



Round hides into flat leather

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The need for flat shoe upper material, with predictable stretch, set and 'memory', are well appreciated in footwear manufacture. Leather can provide these properties. Nevertheless, given the basic uniqueness of each raw hide, the degree of uniformity achieved as a result of conversion into leather is perhaps surprising.

Hides are naturally rounded and contoured to the shape of the living animal (*Figure 1*). In addition, as part of the living animal, the hide or skin also needs to allow flexibility of movement and protection, but these needs vary according to the area being covered. Some parts need to readily stretch, such as the belly areas - particularly with cows - while other areas such as the butt and backbone are thicker, more dense and less extendable. One of the first leather making tasks is to produce a flat leather, but the leather must also show greater uniformity in terms of stretch and shape retention for use within shoe making operations.

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The liming process starts to address this problem of curvature by causing a swelling, thus an opening and separation of the fibre structure. This leads to a general flattening as the fibres can move more readily towards a flat form via various stages in leather processing. However, a major relaxation occurs during the fleshing operation as the membrane-like tissues are cut from the flesh side of the hide, as these restrict and confine movement. This removal is very effective when limed hides are fleshed, and can be seen as a general flattening of the hide as it exits the fleshing machine. This is especially noticeable in the peripheral parts of the hide - bellies and shanks - and in the growthy neck areas.

The hides relax further during the deliming and bating operations as the hides deswell, with the benefits largely

Figure 1 above: Hides are highly contoured. The supported shanks in the photograph shows the peripheral hide areas that need accommodating by this 30 Kg wet salted hide during conversion into a flat leather.

maintained during the tanning process. If managed correctly, the tannage not only stabilises the hide, but also maintains a flat grain with minimised draw and growth. This flattening effect is a function of both the mechanics of the drum operation and the conditions of tannage.

During rotation, the pegs run through the mass of hides turning in the bottom of the drum, stretching the individual hides in all directions; in effect, the hides are tanned under continuous tension. This continuous stretching action induces a hide-flattening effect, and benefits in area retention if coupled with a classic tannage.

If the tannage is performed under low astringent conditions, then the tannage is not conducive to draw and growth accentuation with the associated loss of hide-spread. In addition, as the temperature rises during tannage, the lightly tanned leathers become more plastic. They can therefore relax and stretch more readily, and as more chrome fixes within the hide structure, this relaxed form becomes fixed.

Stretch: aiming for cross-hide uniformity

The other key operations in reducing curvature are the splitting and shaving operations, and changes are particularly

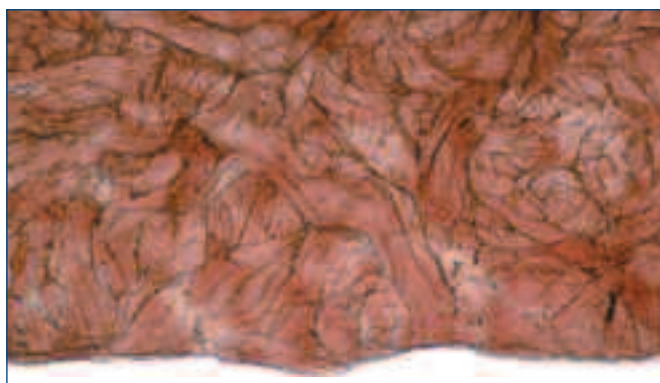


Figure 2 shows the dense collagen fibre structure of a cross section from the butt area of a raw hide.

Micrographs courtesy BLC, Leather Technology Centre

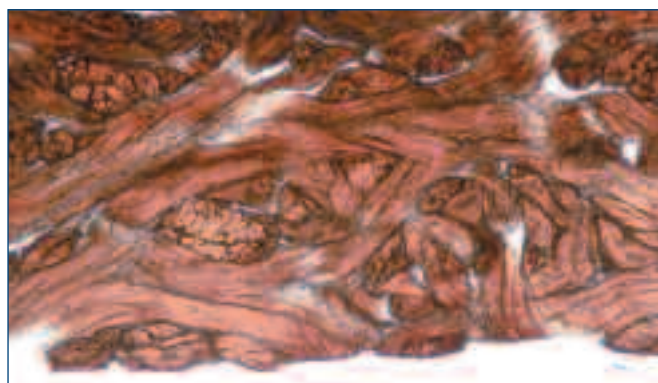


Figure 3 shows the fibre structure from the belly area of the same hide, where the more horizontal angle of fibre weave and the more open fibre structure are clearly visible.

noticeable in lime splitting. As the knife blade cuts through the fibre weave there is considerable relaxation, area gain, and a greater tendency for the hide to lay flat.

However, when splitting either in the limed or tanned state, or during shaving, this shearing action is most severe in the hide parts with naturally high substance and dense structure. In the thinner parts, such as the belly, where the fibre weave is more open and horizontal, the structure remains more intact. This major shearing in the butt and backbone areas allows those naturally more inflexible parts to become more easily stretched, moving somewhat towards the behaviour of the thinner belly sections.

A greater levelling of stretch properties is also developed during retannage as the more open hide parts can be selectively filled. This can reduce the level of stretch in the belly areas, thus improving cross-hide uniformity.

The forces applied during mechanical dewatering such as sammy-setting also plays a significant role. In this stage, the shanks and bellies are extended more than the more densely fibred central hide parts. If this form is retained during the first time drying - that is the more open fibred parts remain in an extended state - then greater uniformity is achieved in terms of stretch and softness.

Where vacuum drying is used for first time drying, as the peripheral parts of the hide need to be flat, additional mechanical effort is applied in those areas before machine closure. If toggle

drying, then the outer hide parts are pulled into the most flattened form, with the tension and flattening increasing as moisture is lost from the hide. However, in contrast, there can even be a degree of relaxation in the more centrally placed parts. The degree of firming on drying can thus be significantly less in the originally thick, firm centre areas, when compared with the naturally more soft and extensible belly parts.

Predictable shape retention and set

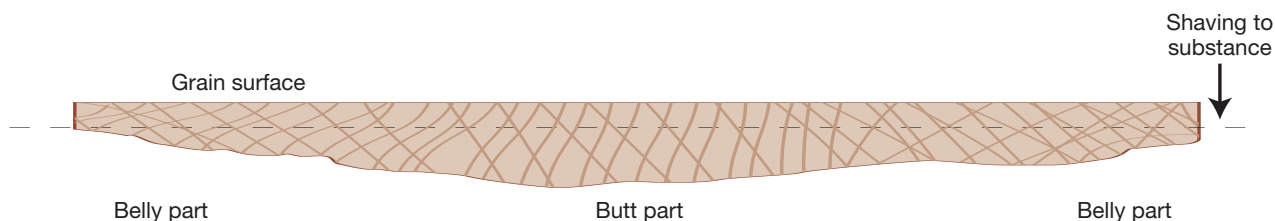
One of the properties of leather is that it shows dimensional stability after first time drying, so the shape and structure at this point becomes set, that is, it is largely maintained throughout the remaining leather processing stages. The transition from the original rounded form of the flayed hide to the flat condition is therefore almost complete by this stage.

Moreover, the outer hide parts are established in a configuration that minimises stretch, while the relaxation in the more dense butt and backbone areas provides more stretch in those parts. Uniformity is never achieved, but the leather is flat and variations in stretch across the hide have become more manageable.

Flat leather into 'round' footwear

Leather exhibits a balance between plasticity and elasticity. A

Figure 4 The effects of shaving to substance



In addition to the differences in fibre structure between the butt and belly areas as shown in photographs 2 & 3, the two parts are significantly different in substance. In the raw hide the butt parts may be twice the thickness of the belly parts.

The hides are sorted and selected in the wet blue condition to make

best use of the hide, thus only a minimum amount of substance is cut away from the belly areas. However, a large proportion of the hide structure is cut from the dense butt causing a weakening. Under given tension the butt area of the final leather therefore extends more readily, with a shift in extension/softness characteristics towards the properties of the belly parts.





Figure 5 By exploiting the elasticity-plasticity balance of leather, a flat component can acquire a new three dimensional configuration. This photo shows how a leather upper is pulled and moulded over the last on a men's Goodyear welted shoe.



Figure 6 This underneath view shows the upper bonded to the insole rib. The upper is further attached to the rib at seat and waist prior to welt sewing. The leather then uses its set properties to maintain the new three dimensional form.

Photos courtesy of Alfred Sargent & Sons Ltd.

temperature increase shifts this balance towards plasticity, so very high temperatures enable the replication of very precise moulding or configurations.

This plasticity - and resultant set - is greatly improved by high moisture content. As chrome tannage can readily withstand temperatures greater than 100°C at high moisture contents, it is eminently suited to footwear construction.

The combination of moisture and high temperature in lasting and forming allows the moulding of chrome upper leather to meet changing footwear designs. On return to normal conditions this newly contoured shape and appearance is maintained. Furthermore, as a degree of elasticity remains in the leather, not only is the shape maintained in wear, but the footwear also provides comfort. 