

Cuir Bouilli Technique - An Historical Method of Hardening Leather

an educational paper researched and prepared by **Jean Turner**

The term 'Cuir Bouilli' has for a long time also been associated with the hardening of leather by dipping it in hot beeswax, and while this can and does work successfully and garments, items and armour can be made using that technique, the term 'Cuir Bouilli' appears to refer more specifically to the technique of water-hardening leather.



While wax-hardened leather is easy to work and cut, having been stiffened somewhat by the wax content, it is heavy and does not provide the same kind of protection as water-hardened leather armour. It is questionable as to whether this is what is indeed referred to by the term Cuir Bouilli.

In fact when translated the term means 'boiled (or cooked) leather'.

Several texts dating from the Middle Ages mention the superior performance of "boiled leather". In his famous article, Froissart describes the Cuir Bouilli process as a method " ... to obtain leather that no iron can pierce." Other texts from the period speak of the remarkable material, deemed essential when

equipping a warrior because of its lightness and strength.

In every day life, Cuir Bouilli was used to form rigid cases, bags and sheaths for protecting blades or other objects.

Top: Cuir Bouilli Box, ?
Right: Water bottle, 1672
Below: Water flask, ?





Although the use of leather was commonplace in everyday life in the form of initially clothing, then shoes, many types of musical instruments and of course precious parchment, the "cuir bouilli" was regarded differently - almost as a "super leather".

Although its uses during the Middle Ages are known, no known record about the method of manufacture exists, and while research has led to some conclusions

being drawn, it is not definite and the process allows much freedom for further experimentation.



After about the 15th Century, "cuir bouilli" seems almost to have been forgotten, possibly due to the fact that arms were developed at about that time, and would largely have rendered its protective qualities as obsolete.

Cuir Bouilli 'Penner' - 1600

Around the 17th Century, the boiled leather seemed to re-emerge, this time in the form of practical objects for every day use such as bottles and as postillions - the closures found on boots at the time.

Hats: 1800



The military used it to make helmets during the Great War, but the items made in this manner during that time were completely different from the way it was used during the Middle Ages - very thick leather was used, with coarsely stitched assembly and often covered with protective tar. Researchers are of the opinion that the techniques used to produce the goods during the First World War were different from those used in the Middle Ages.



German Helmet



Recipes dating from the time of the Great War describe how the leather is first assembled by sewing, softened in warm or hot water, and then put into two-part molds which were then put in an oven to dry. Objects made in this manner have a tendency to be stiff, brittle as glass, and are prone to surface cracking, thought to be caused by prolonged high temperatures breaking down the fibres within the leather itself. The other major disadvantage to using this method of treatment is that when the leather is exposed to high temperatures when it is immersed in boiling water, it shrinks sharply - by nearly $\frac{1}{4}$ of its surface area. Different parts of the hide also react in different ways, and so it is necessary to plan for these tendencies when making items using this method.

It is believed that the "boiled leather" referred to during the Middle Ages and that of the 17th Century refer to two completely different products - despite being called by the same name - and experiments have shown that the product created during the Middle Ages would probably not have been produced using high temperatures due to the fragility of the boiled leather and its susceptibility to brittleness and damage when twisted. These conclusions were based on the usage requirements of the "cuir bouilli" during the Middle Ages - items such as shields and breast plates had to be shock resistant. Leather boiled at high temperatures lack sufficient of this quality to be truly protective.



Cuir Bouilli Case with red cord, inscribed with amorous message
396x80x82mm, Italy, 1450-1500
Collection: Metropolitan Museum of Art

Archaeological excavations have revealed items made in this manner during the past ages, particularly in the form of beautifully worked boxes and knife sheaths which show the considerable skill of the artisans during the Middle Ages. At the Cluny Museum, a notable example shows a finely decorated which probably used wire for its closure which had in its interior a jaw harp - probably not its original contents.

1. The Technique of Water-Hardening Leather.

Vegetable tanned leather is initially soaked in water for long enough to wet it through completely. This takes approximately 10 minutes. If the soaked leather is then placed in a pot of water which has been pre-heated to 180°C, it will begin to change in shape and texture.

After approximately 60 seconds, the leather darkens, goes limp and begins to curl up. If extracted at that stage, it will have shrunk a bit, thickened slightly, and still be able to be stretched, such as a sheet of rubber. At this stage - it is possible to stretch and form the leather into required shapes. After a minute or two, the stretchiness goes away, however, the leather will still be fairly flexible. After air-drying for a few hours, the leather becomes increasingly stiff, thickens slightly and becomes harder.

The longer the period of time that the leather is left in hot water, the more it shrinks, the darker it gets, the thicker it becomes, and the harder the finished product is. Sufficient time in hot water will render leather into something which resembles wood, however, as with most natural things, the process does have a trade-off, in that the harder the leather, the more brittle it becomes. In the case of actual armour, it is likely that the leather would have been hardened to the maximum, and replaced after every battle. For purposes of re-enactment or the making of object d-art - it is desirable to harden the leather without detracting from its strength.

Approximately 30 seconds of immersion is usually sufficient to harden leather to a suitable state - where the leather is hardened but still flexible - and results in a shrinkage of

approximately 1/8th the original size (i.e. the finished article will be 7/8th the size of the original) and an increase in thickness of approximately 25%.

Due to the fact that the process is very temperature sensitive, it is advised that an accurate thermometer is used. To a certain extent, the finished product will also be dependant on the leather itself, and experimentation with scrap leather is recommended. While being guided by the clock, allow yourself to learn how the different types of leather behave and work according to the changes you observe during the process as it proceeds in order to achieve the end result you desire.

The Cuir Bouilli process can be considerably shortened by the use of boiling water. Thirty seconds of immersion in boiling water will result in a shrinkage to 7/8th of the original size and 40 seconds immersion in boiling water results in a shrinkage to 2/3rd of the original size and approximately doubles the thickness of the original leather.

The use of boiling water has the advantage of speed and removes the need for a thermometer, however it does hold two distinct disadvantages, viz. the process is harder to control, and secondly, the hotter water results in a less uniform hardening process. Patchy softness or brittleness can cause surface cracks to develop over a period of time, and makes the lower temperature process more desirable when producing items intended for long-term use or as items of art/functionality.

Forming the final product

Allowance should always be made for the projected shrinkage in the final product

The simplest projects are those where little or no shaping of the leather is required. If it is unknown what the shrinkage will be, it is possible to water-harden a large section of leather, flatten it under a cutting board for a few minutes, and then cut out the required shapes and punch holes while it is still possible to cut it easily.

For slightly curved objects, large hollow objects such as posts can be used - the leather is water-hardened, and then formed around the diameter of the pot - either by placing it inside the curve, or by tying it around the outside - using strips of cloth as the ties rather than string. String will mark the leather while cloth will not. Smaller forms can be used, for example wine bottles, and if required, a section of leather can be moulded around an arm so long as steps are taken to prevent burns from occurring. A towel wrapped around the arm will to a certain extent absorb heat from the leather, however this method cannot be recommended due to the potential of heat burns.

For objects which are more curved in shape, it is possible to shape the water-hardened leather between two forms, easing and stretching it into the first, and then pushing the second in after it to hold it in shape while it settles. Check for creases and re-align if need be, allowing the leather to dry and harden.

2. The Glue-Assisted Technique of Water-Hardening Leather

The written work of Eva Hallasz Csiba: "Le cuir á fleur de peau" (The Leather On Edge) examines the anthropology of leather and its fascinating history. A subsequently published eight page article in *Images of Medieval History*, Issue 19 (April-May 2008), links the profession of Gainier furrelier to the work of "boiled leather". The article describes in detail an attempt to reconstruct a Jew's Harp case, as well as some knife sheaths and another "object" in "boiled leather".

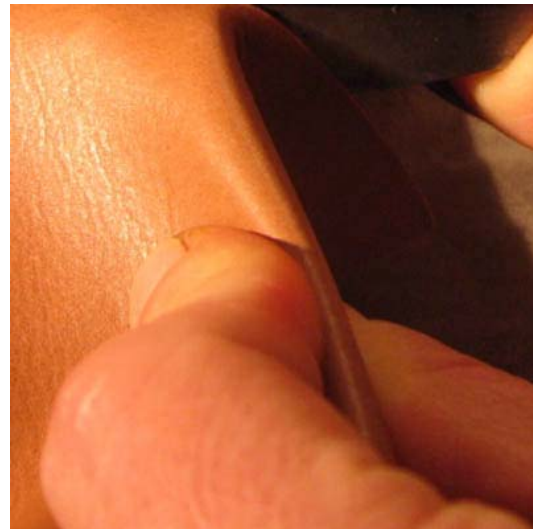
This work proposes an alternative hypothesis on how “cuir Bouilli”, was made during the Middle Ages - a process is described in which the boiled leather can be ‘carved’ (shaped) as though it is clay, while still keeping its quality and appearance. It is based on a well-known 15th century model of a harp-case (which closed by means of a sliding lid) housed by the Cluny Museum, and incorporates the use of glue made from pork trotters.

Experiments in “boiled” leather:

(extracted from Images of Medieval History, Issue 19 (April-May 2008))

The experiment involved the manufacture of a hard leather case, based on the model with a sliding lid which is found in the Cluny Museum, dating from the 15th Century. The project necessitated some basic tools, namely a fine and very thin (and very sharp) cutting knife called a tranchet, a large perfectly flat stone (marble slab), a few very smooth sticks carved from bone and a form made of wood. The leather used was 0.8mm vegetable-tanned calf with a supple and smooth texture.

The glue used was made of pigs’ trotters, not freely obtainable today, however, a suitable substitute may be found in the form of edible gelatine as sold by grocery stores for making desserts. The glue was prepared thus: Two sheets of gelatine were broken and inserted into a jam jar, and then completely covered with cold water. As the leaves are thin, they rapidly swell. After about 2 hours, the jar is gently heated in a bain-marie whilst constantly stirring the contents. At around 23°C the collagen fibres of the gelatine separate from each other, and a homogenous and transparent liquid is obtained. While controlling the temperature with a thermometer, it is now possible to soak the leather in this glue.

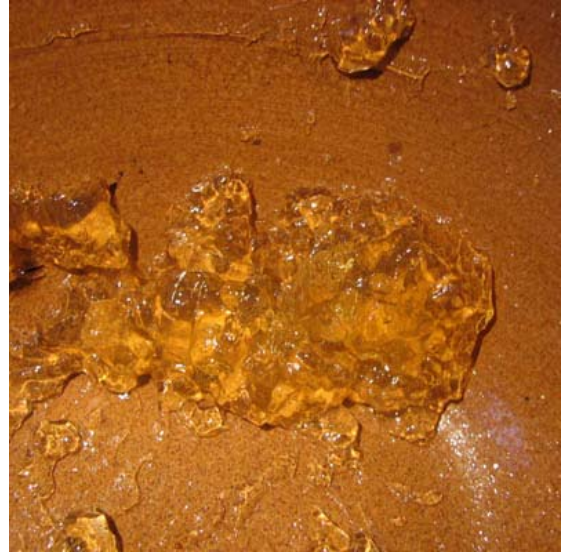


When the leather is immersed, it bubbles, and a ‘boiling’ sound is heard. Within a few seconds, when saturated, the leather becomes flaccid and sticky. Note: It is plausible that this is the stage which caused the leather to be called ‘boiled’ - when the bubbles escape and the sound is heard. While it looks as though it is boiling, the temperature of the liquid used is well below 40°C.

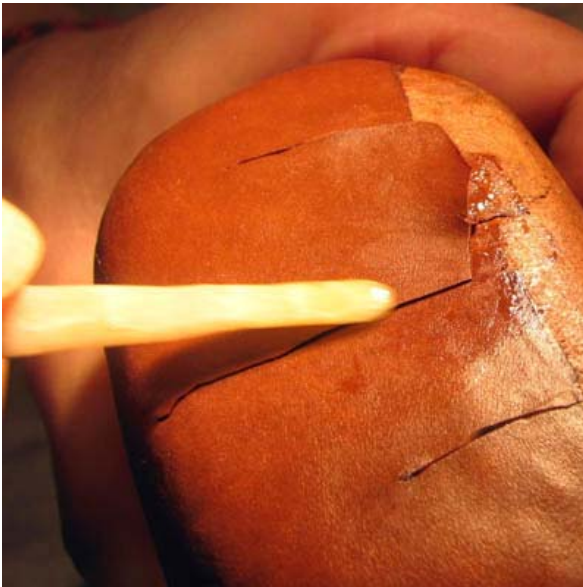
Note: It is imperative that while soaking the leather the temperature of the liquid does not rise above 37°C or damage will occur to the structure of the leather. The optimum temperature is 32°C - the colder the liquid the more slowly it penetrates the leather.

The gelatine jelly after cooling:

Once saturated, the leather is placed on the stone slab and trimmed with the knife (tranchett). It is necessary to skive the edges where the leather will overlap on the pattern in order to prevent unsightly bulges, and this process will help keep the leather joints together - any movement at the joints is unsightly and causes weakness.



The glue in the leather makes this job difficult, as it causes the leather to stick to the slab.



The leather is now placed around the form and the joints are eased into place and then smoothed down with the bone 'sticks':

The joints are smoothed and burnished until the edges are flush.

Note in this image how the sliding bar is held to shape by a piece of thicker leather.



It then remains only to decorate the object before it is completely dry. This is achieved with shapers made from pieces of bone.

It is possible to paint the leather before it is soaked in the warm glue solution. This makes it easier to decorate as you are working on a flat surface.

The results from using gelatine glue are extremely tough and is resistant to piercing.

The completed case:



3. Wax-Hardened leather

Although the information relating to the technique of wax-hardening leather has been lumped together with "cuir bouilli" for some time, the concept is in actual fact a modern one. Although the strength of the wax hardened leather is not to the same standard as water-hardened leather, the method has its place in terms of weather-proofing leather, helping to retain its form, and rendering it useful for carrying objects and liquids and use as re-enactment armour. Due to the fact that it is far more easily pierced by a sharp instrument, its use on the ancient battlefield appears to have been limited.

IMPORTANT WARNING:

Wax is extremely flammable with a very low flash point. The vapour of paraffin wax is explosive, and for obvious reasons this technique should never be carried out over an open flame. There is a REAL risk of explosion and potential for severe burns.

Vegetable tanned leather that is heated in the presence of either water or wax tightens up, can be stretched and formed into shape, and be made as hard as many modern plastics. Time and patience and unwavering attention is critical to the success of this technique.

The method devised by Bob Hurley involves soaking the leather and then drying it in an oven set to a very low heat - a temperature described as "low enough that you can hold the oven rack in your hands without being burned, but warm enough that it is uncomfortable to do so".

An aluminium disposable roasting tray is placed on a cookie sheet into the oven. The cookie sheet helps to diffuse the heat and prevent hot spots. The leather is soaked in water (overnight for really tightly curved items such as elbow pads) for just long enough to be able to shape the item comfortably. This is then placed on the aluminium tray in the oven and occasionally removed and reshaped as required until such time as it is completely dry before attempting to wax the item. This is necessary as any parts which remain damp will end up brittle and will shrink and twist when the item is wax treated.

Once completely dry, the item is then wax-treated.

The wax should be held only just above melting point. If it is too hot - it will burn or cook the leather which will then shrivel up and become very brittle. When leather is dropped into wax of the correct temperature, tiny bubbles will emerge almost immediately and begin to stream up to the surface.

Optionally, the item can be left in the wax until the bubbles stop forming, or removed after a short while. If the item is left in the wax, it is important to watch that the leather touching the base of the pan does not get burned. Heavy vegetable tanned leather can take 20 to 45 minutes to absorb the wax properly.

After removing the leather from the wax, some shaping may be required, although most of it will have been carried out during the initial water hardening process. Any shaping done at this stage can relax if the piece gets hot later on (e.g. in the boot of a car or when left in the hot sun).

Maintenance can be carried out by replacing the item in an oven and re-shaping. The wax will run and fill any scratches or dents.

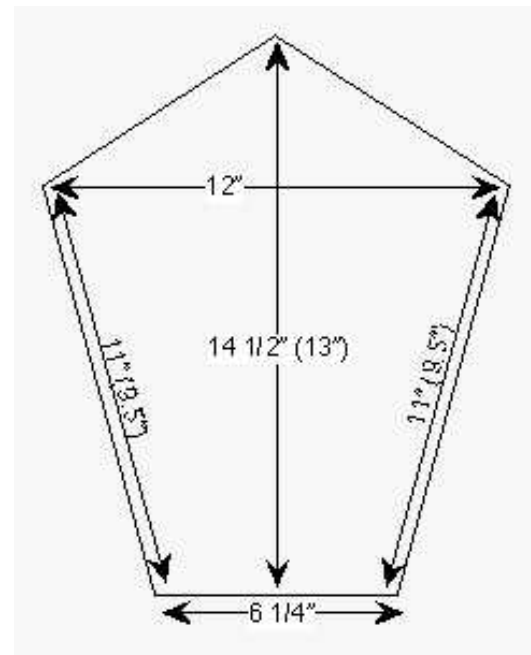
Project Suggestions

(Final sizes are determined by the thickness of the padding and the size of the body parts to be covered)

Elbow cops: Start with a roughly oval shape of approximately 250mm x 190mm (10" x 7.5"). Use two bowls with a diameter of approximately 160mm (6.5") which will nest together easily. Cut the leather slightly larger than required, water-harden it and then stretch it quickly into one of the bowls, easing it into shape with your fingers. Once set to the shape you require pushing the second bowl into the first to hold the leather tightly between the two. Straps can be riveted or sewn on if required.

Knee cops: are made in the same way, using 200mm (7.5") diameter bowls and leather approximately 360mm x 190mm (14" x 7.5") in size, taking care to ease out any folds and crinkles with the fingers, and making sure that the leather lies smoothly in the mold. Rivet or sew on straps as required.

Bazubands (Islamic forearm and elbow protectors): Use either a wine bottle as a positive form or a purpose made wood form as either a positive or a negative form. A heat-protected arm can also be used, but requires a second person to help. Existing steel bazubands can also be used as nested forms, in the same way as the elbow and knee cops mentioned earlier. Begin with a kite-shaped piece of leather, measuring 300mm across the widest point, 160mm across the base, 370mm from the centre-base to the tip at the top, and 280mm down each long side (see attached image). For smaller, child-size bazubands, decrease the sizing accordingly.



Troubleshooting

It is possible to use 'selective shrinkage' to help solve problems such as where the leather has not formed as tightly as wished (for example around an elbow). By re-water-treating only a section of the leather, it is possible to further shrink it and make it slightly stretchy once more, allowing further shaping. Re-treating the leather in this way simply progresses the transformation of the leather itself, it does not re-start the process, and care should be taken to not finish up with an item which is too brittle to be of any practical use.

Resources and Sources of Information:

- <http://astelier-medieval-du-cuir.over-blog.com/article-21921258.html>
- Wax Hardened Leather Technique and article by Bob Hurley
- The Arador Armour Library
- Historical Hardened Leather ("cuir Bouilli") Technique by David Friedman
- Forum of Medieval Armoury (French)

Credit must go to the many places on the internet where I sourced the photos and the information. Their public spiritedness must be honoured - this .pdf may not be sold - it is freely offered for educational purposes only.

- JbT, 2009