Leather

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Leather is derived from the hides of skins of animals. It is a remarkably durable, strong and versatile material, which in its various forms has been made into objects ranging from African shields and drums to European saddles and kinky underwear. From as early as 2700 BC until fairly recently leather was also in the forefront of information technology with its use (as skins, vellum and parchment), for writing on, and its important role in bookbinding. (Uses of leather; Figure 1).

The skins usually used are derived from cattle, goats, pigs and sheep as byproducts of the meat industry, though theoretically any skin can be used from ostrich to sharkskin or snakeskin. Closer to home, in the medical school pathology museum at Bristol University stands the skeleton of a condemned criminal, whose skin was apparantly used to bind his legal case notes.

Essentially leather consists of the modified dermis of the skin (Figure 2). The dermis, or corium in leathermaking terms, consists of the grain layer (papillary dermis) and the fibre network layer. It consits of four major components: collagen, elastin, ground substance, and the cellular components.

It is the first of these, collagen, which composes 80–85% of the dermis by dry weight, which forms the reticular network or weave of fibres, imparts much of its bulk and strength to the skin, and gives leather a unique character which to date has been impossible to reproduce artificially. The complex and random manner in which the fibres ramify is interrupted in the grain layer by the hair follicles, giving rise to the characteristic pattern or grain unique to each animal and so prized by leatherworkers. So deeply engrained (!) in human nature is the attraction afforded by the textured surface, that artificial grains may be embossed upon plain surfaces of split skins, on defective hides to give an impression of better quality, and even on artificial materials such as plastics.

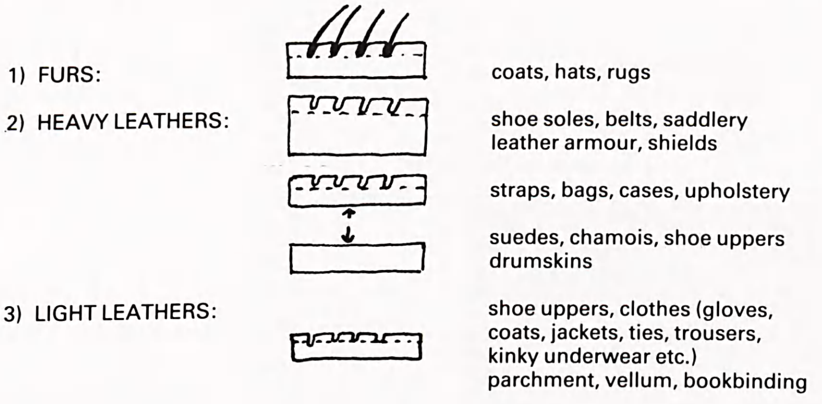

Figure 1

Uses of leather.

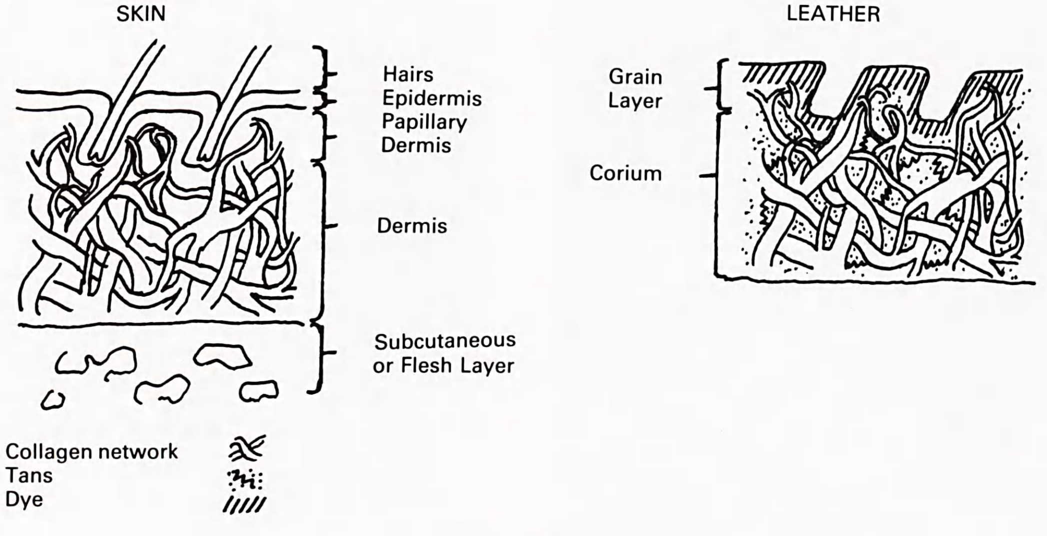

Figure 2

Structure of skin and leather

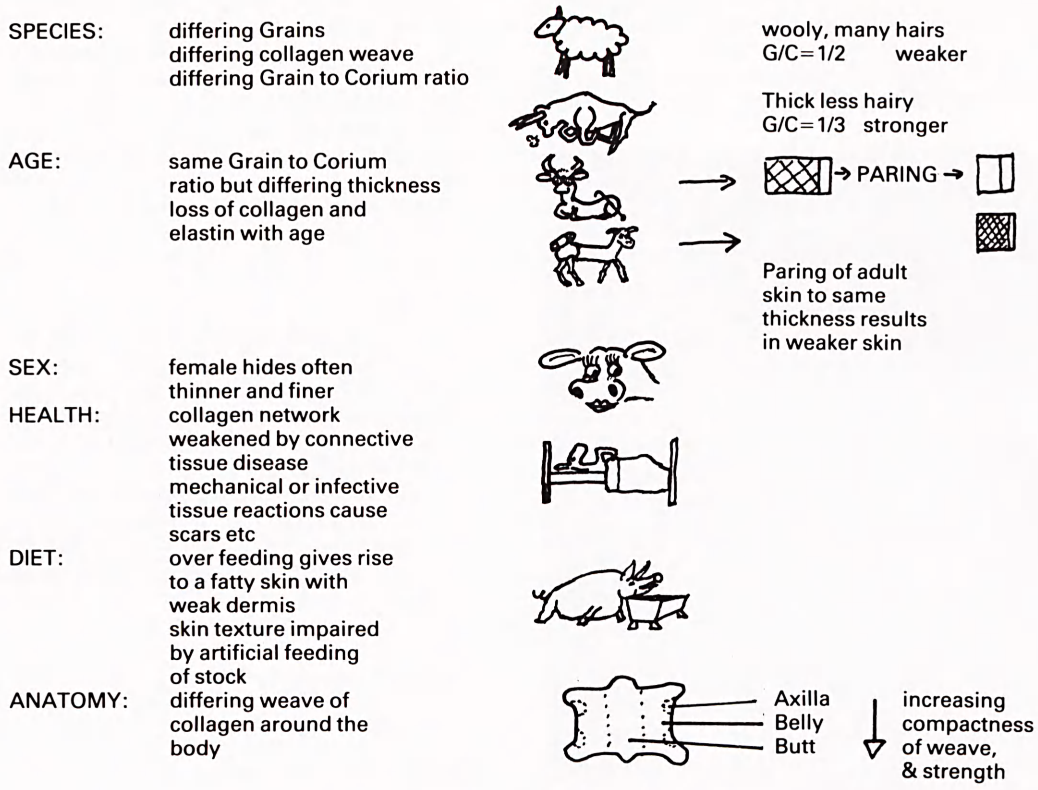

Figure 3

Factors influencing properties of animal skins and leathers

During life, skin is a dynamic structure. There is of course constant turnover of the epidermis, with an epidermal transit time of 28 days, but there is also continuous recycling and renewal of the collagen network, as well as of elastin and the stromal ground substance, by the cellular components of the skin.

With increasing age the skin of an animal increases in thickness, but the ratio between the grain layer and the fibre network layer of the corium remains constant. Since the collagen network in the grain layer is interrupted by the hair follicles it follows that the grain layer is weaker than the rest of the corium. Coupled with the fact that there is a net decrease in the amount of collagen (as well as elastin) with age, it may be seen that the skin of a young animal makes a finer, stronger leather than that of an adult which has been pared down to make a leather of equivalent thickness (see figure 3).

Other factors influencing the quality of the products that can be made from leather include the species, sex, health and diet of the animal, and the site from which the leather was taken (Figure 3).

In essence, the manufacturing process can be divided into three stages: pretanning, tanning and finishing (post tanning). However each skin may have to undergo a plethora of steps (Table 1), the exact nature and order of which will depend upon the type of skin, and the intended use of the finished product.

Pretanning involves the removal of the skin or hide from the animal, preserving, softening, and preparation for the subsequent tanning. The unwanted subcutaneous fat, and the hair and epidermis must be removed by a mixture of mechanical and chemical methods, and the fibre network of the corium must be loosened or otherwise exposed to the action of tans, by the removal of varying fractions of the ground substance.

Once upon a time, these preliminary steps required the use of such antisocial raw materials as dog or chicken dung (which supplies the enzyme trysin and aids softening of the hide and loosening of the epidermis and hair), and the beating in of oils to facilitate the tanning. The process has been developed in modern times to be rather less prolonged and a great deal less unpleasant by the use of powdered enzyme mixtures, chemicals and of course mechanization.

The tanning that follows is no less complicated. There are many different types of tan (Table 1), each imparting slightly different properties to the leather, though most have actions in each of the following spheres:

1. Increasing the number of stable bonds between collagen molecules, thus strengthening it and resisting bacterial breakdown, and oxidation.
2. Increasing the number of crosslinks between natural and added oils again increasing durability of the skin while maintaining the suppleness.
3. Filling the spaces between the collagen weave, reducing elastic recoil and enabling maintenance of the distortion caused by tooling and moulding.
4. Action of ingredients in the tanning mixture as buffers reducing damage due to atmospheric pollutants such as sulphurdioxide and exposure to human sweat etc. Other agents may directly inhibit bacterial growth.

Once tanning is completed the leather undergoes a variety of further processes (Table 1), before it is ready for its intended use.

The prayer book (Figure 4) shows the interesting use of leather to recreate the texture of skin on the hands (balsa wood and epoxy putty sculptured bookboards), and, the illustration of the binding of Vesalius' De Humani Corporis Fabrica, a magnificent collection of early, but highly accurate and ahead of their time, anatomical studies (Figure 5) shows the comparative anatomy (grains) of the skins of different

Table 1

Processes in Leather Manufacture

Process	*Function*
Pre-tanning	
Flaying	produces raw hide or skin from carcass
Curing	prevents decay
Soaking	cleans and softens
Liming	loosens hair and epidermis
Unhairing and Scudding	removes hair and epidermis
Fleshing	removes subcutaneous tissues
Splitting	produces a greater surface area and produces leathers for different uses
Deliming	neutralizes alkalinity
Bating	enzymatic softening and loosening of fibre network weave
Pickling	preserves, de-greases and corrects pH
Tanning	
Vegetable tans	tannins produce firm, mouldable leather good for bookbinding
Chrome tans	gives a soft, but less flexible leather which takes dyes well
Zirconium tans	produces white washable leather
Alum tawing	soft white leather, unstable to washing and resilient to tooling
Oil tanning	soft, stretchy leather often used for chamois leathers
Aldehyde tanning	produces a washable leather with similar properties as vegetable tans
Smoke tanning	forms aldehyde crosslinks to make durable skins used to improve the penetration of vegetable tans
Post-tanning	
Drying/Draining/Washing/Neutralizing	
Shaving	renders the thickness uniform
Dyeing	surface dyes/colouration or immersion dyes
Fatliquoring	emulsified oils give greater flexibility and softness
Setting out	removes creases which may dry in
Boarding	brings out natural grain qualities
Plating/Embossing	imparts many kinds of 'grain' patterns
Brushing	polishes the grain

Figure 4

'Philip Smith Hands' New Testament and Psalms

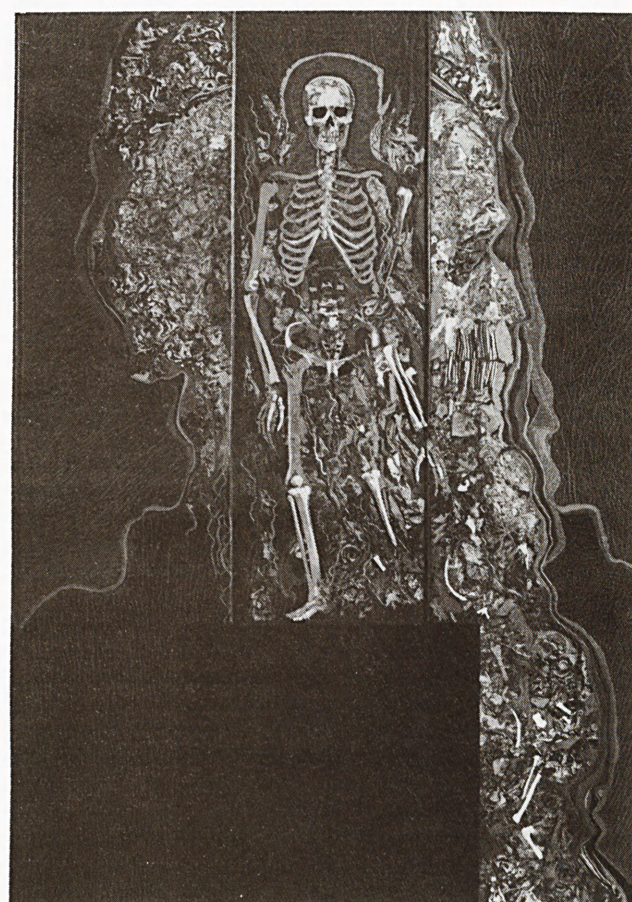

Figure 5

Vesalius' De Humain Corporis Fabrica

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THE TREATMENT OF SUBTROCHANTERIC FRACTURES OF THE FEMUR USING THE DYNAMIC HIP SCREW

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In previously reported series of subtrochanteric fractures treated by reduction and nail-plate fixation, the rate of implant failure has been between 17 and 40%. Since 1981, we have used the Dynamic Hip Screw (DHS) in preference to other devices because of its apparently improved design.

Between 1981 and 1986, 80 patients with a subtrochanteric fracture were treated using a DHS. Patients under the age of 60 with high velocity fractures and those with pathological fractures were excluded leaving 55 patients (48 female, 7 male: average age 80.5 years) in the series.

Using the method devised by the American Society of Anesthesiologists (1978), patients were assessed for pre-existing systemic disease. In 28% there was none. In 44% it was mild, in 23% severe but not incapacitating and in 5% severe and incapacitating. Their level of dependence was classified by Hall and Ainscow's system (1981) as fully independent (63%), sheltered (32%) or institutionalised (5%).

The fractures were classified by Seinsheimer's method (1978) as undisplaced (2%), 2-part (28%), 3-part (28%), 4-part (12%) or subtrochanteric with intertrochanteric extension (30%).

Reduction and fixation of each fracture was carried out in the standard manner. In 37 patients a four or six-hole plate was used: 18 had plates of eight, ten or twelve holes. The mean operating time was 77 minutes and the average intraoperative blood loss 510 mls. Each patient spent an average of 5 days in bed postoperatively before walking with a frame and was discharged 12 days later.

Fourteen patients (24.6%) died within 3 months of operation. Their mean age was 86 years. In each case the combination of fracture and operation was thought to be a major contributory factor. Each had pre-existing systemic disease and in 8 cases this was severe. Only 5 of the 41 surviving patients (12.2%) failed to return to their previous level of independence. A sheltered existence and severe pre-existing disease both predisposed to death within three months. Early death was unrelated to fracture type, grade of operating surgeon, plate length, duration of operation and blood loss.

The fixation failed on three occasions (5%). In two cases the lag screw cut out of the femoral neck due to poor placement; in one case the lower screws pulled out of the femur. This figure is significantly lower than those previously reported using other devices. There were no other major differences between the series.

We conclude that the Dynamic Hip Screw provides considerably better fixation of subtrochanteric fractures than other nail-plates. The high mortality rate is related to age, pre-existing disease and increasing social dependence but is unaffected by the method of fixation.

EXTERNAL FIXATOR OR REMANIPULATION FOR UNSATISFACTORY COLLES REDUCTION?

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We report a radiological review of 50 patients (aged 16 to 80) with fractures of the distal radius who underwent apparently satisfactory closed reduction, but on subsequent X-ray (2 to 14 days later) were found to have slipped to an unacceptable position.

25 were further treated by remanipulation and 25 with an external fixation device. The two groups were matched for age, sex and degree of displacement.

Review of X-rays at 6 to 12 weeks following the fracture shows improved correction of radial length, radial deviation and dorsal tilt in the group treated with external fixation.

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animals and different sites of origin for the leather, as well as the integration of ancient (leather) and modern (plastic Airfix model skeleton) materials.

The advent of modern methods and synthetic materials has, as in most fields including medicine, greatly affected utilizaton of older methods and materials. But, while the utilization of artificial polymer based materials has intruded substantially into the realm of footwear and the widespread adoption of the paperback book has caused the decline of leather in another very different field, the occurrence of unforeseen complications such as Juvenile Plantar Dermatosis due to the former, and the decline of traditional bookbinding with the new trend towards the artist craftsman, makes such leather products all the more desirable, and it seems unlikely that this very complex and useful substance will ever by entirely replaced.

ACKNOWLEDGEMENTS
I would like to thank Dr. J. R. Burton for his encuragement and Mr. C. P. Smith for the kind loan of photographs of his bookbindings.

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