Technology Profile

Value to Wood

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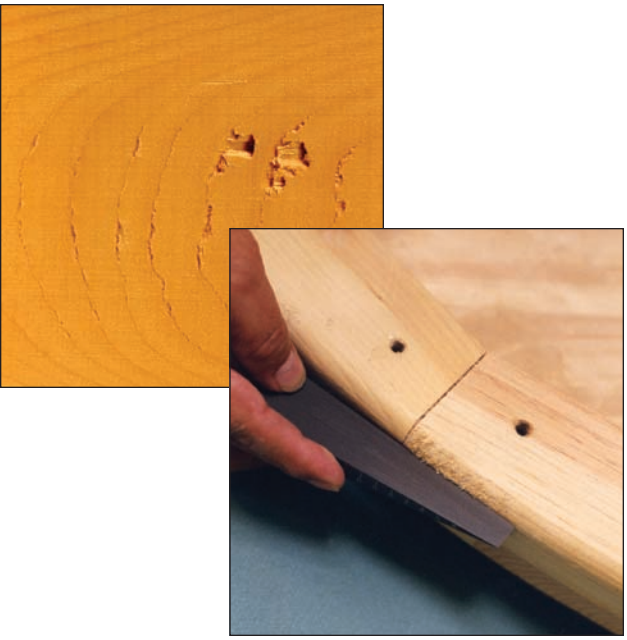

Twists and Turns of Quality Wood Machining

While the industry is placing greater emphasis on producing higher-value secondary wood products, there is a concurrent need to understand species-specific characteristics as the wood goes through various manufacturing processes.

Forintek assists secondary wood processors in the design and manufacture of higher-value products, and helps promote Canadian species in domestic and export markets. To reach the high quality standards required by today's end-user of value-added wood products, Forintek is assisting manufacturers choose the appropriate species and process technology for their products.

In recent years, Forintek has carried out extensive studies on the machining and fastener withdrawal properties of numerous Eastern and Western Canadian species, including engineered wood products such as particleboard, medium-density fibreboard (MDF), and oriented strandboard (OSB). These studies also examined a number of lesser-known wood species and second-growth variants of some of the more well-known commercial wood species. Examining the characteristics of these "newer" species and comparing them to the more commercially-known wood species enables manufacturers to make optimum tooling adjustments.

By understanding the diversity of the raw material, manufacturers are better able to increase the quality and value of their products by lowering the number of rejects, and the amount of labor spent on reworking their products to counter such problems as fuzzy, torn and raised grain. In addition, the inherent qualities of the raw material can be enhanced through correct tooling choice and proper machining.

Methodology

Forintek studied machining operations in secondary wood processing plants, where value is added by planing, shaping, boring, mortising and turning. Full listings of all the species studied are available in the

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reports cited at the end of this Profile, as are detailed accounts of testing methodology and specific procedures and equipment used. Some adaptations to standard methodology such as the inclusion of knots in test pieces were required to make these tests representative of current wood machining practice, and to take into consideration the industry's evolving technology.

Statistical analysis was performed on the samples from each species tested to ensure that the specific gravity for each sample was representative for that species. Moisture content can greatly affect wood machining outcomes. As a result, all softwoods were dried to uniform moisture content of 12% and hardwoods dried to a moisture content of 9%. These values are industry norms for products used in value-added applications.

Wood machining tests

Planing:

Planing is second only to sawing as the most important machining operation in a wood processing plant, since all lumber must be dressed to size and surfaced before further use. Planing provides excellent opportunities for adding value. In the B.C. study, excellent planing results were obtained with lodgepole pine, yellow cedar, western white pine, western white birch and red alder.

In the Alberta study, the best overall planing results were obtained for trembling aspen, followed by jack pine and lodgepole pine. The most prevalent defect observed in the Alberta study was fuzzy grain and, in most cases, the degree of severity was slight and the defect could be easily removed with light sanding. Of the eastern species tested, excellent results were obtained with red pine, yellow birch, trembling aspen, eastern white pine and eastern white cedar.

The optimal cutting conditions for the B.C. and Alberta wood species tested are shown in Table 1. It can be seen that planing with a higher number of knife marks per inch produces more defect-free surfaces.

Table 1. Optimal Planing Conditions for some B.C. and Alberta Wood Species

Species	Cutting angle	Knife marks/inch	Typical defects (in order of severity)
Douglas-fir	20	20	Raised grain, fuzzy grain
Yellow Cedar	20	8,12,16, or 16	No major defects
Lodgepole Pine	20	8,12, or 16	No major defects
Western White Birch	12 or 20	12,16,or 20	No major defects
Trembling Aspen	12	20	Fuzzy grain
Jack Pine	20	16, or 20	Fuzzy grain, raised grain

Sanding:

Sanding prepares the wood surface for application of a finish coating, and is the first step in achieving a first-class finish. Mistakes made in sanding often show up after the finish is applied. In the B.C. study, all species except black cottonwood produced sanding results in the 90%+ defect-free range, whereas in the Alberta study, only trembling aspen failed to produce 100% defect-free results. Trembling aspen samples were 71% defect-free, with the remainder of the samples exhibiting fuzzy grain, though it was of a light category. Eastern white cedar, jack pine, tamarack and sugar maple performed well in the eastern species study.

Shaping:

Shaping is similar to planing with respect to the cutting action and the type of tooling. The major difference is the shaper's ability to profile curved pieces of wood. A shaper is a versatile machine that can provide a variety of cuts (grooves, rebates, profiles, dados, etc.). B.C. species that produced high scores in the shaping tests included Douglas-fir, western white pine, yellow cedar, red alder, trembling aspen and western white birch. In the Alberta study all species had high shaping test scores. Of the eastern species, trembling aspen, tamarack and yellow birch had the highest scores in the shaping tests.

Boring:

Boring is used extensively in the manufacture of Ready-to-Assemble (RTA) furniture, to create holes to receive dowels, screws and other fasteners. The bored hole must be round with no noticeable distortion and have an inner surface conducive for good glue bonding. Of the B.C. species tested, Douglas-fir, western hemlock, western larch and western white birch performed well; of the Alberta species tested, jack pine and black spruce performed well. The most common defect for all species was crushing of severed or partially severed fibers against the inside of the hole. In these instances, bonding failure is likely, as glue will adhere to fibers that are themselves not firmly attached.

Mortising:

The mortise and tenon joint is common in furniture making and in window and door joinery. The tests showed that of the

western species, Douglas-fir, Sitka spruce, western hemlock, western white spruce, jack pine and lodgepole pine performed well. For the eastern species tested, the best mortise quality was obtained with trembling aspen.

Turning:

In the turning test, samples of wood with no knots present were turned into a standard shape. Though these samples were short in length, they provided a good indication of how well a wood species would perform in full-size conditions, e.g., the production of stairway spindles. In the B.C. study, Douglas-fir, western larch, western white pine, yellow cedar, red alder and western white birch performed well. In the Alberta study, white birch had the highest defect-free rating while trembling aspen had the lowest. Of the eastern species tested, eastern white pine performed even better (albeit slightly) than the high scoring hardwoods.

The most prevalent defect observed was torn grain followed by fuzzy grain and rough end-grain. It must be pointed out, however, that all the defects were in the slight category - easily removed by sanding.

Fastener withdrawal

The fastener withdrawal tests provided quantitative data on the force required to withdraw nails and screws. Western white birch required the greatest force to withdraw a screw, followed by western larch. Of the Alberta species, jack pine required the greatest force to withdraw a screw. As expected, the eastern hardwoods showed a better performance over softwoods for screw and nail withdrawal properties. A close relationship between increasing specific gravity and the force required for screw withdrawal was indicated.

Summary

In the B.C. study, western white birch was the best performing wood species overall with Douglas-fir, yellow cedar and western larch following. Other species, such as lodgepole pine, did well in planing and not so well in other tests. In the Alberta study, jack pine was the best performer, followed by black spruce and lodgepole pine. White spruce and trembling aspen were about equal.

Table 2. Summary of Comparative Machining Performance Using Only Defect-Free Quality Criteria (Alberta & Saskatchewan Studies)

Species	Planing (Defect-free) Avg	Planing (Defect-free) Best	Sanding (Defect-free) (%)	Boring (Defect-free) (%)	Shaping (Defect-free) (%)	Mortising (Defect-free) (%)	Turning (Defect-free) (%)
Trembling aspen	72	100	71	69	17	4	63
Jack pine	66	98	100	84	54	80	96
Black spruce	45	96	100	84	42	64	92
White spruce	72	76	100	58	68	65	56
White birch	98	100	98	92	80	50	100
Lodgepole pine	72	96	100	76	64	76	90

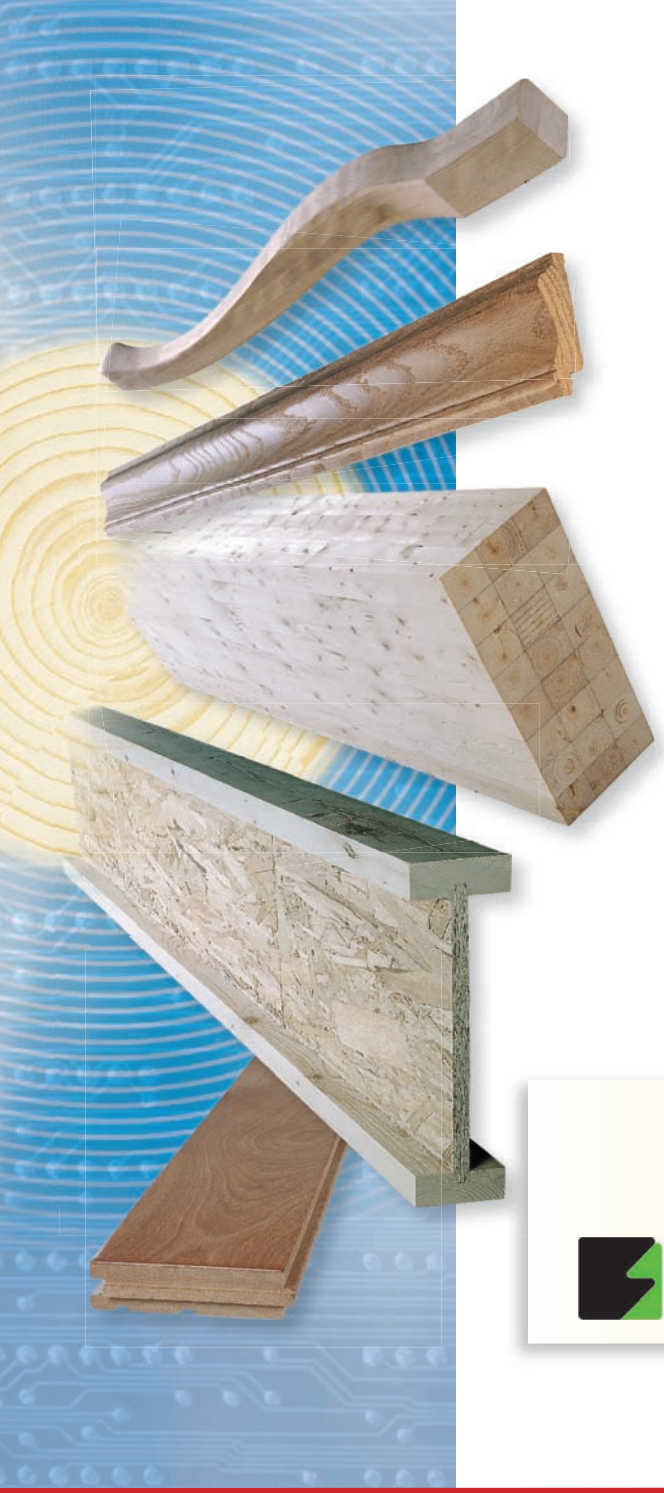
Table 3. Summary of the Machining Properties of 17 Species in Decreasing Order of Overall Performance (Eastern Species Study)

Species	Planing Good to Ex.**	Sanding Ex.	Spur* Good to Ex.	Shaping Good to Ex. (%)	Mortising Fair to Ex.	Turning Fair to Good	Avg.
Red pine	83	68	96/80	72	78	96	82
Yellow birch	89	52	98/86	78	56	100	80
Eastern white cedar	71	94	100/68	60	56	98	78
Sugar maple	69	82	98/100	56	38	100	78
Jack pine	57	84	94/76	58	62	94	75
Trembling aspen	74	4	98/66	86	98	96	75
Tamarack	49	84	98/64	82	66	72	74
White birch	70	8	98/88	74	66	100	72
Black spruce	66	52	92/80	68	52	90	71
Eastern white pine	78	52	100/86	58	24	100	71
Red maple	63	40	92/98	50	42	100	69
Scots pine	66	40	96/80	70	36	94	69
Norway spruce	66	74	96/56	58	70	50	67
White spruce	67	52	92/50	74	44	62	63
Balsam fir	47	54	94/62	52	64	54	61
Sugi	91	66	96/54	60	24	30	60
Eastern hemlock	36	72	94/56	66	18	6	50

* Boring brad point/multiple spur
** Excellent

In the Eastern study, red pine showed the best average performance of all the species, showing no major defects in any of the machining tests. Yellow birch and sugar maple were the best-performing hardwoods. Trembling aspen reached a high average score but performed poorly in the sanding tests due to the presence of fuzzy grain. These results show that there are opportunities for some eastern Canadian species such as red pine, eastern white cedar and jack pine in domestic and international value-added markets. When correctly dried to a moisture content of 6 to 12%, a range generally applied in the secondary wood processing industry, these softwoods performed very well in all machining operations.

A secondary wood products' manufacturer can use this information to determine the suitability of different species for a particular application. Matching the species-specific characteristics to the manufacturing processes available enables the manufacturer to extract the maximum value from the raw material.



Reports Available

Forintek Canada Corp. 1999. Machining and Fastener Withdrawal Tests for Alberta MDF, OSB, and Softwood Plywood. [W-1882], Vancouver BC.

Forintek Canada Corp. 2001. Wood Processing Guide for Saskatchewan Value-Added Manufacturers. [W-1953], Vancouver BC.

Lihra, T. and S. Ganev. 1999. Machining Properties of Eastern Species and Composite Panels. [E-3277] Forintek Canada Corp., Quebec, QC.

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*This **Technology Profile** has been edited by Derek Williams and Roland Baumeister, Western Division, Forintek Canada Corp.*

*Ce **Profil technologique** est également disponible en français.*

Value to Wood

As part of the ***Value to Wood*** program, funded by Natural Resources Canada, Forintek's Industry Advisors are providing technical services to value-added wood product manufacturers in all regions of Canada. If you need information on any technical issue related to wood product manufacturing, you can:

- Send a request via *valuetowood.ca* (Help Desk).
- Contact a *Value to Wood* co-ordinator at one of the following locations:

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