FINAL REPORT

Solid Wood Product Opportunities from Short Rotation Hybrid Poplar Trees

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Michael Carlson
Vicky Berger
Ministry of Forests
Kalamalka Forestry Centre
Vernon, B.C.

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Project Leader's Name: **Michael Carlson** Organization: **Ministry of Forests**

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Abstract

Fast growing hybrid poplar trees are being plantation grown in the Pacific northwest of the United States and British Columbia for the production of chips for pulp. If allowed to grow somewhat longer (to a rotation age of 9-10 years) and achieve saw log size, the basal log(s) might be used to produce lumber for solid wood products with the remaining stem volume chipped. Solid wood product manufacture would likely result in value added to the raw material.

This study estimated lumber recovery rates from hybrid poplar logs, determined certain important manufacturing characteristics of this lumber (machinability, fastening, laminating, finishing and strength) and examined some of the possible products that could be made from this wood.

Recovery of usable dry lumber from hybrid poplar logs varied from 42% of log volume for small 7"-9" diameter logs to 54% for large 11" plus diameter logs. Recovery rates would presumably be higher yet for larger log sizes. The wood was comparable to other low to moderate density woods for machinability, fastening, laminating and finishing characteristics and would be well suited for products not requiring high strength, surface hardness or exterior applications. Items successfully produced included: a desk, bookcases, tongue and groove paneling, trim moldings and thin walled decorative boxes for high value foods, wine, and clothing.

This work was conducted in Vernon by British Columbia Ministry of Forests, Research Branch staff.

Introduction

The somewhat "serendipitous" discovery of the exceptional genetic combining ability of western black cottonwood (*Populus trichocarpa*) and eastern cottonwood (*Populus deltoides*) in the early 1970s by a University of Washington forest geneticist has led to a "New Beginning in Forestry" in the U.S. Pacific northwest (Drs. Paul Heilman and Reinhard Stettler, pers. comms.) . In the next two decades more than 100 crosses were made between selected parents of these two widely separated species and a small number of exceptionally fast growing offspring selected and tested for production across a range of environments from Oregon to British Columbia These hybrid clones produce wood (cellulose and lignin) faster than any other woody plant at 49° to 50° north latitude anywhere in the world. The project leader has grown these hybrids in Vernon under municipal wastewater irrigation for the past eleven years with rates of volume productivity averaging 30 cubic meters per hectare per year.

Short rotation intensively grown hybrid poplar trees occupy 30,000 hectares in Washington and Oregon states. The British Columbia Ministry of Forests has experimented with these same hybrids in a variety of B.C. environments starting in 1984 and today one B.C. forest products company, Scott Paper, has made a very substantial commitment to growing their own future fiber supplies on both public and private lands in south western B.C. Other B.C. forest companies are also evaluating the feasibility of growing their own wood to augment supplies from crown lands. To date wood from these fast growing trees, both in the U.S. and B.C., has been used exclusively for pulp chips for the manufacturing of tissue and paper products.

When grown at slightly more open spacings than currently used to grow pulping fiber, these hybrids, on good quality sites, will produce trees with 30 cm dbh and more than 20 meters height in 8-10 years. Internodal stem sections of 2.5-3.5 meters are common after age 2 years. These stem sections typically have only small epicormic branches (those produced along the stem during the season of stem elongation) and thus produce a high grade of nearly clear wood/lumber. The first two or three stem sections less nodal pieces (large limbed nodes) from such trees could produce lumber with the remainder of the tree stem debarked and chipped for pulp as is the current practice. If enough lumber of sufficient quality can be taken from basal logs with the rest chipped and the lumber so derived used to produce solid wood end products (paneling, furniture, moldings, etc.), it seems reasonable to assume that more value (economic return) will accrue to both the tree grower and to manufacturers of solid wood products. Some interest in producing solid wood products is developing among certain U.S. forest companies and the project leader has had several inquiries from B.C. forest companies in the past 12 months. To date, the project leader is not aware of anyone doing work of the type reported here.

Simply put, the concept is to develop a higher end product value for some of the wood grown in short rotation hybrid poplar plantations. Many feasibility questions need answers:

a. how much, what quality, and at what costs can lumber be derived from such trees?
b. what are the physical characteristics of this wood that will determine its utility for manufacturing various end products?
c. what are the manufacturing characteristics of this wood, behavior during machining, fastening, laminating and finishing?
d. what handling and manufacturing problems does this lumber present over and above those experienced with other woods?
e. what products can be produced from this wood and how competitive might they be with similar products made from conventional wood sources?

Specific objectives of this project were:

a. To determine the lumber recovery factor from logs of three sizes (1^{st}, 2^{nd}, and 3^{rd} logs of hybrid poplar trees)
b. To quantify, using standard lumber testing protocols the following characteristics of this wood:
    - machinability including planing, boring, sanding, shaping, mortising and turning
    - lamination (adhesives)
    - fastening (nail and screw withdrawal)
    - finishing (paint and primer, stain/lacquer, wax)
c. To determine products that can be produced from kiln dried lumber by local wood craftsmen and manufacturers (millwork, furniture, etc.)
d. To determine the best kiln drying regime(s)

This project involved six phases or activities:

a. harvesting and delivery of logs
b. log scaling and primary breakdown to cants and lumber and scaling of these

c. air drying of lumber
d. resawing, planing and scaling of finished lumber and estimation of losses during processing
e. properties testing including machining and fastening, laminating and finishing
f. product manufacturing

Methods

Methods used in accomplishing the six project phases included:

Harvesting - A nine year old 10 hectare irrigated research plantation of hybrid poplar was growing on Vernon municipal lands south of Vernon. Trees in the area that were harvested averaged 25 cm in breast height diameter and 20 m in total height. Approximately 150 trees were felled and 1st, 2nd, and 3rd stem sections (logs) cut from down stems. Stem sections (logs) were trimmed to 2.75 m in length and small ends color coded with paint according to log origin within the tree (1st, 2nd or 3rd). Logs were delivered to Rouck Bros. Sawmill near Lumby.

Log Scaling and Breakdown - Logs of each of the three size ranges were scaled. All logs were sawn so as to maximize initial recovery of 2", 1" and 1/2" raw lumber. All resulting lumber was scaled by log-size origin.

Air Drying and Kiln Drying - Samples of this raw lumber (cants and boards) were, before drying, sent to Forintek Canada in Vancouver for both kiln drying and various wood properties testing. The majority of the lumber produced was air dried to approximately 15% moisture content and then sent to a kiln near Vernon for drying to approximately 8% before further manufacturing activities.

Resaw and Planing - Some of the lumber, after air drying only was planed and used to produce tongue and groove wall paneling, window and wall moldings and picture framing material. The remaining lumber, after both air and kiln drying was variously resawn and/or smooth planed prior to manufacture of furniture and decorative boxes.

Wood Properties Testing - Approximately 1000 board feet of rough lumber was delivered to Forintek Canada of Vancouver for the following evaluations:

a. Machining and fastener holding tests using the American Society of Testing and Materials Test (ASTM) D1666 and D1761 test procedures respectively. Six machining tests (planing, sanding, boring, shaping, mortising and turning) were performed plus screw and nail withdrawal testing.
b. Lamination tests used a combination of CSA 0122-1977 and ASTM D1101 and D905 test procedures to determine shear and delamination values. Five adhesive types and two glue presses were used.
c. Finishing tests included paint (ASTM D661 and ASTM D3359), stain and lacquer combinations (18 in total) and a wax finish. The latter tests were subjectively evaluated.

Product Manufacturing - After either or both air and kiln drying, resawing and planing 200-500 board foot samples of various dimensions were delivered to each:

a. Rouck Bros. Sawmill of Lumby (Earl Rouck)
b. Coldstream Custom Kitchen Design of Coldstream (Art Ferris)
c. WoodPac Industries of Vernon (Bill Birdsell)

These local wood product manufacturers used the finished lumber to make respectively:

a. tongue and groove wall paneling, door and window trim and picture frame material
b. light furniture - computer desks, bookcases, etc.
c. decorative boxes

Results

Log Scaling and Breakdown - Logs delivered to the sawmill were of 3 diameter classes:

- 7" - 9" (blue)
- 9" - 11" (white)
- over 11" (red)

An "assorted size class" load of a different hybrid type was also delivered (7" - 11"+, green) for sawing.

Logs of these size classes were scaled according to local rules and sawn so as to recover maximum amounts of usable 1/2", 1" and 2" lumber. Scaled log volumes and lumber volumes

cut of varying widths and thicknesses from these log size classes are shown in Table (1).

In the last column of Table (1) are lumber volumes (FBM = board feet. One board foot = 1" x 12" x 12") recovered per cubic meter of log volume. Large diameter logs (over 11") yielded about 28% more lumber per cubic meter log volume than small diameter logs (7" - 9") and about 12% more lumber per cubic meter than the mid size class (9" - 11"). Large diameter logs yielded about one-third (34%) their volume as 2" lumber and two thirds (66%) as 1" lumber. The same fractions for small diameter logs were one fifth (21%) and four fifths (79%). The mid size log class fractions of 2" and 1" lumber recovered were similar to those of the large size class (41%, 59%). The two larger log size classes yielded considerably greater fractions of 6" and 8" board widths in both 2" and 1" lumber thicknesses than did the smaller log sizes.

Thus, both a greater lumber recovery per cubic meter of log volume sawn and proportionately more lumber of the higher value 2" thickness (6" and 8" widths) was produced from 9" plus log sizes when compared with smaller logs. All lumber produced was graded acceptable or not according to percentage visible defect. Defects noted included loose knots, excessive warp in any direction, rot, and serious checking. Approximately 90% of the lumber cut was classed as acceptable for further drying, planing and potential use (ie. about 10% of lumber volume was lost at this stage). All large diameter logs (11"+) and some of the next size class (9"-11") were basal logs of harvested trees and as such had been branch pruned before the start of the sixth growing season, see photo (3) appendix 2. In theory, all wood laid down subsequent to pruning is clear wood, in practice about three years are required to completely cover branch scars and start the production of clear wood. In the sawmill breakdown of these logs what little clear wood may have existed four years after pruning was lost as slabs and edgings.

Air Drying and Kiln Drying - The majority of the lumber cut was stickered, weighted and air dried in a ventilated shed at the Rouck Bros. sawmill over a two month period, mid August until mid October 1997. Moisture content achieved was about 15%. Some end checking was observed particularly in the 1" boards. Checking extended into board ends about 3-4 cm on average resulting in some volume loss. A portion of the boards, particularly those cut from log centers exhibited crook, bowing, twisting and cupping to such degrees that they were discarded resulting in further volume losses (about 5% loss). After air drying and before manufacturing was attempted, lumber was kiln dried at a local planer mill using the standard protocol for cedar dimension lumber of 1" and 2" thicknesses. Little or no additional volume losses from warping, cupping or checking was noted after kiln drying but some shrinkage may have occurred. Final moisture content was about 8 - 9%.

The green(wet) lumber sent to Forintek Canada for properties evaluation was kiln dried using a forced air and steam spray method - see section 8, pages 29-37 of Appendix (1). This method is characterized as "long and gentle" by wood industry standards with the objective of a final moisture content of 9% and as little drying defect loss as possible - see page VI -1 for drying schedule.

Warping results (crook, bow, twist, cup) indicated no differences between boards cut from the three log sizes, Table 15, page 31. Hybrid poplar exhibited a lower ratio of tangential to radial shrinkage than either of it's parent species (black cottonwood, eastern cottonwood) which is a preferred characteristic where glued products are to be manufactured. Overall, hybrid poplar warp characteristics were considered moderate in comparison to those measured in other tree species.

Resaw and Planing - It was anticipated that the hybrid poplar lumber would require planing to both ready it for product manufacture and to remove warping defects (cupping and bowing). Much of the air dried 1" lumber was planed to 5/8" and made into 3" and 6" tongue and groove paneling and various moldings. The kiln dried 1/2" boards were sanded to 5/16" and 1/4" thicknesses for decorative box manufacture. Much of the 1/2" material was cut from outer log edges which resulted in mostly clear lumber. Two inch thick kiln dried boards were planed to 1 3/8" and used in furniture manufacture.

A planing study conducted by Forintek is found in section 4, pages 4 and 5 of Appendix (1). Results indicate that the wood planes well but a high percentage of pieces have a fuzzy grain surface that must be lightly sanded before manufacture.

Wood Properties Testing - Forintek Canada testing protocols included:

a. Machining (Section 4, Appendix (I))

    - planing
    - sanding
    - shaping
    - boring
b. Fastening (Section 5)
    - screw withdrawal
    - nail withdrawal
c. Laminating (Section 6)
    - shear test
    - delamination test
d. Finishing (Section 7)
    - paint tests
    - furniture finish tests
    - wax finish test
e. Drying Evaluation (Section 8)
f. Strength Tests (Section 9)

Only brief summaries of Forintek's findings will be given here. Readers should refer to the appropriate sections of Appendix (I) for details.

Machining:
Planing and Sanding - As described previously, planed hybrid poplar wood has a fuzzy grain requiring sanding. This was not viewed as a serious matter in that all woods made into most products eventually require sanding before a finish coating (sealer, stain, oil, lacquer) is applied. Hybrid poplar wood was easy to sand and compared well in defect-free percentage with other woods tested including lodgepole pine, white spruce, black cottonwood, red alder and trembling aspen.

Shaping - Shaping is the profiling of curved pieces of wood. Hybrid poplar rated as good or better than comparison wood types for percentage of good to excellent shaping samples. A significant percentage of hybrid poplar samples (72%) were degraded to good from excellent however due to either appearance of rough end grain on curved wood surfaces or fuzzy grain.

Boring - Hybrid poplar was rated the best of all woods tested with the Brad point bit (most commonly used bit in most wood manufacturing) and the poorest with the single twist bit.

Machining Properties Summary - Hybrid poplar compared very well to the other five woods for all four machining properties tested - see table (5) Section 4. Page 12. Hybrid poplar wood performance equaled or exceeded the other woods for sanding, Brad point boring and shaping. Only in planing was it considered less desirable than four of the five comparison woods.

Fastener Withdrawal:
Hybrid poplar wood had the fourth highest rating (among six woods) for screw withdrawal force and the lowest rating for nail withdrawal force. Withdrawal force required is inversely proportional to wood specific gravity, less dense woods (hybrid poplar, cottonwood) don't hold screws and nails as tightly as more dense woods (aspen and red alder).

Laminating:
Shear - Shear tests determined the strength of glued joints with hybrid poplar and five other woods. Hybrid poplar wood rated poorly with low viscosity adhesives and very well with adhesives of high viscosity. The shearing force required to break glue joints with hybrid poplar wood was only about 15% less than that required to shear solid hybrid poplar wood. This coupled with the fact that hybrid poplar wood had the second highest compressive shear strength of the six woods tested resulted in the conclusion that hybrid poplar wood glue joint strength is excellent (with high viscosity glues).

Delamination - This test determines the resistance to delamination of wood laminations used in exterior applications. Generally, hybrid poplar wood gave high delamination rates (failures). The cause was thought to be the large percentage of high porosity juvenile wood which absorbs the adhesive unless a high viscosity glue is used. Higher glue spread levels and higher viscosity glues would likely solve this problem.

Finishing:
Nine paint type finishes (4 interior, 5 exterior), thirty three furniture stain/sealer/topcoat combinations and four wax coatings were tested. A variety of criteria were used to evaluate these three types of finishes.

Paint - Hybrid poplar wood was considered to be a suitable substrate for most common painting systems. This wood will most likely be used for interior applications and it tested well with interior paint finishes.

Furniture Finish - Generally, hybrid poplar wood stains well but the results and the consultants comments are varied and many - see Section 7.2.3. for specifics.

Wax Finish - As with stains and sealers, hybrid poplar wood performed well with wax coatings - see Section 7.3.3.

Drying Evaluation:
Shrinkage - As mentioned previously kiln drying was done with a forced air and steam spray method over about a one month period - a method thought to likely provide the least warp and shrinkage losses with the low density hybrid poplar wood.
Thickness and width shrinkage averaged about 3%, volume shrinkage about 6% for boards from the two large log sizes. Shrinkage figures for boards from the small diameter logs were less. Hybrid poplar has a lower ratio of tangential to radial shrinkage than native cottonwoods and this is a desirable characteristic for wood used in glued product manufacture.

Warp - Warp defect can be corrected by resawing and/or planing but at extra expense. Of the four warp types (crook, bow, twist, cup) high crook frequencies in the medium to heavy categories was the most troublesome feature while twisting defect was the least. Overall, warping defect with hybrid poplar was considered ‘moderate’ - see Table 15, Section 8.3.2.

Strength - Static bending strength tests were done to determine the modulus of elasticity (MOE) and the modulus of rupture (MOR). Neither MOE or MOR differed significantly among wood

samples from the three log sizes. Both MOE and MOR were greater for the "Red/White/Blue" wood samples in comparison to the "Green" wood samples - see Table 16, Section 9.3. page 33. The R/W/B logs were from hybrids of the *P.trichocarpa* x *P.deltoides* type while the Green logs were from *P.deltoides* x *P.nigra* and *P. nigra* x *P.maximowizii* hybrids. Specific gravity of the R/W/B samples were also higher than for the Green samples. As a group the "TD" hybrids are the more productive and are used extensively throughout the Pacific Northwest while the "DN" and "NM" hybrids are used mostly in eastern North America.
In comparison to five other species hybrid poplar wood had the lowest MOE, the third lowest MOR, and third lowest specific gravity - see Table 17, Section 9.3, page 33.

Conclusions taken from Forintek report, page 34 of Appendix I:

Hybrid poplar machined moderately well when compared to a selected group of other wood species; its performance in the all important planing test was below average as it encountered light fuzzy grain however, this defect was easily removed by sanding. If not for this defect hybrid poplar would have performed as well as the other species it was compared to. It is interesting to note that hybrid poplar far exceeded the performance of black cottonwood in all the machining tests.

With respect to its strength properties hybrid poplar when compared to the other wood species, produced results that were about average in the screw withdrawal and MOR tests but had the lowest specific gravity along with exceedingly large growth rings. It is fair to say that hybrid poplar probably does not have a future in structural applications when these results are considered.

Hybrid poplar can be glued using commonly available adhesives found in the wood processing industry though adhesives with low viscosity (thin glues) should be avoided. Delamination results were inconsistent, hence indications are that hybrid poplar should only be used in applications where wetting is not likely to occur.

Finally, hybrid poplar performed very well with regard to finishing. It takes paint, stain/lacquer and wax coatings well and had a pleasing appearance. Considering how much of the lumber supplied included wood from near log centers which typically has greater defect percentages and does not finish as well as wood further from the center the results indicate that properly selected lumber would make attractive furnishings that present no problems in finishing.

Product Manufacturing - Three types of products were manufactured with hybrid poplar lumber; paneling and moldings, furniture including a desk, a table and bookcases, decorative boxes for retail sales of salmon, candy, clothing, wine, etc. These various items and their manufacture are shown in photos 12 through 19.

In general, carpenters working with the paneling, a custom furniture maker and a box maker all found the wood easy to work with (cutting, shaping, fastening and finishing). However, a few concerns included:

a. paneling had to be carefully dried in the final location (room) and attached to the walls while dry to avoid problems with warping (crooks in particular).
b. furniture wood was also further dried (to about 5-6% moisture) before cutting and assembly. Furniture had to be kept very dry until finished as well to avoid moisture absorption and possible warping.
c. resawing for box manufacture resulted in further volume loss due to saw kerf (unavoidable) and warping defect (maybe 10% volume loss). Warping (cup) of certain box surfaces (unfinished) was also a problem.

Wood Volume Losses - From the time of log sawing through product manufacture hybrid poplar wood volume is lost from use at several steps. Estimates of these losses are as follows:

	% lost
1) log volume to green lumber volume - (35.85 FT^3 / M^3, 12 FBM/Ft^3, 430.2 FBM/M^3, 203/430.2=47.2% recovery)	52.8%
2) green lumber culling	10%
3) post drying defect culling	5%
4) shrinkage loss	6%

So, the fraction of green log volume (across diameter classes) recovered as useable dry lumber is approximately:

$$47.2\%-0.10(47.2)\%-0.05(42.5)\%-0.06(40..4)\%=37.9\%$$

The first and largest loss (green log to green lumber) are primarily losses due to slab and edging wastes and saw kerf - losses common to log processing regardless of species. As pointed out larger logs have less proportionate waste at this step (45.6% versus 52.8% average across log sizes). Logs of 14" - 15" diameter would likely have less than 30% waste at this step. Some additional losses at this step might be expected with hybrid poplar logs due to breakage during log handling (heavy, relatively weak logs) in preparation for sawing. The latter, smaller losses may or may not be more with hybrid poplar than with other woods.

Extension

Extension activities to-date include:

1. Hybrid poplar paneling was used in one room of the Vernon Tourist Information and Chamber of Commerce Building. An interpretive sign is also being designed to be displayed on a wall in this room. Tourist information staff have been briefed on the significance of this paneling material.
2. Furniture has been taken and displayed at two "Value Added" wood forums in the interior (Lumby, Nelson, summer and fall 1998).

3. Furniture, paneling and boxes are on display for the public at Vernon City Hall and the Kalamalka Forestry Centre, Vernon. Public tours (school groups, tourists, etc.) at Kalamalka Forestry Centre are shown these products etc.
4. The final report is being distributed to interested industry trade persons coast and interior.

Future extension activities planned include:

1. Report dispersal to interested growers, silviculturists, and manufacturers in cooperation with the B.C. Ministry of Agriculture, Fisheries and Food.
2. Presentation to Vernon city council on opportunities for growing hybrid poplars on city owned lands using municipal reclaimed wastewater for the purpose of creating local manufacturing and value added product opportunities.

Discussion

Objectives of this project were:

a. to determine lumber recovery rates from logs of three diameter size classes
b. to quantify, using standard lumber testing protocols various lumber physical characteristics including; machinibility, fastening, laminating, and finishing
c. to determine the best kiln drying regimes to use for preparing hybrid poplar lumber for manufacture
d. to determine products that could be produced from hybrid poplar lumber

A brief discussion of findings for each objective follows:

Lumber recovery rates of 40% to 50% of green log volume were achieved for a range of log sizes from trees nine years of age. Hybrid poplar trees grown to rotation ages of 10-14 yrs could be expected to produce basal logs of approximately 12"-15" diameter. Logs of this size will likely result in lumber recovery rates of 60%-70%. Most of the losses encountered between log and lumber occur during log breakdown and larger logs have proportionately less slab and edging volumes discarded. Losses from defects associated with knots (loose and tight) will be somewhat less with larger diameter logs assuming the larger diameters were achieved through lengthening of rotation rather than wider initial spacing. At sawlog spacings (3-3.5m between trees) branches will begin dying and falling off at tree ages of 6-7 years. At additional growing cost trees could be pruned once or twice to produce basal logs with some clear wood by rotation age/size. Clear wood may command a higher price for certain products but will also result in higher growing costs.

Forintek’s machinibility testing began with planing and sanding protocols. Hybrid poplar was considered to perform below average in planing compared to selected other woods tested (such as spruce, pine, and aspen) because of lifting of the grain and a resulting fuzzy surface. This fuzziness could be easily removed however with a sanding, a normal step in most product manufacturing. Next, tests involving shaping and boring were performed. Shaping is an important step in the manufacture of moldings and trim materials. The wood was judged excellent for shaping along the grain but exhibited some slight defect when cross-grain cutting was done. Some fuzzy grain again occurred after shaping. Overall, hybrid poplar compared very favorably with other woods for percentage of good to excellent samples after shaping. Hybrid poplar performed well in boring tests when the more popular "brad point" bit was used exhibiting 80% defect-free samples.

Overall, hybrid poplar was comparable to or better than other species tested in all machinibility aspects except planing where it’s performance exceeded only that of black cottonwood. Hybrid poplar was, in fact superior to black cottonwood for all aspects of machinibility.

Next came fastening tests involving screw and nail withdrawal specifically. Hybrid poplar had the lowest force required for nail withdrawal but exceeded white spruce and black cottonwood for screw withdrawal force. Since most of the potential applications for hybrid poplar lumber will not have high strength requirements (shear, compression or tension) fastener holding is of only moderate importance in evaluating the wood’s utility.

Important characteristics of wood to be used in furniture manufacture are glue bonding strength (shear strength) and the propensity for glued joints to delaminate when subjected to alternating wetting and drying. Hybrid poplar rated excellent in shear strength tests with the forces required to break glue bonds only slightly less than that required to shear the wood itself. Among species tested (6) only red alder required more force to break glue bonds. The delamination tests showed hybrid poplar to require higher than average applications of adhesives in order to achieve acceptable delamination failure rates. Forintek concluded that outdoor applications with hybrid poplar should be discouraged unless thorough surface and joint finishing could be accomplished.

Finishing tests including use of paints, stains, sealers and waxes indicated that hybrid poplar wood has a very accommodating surface for nearly all standard finishing products. The wood was judged a suitable substrate for most common painting systems for interior applications.

Drying tests determined percentage shrinkages in board thickness, width, and volume and evaluated four categories of warp; crook, bow, twist, and cupping. Drying was performed using a long gentle drying cycle of forced air with a steam spray. Thickness and width shrinkage percentages averaged about 2.5% across log diameter classes although there appeared to be differences between size classes with the larger diameter logs having somewhat higher shrinkage values. Volume shrinkage was 5%-6% on average. Crook was the most common warp defect followed in decreasing order of percentage sample defect by cupping, bowing, and twisting. Most warp defects can be eliminated with further cutting operations such as cross and rip sawing and/or planing but at extra production cost. A new low temperature dehumidification drying system is now available and would likely reduce the frequency of warping defects observed with the more conventional drying protocols used here.

Static bending strength tests were used to determine modulus of elasticity (MOE) and modulus of rupture(MOR). Poplar wood had the least MOE of woods tested (aspen, cottonwood, pine, spruce, and subalpine fir) meaning that it was the most flexible through it’s range of bending . MOR values exceeded those for cottonwood and subalpine fir only. There appeared to be some variation among samples from the 3 log diameter classes with the larger log samples having the least MOR and the lowest specific gravity value.

Products successfully manufactured from dried hybrid poplar lumber included furniture (desk, bookcases, tables), tongue and groove wall paneling, floor and door and decorative moldings, picture frame stock and a series of decorative boxes. Craftsman making these items and a finish carpenter installing the wall paneling agreed that the wood was easy to work with and finished well. All wood had been dried to about 8% moisture content prior to final manufacturing and as such no checking, warping or cracking occurred. The wood is relatively soft and dents easily. It must be used in applications where rough handling does not occur. The suggestion was made that this wood could easily substitute for interior pine or spruce where surface hardness or durability were not issues. most of the wood created and used in this study had at least small tight knots. Furniture pieces and paneling made were deemed quite attractive. Knot-free wood may be preferred by some for furniture and could easily be grown with pruning treatments applied early in a stand’s development.

Conclusions

Hybrid poplar trees that are today grown for chipping, pulping and paper products manufacture could be used to provide both pulping fiber and solid wood for making a variety of products ranging from furniture to wall paneling to decorative boxes. /P>

Lumber recovery rates of 40-50% of green log volume from nine year old trees in this study seem low but could likely be increased to 60-70% with additional growing space for individual trees and/or longer rotation times than are now in practice for producing short rotation pulpwood logs. Larger diameter logs from older trees would also allow for production of more clear knot-free lumber resulting from early pruning.

Hybrid poplar machined moderately well when compared to a selected group of other wood species; its performance in the all important planing test was below average as it encountered light fuzzy grain, however, this defect was easily removed by sanding. If not for this defect hybrid poplar would have performed as well as the other species it was compared to. It is interesting to note that hybrid poplar far exceeded the performance of black cottonwood in all machining tests. (Forintek report, Appendix I, pg. 34.)

With respect to it’s strength properties hybrid poplar when compared to the other wood species, produced results that were about average in the screw withdrawal and MOR tests but had the lowest results in the nail withdrawal and MOE tests. This can be attributed to the fact that hybrid poplar had the lowest specific gravity along with exceedingly large growth rings. It is fair to say that hybrid poplar probably does not have a future in structural applications when these results are considered. (Forintek report, Appendix I, pg. 34.)

Hybrid poplar can be glued using commonly available adhesives found in the wood processing industry though adhesives with low viscosity (thin glues) should be avoided. Delamination results were inconsistent hence indications are that hybrid poplar should only be used in applications where wetting is not likely to occur. (Forintek report, Appendix I, pg. 34.)

Finally, hybrid poplar performed very well with regard to finishing. It takes paint, stain/lacquer and wax coatings well and had a pleasing appearance. Considering how much of the lumber supplied included heart center the results indicate that properly selected lumber would make attractive furnishings that present no problems in finishing. (Forintek report, Appendix I, pg. 34.)

Several solid wood products can be made from hybrid poplar wood taken from rapidly grown trees. These include furniture, wall paneling, moldings, trim, picture frame material, decorative box stocks, etc. Limitations of this wood include; relatively low surface hardness, low bending and shearing strengths, and poor dimensional stability when subjected to wetting and drying. Advantages of this wood include; ease of working (sawing, planing, shaping, sanding, finishing), light weight and a bright, white, pleasing appearance.

During the course of this study the author distributed many samples of hybrid poplar wood to a variety of craftsmen. The near unanimous opinion of these persons is that hybrid poplar wood can be used successfully for manufacturing a variety of products and that it’s future will depend upon costs of production, availability of supply and market acceptance.

This study and report have served the purpose of creating awareness among growers and craftsmen in British Columbia of the potential for utilization of solid wood sawn from fast grown hybrid poplar trees heretofore grown only for pulping fiber.