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Dimension Stock and Other Uses of Aspen

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LAKE STATES ASPEN REPORT NO. 12

DIMENSION STOCK AND OTHER USES OF ASPEN

—BY—

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FOREWORD

During and since World War II, there has been increasing interest in aspen (*Populus tremuloides*) in the Lake States, its availability and supply, properties and uses, and management. Aspen is a tree of primary importance in 20 million acres or 40 percent of the total forest area of the three Lake States - Michigan, Minnesota, and Wisconsin.

At an informal meeting at Madison, Wisconsin, in January, 1947, forestry representatives of several federal, state, and industrial groups in the Lake States agreed that it would be desirable to bring up to date what is known on aspen and make it available to anyone interested. The job of preparing this information in the form of reports was assigned to each of the groups listed below. The reports will be duplicated as rapidly as completed, and the entire project should be finished by the end of 1947. Each report will concern one aspect of the subject. Copies will be available from the Lake States Forest Experiment Station or from each contributor.

Report Number	Subject
1	Aspen Properties and Uses
2	Aspen Availability and Supply
3	Logging Methods and Peeling of Aspen
4	Milling of Aspen into Lumber
5	Seasoning of Aspen
6	Aspen Lumber Grades and Characteristics
7	Mechanical Properties of Aspen
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9	Aspen Lumber for Building Purposes
10	Aspen for Containers
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12	Small Dimension and Other Industrial Uses of Aspen
13	Aspen for Veneer
14	Aspen for Pulp and Paper
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17	Aspen Defiberization and Refining of Product
18	Chemical Utilization of Aspen
19	Preservative Treatment of Aspen
20	Marketing of Aspen
21	Possibilities of Managing Aspen

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REPORT NO. 12

DIMENSION STOCK AND OTHER INDUSTRIAL USES OF ASPEN

By

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INTRODUCTION

Utilization of aspen for pulpwood, excelsior bolts, veneer logs and lumber has increased steadily during the past 10 years. This was particularly true during the war years when, because of the scarcity of other timber, aspen entered many new phases of utilization. In the lumber field alone the wider acceptance of aspen has been reflected in an increase in the annual production from 67 million board feet in 1941 to 152 million board feet in 1946. It is estimated, however, that aspen stands in the Lake States can provide an annual cut of at least 300 million board feet of lumber.

With general improvement in the lumber supply after the war a considerable slump in the utilization of aspen lumber occurred. Aspen is the only specie in the Lake States in which growth far exceeds the cut. As other northern timber species -- maple, birch, and hemlock -- become progressively depleted, the importance of aspen as a source of raw material for local wood-using industries, should increase.

This report deals with the use of aspen in the manufacture and utilization of dimension stock. It also explores a number of other present and potential industrial outlets for aspen.

DIMENSION STOCK

Definition of Dimension Stock

Dimension stock is flat or square wood-stock, varying in size from 1/2 to 6 inches in thickness, 1/2 to 8 inches in width, and up to 8 feet in length. The stock may be green, air-dried or kiln-dried, and either hardwood or softwood. Dimension stock may be rough or dressed, cut to the approximate size required for the various products of woodworking plants, or it may be furnished refined to conform to specific requirements of the user. In some instances it may be glued and in a highly finished form, ready for final assembly.

Sometimes a distinction is made between dimension stock and "ready-cut stock." In this case the latter is defined as material fabricated to the exact requirements of the user, ready for final assembly into a finished product, while the former is considered as rough or only partially fabricated material. Dimension stock is also produced and sold under a variety of other names, such as squares, blanks, cut-to-size stock, chair and leg stock, etc. The term dimension stock, however, should not be confused with the term "demension" as applied to heavier lumber or plank, used in general construction.

Industrial Uses of Dimension Stock

It has been estimated that as much as 90 percent of all hardwood lumber produced in the United States is further remanufactured into some finished product by wood-using industries. Of the total amount used only a small percent is consumed in widths of 5 inches or over, and in lengths in excess of 8 feet. More than 80 percent of the hardwood lumber is used in pieces under 4 inches in width and 2 feet in length (1,2,5). In other words, the bulk of hardwood lumber is ultimately converted into small dimension.

According to Sands and Malcolm (9), the consuming industries that may provide outlets for dimension stock are numerous and diversified. Some of these outlets are relatively new, and therefore their requirements are not standardized; examples of these are precut houses and house trailers. Other industries, such as sash, door, and millwork plants, have fairly stable and well known requirements for cut-up stock. Finally, the requirements of furniture plants, a very extensive potential market for dimension stock, are so diversified and changeable that they can be met only through individual contacts.

The major users of dimension material may be broadly classified under the following headings:*

TABLE 1 -- MAJOR USES OF DIMENSION STOCK

I. Factory House Group	II. Millwork Group
House trailers	Door and window frames
Prefabricated houseframing	Stock sash and doors
Precut houses	Screens, screen and combination doors
	Door core stock
	Shutters and blinds
	Moldings
	Interior trim
	Custom millwork

*Based in part on Sands and Malcolm, reference No. (9).

III. Household Equipment Group
- Furniture parts
- Radio cabinets
- Kitchen cabinets
- Refrigerators
- Laundry appliances
- Window shade rollers and slats
- Venetian blind slats

IV. Container Group
- Caskets and rough box
- Boxes and crates
- Trunks and luggage
- Pallets
- Cooperage

V. Implement and Appliance Group
- Agricultural implements
- Laundry supplies
- Apiary supplies
- Tools

VI. Miscellaneous Group
- Stepladders
- Grain and coal doors
- Turning squares
- Toys and novelties
- Picket and snow fencing

Manufacture of Dimension Stock

Most of the hardwood dimension stock is produced either from: (1) lumber, 8 feet and over in length, (2) bolts, i.e., short logs under 8 feet in length, and (3) mill residue. All aspen dimension is produced either from lumber or short bolts. Because of the small size and relatively low quality of aspen logs, aspen mill residue is poorly suited for conversion into small dimension material.

Milling of aspen logs and bolts. Aspen lumber in the manufacture of dimension stock is cut almost exclusively either in circular mills or with a splitter saw, followed by a horizontal resaw.

The single circular sawmill has the advantage of relatively low capital investment. It also presents the opportunity to obtain a higher yield of better grades, if the logs are turned in sawing. In practice, however, because of the small size of the aspen log, most mills cut aspen through and through, without any regard for grade of lumber. The per hour production in circular mills cutting aspen varies greatly with the mill and the size of the logs. The mills covered by this study report an hourly production of 4/4 lumber ranging from 500 to 1200 board feet.

The splitter-resaw equipment consists of a circular head saw, placed in a trough, that splits the logs as they are advanced toward it by the lugged chain, and a horizontal band resaw. The resaw reduces the half-logs into lumber of the desired thickness. The lumber is cut without any regard for grade, and reported output ranges from 3,000 to over 5,000 board feet of lumber per hour. The cost of such equipment is several times that of a single circular mill.

Telford and Malcolm (11) have also shown that for logs from which the single circular headsaw cuts 1,000 board feet of 4/4 lumber, the splitter-resaw mill will produce 1,075 board feet. On the cord basis it takes about $2\frac{1}{2}$ cords of 100-inch, woods-run aspen, 6 inches and over in diameter, to produce 1,000 board feet of 4/4 lumber.

Mills cutting short aspen bolts in most instances use splitter-resaw equipment. Specially designed circular mills equipped with short-log carriage are also in use.

Yield and quality of lumber. Most mills manufacturing small dimension from aspen procure the logs by cord measure, in 100-inch length or in the form of bolts ranging from 48 to 52 inches in length. The minimum top diameter of logs and bolts is generally limited to 6, and in some cases to 8 inches.

Rees (7) has shown that in northern Minnesota in a typical lot of aspen logs, ranging from 5 to 15 inches in diameter, about one-third of the total lumber produced was in widths of 5 inches or less; about 50 percent was in widths of 6 to 8 inches, and the remainder in widths over 8 inches. Since diameter of the log at the small end determines to a large extent the width of lumber produced, this study indicates the desirability of eliminating logs under 8 inches in diameter, if the accumulation of narrow-width lumber is to be avoided. It should be pointed out, however, that the narrow boards, because they are cut from the sapwood part of the log, frequently comprise the best quality lumber. This may in part compensate for the higher cost involved in sawing and handling of such stock.

Grade rules for aspen lumber. Aspen lumber is seldom sorted into grades. This is especially true at the mills that saw it for their own use. The usual practice at such mills is to sort the usable lumber from the cull. The latter is determined by the minimum requirements for quality acceptable in the manufacture of their products (13). When lumber is purchased on the open market or from a sawmill it is usually sold on a mill-run basis.

Even though grading of aspen lumber is seldom practiced, there are at present four different sets of grading rules proposed for aspen. Two are the National Hardwood Lumber Association rules for aspen factory lumber, and aspen construction lumber; the third is the Northern Hemlock and Hardwood Manufacturers Association rules, under which aspen is graded as a softwood yard lumber; and the fourth set is special aspen rules drawn up by the Northern Pine Manufacturers Association. The latter rules are sometimes employed when aspen lumber is sorted for dimension stock. These rules provide for Select and Better grades, No. 4 and Better Common grade, and No. 5 Common. In most mills visited in the course of this study the cull lumber corresponded closely with the No. 5 Common grade, as established by the Northern Pine Manufacturers Association. In other words, all of the No. 4 Common and Better material was considered usable. Exceptions to this were a plant specializing in production of core stock and a plant engaged in production of specialty items, such as wooden heels and certain classes of turned articles. Such plants could use only material corresponding to No. 1 Common and Better grades.

From information obtained in a study conducted in Northern Minnesota, it was estimated that one million board feet of aspen lumber, from logs 6-inch and over top diameter, will have the following grade distribution (13):

TABLE 2 -- GRADE YIELD OF ASPEN LUMBER

Grade of lumber*	Volume in board feet	Percent
F & S	12,000	1.2
Selects	8,000	0.8
No. 1 Common	120,000	12.0
No. 2 Common	520,000	52.0
No. 3 A Common	200,000	20.0
No. 3 B Common	140,000	14.0
Total	1,000,000	100.0

Information obtained in the field from the producers indicates that the yield of better quality aspen lumber, i.e., No. 1 Common and Better grades, varies considerably in different lots of logs. The percentage of such higher grades, as reported by the producers, ranged from 10 to 30 percent of log yield. Plants utilizing all usable aspen lumber, i.e., an equivalent of No. 4 Common and Better grade, report 70 to 90 percent of log yield as usable stock.

Dimension Stock Plant Equipment

In addition to a head-rig, the equipment of a dimension stock plant consists of one or more of cut-off saws, ripsaws, resaws, and a planer. If assembled items such as core stock are manufactured, the plant may also have jointer and gluing equipment, consisting of a glue spreader, clamping devices, or modern steam or high-frequency electric, batch, batch-continuous or continuous-feed presses.

Since most aspen dimension is manufactured from lumber, the first operation consists generally of planing the boards on one or both surfaces. This is done to reveal hidden defects, which can then be eliminated more efficiently in subsequent operations.

Because of the relatively low value of aspen lumber, planed stock quite frequently is ripped the full length of the board. In one mill the surfacing and ripsawing operations are performed in a specially built combination planer and gang-ripsaw machine, thus saving one handling. In some mills the planed and sometimes the rough boards are first crosscut to the desired length and then ripped with a self-feed, straight-line type ripsaw.

*National Hardwood Lumber Association grades.

Where boards are ripsawed the full length the resulting strips are cross cut into the desired lengths. Each piece is handled individually and this gives a skilled operator an opportunity to eliminate the defects and to obtain the maximum amount of usable cuttings from each piece.

When aspen dimension stock is to be glued, the individual pieces may be passed through a jointer to obtain a flat and square edge, and a smoother gluing surface. However, for core stock a satisfactory glue joint may be produced with a straight-line ripsaw. Toole (12) reports that the swage-set saw is believed to produce the cleanest cut, but that the spring-set saw is also satisfactory, when accurately fitted.

Seasoning and Handling of Dimension Stock

For many uses dimension stock must be seasoned to below 10 percent of moisture content. This means that in these instances dimension material must be kiln-dried. An important exception to this is the lumber for boxes and crates, pallets, grain and coal doors, and similar industrial items. These products need not be seasoned below 15 percent moisture content, and the stock can therefore be air-seasoned.

Dimension stock from seasoned lumber. Because of the expense involved in handling small pieces, dimension stock of lower moisture content is generally produced from the preseasoned lumber or plank.

Aspen is considered to be a fast-drying species. During the active drying season, i.e., through the spring and summer months, properly piled aspen will dry to a thoroughly air-seasoned condition in 2 to 3 months, depending on the thickness of lumber. Lumber stacked in the fall and winter will not become completely air-dried until the following summer.*

Sapwood and normal heartwood of aspen can also be satisfactorily kiln-dried, either from green or air-seasoned condition. For such stock the schedule in Table 3 is recommended (10). This schedule should result in rapid drying with a minimum of degrade. In kilns with fast forced circulation 6/4 aspen lumber green from the saw has been dried to 6 to 8 percent of moisture by this schedule in 5 days. In kilns with slower circulation the drying time required will be proportionally longer.

*For complete information on air-seasoning and kiln-drying of aspen, see reference No. (10).

TABLE 3 -- DRY-KILN SCHEDULE FOR 4/4, 6/4, AND 8/4 LUMBER

Moisture content at which change should be made	Temperatures		Relative humidity	Equilibrium moisture content
	Dry bulb	Wet bulb		
Percent	°F.	°F.	Percent	Percent
Above 60	160	140	58	7.9
60	160	130	43	5.8
40	170	120	24	3.2
20 to 7	180	130	26	3.3
Conditioning treatment (2 to 4 hours)	180	170	80	11.4

If produced for market, hardwood dimension stock in smaller sizes is bundled to reduce handling charges and to protect the stock from damage in handling. Shipping bundles are either loose or rigid. In loose bundling the stock is tied with twine or soft wire. The chief purpose of such bundling is to group small pieces for more advantageous handling. Loose bundles, however, frequently become disarranged, because of the misplacement of pieces within the bundle. Rigid bundling involves tying of a number of compactly arranged pieces with wire or with metal band straps. Rigid bundles are generally tied with specially designed wire or tape-tying machines. Better grades of prefabricated stock must be carefully protected against any damage; such material is often wrapped in heavy paper and then strapped.

Unless immediately used, dry dimension material should be stored indoors to prevent an increase in moisture content. This can be best accomplished by bulk-piling, i.e., piling solid, without stickers. In this way the stock can be maintained at a proper moisture content for a long time, especially if the temperature is kept at 50° to 100° F. The temperature should be so adjusted that the corresponding relative humidity of the air will keep the wood at the desired moisture content. If humidity of the air is too low some form of humidification is desirable.

Dimension stock from green lumber and bolts. Handling of green dimension falls under two headings: (1) piling for air drying, and (2) piling for kiln drying.

To reduce handling, the smaller sizes to be seasoned are generally bundled. The bundles can be solid or stickered. In the solid bundles the pieces are in close contact with each other and are, therefore, well supported. On the other hand, poor circulation that results from this practice prolongs drying time and may lead to excessive staining.

The stickered bundles are formed by placing strips of wood 1/4 to 1/2 inch thick between each course of dimension stock. The material so separated dries more rapidly than a solid bundle, but considerable degrade may result because of warping.

In air-seasoning the bundles are then stacked outdoors or in the shed, each row of bundles separated by stickers of convenient sizes. Bundled material dries more slowly than loose dimension. The drying is nonuniform, and excessive molding and stain are common. Furthermore, as the stock dries and individual pieces shrink, some of the pieces in the bundles become displaced and are free to warp. With very small dimension, such as 1-inch squares, this cannot be avoided, since there is no other practical way of handling quantities of such stock in drying. With larger dimension the practice of bundling green material should be discouraged.

When handled as individual pieces, dimension stock can either be sticker-piled, cob-piled, lap-piled, or crib-piled. Sticker-piling refers to the method of piling where either regular or self-stickers are used, as in conventional lumber piling. Cob-piling is a form of piling where every layer consists of approximately the same number of pieces piled openly, i.e., with space left between the individual pieces, and where alternate layers are at right angles to each other. In lap-piling flat and relatively short stock is laid in a fairly straight, continuous pile of some definite width, so that the ends of each successive piece overlap the one below sufficiently for support; such piling requires only 2 tiers of stickers, one at each end of the pile. Crib-piling is a method of stacking dimension stock in which a center space is enclosed by 3 or more single tiers of stock, where the ends lap or cross each other, as in an old-fashioned rail fence.

To protect high-grade dimension stock from the effects of rain, snow, or direct sun, it is highly desirable to season it in a shed. The shed should have a good tight roof, and either open or louvered sides.

If dimension stock is to be kiln-dried, the method of piling is determined largely by the direction of air circulation in the kiln. The stock should be piled so that the air can pass through the load without encountering too many obstacles. Careful attention should be given to supporting the stock adequately to prevent warping. Only dimension and stickers of uniform thickness should be used in a pile. Drying of tightly bundled material in a kiln is generally unsatisfactory, because of slow and nonuniform drying that results from this practice.

No special drying schedules have been developed for kiln-drying aspen dimension. It is believed, however, that the schedule (Table 3) suggested for drying lumber can also be used with the dimension material.

SUITABILITY OF ASPEN FOR DIMENSION STOCK

The characteristics required of dimension stock material are dictated by the ultimate use of the stock, and are, therefore, quite variable. There are, however, certain considerations which are applicable to any wood used in the manufacture of dimension material. These may be grouped as economic factors, and machining characteristics and other physical properties of the wood that enter into successful manufacture of this wood into dimension stock.

Economic Factors

These involve consideration of cost of material, i.e., logs, bolts, or lumber, in relation to the yield of salable dimension material.

Cost of raw material. At the time of this study the prices paid for 100-inch aspen logs ranged from a low of 16 dollars a cord for woods-run logs, 6 inches and over in diameter, to a high of 32 dollars a cord for selected logs, 8 inches and over in diameter intended for special uses, such as match stock and cooperage. The lowest purchase price for air-seasoned, No. 4 Common and Better, 4/4 lumber was 28 dollars a thousand, while the average prevailing prices ranged from 35 to 42 dollars a thousand. Correspondingly higher prices were paid for selected and kiln-dried lumber.

Yield of dimension stock. Yield of usable dimension stock varies with the quality of lumber or plank, the quality of dimension desired, and the size of cuttings. A box and crate concern, utilizing No. 4 Common and Better lumber, reports waste totaling only 10 percent of lumber. In this plant the short ends and trimmings are saved and cut into packing blocks, down to $3\frac{1}{2}$ inches in length. More commonly residue in box and crating manufacture ranges from 20 to 30 percent of the lumber used.

There is also considerable variation in the amount of usable cuttings in the manufacture of core stock. While one plant uses only No. 1 Common and Better lumber, and reports 60 percent yield in usable cuttings from the higher grades of lumber, another manufacturer utilizes No. 4 Common and Better grades, and reports recovery in excess of 65 percent in usable material. A shoe manufacturer obtains an average yield of 2 pairs of wedgie heels from one board foot, surface measure of lumber. The yield of acceptable turning squares ranges from 300 to 400 board feet of squares per cord of 52-inch aspen.

The estimated yield of squares from No. 1 Common and Better lumber ranges from 45 to a maximum of 60 percent of squares suitable for turning. If lower grades of lumber are also included, a yield of 40 percent or less is obtained.

Machining Characteristics and Related Physical Properties of Aspen (4, 6)

Machining, as applied to production of dimension material, refers principally to sawing, planing and resawing of the wood. Since, however, certain classes of dimension stock, such as core stock or furniture parts, undergo further remanufacture, machining of dimension may also include jointing, shaping, mortising, turning, and sanding. Other physical properties of a wood that have direct bearing on its suitability for manufacture and use as dimension stock are gluing and finishing characteristics, its ability to hold fasteners, and its general stability as determined by the amount of

shrinkage and tendency to warp. The relative hardness of the wood may also be very important in such uses as furniture parts.

Weight and hardness. Aspen is one of the lighter and softer of the native hardwoods. When thoroughly air-seasoned its weight is about 27 pounds per cubic foot, or 1,800 pounds per thousand board feet of 4/4, surfaced lumber. The light weight of aspen is an asset for such uses as containers, core stock and turned articles, because of ease of handling and the reduction in cost of transportation.

Aspen is soft and uniform in texture. It meets the requirements for a combination of softness and uniformity of texture about as well as yellow poplar and basswood. This makes aspen suitable for such uses as drawing boards, matches, and certain turned items where softness is a desirable quality. On the other hand, the softness of aspen accounts for difficulties encountered in planing and sanding, and particularly in turning and shaping of this wood. The softness of aspen also restricts its use in furniture to parts not subjected to hard usage or in which good screw-holding power is not required.

Dimensional changes. Aspen shrinks and swells little in comparison with other light hardwoods. This means that many troubles associated with changes in dimension, due to changes in atmospheric conditions, are minimized in the case of aspen products. The small shrinkage of aspen recommends it highly for interior trim, doors, windows, staves, furniture stock, and similar uses, where stability of wood is of paramount importance.

No reliable information is available on the comparative warping tendencies of aspen. It is believed, however, that since it is a relatively straight-grained wood and its shrinkage is low, aspen may be classed among woods of moderate warping tendencies. Much of the reported trouble with warping of aspen encountered in service is undoubtedly due to the use of improperly seasoned stock.

Nailing and screw-holding characteristics. Aspen is classed among the best native hardwoods from the standpoint of freedom from splitting by nails and screws. It is, however, low in ability to hold such fasteners. In this respect aspen is about the same as basswood but is poorer than white pine or yellow poplar. A tendency of fasteners, such as small screws, to pull out of aspen core stock is a frequent complaint. Whenever possible larger screws and nails should be used to obtain the required holding power. Because of the softness and uniformity of texture of aspen wood, this can be done in most cases without danger of splitting.

Finishing. The experience of industrial users indicates that aspen takes stain readily. When used in combination with other woods aspen, because of its relative open-porousness, tends to take up stain faster and deeper than closer-textured woods. Therefore, if the same overall technique of staining is employed, pieces made of aspen tend to stain darker. Occasionally the staining of aspen is spotty because the penetrability of aspen is not uniform.

The appearance of finish coats of enamel and paint, and particularly of varnish, lacquer or wax, is affected to a large degree by the smoothness of the underlying surface. In other words, the smoothness and the appearance of the finished surface is dependent on how smoothly the wood surface was planed or sanded prior to the application of finishing materials. Whenever smooth aspen stock is obtained, this wood presents considerable possibilities for natural finish because of the prevalence of a creamy-colored, satiny, figure, reminiscent of true satin wood. In such products as interior paneling and trim, the darker and irregularly colored heartwood does not detract, but on the contrary enhances the overall pleasing appearance of this wood.

Relatively little information is available on the painting and enameling characteristics of aspen. It appears, however, that aspen may be classed among the hardwoods that take and retain such finishes well. The smoothness of the surface, particularly when enameled, depends on the care with which the surface has been prepared for the finish.

Machining of aspen. Aspen is classed among the hardwoods easy to machine, from the standpoint of low-power consumption and dulling effect on cutting tools. On the other hand, it is more difficult with usual production methods to obtain smooth surfaces on aspen than on harder woods. The surface thus obtained is entirely satisfactory for such rougher uses as containers. With some care, satisfactorily machined surfaces can also be obtained for more exacting uses such as core stock or certain classes of turnings. For precision work, however, such as furniture or better quality turnings, aspen is rated only as fair to poor. It has been suggested, however, that the unsatisfactory machining performance of aspen can also be attributed to the common practice of machining this wood with equipment built and set for working other woods. This suggests the desirability of further study of machining characteristics of aspen, with a view to developing special machines and production methods specifically designed for this wood.

(1) Planing. Planing is one of the most important operations in the production of core stock and other finished items. In planing properties aspen is considered poor and is classed with such woods as soft elm, sycamore, and cottonwood. The most common defects developed in planing aspen are fuzzy and chipped grain. These defects, however, can be substantially reduced by drying lumber to 12 percent or less of moisture before planing, and by use of sharp planing knives, placed at the correct angle (about 30°). Some fuzzy grain can also be eliminated by feeding the lumber, whenever practical, so that the cutterhead will revolve with the grain. It was also found that the extent of chipped grain in planing aspen depends on the number of knife cuts per inch; experimentally the best results were obtained with 13 to 22 cuts per inch.

(2) Shaping and turning. In shaping and turning characteristics aspen is considered to be among the poorest hardwoods. Limited experiments, conducted at the Forest Products Laboratory and at Michigan State

College, indicate that there is no satisfactory way of producing shaped or turned cuts of smoothness comparable to better shaping woods, for instance hard maple, birch, or beech. This information corresponds with the opinion prevailing in the industry. Again, it is quite possible that much better results could be obtained with equipment especially designed for aspen.

The inferior shaping and turning characteristics of aspen do not preclude its use for items not requiring very exact and complicated detail. Aspen is used commercially for a number of small variety-lathe items, as well as for special items turned on profile and special lathes. In the opinion of the producers better variety turnings can be obtained from stock dried to a moisture content of 12 percent or less than from greener material. This corresponds with the experimental data already mentioned. Turnings of acceptable smoothness, however, can also be obtained in a properly tooled profile lathe, from green wood.

(3) Sanding. Sanding of aspen is of particular importance because of the prevalence of fuzzy grain in planing, and because of the roughness of shaped and turned surfaces. Because of its softness aspen tends to show scratches and is classed as a difficult wood to sand. The use of coarser abrasives may accentuate fuzziness instead of removing it. Fuzziness in aspen may also develop as a result of sanding against the grain. When properly done, surfaces of satisfactory smoothness can be produced, but considerable attention to detail of sanding and longer time are required than in the case of harder and closer-textured woods.

USE OF ASPEN DIMENSION STOCK

Boxes, Crates and Crate-bases, and Core Stock

At the present time the major uses of aspen dimension stock are in the boxing and crating industry and for manufacture of core stock. These uses are discussed in detail in other aspen reports (8, 12). Very close utilization of aspen lumber is possible in either case.

Aspen is used for reinforcement of cardboard boxes in shipping heavy items and for supporting frames for innerspring mattresses. Considerable quantities of aspen dimension stock are also used for shipping crate-bases, for such items as refrigerators, stoves, and radios. The plywood or corrugated type of box fitted over the item is nailed to the base.

Pallets

There is considerable divergence of opinion among producers and consumers on the merits of aspen in pallet construction. The objections to the use of aspen in pallets arises from its relatively low strength properties and poor nail-holding capacity. In fact, however, except in stiffness, aspen is equal or superior to other lighter hardwoods and such softwoods as jack and white pine. Its low nail-, screw-, and bolt-holding power can be overcome to a large extent by increasing the size of such

fasteners. When properly constructed, aspen pallets should, therefore, be satisfactory for any but very heavy use. To produce the most efficient pallet, it must be designed specifically for the item it is to handle, as well as for the equipment which will be used in moving it.

In construction of pallets either green or air-seasoned lumber is used, depending on the requirements of the consumers. Some manufacturers use aspen only for pallet decking, with the stringers of a heavier hardwood, such as maple, beech, or elm; this is done to obtain a more securely nailed pallet. Other producers reverse the order and use aspen only for stringers, with decking constructed of a heavier hardwood; this results in a pallet with a stronger decking, while at the same time advantage is taken of easier nailing into aspen. Many instances of all-aspen pallets have also been found, especially for uses where strength requirements are not excessive.

Interior Finish

Although not made in large quantities, many examples of the use of aspen in attractive flooring, paneling, matched ceilings, wainscoting, and trim in dwellings and in business establishments may be found throughout the northern Lake States. At present these items appear to be made only on a custom basis, or experimentally.

No special problems in the manufacture of any of these products have been reported. In all instances lumber properly kiln-dried to about 8 to 10 percent is required for satisfactory service. High grade flooring is the most difficult item to produce in quantity because of the low yield of clear cuttings of sufficient length.

The other interior finish products can admit more defects, especially knots, and therefore, can be made of No. 3 Common and Better grades of aspen. The most serious objections to aspen in the manufacture of these products is the prevalence of collapse in the lower grades of lumber. It has been suggested that because of this the lower grades of lumber should be sawed extra heavy, to allow for planing out of the collapsed areas. Unless perfectly smooth paneling is desired, slight collapse does not appear to be very objectionable. In fact, by imparting a somewhat weather-beaten appearance to the paneling, it may appeal to the persons desiring a rustic effect.

No adequate service reports are available to indicate the wearing qualities of aspen flooring. Several instances are, however, on record of aspen flooring giving satisfactory service in such public places as offices, restaurants, and saloons. A very attractive natural finish can be obtained in paneling and trim, whenever proper attention has been given to surfacing of the stock.

It appears that the major problem with large scale production of well-made aspen interior finish is not that of manufacturing, but of

merchandising. The product should not be offered to the consumers under the greatly misused name of "popple." More attractive names such as aspen, Michigan, Wisconsin, or Minnesota aspen, silver aspen, etc., may create more interest in and respect for the product. A promotional program, pamphlets and advertising in trade and professional periodicals, as well as exhibits of finished items, designed to draw the consumers' attention to the decorative possibilities of aspen, should do much to bring about a wider acceptance of this wood for interior decoration.

Furniture

In addition to core stock, quantities of aspen are used for frames in upholstered furniture and for drawer bottoms, mirror, and cabinet backing and for similar other uses in concealed places, or where a low density wood of uniform texture is desirable.

Aspen is used in the smaller shops for juvenile furniture, what-nots, small bookcases, and unfinished furniture. In general the use of aspen is considered a poor risk whenever the article is to be subjected to hard usage. Other objections to the use of this wood in furniture are low recovery of high grade material, inability to obtain a smooth surface with the standard planing and sanding methods, and low nail- and screw-holding capacity.

Of these objections the most valid is the low recovery of high-grade material. A manufacturer using aspen lumber cannot expect to obtain paying quantities of acceptable clear cuttings from No. 2 and No. 3 Common grades of kiln-dried aspen lumber, because of the prevalence of collapse, shake, and numerous small knots. Since most aspen lumber is bought on a mill-run basis large quantities of low grade aspen, unsuited for conversion into furniture stock, will tend to accumulate at the plant. Such material is difficult to dispose of, except when converted into boxes and crates at the same plant.

Aside from core stock the custom manufacture of cut-up stock from aspen for the furniture trade and other more refined uses does not appear to be economically feasible at the present time. The main reasons for this are: (1) the generally unstable conditions in the hardwood small dimension trade; (2) severe competition from already established dimension plants, particularly those operating in the south; (3) competition from the better grade hardwoods, such as maple, birch, and red gum, which are available in large quantities and possess more desirable characteristics for furniture manufacture; (4) limited usefulness of aspen in better grades of furniture, because of the working and finishing properties of the wood; (5) small size and poor quality of aspen logs, with the resulting low yield of higher grades of lumber; (6) abundance of defects in Common grades that largely preclude the possibility of remanufacturing the lower grades of aspen into dimension; (7) inability of manufacturers to produce aspen dimension stock on schedule or in sufficient volume to satisfy customers' needs.

Turning Squares

As was previously indicated, aspen is classed among the poorer turning woods. Nevertheless, quantities of aspen squares are used in production of less exacting turnings. Among these are variety and special lathe turnings, not requiring a very smooth finish. Examples of such turnings are: parts for railroad flares, cores for oil filters, paper plugs, lower grade handles, and clothes pins.

Most of these articles are turned from stock dried to less than 15 percent of moisture. Generally no attempt is made to find out the exact moisture content most suitable for turning a given item. The stock is considered suitably dry whenever articles of sufficient smoothness are obtained. Some types of turnings are produced from green material. For instance, aspen fish net floats are turned green and then dried in revolving, steam-heated drums. To retain a perfectly round shape, paper plugs, ranging from $2\frac{1}{2}$ to 5 inches in diameter, should be turned twice, first green to a size sufficient to allow trueing up, and later, after drying to about 15 percent, to the final, required size.

In spite of poor shaping characteristics aspen is used in the manufacture of wedgie shoe heels and in shaped flat toys. Appreciable quantities of 4/4 to 8/4 better grade aspen lumber are used for wedgie shoe heels by a mid-western and by a southern manufacturer; the latter prefers aspen to southern hardwoods and pine because of its higher resistance to splitting. An average yield of 2 pairs of acceptable heels is reported from one board foot of lumber, surface measure.

Snow Fences and Corn Crib Slats

Aspen is used along with other woods, in the production of snow fence lath. A yield of 1,800 pieces per cord of 4-foot, woods-run aspen bolts is reported; of these two-thirds are of first grade. Some of the poorer material and shorter pieces unsuited for lath are converted into grading stakes. The bolts are sawed into planks, which are ripped into squares. The squares are put through a multiple circular resaw, capable of producing 4 laths at a time. The lath is rough-graded and wired into bundles of convenient size. The wiring of lath into fencing is done as a separate operation. The same lath is also used extensively for corn cribs.

Miscellaneous Uses of Aspen Small Dimension

Aspen has been successfully used for drawing boards, for which purpose its softness and uniformity of texture recommend it as highly as basswood. It can also be used, along with basswood, in the manufacture of candy trays and novelties, items which either allow a certain number of knots and non-rot discolorations or can utilize numerous short cuttings of clear material.

Aspen can be used in agricultural implements, for instance in combines, where woods with fair wearing characteristics are required. At present cottonwood is a favored wood, but since in wearing characteristics aspen is equal or superior to that wood, it should be fully acceptable if a supply of well manufactured lumber of good quality could be assured. Other potential outlets of a similar nature are in the manufacture of laundry appliances, for instance clothes driers and curtain stretchers, and luggage and instrument cases, in place of basswood.

The use of aspen in Venetian blinds and rolls has not proven successful. The objections to this wood in these instances are in the cost of obtaining clear cuttings of sufficient lengths, and the difficulties experienced in obtaining smooth surfaces suitable for enamel finish. In Venetian blinds small knots, common in aspen, are particularly objectionable, because they show readily in the finished product.

During the war some aspen was sold to a piano manufacturer for piano keys, to replace basswood. No objections were voiced to the working qualities of aspen for this purpose. The manufacturer, however, went back to basswood as soon as that wood became available again in sufficient quantities, because of the more dependable supply and greater familiarity with the working characteristics of this species.

No instance of the use of aspen for apiary supplies has been found. Again, the objections to aspen seem to be not the working characteristics of the wood, but the problems connected with procuring aspen lumber of high enough grade to make the operations as profitable as those based on basswood.

MISCELLANEOUS INDUSTRIAL USES OF ASPEN

Grain and Coal Doors

A good outlet for the lower common grades of aspen lumber is in the manufacture of grain and coal doors. These doors are 6 to 7 feet long and are made of a single thickness of lumber for coal and of double thickness for grain doors. Better workmanship and "grain-tight" lumber are required for grain doors. No. 3 and No. 4 Common grades can be used.

Cooperage

Satisfactory tight cooperage for small barrels for pickles, fish, and similar products can be made of aspen. For this purpose only the better grade of logs should be selected, to guarantee a reasonable yield of usable staves. The staves are said to be of good quality, though some fuzzing has been experienced in sawing logs of high moisture content. An important objection to the use of aspen staves is their relatively narrow width, requiring a larger number of staves per container than is the case of staves made of other woods. The problem of procuring aspen logs of uniformly good quality constitutes probably the greatest simple deterrent to the wider acceptance of aspen for this purpose.

Blocking Wedges

Aspen is used for blocking wedges for rail and truck shipping of heavy items. These wedges are made from 4/4 to 8/4 material and are nailed together either in a V or A-shape.

"Iron Sponge"

Another use for low grade aspen in the form of bolts is in the manufacture of "iron sponge," thin wood strands coated with iron oxide and used for the purification of gas. Bolts down to 3 inches in diameter can be used; 4- and 5-inch bolts are preferred.

In this operation the bolts, with the bark on, are chipped in a specially designed chipper across the grain. The resulting strands of wood are about 1 inch wide and 1/16 inch thick. Quality of the wood is not very important and therefore there is a real opportunity for utilization of the poorer grades of aspen bolts, unsuited for more exacting purposes.

SUMMARY

Utilization of aspen for dimension stock is restricted by the working and finishing characteristics of the wood, small size of logs and the low yield of high grade cuttings from the unsorted aspen lumber.

Under the prevailing economic conditions, utilization of aspen for dimension stock is confined largely to its use in containers, core stock, certain rough industrial items, and, to a limited extent, to turning stock.

Aspen is in a poor competitive position with the better hardwoods, in so far as furniture and other more refined uses are concerned; this is due to its less desirable working and finishing characteristics, prevalence of kiln-drying defects and low yield of high grade material. Inability of producers to supply large volumes of high grade material on a study consignment basis is also believed to be an important factor warring against wider acceptance of aspen by wood-using industries.

More extensive utilization of aspen appears feasible in interior finish and for such industrial uses as agricultural implements, drawing boards, luggage, laundry supplies, and other similar uses, particularly where basswood and cottonwood are recognized as standard woods. To achieve wider acceptance of aspen by the manufacturers and consumers it is necessary to give more attention to a dependable supply of well manufactured and graded aspen lumber. A sensible promotional campaign, stressing the desirable characteristics of aspen for interior finish, may be necessary to arouse consumer interest in the possibilities of this wood.

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