FINNISH CURLY BIRCH SOCIETY
VISA DESIGN CHALLENGE 2027

CURLY BIRCH AND ITS PROCESSING



(Kuva: Markku Tonttila)

1. Growth characteristics, wood properties and machining challenges of curly birch

Curly birch (*Betula pendula* var. *carelica*) is a special variety of silver birch, known for its hereditary and unique, highly decorative curly-grained and brown-figured wood. Curly birch trees generally grow more slowly than ordinary silver birch and usually remain smaller. The log of curly birch is typically leaning or forked and covered with thick, coarse bark. The log often features swellings, ring-shaped enlargements, knots, protuberances or longitudinal ridges.



Ordinary silver birch grows faster than curly birch. The photograph shows an ordinary silver birch surrounded by curly birch trees. (Kuva: Anneli Viherä-Aarnio)



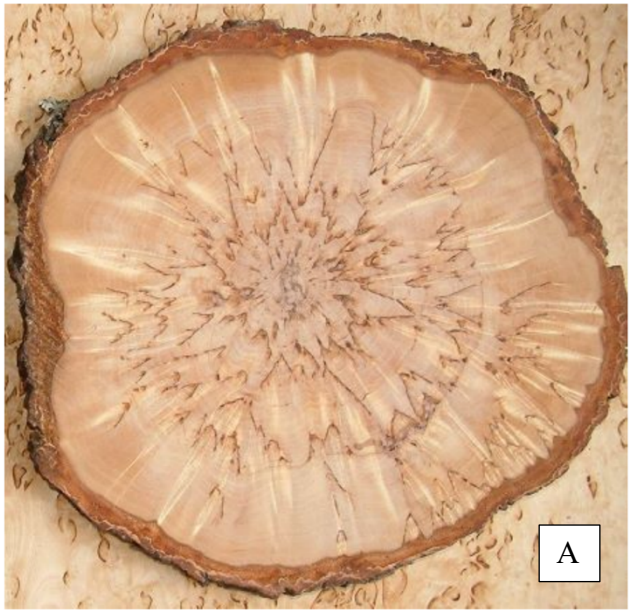
A crooked, multi-logmed curly birch specimen from which a log suitable for turning cannot be obtained. (Kuva: Risto Hagqvist)

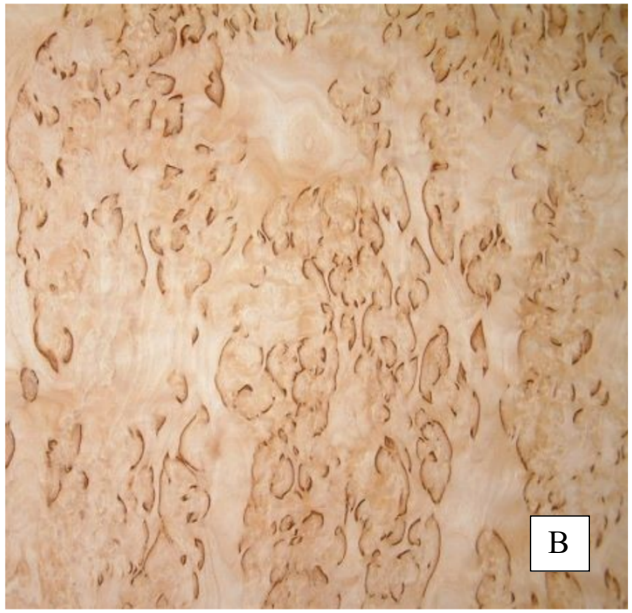


The most valuable type of curly birch is a straight-stemmed tree, which is suitable for rotary cutting of logs for vaneer production and contains a rich curly configuration in the wood. Clonal planting stock for forest cultivation is generally propagated from selected trees representing this type. (Kuva: Teijo Nikkanen)

Processing curly birch wood is a highly specialised field in its own right because of its exceptional structure. Curly birch wood is dense-textured and extremely heavy, with a density of up to 930 kg/m³ when green, approximately 700–730 kg/m³ when air-dried to 12% moisture content, and approximately 680 kg/m³ when oven-dried to 0% moisture content. Density is likely to vary considerably depending on the degree of figure development in the wood. In the same study, the density of ordinary silver birch at 15% moisture content was 640 kg/m³.

In a cross-section of curly birch, brown V-shaped patterns can be seen, sometimes forming a closed ring known as a "visa-flower". In addition to the brown figure, pale areas with a shimmering appearance, similar to that of ice birch, are occasionally visible in the wood. The surface of the debarked log typically features narrow longitudinal ridges and grooves. Curved, lens-shaped patterns are visible on tangentially cut surfaces and in rotary-cut veneer. The bark of curly birch is often dark and thick, and develops fissures earlier and more extensively than that of ordinary silver birch, although there are considerable differences between the various types of curly birch.







(Kuvat: Risto Hagqvist)

C

In photographs A, B and C, three characteristic structural features of curly birch are clearly visible. The first photograph (A) shows the continuous ring formed by brown V-shaped patterns in a cross-section of the log, known as the visa flower. The second (B) shows the droplet-shaped, flame-like figure visible on a tangentially machined surface, for example in rotary-cut veneer. The third (C) shows the surface figure of a board sawn longitudinally in the radial direction, which differs clearly from the two previous patterns. These are not merely surface patterns; they reflect the three-dimensional structure of the wood grain.



(Kuvat: Markku Tonttila)

All the material types described above can be produced from large-diameter curly birch logs, approximately 25 cm or more in diameter. However, curly birch growers are also keen to find uses for smaller-diameter logs which typically have a maximum diameter of approximately 10–15 cm. When used as whole rounded wood, the material should be partially debarked and at least air-dried. Producing veneer from such small logs is not economically viable because the yield rate is very low. The small diameter and possible irregularities or swellings in the log also restrict potential applications or increase material waste. Nevertheless, small-diameter curly birch offers opportunities when products are designed to take its characteristics into account. The supply of small-diameter curly birch is greater than that of large-diameter material suitable for rotary cutting of logs, and it has been estimated that the availability of small-diameter curly birch will multiply during the 2030s.

Processing curly birch is a challenging special field because of the wood's exceptional structure. Compared with ordinary silver birch, three interrelated characteristics must be taken into account when machining curly birch:

1. **Strong and irregular grain deviation.** The grain does not run straight along the log but twists, meanders and forms localised clusters and convolutions.
2. **Variations in density and hardness.** Considerably softer areas may occur alongside hard, dense zones. The cutting tool therefore encounters constantly changing resistance.
3. **Internal stresses within the log.** Irregular growth and log sweep can create stresses that are released during sawing and drying. As a result, the workpiece may split, warp or twist.

For product design, it is important to understand that the machining direction affects both workability and the final surface figure of curly birch. The same piece of wood can produce completely different visual effects depending on the direction in which it is sawn or turned.





(Kuvat: Markku Tonttila)

2. Sawing the log

Sawing the log is one of the most critical stages in the entire manufacturing process. In particular, when dealing with irregular and logs with internal stress, it is advisable to prepare a sawing plan before making the first cut.

Preparing the log

- Select the straightest and healthiest possible section of the log if the aim is to produce sawn timber.
- Examine the log from several directions and mark its curvature, knots, protuberances and any visible cracks.
- Assess where the curly structure is most pronounced.
- Do not automatically aim to maximise the volume of sawn timber. With curly birch, figure quality and the intended end use may be more important than yield rate.
- Avoid splitting the log unnecessarily before assessing its internal stress condition, including asymmetry of the visa flower and log sweep.

Sawing method

Bandsawing is recommended because it allows the sequence of cuts to be controlled and the shape of the log to be taken into account.

Particularly highly stressed logs should first be sawn into smaller blanks according to the requirements of the intended end products. This helps prevent the uncontrolled release of internal stresses from splitting valuable material.

(For more information on sawing methods, see, for example: https://puuproffa.aalto.fi/fi/puutieto/index.html





(Kuvat: Markku Tonttila)

Selecting the sawing pattern

Sawing direction	Figure obtained
Cross-cutting	Visa flower
Radial sawing	Droplet-shaped and flame-like figure
Tangential sawing	Variable clustered and flame-like patterns

The sawing directions given here are general guidelines. The final figure is determined by the local grain structure and the position of the cutting plane.

Sawing boards and blanks, and producing wood discs

When sawing boards and blanks from a log, it is useful to distinguish between two objectives: achieving the best possible figure and producing a dimensionally stable blank. These objectives cannot always be achieved using the same sawing method.

Recommended principles:

- Where possible, saw blanks slightly oversize to leave sufficient machining allowance for subsequent flattening and planing.
- Avoid excessively wide and long continuous boards if the log has pronounced curvature or internal stresses.
- Saw highly stressed logs into several smaller blanks.
- Monitor changes in the shape of the workpieces after sawing. Such changes may take days or weeks, particularly as the wood dries.
- Mark the original sawing direction and the position of each piece within the log. This will help identify the most suitable machining direction at a later stage.



(Kuvat: Liisa Valsta)

Sawing wood discs presents one particular problem: the end-grain surface dries easily and unevenly and is prone to cracking.

Recommended procedure:

1. Saw the discs slightly thicker than their final intended thickness.
2. Use a sharp, fine-toothed bandsaw blade or another accurate cross-cutting method. When sawing a round workpiece, it must be secured against a suitable support or jig; otherwise, it may rotate violently during cutting.
3. Immediately after sawing, seal the freshly cut end-grain surfaces with a suitable end-grain sealer to slow moisture loss (e.g. glue, wax or paint).
4. Dry the discs slowly and evenly.
5. Avoid direct sunlight and strong air currents.

Drying thick wood discs is particularly challenging because moisture escapes rapidly through the end grain. The risk of cracking increases with the diameter and thickness of the disc. Final flattening and surface sanding should only be carried out once the wood has reached the moisture equilibrium required for its intended application.

3.Drying – a prerequisite for successful machining at every stage

Drying deserves a section of its own, since curly birch that has been inadequately dried can cause problems throughout the subsequent manufacturing process. Properly dried wood is easy to machine, glue and finish, and is less likely to warp or crack in the finished product. Drying also prevents discolouration caused by microorganisms, such as blue stain. Rapid drying of curly birch can cause cracking. In addition, the release of internal stresses can result in deformation during subsequent machining.



(Kuvat: Markku Tonttila ja Pekka Valkeapää)

Curly birch is recommended to be felled in winter, preferably no later than the end of March, when its moisture content is at its lowest. The first stage of drying is air-drying in a stick-stacked lumber, with the boards stacked in a pile (a *stack*), for approximately 3–9 months. Moisture content may fall to 13–15%, although it is often higher, at around 15–25%.

Recommended procedure

1. First, saw the freshly felled timber into blanks of suitable dimensions and intended uses.
2. Roundwood should be partially debarked by removing bark from several sides, while leaving a solid collar of bark at each end.
3. Seal the end-grain surfaces immediately to slow down moisture loss (e.g. using glue, wax or paint).
4. Dry the wood under controlled conditions, evenly and sufficiently slowly.
5. Use stickers and apply evenly distributed weights when drying sawn timber. When drying smaller quantities, warping can be prevented by clamping the pieces together or securing them to a suitable supporting frame or jig.
6. Do not dry thick discs or irregularly shaped blanks using the same methods as ordinary sawn timber. Several alternative methods are available, including vacuum drying, microwave drying, sealing the ends of the disc with adhesive or wax, or immersing the disc in a polyethylene glycol (PEG) solution.
7. Allow the blanks to condition and reach moisture equilibrium before final machining to size.

Because of internal stresses, it is also important to observe how the workpiece behaves after drying. For example, if a board opens up or bends after sawing, this indicates the release of internal stresses. In such cases, final flattening should not be carried out until the deformation has stabilised. After sufficient air-drying and conditioning, the timber should be transferred to a drying kiln, for example, for approximately 2–3 weeks of condensation or conventional chamber drying (accelerated drying at low temperatures under humidified conditions), or alternatively to a vacuum kiln or a suitable indoor drying space. To achieve good results, traditional drying in a heated indoor environment should be prolonged, lasting at least three months and potentially up to a year. Wood can be machined at a moisture content of 7–12%. For furniture manufacture, for example, the timber should be *joinery-dry*, with a moisture content of 6–8%.
(For more information on drying, see, for example: https://puuproffa.aalto.fi/fi/puutieto/index.html



(Kuvat: Markku Tonttila)

4. Planing

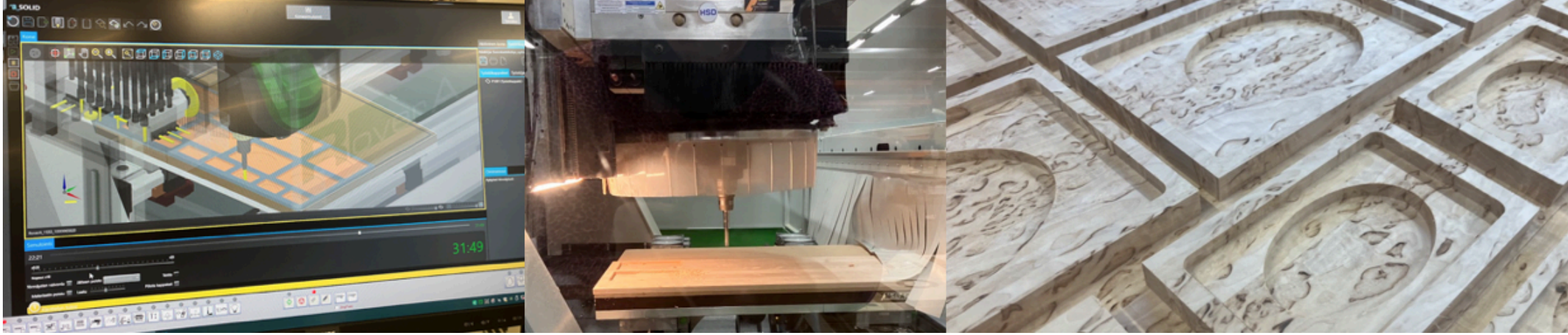
Planing is probably one of the most challenging machining operations when working with curly birch. Descriptions of curly birch specifically mention its difficult machinability and the tendency of its fibres to tear out during planing. This is understandable, since the grain in curly birch does not run uniformly in the direction of the planer's movement.

Recommended procedure

1. Use an extremely sharp plane blade or planer knife.
2. Take the thinnest possible shavings.
3. If necessary, use a skewed-blade or spiral cutterhead.
4. Avoid deep planing cuts.
5. Test the machining direction from different orientations before planing the entire workpiece.
6. Use the lowest practical feed speed.

It is particularly important to recognise that a planer knife may encounter fibres running in different directions at the same time. In one area, the surface may be cut cleanly, while in another, fibres may be torn out from considerably deeper within the wood.

Curly birch should be surfaced and planed using sharp knives and a low feed speed. Large curly birch surfaces should not be planed to their final dimensions using a conventional thickness planer. Instead, they should be planed with a small machining allowance and finished using a wide-belt sander at a low feed speed.



(Kuvat: Liisa Valsta)

5. Routing

Routing is a useful machining method for curly birch, but the choice of router bit is particularly important. The grain direction in curly birch can change over very short distances. Consequently, a conventional router bit may cause localised tear-out even when the routing operation is otherwise carried out correctly.

Recommended tools

- Sharp carbide-tipped router bits (TCT).
- Helical spiral router bits, particularly for finishing operations.
- Router bits with shear-cutting geometry designed to minimise surface tear-out.
- Small-diameter router bits for detailed work and decorative shaping.

When selecting spiral router bits, it is important to consider the effect of the cutting direction:

- Up-cut spiral router bits evacuate chips efficiently and help keep the groove clear.
- Down-cut spiral router bits press the surface fibres towards the workpiece and can reduce tear-out on the upper surface.
- Compression router bits, combining up-cut and down-cut geometries, can be useful for sheet materials when a clean finish is required on both faces.

Recommended procedure

1. Use a sharp router bit. A blunt router bit compresses and tears the fibres instead of cutting them cleanly.
2. Make deep routing cuts in several passes.
3. Use a moderate depth of cut.
4. Avoid excessively high feed rates and excessively slow feeding, which may cause burning.
5. Secure the workpiece properly, as the irregular grain structure may cause unexpected variations in cutting forces. When using vacuum clamping, bear in mind that the wood may contain through-holes caused by its grain structure, which can reduce the effectiveness of the vacuum.

The attractive grain figure of curly birch can be revealed particularly effectively by routing away different levels of the wood. This technique can be used, for example, to create three-dimensional decorative surfaces on products. For small curly birch products, a handheld router is a useful tool. A computer numerical control (CNC) router, in turn, enables the manufacture of precisely shaped and repeatable products.

In industrial production, the high density of curly birch and its hard figured areas cause rapid router bit wear. For this reason, solid carbide (VHM) or polycrystalline diamond (PCD) router bits are used to ensure a long tool life. The variable grain direction of curly birch makes machining against the grain particularly likely, resulting in fibre tear-out. Compression router bits, with their up-cut and down-cut geometry, effectively prevent chipping on both the upper and lower surfaces.

During finishing, climb milling reduces the risk of tear-out compared with conventional milling (up-cut milling). To maintain consistent router bit loading and prevent corner chipping, sharp changes in direction and acute internal corners should be avoided. A consistent machining allowance should be left for the finishing pass.

An excessively low feed rate in relation to spindle speed causes the router bit to rub against the wood rather than cut it. This results in surface burning and premature router bit wear. The feed rate should therefore be sufficiently high to ensure clean cutting, while the depth of cut should remain moderate because of the wood's high density and hardness.

Industrial production often employs machine vision or laser projection for aligning workpieces onto a raw material blanks so that the most attractive curly figure appears on the most visible surface of the finished product, while knots and bark inclusions are avoided. Due to the high cost of the raw material, tool paths and workpiece positioning must be optimised with great precision. Surplus edge pieces and central offcuts are often sorted and used as raw material for smaller products.



6. Turning

(Kuvat: Markku Tonttila)

Turning is an exceptionally suitable machining method for curly birch. However, possible bending and twisting of long, solid workpieces must also be taken into account. One advantage of turning is that the cutting action between the tool and the wood can be controlled even when the grain direction varies.

Recommended procedure

1. Use extremely sharp woodturning tools.
2. Keep the cutting action under control.
3. Avoid applying excessive pressure.
4. Ensure adequate workpiece support and secure mounting.
5. Pay particular attention to imbalance, especially during the initial stages of turning.
6. Do not assume that the hard structure of curly birch can withstand abrupt or aggressive tool movements.

Turning curly birch provides an opportunity to reveal different dimensions of its grain figure. This is one of the most interesting possibilities when manufacturing small curly birch objects.

In series production, turning is automated using, for example, CNC woodturning lathes, hydraulic or mechanical copying lathes (using templates), or form tools corresponding to the profile of the workpiece. A lathe may be equipped with several parallel machining heads, allowing the machine to produce several identical components simultaneously. Many industrial woodturning machines incorporate an automatic abrasive-belt or brushing unit that finishes the surface before the workpiece is released from the machine.

7. Sanding and surface finishing

Careful sanding is an important stage in the finishing of curly birch products. Curly birch sands well, and when properly sanded, its surface can become exceptionally smooth and glossy. This is one of the material's advantageous properties.

The challenge in sanding is that different parts of the wood do not wear away at the same rate. Softer areas may be sanded down more deeply than harder areas.

Recommended sanding sequence

Operation	Abrasive grit	Objective
Coarse levelling	P80–P100	Removing machining marks
Intermediate sanding	P120–P150	Evening out surface roughness
Fine sanding	P180–P240	Revealing the grain and figure
Final sanding	P320–P400	Achieving a smooth surface
Special finishing	P600, if required	Achieving an exceptionally fine surface

The grit sizes given are indicative. If the workpiece contains deep planing tear-out, it is not advisable to try to remove it simply by using progressively finer abrasive paper.

One useful operation is to lightly moisten the surface before final sanding. This raises the surface fibres, which can then be removed by fine sanding. This reduces the tendency of the surface to become rough again after finishing.

Industrial turning lathes often incorporate built-in sanding units. These smooth the rotating workpiece immediately after the cutting operation and before it is released from the machine.

For surface finishing, it is worth experimenting with products such as oil wax, hardwax oil, natural oils and clear lacquer. Different finishes emphasise the curly figure in different ways, making test pieces essential.



(Kuva: Erkki Oksanen/LUKE)

8. Curly birch veneer

Curly birch veneer is rotary-cut or sliced from freshly felled wood with a moisture content above 30%, typically around 50–80%. For veneer production, the moisture content of the wood must be above the fibre saturation point to ensure that the veneer can be cut continuously without cracking. During rotary peeling, moisture acts as a natural lubricant between the cutting blade and the wood.

Rotary-cut and sliced veneer allow larger surface areas to be produced through careful composition and matching of the veneer sheets. The sheet size of rotary-cut veneer varies according to the recovery rate.When covering larger surfaces, the continuity of the figure in sheets peeled from the same log makes veneer matching easier. When the sheets are joined, the resulting surface has a more closely repeated, rhythmic pattern.When dry, curly birch veneer is brittle. Its surface is often uneven due to the underlying grain structure, and it must therefore be handled with care. Before veneering, the veneer is moistened. Glue is applied to the clean, dust-free substrate, after which the moistened veneer is positioned and pressed firmly against the surface to ensure proper bonding. Finally, the veneer edges are trimmed to size, the surface is sanded and the finish is applied.

When several thin veneer layers are bonded together to form thin plywood, the resulting material is flexible, easier to machine and easier to store. Curly birch veneer or curly birch thin plywood is a particularly manageable material for covering larger surfaces.



(Kuvat: Markku Tonttila ja Kateryna www.instagram.com/karelianbirchstab)

9.Colouring

Coloured oil waxes appear to be particularly suitable for colouring and finishing curly birch. They give the material an entirely new and fresh appearance. Curly birch can also be coloured using alcohol-soluble or water-soluble wood stains. The stained surface can be protected with clear oil wax or lacquer.

Carefully controlled colour choices can also work well on larger surfaces without compromising the distinctive character of the curly figure.

Curly birch can also be coloured by methods such as vacuum impregnation with coloured resin, producing what is known as *stabilised curly birch*. Stabilised curly birch is resistant to water and general wear. It does not shrink or crack and can also be machined using conventional woodworking tools or CNC machines. During stabilisation, the colour penetrates throughout the entire wood structure, unlike conventional stains or colouring agents, which generally affect the surface or penetrate only to a limited depth.





10. Using curly birch figure in product design

(Kuvat: Markku Tonttila ja Liisa Valsta)

The interesting feature of curly birch is not simply its hardness or durability, but the possibility of obtaining very different visual surfaces from the same wood material.

- Cross-sectional surface
- Radial surface
- Tangential surface
- Turned surface
- Veneered or composite surface

The figure of curly birch often reveals surprises as machining progresses. However, the figure can also be controlled through different cutting directions and careful composition.

Depending on the curly birch variety or clone, the figure may be dense and pronounced or more subtle. This also allows the intensity of the figure to be taken into account when selecting the material.

The unique structure and visually fascinating appearance of curly birch make it a rewarding challenge and an opportunity in skilled hands, adding considerable value to the finished products.

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(ChatGPT-searches have been used to compile the text.)
More about curly birch, working with it and about modelling of it can be found in the videos at the site of the Finnish Curly Birch Society: https://www.youtube.com/@Visaseura-ry.