous sheet. It is further specified that 'water, steam or horse power may be used to propel the machine...or by...a crank upon...the cog wheel it may be propelled by hand.'"[1]

The first patent concerning the manufacture of plywood was patent No. 51,735, taken out on December 26, 1865, by John K. Mayo of New York. It was reissued at least three times. The first reissue shows that the inventor was very farsighted concerning his product. His description follows.

> The invention consists in cementing or otherwise fastening together a number of these scales or sheets, with the grain running crosswise or diversely from that of the others... The crossing or diversification of the direction of the grain is of great importance to impart strength and tenacity to the material, protecting it against splitting, and at the same time, preserving it from liability to expansion or contraction.[2]

A great number of patents were issued in connection with plywood and the use to which it could be put. Many furniture items were mentioned. Some more unusual purposes for the proposed use of plywood were bridges, pavement, railroad tracks, docks, forts, and canal locks.

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1. Perry, Thomas D., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 26.

2. Ibid.

The next important patent was issued to George Gardner, of Brooklyn, New York. It had to do with perforated chair seats. Gardner and Company produced many curved and perforated seats for railroad and ferry stations. The curved seat was formed while the glue was still wet and held in place until the adhesive dried. The curve remained rigid and was strong enough to support the weight of the people. The design perforated in the back and seat was punched by hand by child labor. Many times the name of the railroad was used in the design. Due to mergers of the railroads, many of the smaller lines were absorbed by the larger ones, but the benches in the waiting rooms remained with the orginal names testifying to the lasting quality of plywood.[1]

A very important name in the manufacture of plywood products was the Indianapolis Cabinet Company, which grew out of the Sewing Machine Cabinet Company. This company originally constructed sewing-machine cabinets for Singer, Wheller and Wilson, Howe, and other sewing machine manufacturers. Later they developed a new line, "supplying plywood bellows, cabinet ends, and fretwork for the...cabinet organ that was the principal source of homemade music in the closing years of the last century."[2]

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1. Perry, Thomas D., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 301.

2. Ibid.

Plywood desk tops that would not warp and split as the former solid stock tops were soon presented to the public. Then plywood furniture of many different descriptions was developed by the manufacturers. At first the traditional conservatism of the woodworker would not accept the new "pasted wood"[1] as it was called. During the years 1885 to 1900, the amount of plywood used in furniture grew by leaps and bounds.

New plywood factories were built in the east, west, and south. However, the first factories specializing in plywood production were in Russia in the early 1880's.[2]

Because of the increasing use of plywood, the buying public was now able to purchase furniture that was superior in appearance, workmanship, and material.

The plywood door was the next important development of the growing plywood industry. The new doors were far superior to the standard raised panel door of solid construction. Later, the flush door became popular and could only by constructed of plywood. Plywood sleighs were then developed and became very popular because of their flexibility and ruggedness. They were also much lighter in weight. Probably one of the most

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1. Perry, Thomas D., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 21.

2. Encyclopedia Britannica, Chicago: Encyclopedia Britannica Publishing Co., 1953, Vol. 18, p. 94.

widely bought products of the plywood industry around 1890 was the barrel-top trunk, many of which are in existance today, again demonstrating the lasting quality of plywood.[1]

About 1890, the West Coast Plywood industry started in Tacoma, Washington. At first, its products were used primarily for baskets and fruit packages. Some veneers were shipped to Grand Rapids for use in manufacture. Douglas Fir was not used for plywood until 1905, but since that time, the Douglas Fir Plywood industry has grown to one of the largest industries of the West Coast.[2]

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1. Perry, Thomas D., Modern Plywood, New York: Pitman Publishing Co., 1943, p. 32.

2. Ibid., p. 33.

TECHNIQUE OF PLYWOOD MANUFACTURE

The technique of plywood manufacture is an interesting process. Precision machinery and skilled workmen are required. Each type of veneer and adhesive presents different problems. Plywood manufacture can be thought of as having several basic steps, among which are the cutting of veneers, drying, preparation of the adhesive, and the assembly of the panels.

Cutting

Before any cutting of veneer can be done, it is necessary to prepare the log. Depending upon the type of wood, this process may be comparatively simple or relatively complicated. Douglas fir veneers may be cut with no preparation other than debarking, while other more dense woods require long periods of soaking or steaming. If the logs are improperly prepared, the fibers of the wood will tear rather than shear, thus making the veneer unuseable.

Softwood veneers are usually cut 1/100 to 1/4 inch thick. Hardwood veneers are usually cut 1/28 inch thick.

There are four primary methods of cutting veneers. These are rotary, half-round, sliced and sawn. The type of cut depends upon the results required.

Rotary cutting is achieved by lacing a section of the log on a lathe and revolving the stock against a knife and peeling the veneer from the log. Over 90 percent of all the veneer produced is cut by the rotary method.

Generally, the lathes are equipped to handle logs eight feet long, although in some of the larger mills, lathes are available that handle stock up to sixteen feet.

Sliced veneer is used especially for face veneers. In this process, the log is quarted and clamped to a table that moves either back and forth or up and down as veneers are cut in predetermined thicknesses. This method of cutting produces no rupture of the fiber and does not have the tendency to curl as it dries as does veneer cut by the rotary method.

Half round veneer cutting is accomplished by splitting the log in half and attaching the two pieces off-center to the lathe. If the core side of the log is attached to the lathe, the resulting veneer is called half-round. If the bark side of the log is attached to

the lathe, the resulting veneer is called back-side veneer.

The fourth method of cutting veneer is called sawn veneer. The log is sawn in successive layers, either flat or quartered. There is much waste because of the saw kerf, so this type of cutting is limited primarily to quartered oak, the flake of which is inclined to splinter when cut by a knife. This method of cutting is also used for heavy, knotty or extra-long veneers.[1]

Drying

After the veneers have been cut and stacked in sequence, they are placed in a drier where the moisture content is reduced to 10 percent. This is done as soon as possible after cutting. If the log has been "cooked," it has a strong tendency to develop mold and fungus. Some species tend to lose their deep color characteristics when drying is not properly timed.

There are several different types of driers but in general they are similar. They are long chambers, equipped with rollers or belts to advance the veneer longitudinally through the chamber. Fans and heating

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1. Meyer, Louis H., Plywood, What It Is, What It Does, New York: McGraw Hill Book Co., 1947, p. 7.

coils are located along the sides of the chamber circulating and recirculating the air back and forth across the chamber. Most driers are two-way, green veneer can be fed in from both ends and dried veneer is discharged from both ends, doubling the efficiency of the machine.

Glues and Bonding Agents

The increasing popularity of the use of plywood correlates very closely with the scientific improvements in the field of adhesives. One of the criticisms of plywood was that the different layers of wood came unglued. In the past, it was not uncommon to see expensive looking furniture with the veneers peeling off.

Glues, a few years ago, were designed to stick things together but the new adhesives that have been developed recently are designed to bond or weld the stock together.

Many different bonding agents have been used down through history, but each seemed to have its failing. Some would not resist moisture, others would not resist heat, and still others were susceptible to fungus or bacteria. Since 1935, when the resin adhesives were

introduced in the United States, the use of plywoods has sharply increased. Until 1935, the use of casien glue was the most important bonding agent. It had proved far superior to the other types of glue, but when in the presence of moisture, it tended to soften, although it would harden again to its original strength. It was also susceptible to bacterial attack because of its protein content.

The discovery of Bakelite completely revolutionized the adhesive industry. "With the introduction of an adhesive composed of partly polymerized phenol-formaldehyde resin (A basic form of Bakelite), either in dry sheet form or in a finely divided powder suspended in a liquid spreading vehicle, woodworking was given its first truly waterproof and bacteria-proof bonding agent."[1] The plies of the plywood were not merely stuck together but were welded together. Extensive tests proved this type of bond superior to anything used in the past. The heat test given proved that the wood would burn before the adhesive would lose its strength. Peel tests proved that the fibers would fail before the adhesive. Many resin adhesives have been developed since that time. Some of these are; phenol-resin, resorcinol-formaldehyde,

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1. Meyer, Louis H., Plywood, What It Is, What It Does, New York: McGraw Hill Book Co., 1947, p. 29.

and urea-formaldehyde-resin. Other glues are still being used for special jobs and some types which might be mentioned are casein, soybean, blood-albumun, and vegetable and animal glues.[1] The chart shows the comparative properties of adhesives. (See appendix.)

Panel Construction

Plywood is normally produced in two ways. One is known as the veneer construction and the other, as lumber-core construction. In both methods, odd numbers of plies are used. The plies are selected in pairs and placed symetrically on both sides of the center core. This tends to lie flat and overcome any tendency to warp. Three plies are standard for thicknesses up to 1/4 inch thickness. From 3/8 inch to 13/16 inch thickness, five plies are used. The author has seen as many as fifteen plies used. If five or more plies are used, the center ply is referred to as the core. The outside veneer is referred to as the face and back. The intervening layers are called the cross-bands.

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1. Meyer, Louis H., Plywood, What It Is, What It Does, New York: McGraw Hill Book Co., 1947, p. 29.

There are three basic types of panel construction. The first is called standard construction and is the one with which most people are familiar. The faces run parallel to the length of the panel and the cross-bands are placed at 90 degrees. This type is used for general construction where maximum strength and stability are required.

The second method of construction is called 45 degree plywood because the alternating plies are laid at 45 degrees to each other. This type of plywood is used for construction of aircraft and marine bulkheads. It tends to warp more readily than the 90 degree plywood but has superior nailholding quality.

The third type of construction is laminated wood, in which the grain in all the veneers run in the same direction. Because of this, this type contains much of the cross-grain weaknesses of lumber but exceeds it in stiffness, tensile and compressive strength.

In all types of veneer construction, the process is similar. The faces and backs are selected and matched. If joints are necessary or desired, the pieces are jointed and taped with paper tape to hold them in place. Some processes call for tapeless joints to eliminate the weak area along the taped joint. The cross-bands and

cores are assembled in much the same way. The cross-bands are then fed through a glue spreader machine which applies an even coat of adhesive to both sides. The assemble is then laid up in the following order; back, cross-band, core, cross-band and face. If a cold-setting glue is used, the assembly is clamped up before being moved. If a hot-setting glue is used, the assembly is placed between two heated plate platens which exert the correct pressure. After the adhesive is set, the panel is rehumidified to replace the moisture lost to the heat. Basswood or popular is generally used for the core and cross-bands regardless of the type of wood used in the face and back.

Lumber core construction is simply this. The core is constructed of sawn lumber laid in some pattern to form a support for the cross-bands, face, and back. The cores consist, generally of 3/4 inch stock, three to four inches wide laid up edge to edge and glued in place. When the glue is dry, the section is placed in a drier to remove the excess moisture and then planed to the desired thickness. Then the process of assembly of the finished plywood panel is the same as in the veneer construction.

The lumber core construction is sometimes referred to as the fixture and cabinet-makers standby. The heavy

lumber core permits dowelling, and splining, and dovetailing. The edges may be molded without leaving the undesirable stripped effect of veneer construction plywood.

Many different types of cores have been developed for different and special jobs. When high span strength and low weight is required, very light cores made of balsawood, cellular cellulose acetate, fiberglass, and grids of various descriptions might be used. The face may be made of material other than wood. Fireproof panels, sound-deadening panels, and vapor-proof panels can be manufactured by using special materials in the cores.[1]

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1. Meyer, Louis H., Plywood, What It Is, What It Does, New York: McGraw Hill Book Co., 1947, p. 40.

STANDARDS OF PLYWOOD

Although plywood can be purchased in practically any size, the standard size panel through the industry is 48 by 96 inches. Sizes stocked by one lumber company include panels in measurements of 48 inches by 48 inches, 48 inches by 72 inches, and 48 inches by 84 or 168 or 196 inch lengths. Thicknesses are from 1/8 inch to 1 and 1/4 inch.[1] Other sizes can be purchased.

Certain standards are set up by the industry to guarentee quality. The Douglas Fir Plywood Association's standards are as follows:

1. Standard panels of sound two sides and sound one side grades are stamped or branded on edge; PLYPANEL, D.F.P.A..

2. Wallboard is stamped on the back: Genuine PLYWALL, Douglas Fir Plywood WALLBOARD, D.F.P.A. inspected.

3. Sheating is scored in paralled lines at 16 inch intervals across the face with the name PLYSCORD repeated at frequent intervals and also stamped in the corner of the panel: Genuine PLYSCORD Sheating, D.F.P.A. inspected.

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1. Industrial Arts Catalog, Chicago: Frank Paxton Lumber Co., 1959.

4. Concrete-form panels are stamped on the face: Genuine Douglas Fir PLYFORM Concrete Form Panel, D.F.P.A. Inspected.

5. All exterior-type plywood is stamped or branded on the edge: EXT--D.F.P.A..

6. Marine Exterior plywood is stamped or branded: MARINE EXT. D.F.P.A., with an anchor preceding "MARINE" and after D.F.P.A..

Hardwood plywood standards are quite complicated and extensive. Reduced to simplest form, standards are: Good two sides, and good one side.[1]

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1. Meyer, Louis H. Plywood, What It Is, What It Does, New York: McGraw Hill Book Co., 1947, pp. 108-130.

PLYWOOD IN INDUSTRY

In the building trades, plywood is used for sheathing, sub-floors, finished floor, wall paneling, built-in cabinets, doors, and exterior trim. Decorative fencing may be of plywood. The use of plywood reduces construction time, therefore reducing building costs.

Mobile home manufacturers use plywood almost exclusively for interior paneling. Many unusual and interesting effects are achieved.

In boat building industries, plywood is used for many purposes. Smaller boats may be constructed entirely of plywood while on larger ships, cabin interiors may be constructed of plywood.

Furniture manufacturers use plywood in construction of tables, room dividers, shelves, cases, desks, and innemerable pieces of home and office furniture. Most school furniture is constructed of plywood.

Auto manufacturers, once a big user of plywood for automobile interiors, are now using almost exclusively plastic or metal for finishing interiors. However, some manufacturers use plywood on the interiors of their most exclusive car models.

Cabinet making is one of the oldest uses of plywood. Piano and organ cabinets, radio, television and phonograph cabinets are constructed of plywood.

Impregnating plywood with plastics and resins makes resistant surfaces which allow it to be used where solid stock may be unsuitable. One manufacturer is inserting a strip of aluminum foil under the face ply of table panels. This dissipates heat and protects the surface from burns which may be caused by carelessly placed cigarettes.[1]

Industry and manufacturers work together to develop improvements and applications of plywood products for an increasingly large consumer market.

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1. Fine Hardwoods Selectorama, Chicago: Fine Hardwoods Association, 1956, p. 9.

PLYWOOD IN THE INDUSTRIAL ARTS LABORATORY

In the Industrial Arts laboratory, the uses of plywood for projects are almost unlimited. Plywood could be used in place of solid stock in most projects.

Many different and unusually figured woods are available in plywood, the use of which eliminates the time consuming and wasteful process of cutting and fitting solid stock necessary to achieve the same effect.

Plywood comes from the factory presanded which eliminates the tedious task of sanding. The methods of construction are similar to solid stock with the exception of gluing-up and surfacing after the gluing has been completed. Finishing plywood is similar to finishing solid stock except that very little sanding is necessary.

Using the following procedures when working with plywood in the laboratory will insure a greater degree of success.

When many pieces are to be cut from a large sheet of plywood, plan the layout carefully to avoid waste.

Hand sawing should be done with a 10 to 15 point sharp saw. The plywood should be firmly supported on the under side to reduce splitting. The good face should be up.

A table saw or radial saw may be used to cut plywood. A sharp combination blade or a fine toothed blade with very little set is recommended. The blade should protrude above the stock only the height of the teeth. A table extension with a roller makes the job of handleing large sheets much easier.

When using a power hand saw, the good face of the plywood sheet should be down. If a saw horse is used for support, a strip of scrap stock should be nailed to the top of it so you can saw right through without damaging the saw horse.

If the sawing is done carefully and with a sharp blade, very little, if any, planing of edges will be necessary. When planing, a very shallow cut with a sharp blade should be made. This will prevent tearing or splitting of plies.

Sanding prior to the sealer coat should be done on the edges only. The panels are pre-sanded. Sanding will only remove the soft grain, making the surface less smoothe.

Butt joints, rabbet joints, and dado joints are the easiest to construct and most adaptable to thicker plywood. On thinner plywood, frame construction is recommended.

Nails, flat-headed wood screws, and corrugated fasteners may be used to fasten plywood, but it is recommended that glue be used to reinforce the joints. Nails and glue are usually satisfactory. Flat-headed wood screws are used where more holding power is necessary. Corrugated fasteners are used for mitered joints.

Finishing the edges of plywood has been a problem. Gluing a thin strip of similar wood on the edge has been one solution but on irregularly shaped pieces, this has proven unsatisfactory. Perhaps the most difficult edge treatment is cutting a V-grove and inserting a matching wood strip. Recently, a product known as "Wood Tape" was placed on the market by the Weldwood Co. and it may solve the problem, although it is somewhat expensive. The wood strip is attached to the edge by means of a contact cement backing on the tape itself.

More information on how to work and finish plywood may be obtained by requesting booklets from the Douglas Fir Plywood Association, Tacoma 2, Washington.

SUMMARY

Application of veneer can be traced back in history to an early Egyptian period. It is mentioned in Roman History. So, the use of veneers to beautify is an old art. Due to technological advances, the art has developed to the point where, in addition to beauty, qualities surpassing those of solid stock are produced in the product.

With the invention of machinery to cut veneer more quickly and economically, the use of plywood has become more and more important. Some of the earlier American uses were chair seats, sewing machine cabinets, and doors.

Modern manufacturing processes include stripping logs of bark and peeling off ribbons of wood, called veneers. The veneers are dried to correct moisture content, assembled into sheets, and bonded together with an adhesive designed for the specific purpose for which the plywood is to be used. Revolutionary advances in the development of new adhesives since 1935 have greatly increased the uses to which plywood may be adapted.

Manufacturers have set up standards by which the consumer can be assured of the quality of the plywood product purchased.

By continuing technological research, the plywood industry is improving existing products and developing new products to increase the adaptibility of plywood to industrial uses and uses of the consumer. For example, in home construction, furniture manufacture, boat building and aircraft industry, large quantities of plywood are used.

In the Industrial Arts laboratory, plywood may be used as a wood substitute in many projects. Proper work procedures will produce satisfactory results. A special unit on working with plywood may be introduced.

It is understandable that plywood has been called "America's Busiest Building Material."[1]

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1. Fir Plywood, America's Busiest Building Material, Tacoma, Wash.: Douglas Fir Plywood Association, 1957, cover.

CONCLUSION

Plywood undoubtedly has a place in Industrial Arts as a substitute for solid stock. Using plywood decreases the amount of storage space necessary as compared to solid stock. Extensive machining prior to gluing up stock is eliminated as is the planing and machining after gluing. Plywood is less expensive to use because there is practically no waste.

Industrial Arts instructors should examine their present programs to determine how efficiency may be increased by the utilization of plywood.

APPENDIX

Logs float into mill that will turn them into plywood.

How Plywood Is Made

THERE probably isn't a home in the U. S. without plywood, either in the structure itself or in furniture. On the farm, plywood goes into silos, barns and hog houses. It goes to sea in ocean liners, small pleasure craft, tuna clippers and tugboats. It rides the rails as new, light boxcars. These pictures, taken in one of the 85 factories of the Douglas Fir Plywood Assn., show how it's made.

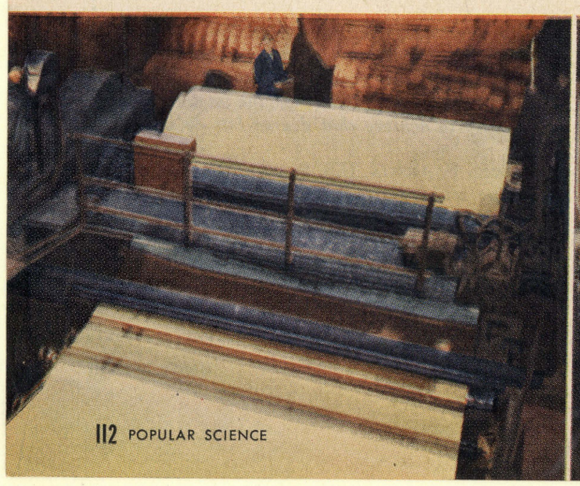
1 BARK is quickly stripped from log as it is whirled at high speed against gearlike cutting head of giant lathe. Select fir logs, usually a thick three feet or more in diameter, come from the Cascade Mountains of Washington, Oregon and California.

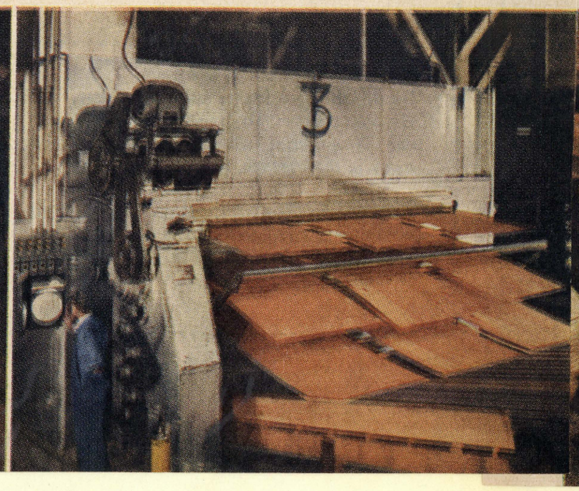
2 BARK-STRIPPED LOG, called a peeler, goes to another big lathe that shaves off ribbons of wood from 1/10″ to 3/16″ thick. Three peelers like the one below, eight feet long and four feet in diameter, supply enough panels for a small plywood house.

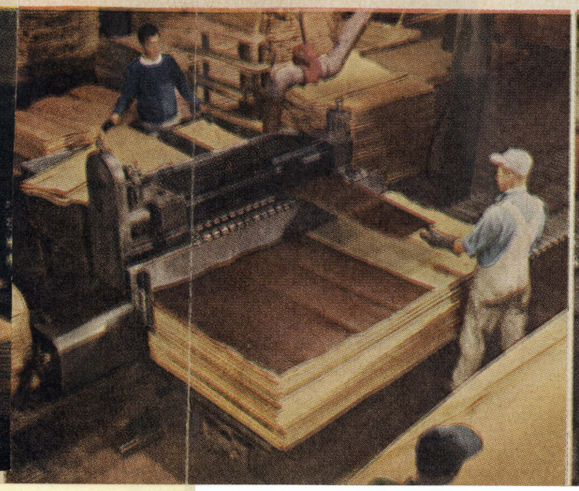
3 GETTING THE MOISTURE out of the thin strips of wood is next step. The wood ribbons travel through 100-foot-long ovens set at a temperature of 350 degrees. Here the strips are shown coming out after moisture has been reduced to less than four percent.

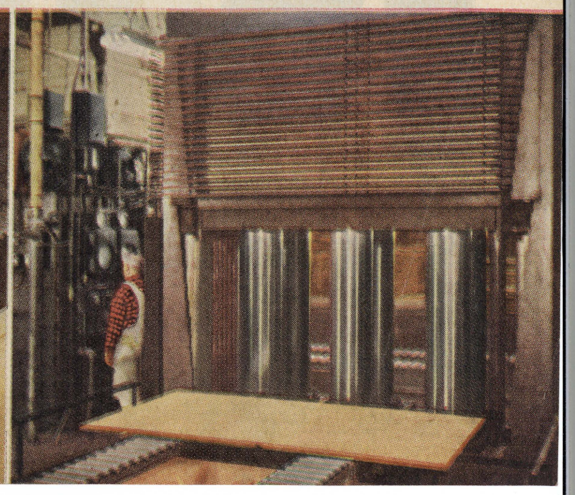
4 HERE IS THE SECRET of plywood's strength. Sheets of wood are assembled with the grain of each ply at right angles to the plies above and below. The layers are then glued together to form a panel that, pound for pound, is stronger than steel.

5 HYDRAULIC HOT PRESS cures the adhesive to make panels in which the bonds between plies are stronger than the wood itself. Inserted between accordion-like plates, the wood-and-glue sandwiches are subjected to simultaneous pressure and heat. END





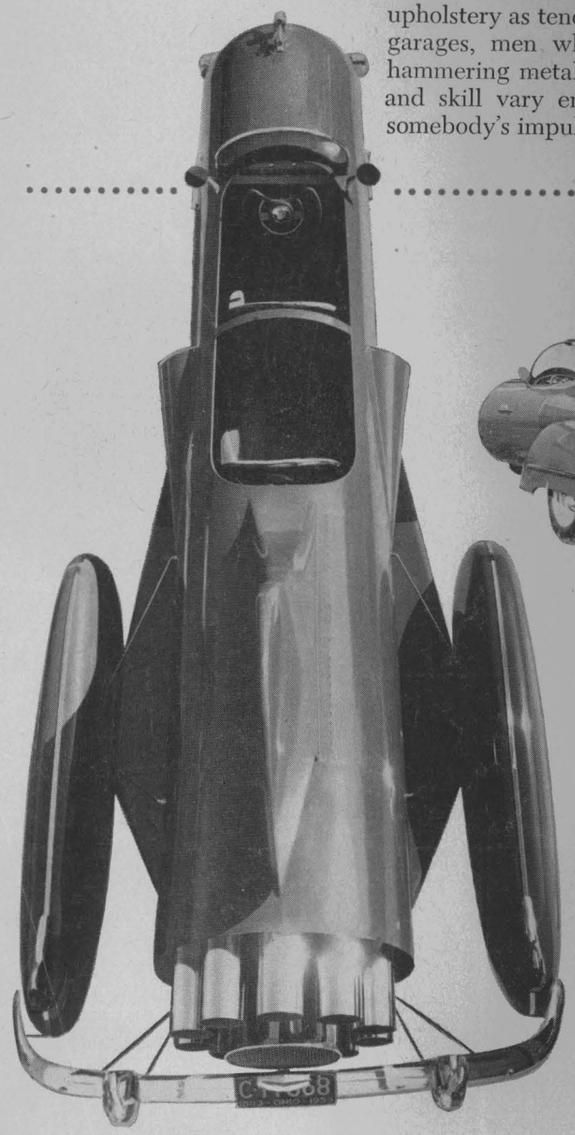


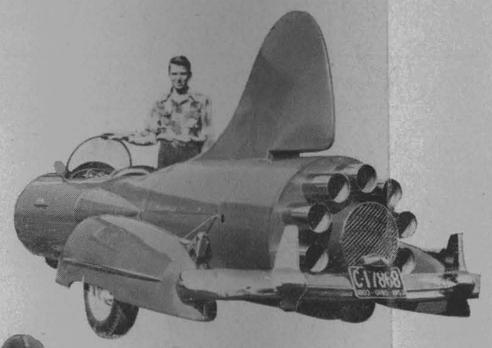


Back-Yard Builders Turn Out

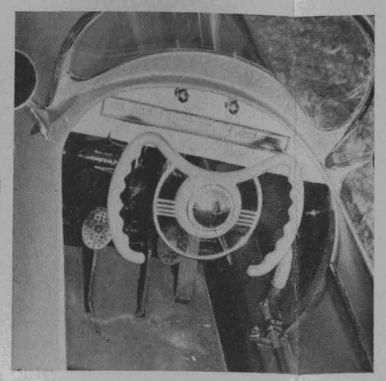
Weird and Wonderful

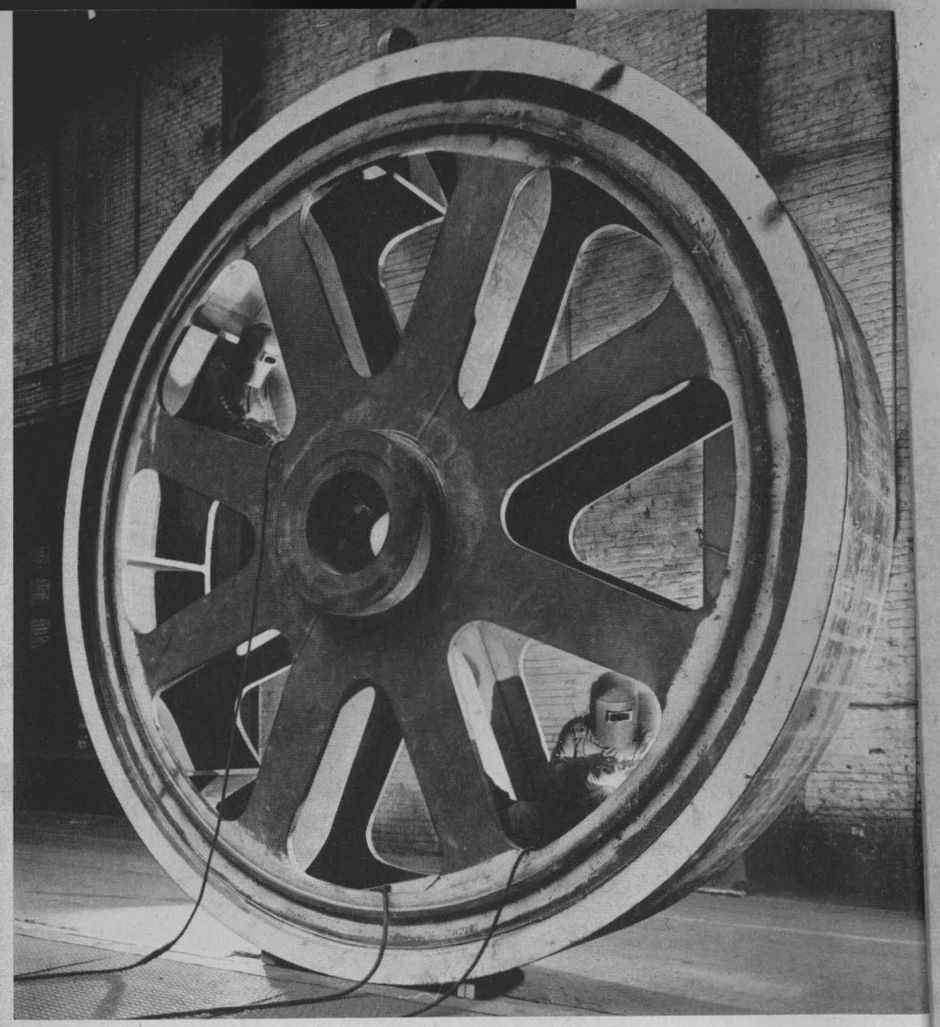
DIG those beasts! And those home-brewed wagons with chromed jet-assist, or with magenta upholstery as tender as a baby. In thousands of U.S. garages, men who want something different are hammering metal into new shapes. The inspiration and skill vary enormously, but every car mirrors somebody's impulse to create something new.





TRICYCLE built by refrigerator technician Stanley Eakin of Grove City, Ohio, is called the Comet, and painted a brilliant scarlet. Eakin spent spare time for six years building the 1,800-pound car, which tops 90 m.p.h. with a 60-hp. V-8 engine. The two scoops at the waist ventilate the rear-mounted engine, air being discharged via 10 tailpipes. In cockpit below, that lever at right works the remote shifting linkage.





37-Ton Pulley Wheel Will Raise and Lower New Bridge

THIS is one of four giant sheaves for a vertical-lift bridge that will span New York's East River to give access to a hospital on Welfare Island. Cables passing over the sheaves, set in pairs high in the bridge towers, will carry two 515-ton counterweights. Bethlehem Steel workers forged, rolled and welded the 37-ton wheels.

They Say Now.....

HENRY B. DU PONT, VICE-PRESIDENT, THE DU PONT CO.: *"To create a useful product out of material which was once thrown away is the essence of technology."*

ERNEST A. HOOTON, HARVARD ANTHROPOLOGIST: *"Civilized man is a partially domesticated animal living in an artificial environment."*

REPORT OF THE NATIONAL MANPOWER COUNCIL: *"For every high-school graduate who eventually earns a doctoral degree, there are 25 others who have the intellectual ability to achieve that degree but do not."*

DAVID F. AUSTIN, U.S. STEEL: *"A friend of mine who fancies himself a humorist explained that American enterprise is the art of making toeless shoes a fashion instead of a calamity. There's a bit more to it than that, however."*

COMPARATIVE PROPERTIES OF ADHESIVES

Name	Purpose	Curing Temp. (F)	Moisture Resistance	Heat Resistance	Bacterial Resistance
Phenol-formaldehyde regular	Veneering	240-350	Insoluable	Beyond charring point	Immune
Phenol-formaldehyde low temperature	Bag molding	130-240	Insoluable	Beyond charring point	Immune
Resorcinol-formaldehyde	Bag molding Laminating high stability timbers	75-104	Insoluble	Beyond charring point	Immune
Melamine-formaldehyde		190-300	Insoluble	Beyond charring point	Immune
Urea-formaldehyde Straight	Veneering	70 min.	Excellent	Up to 135°	Immune to vulnerable
Extended	Veneering	70 min.	High to nominal	Up to 135°	Immune to vulnerable
Fortified	Veneering Jointing	200-300	High to insoluble	Moderate to high	Immune
Casein, straight	Veneering	40	Initially good	Moderate	Low
Soybean, straight	Veneering	40	Initially good	Moderate	Low
Soybean, fortified	Veneering Jointing	40	Initially good	Moderate	Fair
Blood albumin	Veneering	150-175	High	Low	Low to zero
Vegetable	Veneering	Room Temp.	Small to zero	Low	Low to zero
Animal	Veneering	Room Temp.	Small to zero	Low	Low to zero

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