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The Use of Hardboard and Particleboard for Composition Panels in Furniture Construction

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Abstract

This study is concerned with the investigation of lamination using particleboard and hardboard as substrates for overlays. The purpose of the research includes the following:

1. To acquire information about the history and construction processes of particleboard, hardboard, and plastic laminates.

2. To investigate the procedural application of plastic laminates and vinyl overlays to particleboard and hardboard substrates.

3. To relate to the industrial arts students the industrial use of overlays laminated to a substrate.

4. To develop an instructional unit to be used in the industrial arts program.

5. To construct a school shop project in the area of lamination.

The value in the investigation will be the writer's increased knowledge of the lamination field which will be of great value in the development and construction of a lamination unit in the school shop.

Chairman

Approved by Graduate Committee

July 18, 1972

Date

THE USE OF HARDBOARD AND PARTICLEBOARD FOR COMPOSITION PANELS IN FURNITURE CONSTRUCTION

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

In the last decade the furniture and cabinet industry has steadily increased its use of composition panels which exhibit a certain flexibility in their properties in contrast to the simple solid wood panel. Particleboard and hardboard are the latest links in the chain of development of composition panel material and represent a technological advancement over other panel core construction (Suchsland, 1970, p. 31).

Research and development departments in the last five years have made great strides in the use of particleboard and hardboard as substrates for overlays, such as vinyl and plastic laminates. Large industries that extensively use the overlays on substrates as a substitute for solid wood are the mobile home, furniture, and kitchen cabinet industries.

In the industrial arts curriculum, the modern educational concept is to relate the student's learning to the industrial arts program. The writer believes that the present and predicted usage of the field of lamination merits consideration and should definitely be incorporated into a program as a single course or as an important section of another related course. It would be the responsibility of the industrial arts instructor to relate industrial innovations in the field and to instruct the students in the area of lamination.

<u>Statement of the Problem</u>

This study is concerned with the investigation of lamination using particleboard and hardboard as substrates for overlays. The purpose of the research includes the following:

1. To acquire information about the history and construction processes of particleboard, hardboard, and plastic laminates.
2. To investigate the procedural application of plastic laminates and vinyl overlays to particleboard and hardboard substrates.
3. To relate to the industrial arts students the industrial use of overlays laminated to a substrate.
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The value in the investigation will be the writer's increased knowledge of the lamination field which will be of great value in the development and construction of a lamination unit in the school shop.

Importance of the Study

The popularity of furniture covered with overlays has increased at a tremendous rate. Industries have made investments and have modified their factories to manufacture overlay-laminated furniture products.

To update industrial arts programs, instructors must continuously investigate and research the industrial areas. Students in the industrial arts program are or will be consumers of the overlay-laminated furniture. Their awareness of various characteristics of furniture is one phase of the industrial arts program.

One way to instruct the future consumer of the furniture characteristics is through a program including the necessary procedures. This enables the students to work with the materials and acquaint themselves with the procedural application.

Limitations

Lamination is a relatively comprehensive term. Since it is not practical to conduct a study encompassing the entire area of lamination, this study will be limited to methods of application of high-pressure laminates and vinyl film overlays to substrates. Substrates were limited to particleboard and hardboard in this paper because of their increased usage in furniture construction. The procedure of application will be limited to the facilities of an industrial arts shop.

DEFINITION OF TERMS

Adhesive. A substance capable of holding materials together by surface attachment (Duffin, 1966, p. 239).

Calender. To prepare sheets of material by pressure between two or more counter-rotating rollers (Modern Plastics Encyclopedia, 1970, p. 32).

Cauls. Moving plates used to support particleboard mat in its production.

Delamination. The separation of a laminate into layers due to failure of adhesion (Duffin, 1966, p. 240).

Density. Weight per unit volume of a substance expressed in grams per cubic centimeter, pounds per cubic foot.

Extrusion. To shape by forcing through a designed opening.

Hardboard. A manufactured material made by forming wood fibers into sheets, using heat and pressure. The regrouped fibers are held together with the lignin in wood (Wagner, 1967, p. 26-2).

High-pressure Laminate. Laminates molded and cured at pressures not lower than 1,000 psi and more commonly in the range of 1,200 to 2,000 psi (Duffin, 1966, p. 241).

Lamination. Thin sheets of material bonded together with an adhesive.

Mat-formed Particleboard. The mass of prepared particles deposited on a caul plate in particleboard manufacture (Kape, 1966, p. 161).

Overlay. The outermost layer of impregnated paper in the manufacture of a laminated plastic (Kape, 1966, p. 162).

Particleboard. A manufactured board made of flakes, chips, and shavings bonded together with resins or adhesives (Wagner, 1967, p. 2-6).

Plastic Laminate. Sheet produced by a process of laminating specially prepared papers impregnated with synthetic resins, such as melamine, and subjecting them to tremendous heat and pressure (O'Neill, 1958, p. 1).

Substrate. Base material to which a laminate has not been applied (Hammond, and et al., 1972, p. 347).

CHAPTER II

HISTORY

The writer believes that a short history of particleboard, hardboard, and plastic overlays would be of assistance in the development of the complete unit of laminating.

Particleboard

The need to conserve wood and diminishing forests fathered the idea for particleboard. The use of wood waste for the manufacture of particleboard on a semi-commercial basis originated in Europe in the late 1930's (Hackett and Spielman, 1968, p. 685).

Particleboard was first manufactured in this country about 1948. It is the newest of the wood panel products and in a relative short period of time has become well established in the marketplace. According to the U. S. Department of Commerce, particleboard is "the fastest growing segment of the wood products industry" (*Particleboard Design and Use Manual*, 1967, p. 1).

Hardboard

The history of hardboard illustrates how a company and an industry developed out of initiative, resourcefulness, and know-how of one man. In 1924, William H. Mason, an engineer, accidently came upon the process of manufacturing particleboard (Groneman, 1964, p. 254).

Mason was attempting to squeeze moisture out of a mat of wet fibers, using a steam-heated press. When he left his laboratory for a short period of time, he turned off the steam. Upon his return, he found that due to a faulty valve, the steam had kept on heating and the fiber had been pressed into a hot, dense, and dry board that did not split, crack, or splinter. This first hardboard was later to be called Masonite.

Production of hardboard is expected to increase annually. The furniture and cabinet manufacturing industry uses about 20 to 25 percent of the annual hardboard production (Hackett and Spielman, 1968, p. 681).

Plastic Overlays

The plastics industry is just about one hundred years old. Leo Hendrik Baekland, an American chemist, was granted a patent covering the use of phenolformaldehyde resin for impregnating fibrous sheets in the manufacture of laminated products. This discovery eliminated the researcher's belief that resin had no industrial or commercial value (Duffin, 1966, p. 7-9).

Baekland's idea, in 1911, of using phenolic resin for impregnating fibrous sheets seems to have been the first to make a plastic laminate as we know it today. His patent was based on applying heat and pressure to a piece of cardboard impregnated with his new phenolic resin to form a hard, dense mass.

Growth of the industry was steady and rapid. Industrial laminate manufacturers through research have developed new synthetic resin and improved procedures for the construction of plastic laminates. Today, there are approximately 40 major manufactures of plastic laminates in the United States.

CHAPTER III

INDUSTRIAL AND GEOGRAPHICAL INFORMATION

Industries that are manufacturers of wood waste or wood residue products are located in the eastern, western, and southern forest regions of the United States. Converting raw materials into principal products is more profitable than reworking into secondary products, but the industry that is capable of making use of its wood waste is in the best position to make a gain.

Particleboard and hardboard are shipped to suppliers over the United States. Cabinetmakers must secure their supplies from the suppliers. An industry's location is very advantageous to its operation and success.

The leading plastic producing countries are the United States, Great Britain, Italy, Germany, and Japan. In the United States, one-half of the plastic industry is in the eastern section, thirteen percent on the west coast, thirty-four percent in the middle west, and the balance scattered over the southern section.

Pre-laminated panels are produced by one factory and then shipped to other furniture industries to be incorporated into their products. Cooperation between manufacturers is a very important phase of the industrial field.

A considerable number of Iowa's plastic laminate users are small custom cabinet builders. Lumber companies often work with a local custom builder for their laminated requirements. Presently, some home building contractors jointly own a small shop for laminating the furniture for their homes.

CHAPTER IV

OCCUPATIONAL

The furniture industry offers a wide variety of opportunities for anyone interested in working with tools, materials, machinery, and ideas to produce furniture needed in homes, offices, and banks. Furniture building is a big business with over four billion dollars worth produced each year.

An individual who is interested in becoming a hand laminator or laminating-machine operator should aim to complete industrial arts courses related to the field of lamination. Courses can be taken in high school, vocational-technical schools, or at the university level.

Since two-thirds of the furniture factories employ less than twenty people, the individual possibly should be oriented in the cabinetmaker occupation. The cabinetmaker has to be an all-around skilled worker. One would be able to start his own business and develop it into a profitable industry.

Today, many jobs in industry require competencies in math, English, and other related courses. A person's success in this type of job is dependent on his total training program.

CHAPTER V

TECHNICAL INFORMATION

Particleboard Construction Process

Particleboard is made by combining wood chips, scraps, flakes, or other wood fragments with an adhesive and hot-pressing them into panels. Physical properties and uses are affected by such factors as (1) the process, (2) the type and amount of binder, (3) the kind of particles, (4) the amount of compression, and (5) the type of finish.

Wood arrives at the particleboard plant as waste and residue particles from other wood-products mills or in a form of five foot logs. The logs are debarked and carried by a conveyor to slasher saws which cut them into shorter pieces. All of the wood waste then is converted into particles in a flaker machine. The particles then are broken into flakes of desired size and dried (Groneman and Glazener, 1966, p. 61).

Sorting of the various particle size takes place over sorting screens. Correct size particles are sent to the blending machine where a synthetic resin adhesive and emulsion wax are sprayed and blended on the particles to insure uniform coverage of all flakes. Continuous weighing takes place to regulate the amount of adhesive and wax.

Following this preparation, the coated flakes can be processed into particleboard by two different processes. They are mat-forming and extrusion.

Mat-forming Process. Forming machines accept the coated flakes and spread an even, continuous mat on moving cauls. For a three-fourths inch finished board, the mat is about four inches thick. Saws cut the continuous mat into sections, and they are examined before proceeding.

The mats proceed to a cold prepress where it is compressed to about one-half its original thickness. The edges are trimmed and the trim is recovered for reuse. About twenty or fewer trimmed mats are placed in a steam-heated hot press which binds the materials into particleboard. The time, temperature, and pressure used in pressing vary in accordance with the thickness and grade of particleboard required. The mats are cooled and move on to sizing saws (Groneman and Glezener, 1966, p. 62-63).

Panel sizes are available up to five feet in width and sixteen feet in length. Thickness range from one-eighth to one and one-half inches.

Density or weight per unit of volume is an important factor influencing the strength properties of particleboard. In the furniture industry, the recommended density is thirty-seven pounds per cubic foot to fifty pounds per cubic foot (Morschauser, 1969).

Extrusion Process. In the extrusion method of production, the coated flakes are fed into one end of the rectangular shaped opening and forced between the heated parallel plates by a reciprocating ram or piston. The flakes emerge in board form from the lower end as the adhesive is being cured by the heated platens. The board is guided on a curved bed until it is horizontal and is then trimmed to width and cut to length (Kape, 1966, p. 23-33).

The extrusion method is used basically by the furniture manufacturers who produce their own corestock. The main advantages of the extrusion process are the extreme simplicity of the machinery, operation, and the ability to produce economically, boards of greater thickness than are possible by the flat pressing method (Kape, 1966, p. 33).

Hardboard Construction Process

Hardboard is an all-wood panel manufactured from tiny wood fibers. Particleboard uses an adhesive to bind the particles together while hardboard uses only its natural fibers. Wood fibers are made of lignin and cellulose. The cellulose gives the fiber strength, while the lignin is the binder which cements the fibrous material together. Hardboard consists entirely of fibers with a small amount of certain types of chemicals added to give the board special structural characteristics (Groneman, 1964, p. 253).

Wood residues from sawmills and plywood manufacturing plants and thinning smaller trees from the forest which help in producing healthier woodlands are used presently in hardboard manufacturing.

The raw materials first go into a revolving disk chipper which cuts up the chips to a size of approximately five-eighths inch in width and one inch long. The chips are then reduced to individual wood fibers by mechanical defibering or tearing apart by exploding them by steam pressure.

The fibers are then washed to refine the fibers and rid them of the soluble wood sugars and other undesirable elements of natural wood. By means of gravity and squeezing, the water is removed and now the fibers are referred to as "wet-lap". The wet-lap is now four and one-half inches thick and will be fed into multiple presses where heat and pressure will produce a five-sixteenths inch thick piece of thick, hard, dry board sheets (Feirer, 1963, p. 151).

After leaving the press, the hardboard is drier than normal atmospheric conditions. It is then placed in a humidification chamber to add moisture to the board comparable to the atmospheric conditions.

The panels are trimmed to standard dimensions which are five feet in width and sixteen feet long. Thicknesses are one-twelfth, one-tenth, one-eighth, three-sixteenths, and one-fourth up to three-fourths inch. Samples are taken for inspection of quality. The panels are delivered to building supply dealers in heavy paper-wrapped bundles.

Vinyl Film Overlay

The vinyl film is an overlay used for many purposes. Its use in the furniture industry is increasing rapidly. Vinyl film must be laminated to a substrate such as particleboard and hardboard using an adhesive.

Vinyl film is manufactured primarily by a process called calendering. The thermoplastic resin, colorant, and plasticizer are mixed, blended, and liquified. This soft mixture is rolled or calendered between the rolls determines the thickness of the film. The pairs of rolls are set succeedingly closer together to gradually reduce the thickness.

Some of the rolls may be embossed to produce a wood grain or satin matte finish on the film. The most commonly used films are six to ten mils thick which enables it to be folded over an edge and can be mitered at a corner. Figure 1 exhibits an example of vinyl film six mils thick.

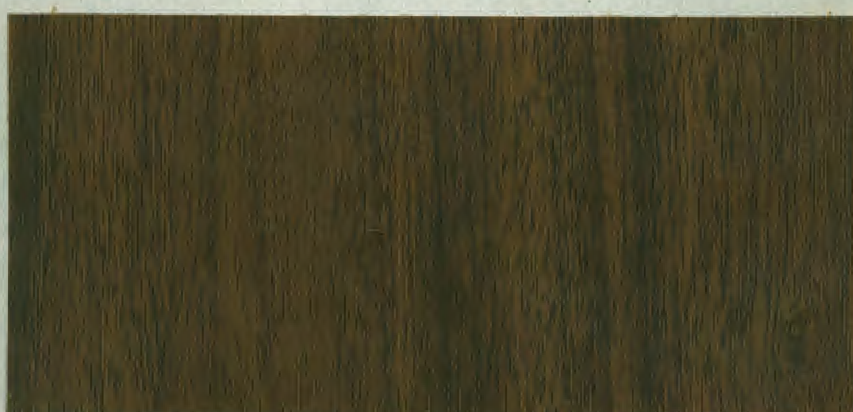

Figure 1. Example of Vinyl Film .006 inch Thick (Phillips 66 Film Division).

High-pressure Plastic Laminate Production

The laminated plastic sheets bonded to a substrate have become especially suitable for many residential, commercial, and institutional uses. The finished decorative sheet is very durable and is used on furniture in homes, schools, and banks.

Manufacture. The plastic laminate is made up of (1) phenolic core sheets, (2) printed pattern sheet, and (3) a transparent melamine overlay as illustrated in Figure 2.

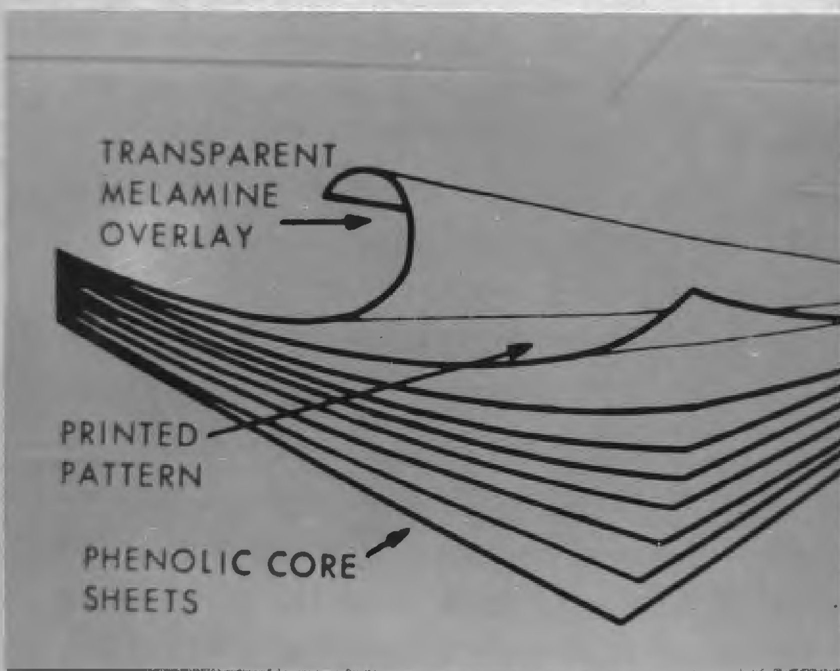

Figure 2. Construction of Plastic Laminate (Wagner, 1967, p. 20-9).

Special kraft papers impregnated with phenolic resins, such as phenol-formaldehyde, make up the bulk of the laminated plastic sheet. The kraft paper passes through a phenolic resin vat, and as it continues, the excess resin is removed.

It then travels through various heat zones of a drying oven shown in Figure 3 on the following page.

Electronic equipment controls the amount of resin maintained in the paper as it moves through the ovens. After drying, the paper is cut and stacked.

The second major layer in the laminate construction is the pattern sheet which is processed in the printing room. Through a rotogravure lithographing process, the pattern and color is printed on a special alpha cellulose paper. Many different wood imitations and designs are printed (Groneman & Glazener, 1966, p. 416).

After printing, the cellulose paper is sent through a vat of melamine-formaldehyde resin as illustrated in Figure 4 on the following page. It then passes through ovens to dry the paper, similar to the kraft paper process. The treated paper is then cut and stacked.

The third and final layer of the plastic laminate is the translucent material which acts as the protective layer. The overlay is made of alpha cellulose or rayon-base paper and is approximately four mils thick. It is also impregnated with melamine-formaldehyde resin which becomes transparent during curing. This resin is used because of its clarity, lack of color, and resistance to heat, water, and stains. After curing, it is cut to size and stacked (Groneman & Glazener, 1966, p. 417). Figure 4 exhibits the steps of preparation of the protective layer.

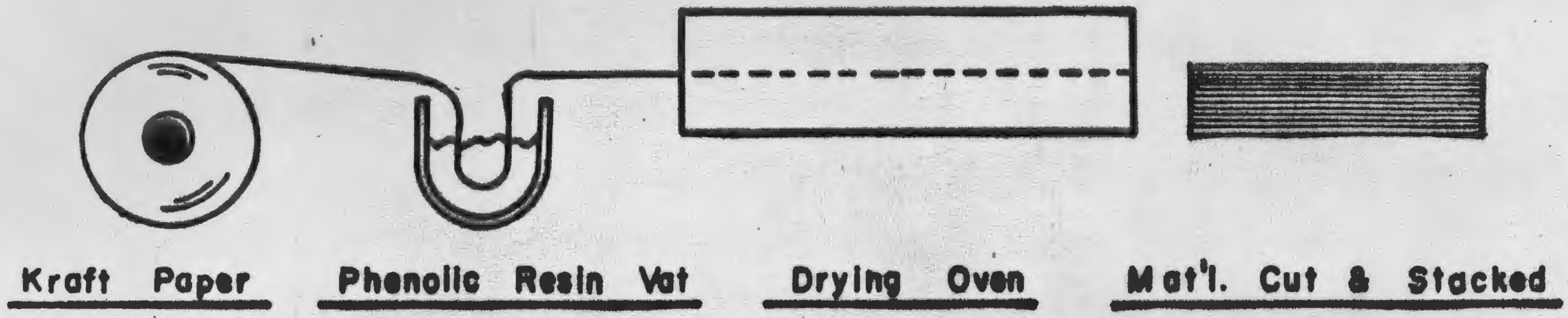

Figure 3. Resin Impregnation of Kraft Paper

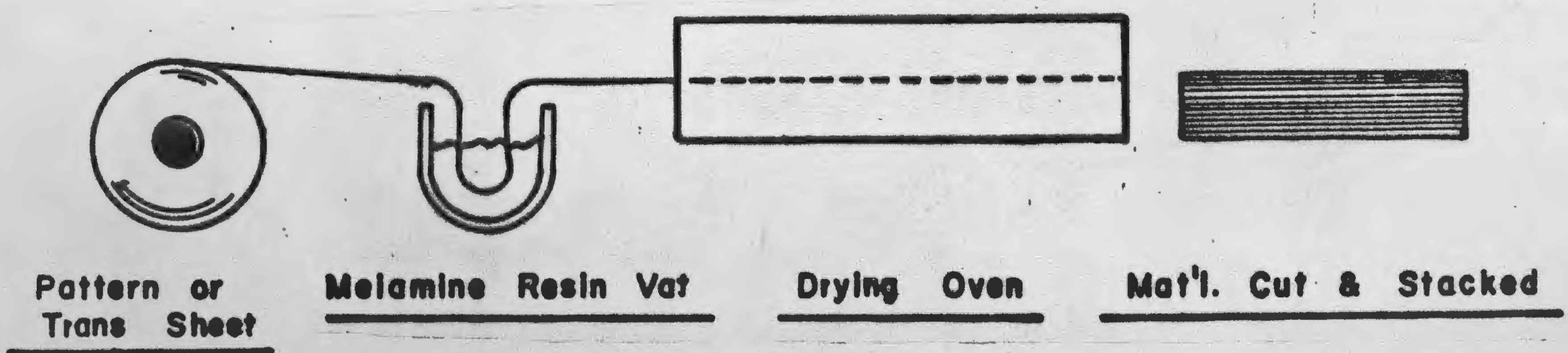

Figure 4. Resin Impregnation of Pattern Sheet and Transparent Sheet

The pattern and overlay sheets must be treated in a special room where the humidity, temperature, and dust are carefully controlled until the sheets are ready for processing.

The final laminated sheet is built up of the treated raw materials. The protective overlay sheet, the pattern sheet, and several layers of kraft paper are placed between highly polished stainless steel plates (Figure 5 on following page). These mirror-finished plates give the finished sheet a high gloss. Several laminate packs are necessary to fill the large press.

Temperatures over three hundred degrees Fahrenheit and pressure of about fifteen hundred pounds per square inch are used to properly cure the decorative material in approximately one hour. The steam in the platens is replaced by cold water which cools the pack. The packs are removed from the press and returned to the build-up room.

After trimming takes place, the back of the laminate is sanded. Sanding insures uniform thickness and provides a rough surface necessary for adhesion to a substrate.

<u>Textures Available</u>. The high gloss finish is obtained by using highly polished stainless steel sheets between the protective layers in the pack. A suede finish is possible by using a layer of aluminum foil between the protective layers and the stainless steel plates. Pumice, water, and brushes are used for the low-glare finish.

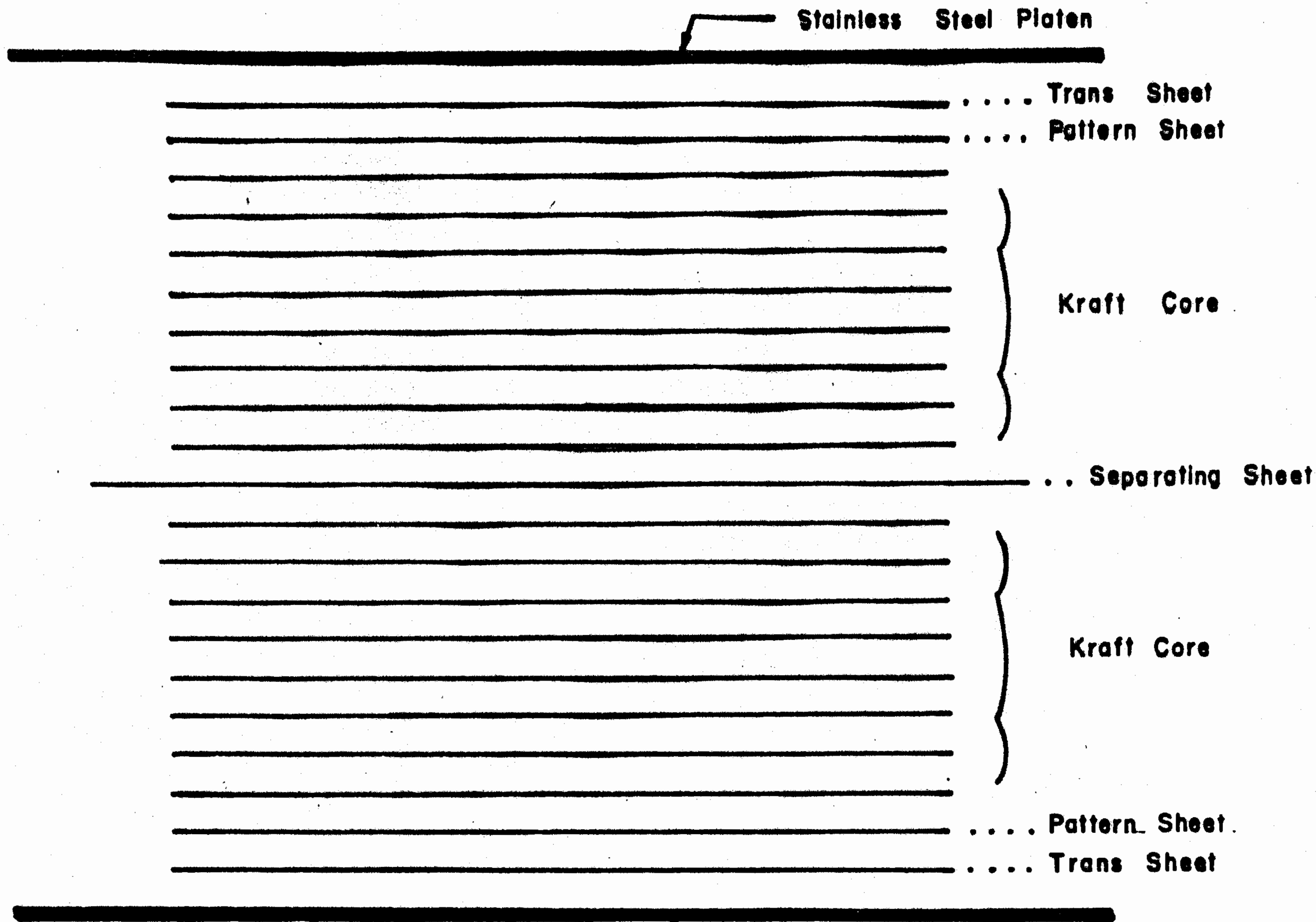

Figure 5. Plastic Laminate Pressing Method.

Standard Types of Laminate. There are four basic standard types of plastic laminates available.

1. General purpose is designed for both horizontal and vertical applications and used where good appearance, durability, resistance to stains, and resistance to heat from ordinary sources are required.
2. Vertical surface is used for vertical applications. Laminates used for vertical surfaces are about thirty thousandths inch thick.
3. Post forming grade is similar to general purpose type laminate, but it can be formed after being heated to a temperature of 325 degrees F. for ten seconds. Simple bending to radii of three-eighths to one-half inch is possible. The post forming grade is fifty thousandths inch thick.
4. Hardboard core has a surface similar to that of the general purpose laminate molded to a hardboard substrate.

Characteristics of Plastic Laminates. A damp cloth or sponge will easily clean the surface material. It is resistance to denting, skuffing, and ordinary temperatures.

The finish and color of the laminates are not visibly affected by mild products such as household soaps, detergents, ammonia, and coffee, Some products like bleach, grape juice, peroxide, and lye should not be allowed to set on the laminate surface.

Sizes of Laminate Sheets Available. Combinations of sizes are available. Widths available are 24-, 30-, 48-, and 60-inch widths. Common lengths are 60-, 72-, 84-, 96-, 120-, and 144-inches. Laminates come in 1/16 (.060) inch thick which is standard. Vertcal laminate is available and is usually 1/32 (.030) inch thick. The post forming grade is 3/64 (.050) inch thick.

Adhesives

There are basically two types of adhesives on the market for the application of the plastic laminate. They are the solvent base and the water base.

Solvent Base. Solvent base adhesives require a great deal of ventilation. One major disadvantage is that it is highly flammable. There is a higher adhesive cost per square foot of bonded laminate. Solvent base adhesives dry relatively fast. Lacquer thinner and naptha are two solvents for the solvent base adhesive.

Water Base. The water base adhesives are non-flammable and therefore do not need ventilation when applying. The drying time is longer than solvent base and is more dependent upon the atmospheric conditions. Having water as a base, the water base adhesives do not contribute to air pollution. A disadvantage is that if frozen the water base adhesive becomes a solid and is unusable. Corrosion is much more prevalent with certain metals and will affect both application and the material to be bonded. Water is the necessary solvent to clean tools and surfaces.

Contact cement is the most used adhesive with plastic laminates. It is available in both solvent and water base forms. The user should determine what the job requirements are and consider them in choosing the correct adhesive. Safety should be a primary factor in his decision because of flammability reasons. The manufacturer's directions should be followed for application and use of the adhesive chosen.

CHAPTER VI

PROCEDURAL APPLICATION

Application of Plastic Laminates

Plastic laminate is not a very strong material when not supported by a substrate, therefore, a serviceable substrate should be selected. There are many suitable substrates that can be used, but this unit will use only particleboard and hardboard. The adhesive used in this application description will be contact cement.

If a laminate trimmer or router is not available, common woodworking tools can be used to cut and trim plastic laminate. The writer will label this method the "break method".

Cutting and Layout. After selecting the substrate and laminate, the substrate should be cut to size and all dust removed by brushing. The laminate should be cut allowing a minimum of one fourth inch overhang.

In layout of the laminate, a pencil can be used to make layout lines. If the surface is too dark, use a piece of masking tape and then draw the line on the tape (Wagner, 1967, p. 20-10).

When cutting laminate with woodworking tools, carbide tipped tools are recommended because laminate causes tools to dull quickly. Fine-toothed blades should be used when sawing laminate. The decorative face should be up when using a table saw (Figure 6) and down when using a portable saw. The relief angle of the saw blade should cut toward the decorative face to prevent chipping.

Figure 6. Cutting Plastic Laminate

Laminates can also be jointed if a square, smooth edge is needed to fit into a corner. Figure 7 on the following page illustrates the jointing of plastic laminate. Depth of cut depends on quality of material being jointed and whether chipping is taking place.

Figure 7. Jointing Plastic Laminate

Figure 8. Materials and Tools for Plastic Laminate Application

If power tools are not available, several of the cutting tools shown in Figure 8 on the previous page can be used.

A carbide-tipped score awl or a scratch awl can be used to score the laminate before breaking. Both the protective layer and the pattern layer must be scored to secure a clean sharp break. The laminate should be bent toward the decorative face when breaking. (Figure 9)

Figure 9. Scoring with a Carbide-tipped Score Awl

If it is necessary to fit laminate against an irregular surface, a divider can be used to score the line on the laminate (Figure 10) and then cut using a tin snips. Small amounts of material should be removed with each cut to prevent chipping. Internal curves can be cut by drilling relief holes in the waste stock and then using a keyhole saw. Cutting should take place only on the vertical downward stroke.

Figure 10. Scoring Along an Irregular Surface with a Divider

Applying Adhesive. The adhesive can be spread with a brush (Figure 11 on following page), a roller, or a spreader. For particleboard, the spreader should be held with the serrated edge perpendicular to the surface. On hard nonporous surfaces and the plastic laminate, hold the edge at a forty-five degree angle (Figure 12 on following page) (Wagner, 1967, p. 20-11).

Adhesive should be applied to the laminate first as it dries more slowly than the substrate surface. If a second coat is desired, the first coat should be thoroughly dry. To test for dryness, a piece of kraft paper is used. If no adhesive sticks and it pulls away easily, the cement is dry and ready for laminating. Drying time depends on the temperature and humidity of the atmosphere. One should wait a

Figure 11. Applying Contact Cement with a Brush

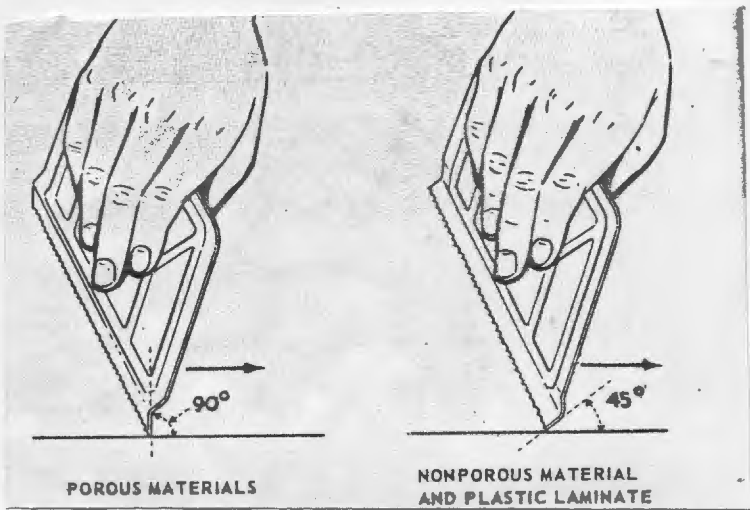

Figure 12. Applying Contact Cement with a Metal Spreader (Wagner, 1967, p. 20-28).

minimum of 15 minutes before laminating. Contact cements have various drying times and the user should consult the manufacturer's directions (Figure 13). (<u>CAUTION</u>: If using a solvent base contact cement, be sure to have sufficient ventilation and keep all sparks and heat away).

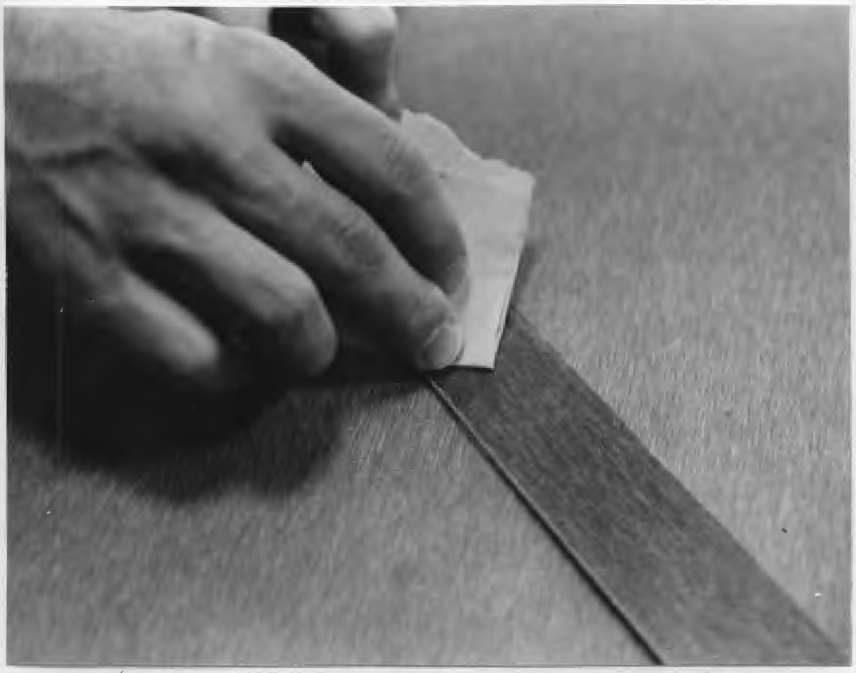

Figure 13. Using Kraft Paper to Test Contact Cement for Dryness

Bonding of Laminate. In the laminating procedure, it is recommended to first laminate the edges so the top piece will overlap the edges. The laminate should be cut from one-sixteenth to one-quarter inch larger than the substrate depending on the trimming method.

The adhesive is applied and allowed to dry. Then the laminate is bonded to the substrate edge. A block of wood and a hammer or mallet (Figure 14) can be used to apply pressure to assist total bonding. The hand roller can be used, but it is difficult to apply even pressure on the edges. The excess laminate is then trimmed using a file or a trimmer.

Figure 14. Applying Pressure to Edges with a Block of Wood

When laminating large surfaces, scrap pieces of laminate or the metal parts from Venetian blinds can help support the laminate while aligning it over the substrate (Figure 15). After fitting, slip the center support from beneath the laminate. The two surfaces will bond and hold the laminate in place while the other supports are removed.

Another method of aligning the laminate on the substrate is the slip-sheet method. (Figure 16) A piece of kraft paper separates the two cemented surfaces. When the laminate is aligned, begin removing the paper from one end and then press the laminate down into position on the substrate.

Applying Pressure to the Laminate. When using contact cement for an adhesive, pressure should be applied over the

Figure 15. Using Supports to Align the Laminate over the Substrate

Figure 16. Slip-sheet Method of Aligning Laminate over Substrate

entire surface. The block and hammer method can be used, but on large surfaces, the hand roller is much more satisfactory (Figure 17).

Figure 17. Applying Pressure with the Hand Roller

When using the hand roller, approximately twenty-five pounds per square inch should be applied to all areas of the surface. Industry uses rotary presses to apply pressure to large flat panels.

<u>Trimming the Laminate</u>. There are several methods to use when trimming the laminate. When a router or trimmer is not available, a file can be used if less than one-sixteenth inch of material remains (Figure 18).

An under scriber (Figure 19) can be used to score the laminate decorative face and a linoleum cutter for scoring

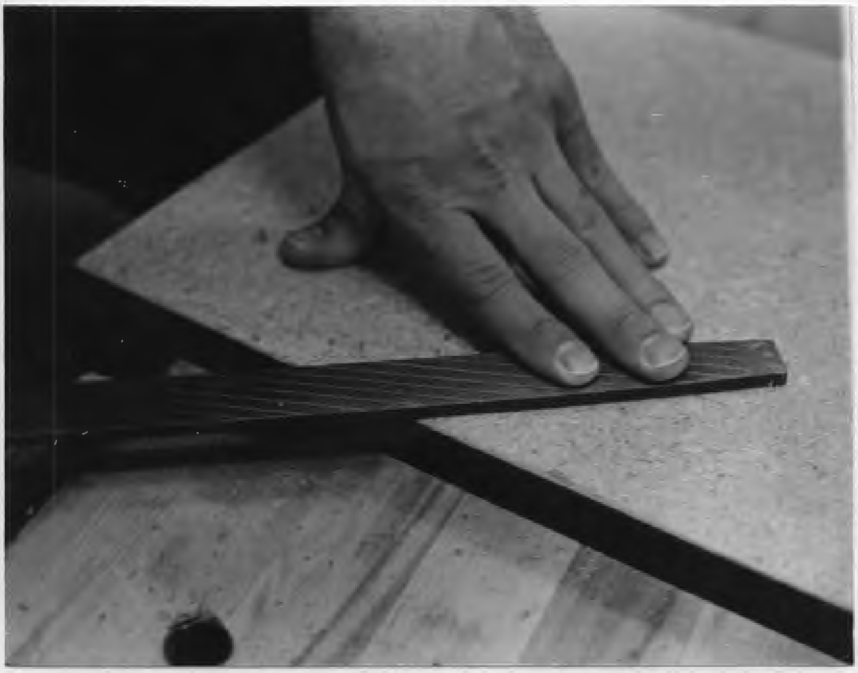

Figure 18. Filing an Edge

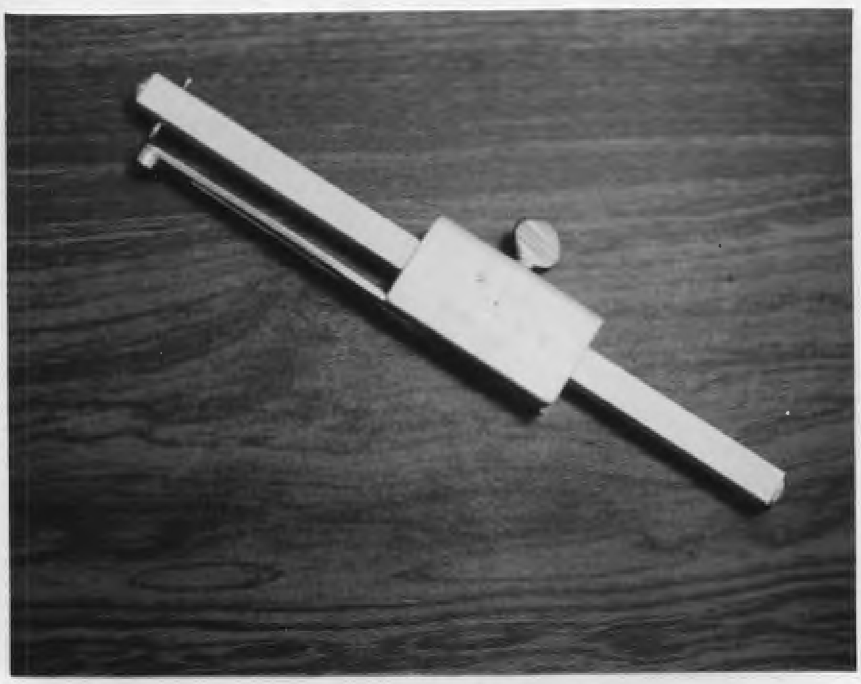

Figure 19. Underscriber Used for Scoring Decorative Face of Laminate

the bottom side against the substrate. The point of the underscriber should be aligned so that only a very small amount of laminate remains (Figure 20). Then break the laminate toward the decorative face. The edge can be finished with a file.

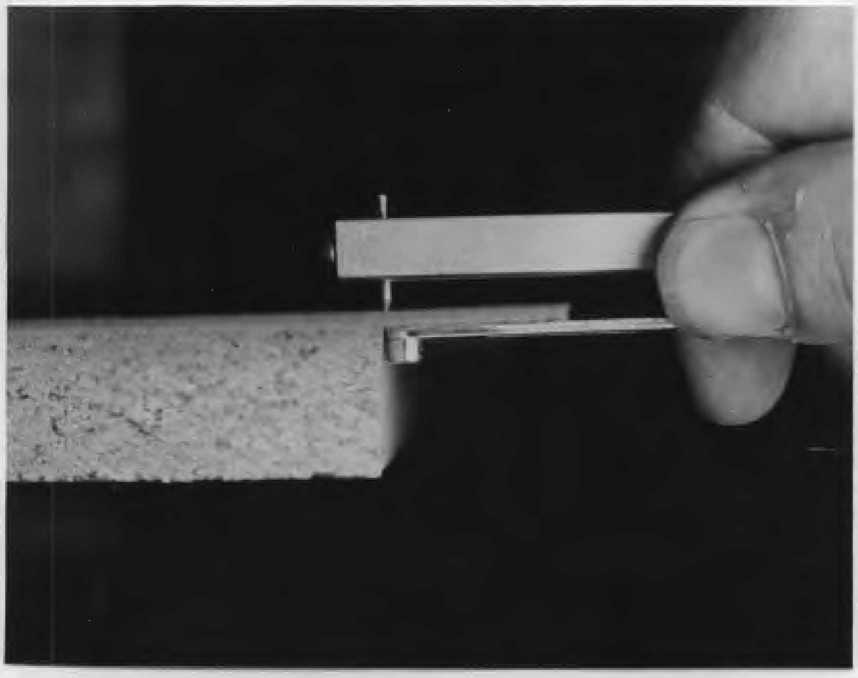

Figure 20. Aligning the Point of the Underscriber

The bevel angles for finished trimming are illustrated in (Figure 21) (Wagner, 1967, p. 20-12). A file, block plane, or trimmer can be used to bevel the angles.

A laminate trimmer (Figure 22) on the following page can be used to trim the excess material. When using the trimmer, it is recommended to leave a one-fourth inch laminate overhang. The laminate trimmer comes with two carbide-tipped cutters, one ninety degree cutter and one angled cutter

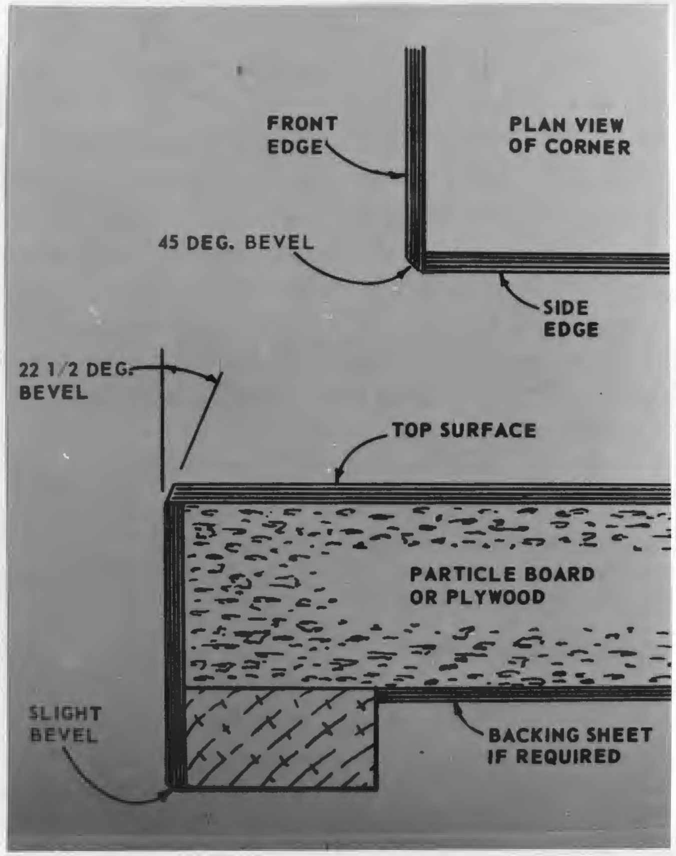

Figure 21. Finished Bevel Angles When Trimming Laminate (Wagner, 1967, p. 20-12).

Figure 22. Laminate Trimmer

Figure 23. Trimmer Bevel Cutter

(Figure 23) which is used for finish beveling on the top edges.

The trimmer has a guide attached to the side for use when squaring off the edges (refer to Figure 22 on page 37). The guide is adjustable and can be set to the desired depth. Figure 24 shows the use of the guide in relation to the laminate surface and the trimmer. The ball bearing roller runs along the laminate to maintain the desired depth.

For finished smoothing of the edges, a 400 wet-or-dry abrasive paper should be used. The final edge treatment determines how the final appearance of the complete project will look.

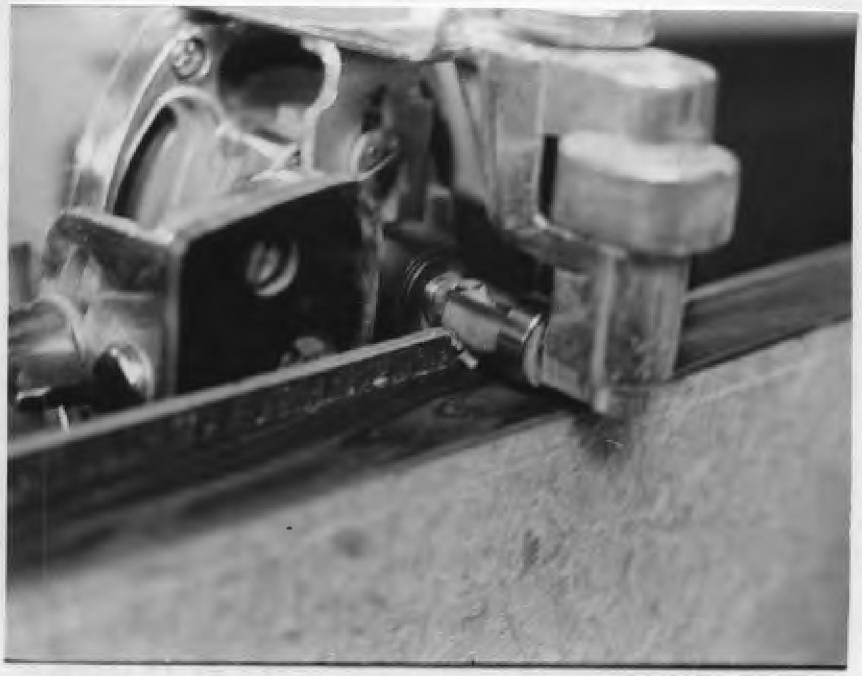

Figure 24. Use of the Adjustable Guide When Trimming Laminate

Safety in Laminating. When performing any of the laminate operations, an individual must wear safety glasses to prevent any chips from entering the eyes. The trimmer is a dangerous machine. Before making any adjustments or changing cutters, be sure to unplug the trimmer.

Vinyl Film Application in Industry

Industry uses an automatic production line to apply vinyl to panels. The industrial processes described are applicable to the shop area only on a smaller scale and using common shop tools.

In Figure 25, the panels are fed into the line at (A). A brush roll (B) cleans the surface which is a necessity for

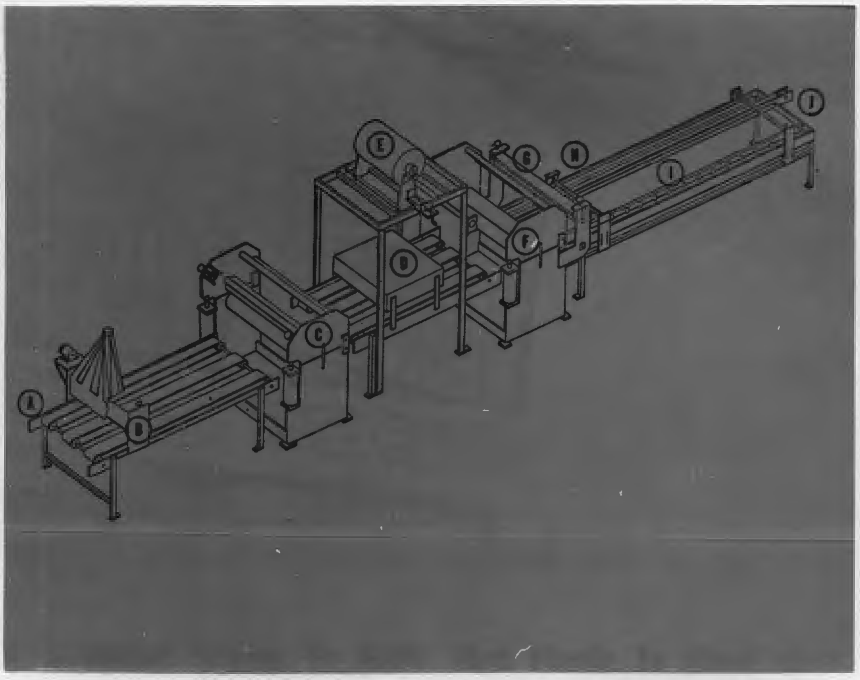

Figure 25. Vinyl Laminating Production Line (Union Tool Corporation)

a smooth bond. The roller coater at (C) applies the water emulsion adhesive. At (D) the oven dries most of the moisture, and the adhesive becomes tacky. The vinyl rolls are located at (E). The vinyl then goes over the spreading roll which stretches the material before it comes in contact with the panel. The laminator (F) applies pressure for a smooth bond. The laminator is equipped with an automatic cutoff roll (G). At (H), an embossing roll gives the vinyl a pattern which resembles wood grain or other decorative effects. The panel now goes to an edge wrapping machine (I) which folds the vinyl down around the edge of the panel and applies pressure to seal the edge.

Industry has only a small amount of finishing work on the ends of the panels. The entire process is handled automatically.

Vinyl Laminating in the Shop

The procedure used in the shop for vinyl laminating is much the same as in industry only on a smaller scale. When vinyl laminating, the substrate must be very smooth. One coat of adhesive can be used as a filler coat depending on the type of adhesive.

Contact cement is difficult to use when vinyl laminating because the vinyl is quite flexible, and once it is applied it must remain. Therefore, one may want to use epoxy adhesives or what is recommended by the producer of the vinyl.

Depending on the vinyl, some adhesives may soak through and affect the color and surface texture. As a result, an individual must know the adhesive that is recommended for the vinyl he has purchased.

When using particleboard as a substrate, one must be careful to not use a water emulsion adhesive as this will affect the particleboard surface and the grain will raise.

The basic tools necessary are a tool to cut the laminate, an adhesive spreader, and a roller to apply minimal pressure.

One advantage of vinyl is that it can be formed around edges and mitered at the corners. This makes it very applicable on drawer fronts, vertical surfaces, and other areas that will not receive an excessive amount of abuse.

CHAPTER VII

INSTRUCTIONAL UNIT

The writer has found the topic of laminating a very intriguing subject. The student in the industrial arts program and the area of lamination would benefit greatly from this instructional unit. The nature of the topic lends itself very well to use in the woodworking or plastics class. For these reasons, the writer believes that a unit on lamination would be of great value in the course.

Objectives

1. To develop in the student a basic understanding of the lamination principles.

2. To acquaint the student with various materials and techniques of plastic laminate and vinyl application.

3. To provide the student with an opportunity to work with the laminate materials and tools.

4. To provide the student with insights into advantages, disadvantages, and limitations of the laminating area.

5. To develop within the student, an appreciation of a significant industrial process.

Lesson Plan Outline

I. Introduction

   A. Definition of plastic laminates and vinyl films

   B. Differences between the two laminations

II. Manufacturing processes

   A. Particleboard substrates

   B. Hardboard substrates

   C. Vinyl film

   D. High-pressure plastic laminate

      1. Manufacture

      2. Textures available

      3. Standard types of laminates

      4. Characteristics of plastic laminates

      5. Sizes of laminate sheets available

   E. Adhesives

      1. Solvent base

      2. Water base

III. Application procedures

   A. Plastic laminate

      1. Cutting and layout

      2. Applying adhesive

      3. Bonding of laminates

      4. Applying pressure to laminates

      5. Trimming

      6. Safety in laminating

   B. Vinyl film application in industry

   C. Vinyl film laminating in the shop

Safety Precautions

Laminating, like most other industrial processes, can be hazardous if the proper safety precautions are not followed. The following set of safety precautions should be rigidly followed when laminating:

1. Always wear safety glasses.

2. Follow all safety practices necessary on all power equipment.

3. When using flammable adhesives, keep sparks and heat away.

4. Be sure to have sufficient ventilation.

5. Be alert when using cutting tools.

6. When using the router or trimmer, be sure to unplug the machine before making any adjustments or changing a cutter bit.

7. Be familiar with the trimmer operations.

8. Be respectful to the other students in the shop.

Student Evaluation

A sound and objective evaluation system should be an integral portion of every industrial arts program. The student should be evaluated on the amount of knowledge gained, his ability to understand and operate the related equipment, and the work accomplished through the use of a specific process. One method of partial student evaluation is through the use of a test such as the one following.

Sample Test.

1. Name the three (3) layers in the construction of a plastic laminate.
2. Several layers of __________ paper are used as the base of the plastic laminate.
3. When cutting plastic laminate on the table saw, which direction should the decorative face be?
4. How many pounds of pressure are recommended for successfully adhering laminate with a hand roller?
5. _________ and _________ are two solvents for the solvent base adhesive.
6. True or False. When breaking laminate after a line has been scored, always break away from the decorative surface.
7. True or False. Vinyl film is produced by a calendering process.
8. When cutting laminates on the table saw, the blade should be equipped with _________-tipped blades.
9. Name three methods of spreading adhesive.
10. What is the slip-sheet method of laminate application?
11. When aligning the laminate, what are two methods used to assure good placement?
12. Describe the use of the underscriber.
13. What is the method of checking the adhesive for dryness?
14. True or False. Plastic laminate is very strong when not supported by a substrate.
15. How is the design printed on the laminate sheet?
16. What is one important advantage of vinyl film?

Teacher Aids

Printed Materials. Respectable units on the lamination of plastic laminates were located in:

Groneman, Chris H. General Woodworking. 3rd ed. Homewood: The Goodheart-Wilcox Company, Inc., 1964.

O'Neill, James M. Fabricating with Formica. Milwaukee: The Bruce Publishing Company, 1958.

Wagner, Willis H. Modern Woodworking. Homewood: The Goodheart-Wilcox Company, Inc., 1967.

No films could be found on the lamination area alone.

Supplies

The following is a list of some of the tools and supplies that can be used in the laminate area. When getting into the power tools and carbide-tipped tools, lamination can be quite expensive.

1.	Laminate trimmer (1/2 H.P.)	$79.50
2.	Carbide-tipped plastic laminate saw blade (10" dia. 60 teeth)	87.15
3.	Flush carbide router bit (1/2 inch)	12.90
4.	15 degree carbide router bit (1/2 inch)	12.90
5.	Smooth mill file (12 inches)	2.35
6.	Linoleum knife	1.95
7.	Contact cement (1 pint)	1.35

CHAPTER VIII

PROJECT DEVELOPMENT

To assist the students in the understanding of the laminating techniques, a useful, enjoyable project was discovered. This project (Figure 26) is entitled "Jumping Frog" (Willis H. Wagner, 1972). The goal of the game is to jump one peg with another and remove the peg that was jumped. The turn that has the last peg is the loser. This project can be used in the junior high or the high school industrial arts program.

Figure 26. "Jumping Frog Game"

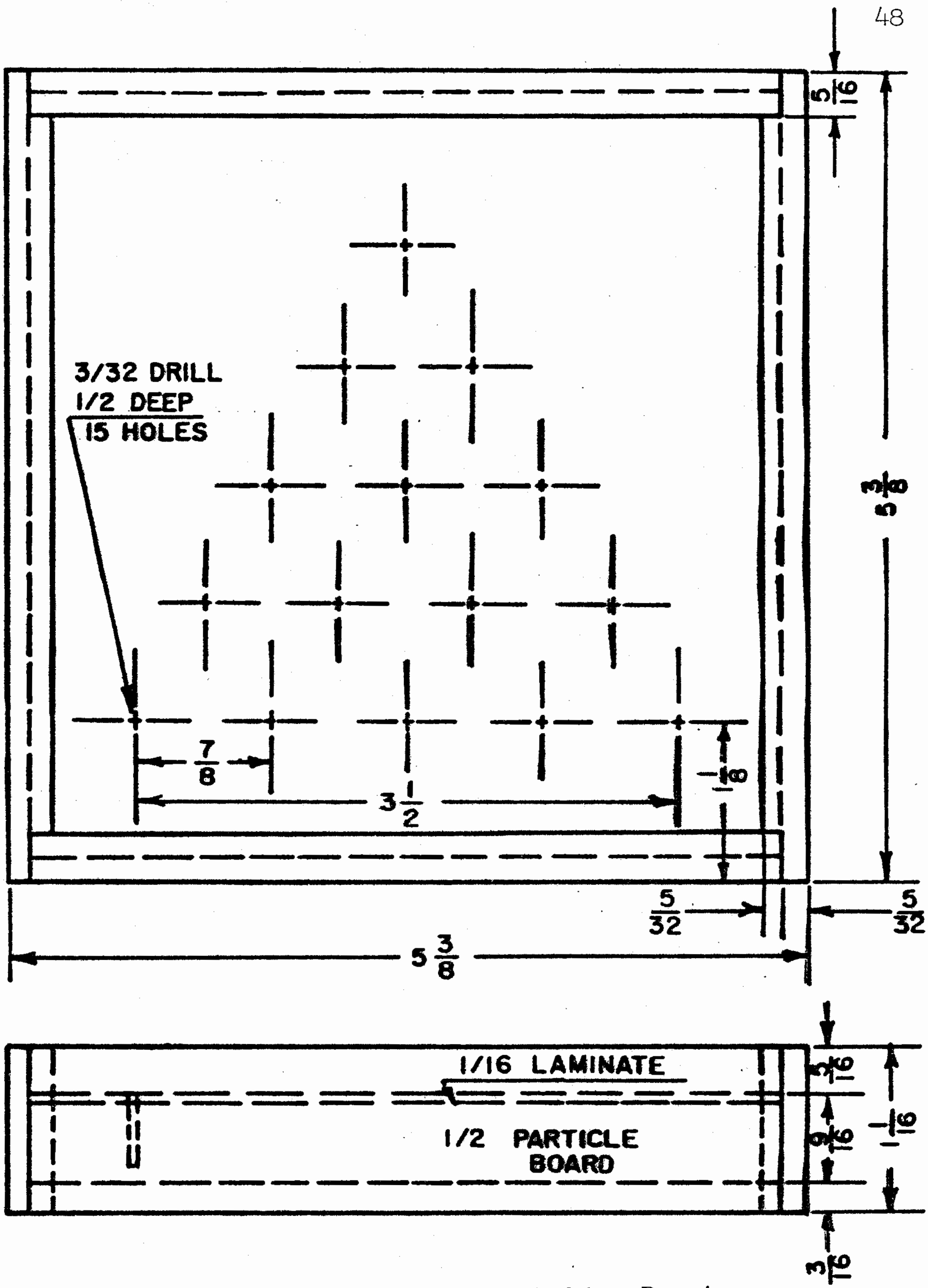

Figure 27. Dimensioned Working Drawing for "Jumping Frog"

Construction of Project

Materials.

1. 2 pieces of willow 5/16" x 1 1/16" x 5 3/8"
2. 2 pieces of willow 5/16" x 1 1/16" x 5 1/16"
3. 1 piece of particleboard 1/2" x 5 1/16" x 5 1/16"
4. 1 piece of plastic laminate 1/16" x 5 5/8" x 5 5/8"

Plan of Procedure.

1. Plane sides to finished dimensions.

2. Cut rabbets on the inside of two longest pieces 5/32" deep and 5/16" wide.

3. Cut a groove in all four sides 5/32" deep and 9/16" wide.

4. Cut particleboard to finished dimensions.

5. Apply adhesive to laminate and particleboard and allow to dry.

6. Carefully place laminate over particleboard keeping uniform overhang.

7. Apply pressure with block of wood or roller.

8. Trim laminate.

9. Drill 15 holes 3/32" diameter 1/2" deep.

10. Trial assemble all parts, check fit of groove and rabbets.

11. Make any corrections necessary.

12. Apply glue to rabbets and groove and final assemble.

13. Finish sand entire project.

14. Apply deft to wood pieces of project.

15. Submit to instructor for evaluation.

CHAPTER IX

SUMMARY

This investigation of lamination techniques has been a very challenging and rewarding study. A great deal of knowledge has been assimilated by the writer about the history of the various substrates and overlays, and the manufacturing processes involved.

The procedural application was very informative in helping the writer to familiarize himself with the tools, adhesives, and materials used for laminating.

Through this in-depth study, the writer will be more competent when incorporating an instructional unit about the lamination field into a woodworking course. The school shop project developed will assist the writer in relating the industrial use of overlays to the student enrolled in the industrial arts program.

Pertinent information learned through this study will assist the writer in understanding the lamination field on the industrial level and will also enable the writer to better advise any student interested in the field of overlays.

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APPENDIX

APPENDIX A

FIELD TRIP

Sterling Tops

On May 9, the writer visited Sterling Tops, Denver, Iowa to view the application of plastic laminates to particleboard substrates. Mr. Sterling is the owner of the shop and is a custom fabricator of kitchen counter tops, bank furniture, bars, and other specialty items.

Mr. Edgar has part-time help occasionally when he has a large construction project underway. Formica is applied to a 45# density particleboard with a contact cement. A table saw, jointer, and router are the basic tools in the shop. A rotary press is used to apply pressure to the flat panel substrate and plastic laminate.

The most used grade of Formica used by Mr. Edgar is the standard grade which is .062 inch thick. For counter tops, a post forming grade is used because of the forming necessity. This grade is about .050 inch thick.

Mr. Edgar has a fine business and is expecting growth. He has a post forming machine ordered and is awaiting its arrival.

Peterman & Haes

Mr. Jack Haes, a sales person and experienced laminate user of Peterman and Haes, Waterloo, Iowa, was very helpful in supplying information about the break method. Peterman & Haes construct a majority of their cabinets on the job site.

Mr. Haes said that they use a water base adhesive for a majority of their work. The reasons are because of cost and spreading footage. The cost of one pint of water base adhesive equals the cost of one quart of chemical base adhesive. Comparing spreading footage, one quart of water base adhesive spreads as much as one gallon of chemical adhesive.

In construction, the router is not used because of cost of upkeep. The break method is used and carried out with the necessary tools described in prior chapters.

APPENDIX B

SAMPLE LETTER SENT TO INDUSTRY

February 28, 1972

University of Northern Iowa
Cedar Falls, Iowa 50613

American Hardboard Association
20 N. Wacker Drive
Chicago, Illinois

Dear Sir:

Currently I am enrolled as a graduate student at the University of Northern Iowa and am majoring in Industrial Arts. This semester I am taking a course entitled "Projects in Industrial Arts", which requires a thorough investigation of one significant industrial topic. The topic which I have chosen for my study is "The Use of Hardboard and Particleboard for Composition Panels in Furniture Construction."

Any information or small samples you may have available in the area of hardboard processing, adhesives, or using hardboard as a substrate for lamination of vinyl films or veneers in the furniture industry would be appreciated.

I will also be developing an instructional unit on my topic for a high school woodworking class. Any information on films, slides, textbooks, or other instructional material will also be very helpful.

To meet my deadline I must start compiling the material no later than March 24. Any information you can supply prior to this date will be most sincerely appreciated.

Very truly yours,

/Jerry/ De Penning /

APPENDIX C

DURAFLAKE COMPANY

P.O. Box 428
ALBANY, OREGON 97321
Telephone (503) 928-3341
DIVISION OF
Willamette Industries, Inc.

February 29, 1972

Mr. Jerry De Penning
UNIVERSITY OF NORTHERN IOWA

Cedar Falls, Iowa 50613

Dear Mr. De Penning:

Thank you very much for your inquiry concerning DURAFLAKE. We are happy to forward to you the information we have available concerning the DURAFLAKE line of products as well as the industry standards that we have on file.

The particleboard industry, we feel, is quite dynamic in the United States today and the possibilities for increased applications of particleboards are becoming greater every day. Personally speaking, I never cease to be amazed at some of the applications to which particleboard is put and find myself in a position of "brain storming" over the telephone with different DURAFLAKE distributors all over the country concerning potential applications that their customers have come up with.

The primary concern to you, I am sure, is the application of particleboard to the woodworking and furniture industry. This is the market towards which we slant the bulk of our production with the industrial density boards being 45#, 48#, 50# and 55# density. In conjunction with this, we do manufacture the 42# underlayment grade board which is also being applied in some areas in a furniture application. We also manufacture a 28# density door core material for solid core doors and a 46# density mobile home decking which is manufactured in accordance with the National Particleboard Association specifications. In addition to the grades of board manufactured, we have several paint line applications to prepare the board for final use as well as certain machining operations to prepare certain of our cut-to-size items for production at the final destination. An example of this would be machining the front and back sides of counter top material to accept the customer's back splash and front lip with no major machining required by the end use customer.

In that particleboard is being used primarily as a substrate in furniture, we find ourselves working quite closely with the paint companies, as well as the laminating industry, to provide a suitable substrate for given applications.

Continued . . . . . .

As you can see, particleboard is a technology in itself as well as an alliance of technologies in getting particleboard to the final product.

We hope this information fulfills your requirements. Should you have any further questions, please feel free to contact us.

Very truly yours,

DURAFLAKE COMPANY

Bruce R. Palmer
Sales Coordinator

BRP:jw
CC: Tom Costello (Dura Rep)