November 2021

Making Leather

AN OVERVIEW OF MANUFACTURE

Part 1 of 10

Introduction and raw materials

Author: © Richard P. Daniels

Recommended by:

SLTC

IULTCS International Union of Leather Technologists and Chemists Societies

UNIDO
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INDUSTRIAL DEVELOPMENT ORGANIZATION

Preface:

- **This study is for people who wish to become leather technicians.**
- **It also contains information for those who need more than the most basic understanding of commercial leather manufacture.**
- **It follows the processes and operations used, and their purposes, for making leather from bovine hides, sheep and goat skins.**
- **It is intended for self-training and distance learning within the global leather sector.**
- **It is also, a base within formal education for discussion and expansion by suitably qualified staff.**

- **Information is set down in condensed form using a mix of headings, images from within the industrial environment, captions and text.**
- **It is a 10 Part series.**
- **Designed for use via smart phone and for larger display.**
- **Intended for use and dissemination free of charge.**

- **This is not an academic or chemistry-orientated work: content of that type is available elsewhere.**
- **This study provides a clear overview of technical manufacture.**
- **It’s about making leather.**

Acknowledgements:

- **Paul Evans: Leather technologist, leather manufacturer, finishing expert and lecturer in leather technology. We worked together within consultancy and education. In particular, thanks Paul for your peer review, and keeping me on track as this study was being brought together.**
- **Walter Landmann: Engineer specialist in tannery machinery and design. Shared experiences throughout my time in leather making and technical publications. Appreciate the enlightenment Walter, and for the provision of machine drawings.**
- **Amanda Michel: Microscopy and leather specialist. We worked together within industrial problem solving and projects. Thanks Amanda, for creating the micrographs used in this study.**
- **Richard Daniels: Leather manufacture, environment and technology transfer. Layout and design, schematics, images and panels unless credited otherwise. Images from around 80 industrial locations - mainly Africa, Americas, Asia, China, and Europe.**
- **Part 5: Application of the finish: Authors Richard Daniels and Paul Evans.**

Content of Series:

Part 1: Introduction and raw materials.
Part 2: The removal of unwanted materials and extension of the structure.
Part 3: The introduction of new materials and extension of the structure.
Part 4: The removal of water and reconfiguration to a flat form.
Part 5: Application of the finish.
Part 6: Different types of bovine leathers.
Part 7: Small skins: hair sheep and goat: grain leathers.
Part 8: Small skins: wool bearing sheep: double face, shearling and rugs.
Part 9: Discussion.
Part 10: Annex.

Additional information:

Full size copies of Schematics 1(a) and 1(b) presented in "Overview" are held in Part 10: Annex. Printing is recommended for ease of reference.

Two advanced studies designed for the Leather Technologist are undergoing edit, with completion targeted for 2022.

i] "Making Leather: THE TECHNOLOGY OF MANUFACTURE".

Central are the properties of hides and skins undergoing the leather making process, and the management of physics and chemistry to advantage.

ii] "Making Leather: FINISHING TECHNOLOGY TO SPECIFICATION".

The objective is to provide knowledge and ability to meet customer needs in terms of aesthetics and performance to specification.

Summaries are set down in Part 10: Annex.

RAW MATERIALS

Bovine hides*, and skins from sheep and goat are used for the manufacture of leather.

Leather is a major resource based on this natural raw material.

It is used for a vast range of purposes.

Leather offers impressive physical performance combined with classic aesthetic characteristics.

** Buffalo hide processing is an important part of leather making. Details for preservation and leather manufacture are essentially the same as processing cattle hides. However, the grain structure is distinctive, setting some restrictions on end use. Similar restrictions also apply to pigskin, being significant in volume too.*

Cattle, sheep and goat are reared globally

Argentina: cattle from ranching.

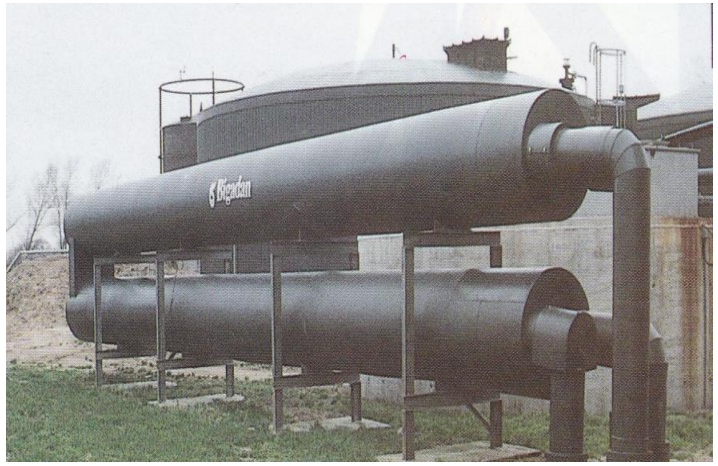
Zimbabwe: sheep and goat flocks.

- **Cattle, sheep and goat are valued for their meat, milk, dairy products, wool and the nutrition they provide.**
- **They are never bred or husbanded for the value of the hides and skins.**
- **Ultimately, skins are a putrescible waste from the meat industry.**
- **When there is no demand, skins are dumped or sent for landfill.**

Hide and skin uses

Dog chew products ?

Bio-gas generation with other wastes ?



- **Few alternative uses apart from gelatine manufacture, sausage casings, texturing in food production, and waste disposal.**
- **Other options can include bio-gas production, fertiliser or fish / animal feed supplements.**
- **These options destroy the world's only natural raw material that offers a strong and usable interwoven fibre structure.**
- **Can be converted into a viable product with significant end uses.**

Global meat production

The global herds and flocks total around 1 billion cattle, sheep and goat respectively.

Each year approximately 300 million cattle, 540 million sheep, and 440 million goat are slaughtered for food.

Residual from this meat production are:

- **300 million bovine hides at 25 Kg weight average.**
- **540 million sheep skins at 1.5 Kg weight average.**
- **440 million goat skins at 1.5 Kg weight average.**

(Based on global meat production 2008 – 2017: Food & Agricultural Organisation of the United Nations)

Between 7 and 8 million tons of problematic waste

- **Sufficient waste to create three pyramids the size of the Great Pyramid of Giza !**
- **Enough to cover an area of 7 to 8 sq km to a depth of 100 cm.**
- **Or a sustainable resource offering significant value in many applications.**

(Image: credit unknown)

Hides and skins in leather manufacture

Hides:

Refers to skins obtained from mature cattle. These are heavy and have a large area and thickness.

Leathers made from hides are mainly used for footwear, automotive purposes and furniture, larger size leather goods, clothing and industrial applications.

Skins:

Refers to skins from smaller animals such as goat and sheep. These are relatively light in weight, and have a small area and thickness.

Leathers from skins tend to be used for clothing, footwear, bags, small leather goods, and gloves.

The collagen structure

The complex skin structure.

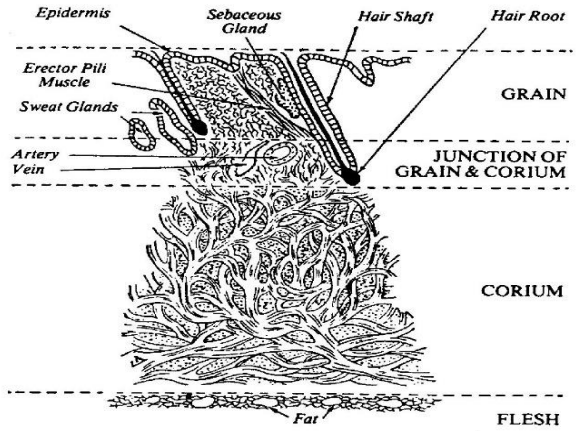
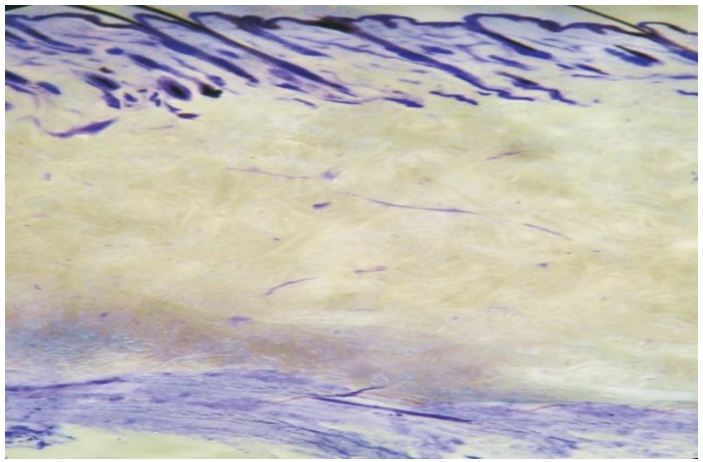


Image: grain and corium sections ***(x20 mag).***



- **A strong interwoven collagen structure is found within all hides and skins.**
- **In leather making, this is isolated as a base for the various leather types.**
- **It is central to all leather properties.**
- **Various other skin components need removal in the early stages of manufacture to release this complex matrix.**
- **The two parts of the structure that are of use in making leather are the grain and corium sections.**

(Diagram: Credit J.H.Sharphouse – Leather technicians handbook)

The grain layer:

The grain has a hard outer layer known as the epidermis, with hair embedded in follicles reaching down into the skin structure. With the exception of sheepskins, where the wool may be of value, hair and the epidermis are chemically removed in the early stages of processing.

The basic structure of the grain is a densely interwoven fibrous tissue made from the protein collagen. This provides a fine, flexible and sensitive structure that is the key to good leather quality and the characteristic appearance of each leather type.

The corium:

The corium supports the grain layer and is relatively thick. The structure is fibrous, strongly interwoven but coarse. The density and interlacing of this collagen matrix varies according to the animal species and the different areas across the skin.

The angle of weave of these fibres strongly influences the hardness and stretch characteristics of the leather, and provides basic strength. These properties are modified during leather manufacture.

The junction:

The junction between the grain and corium is sensitive to both bacterial attack and mechanical stress. A weakening of this component can result in reduced grain support leading to poor appearance on folding and flexing.

The flesh layer:

The raw skin carries flesh residues that are cut away in manufacture. Veins, fats and non-fibrous proteins are also contained within the matrix and are mainly removed in processing.

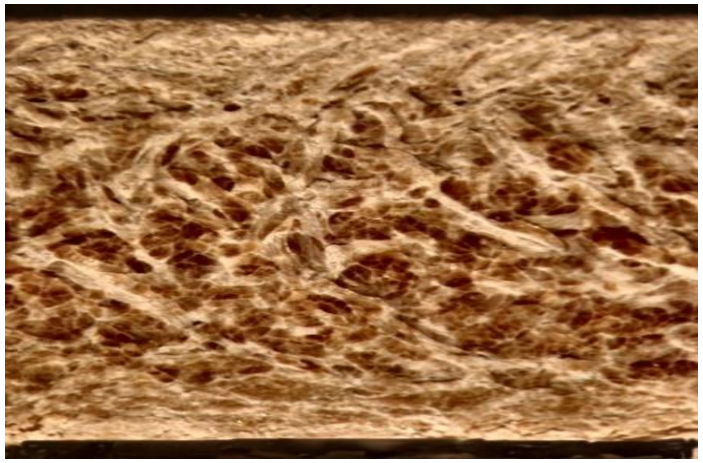
The diagram and image *(1:14)* show these features, but the details are difficult to observe in raw skins.

However, once unwanted components are removed in early processing and leather making complete, the delicate structures of the grain and corium can be clearly observed.

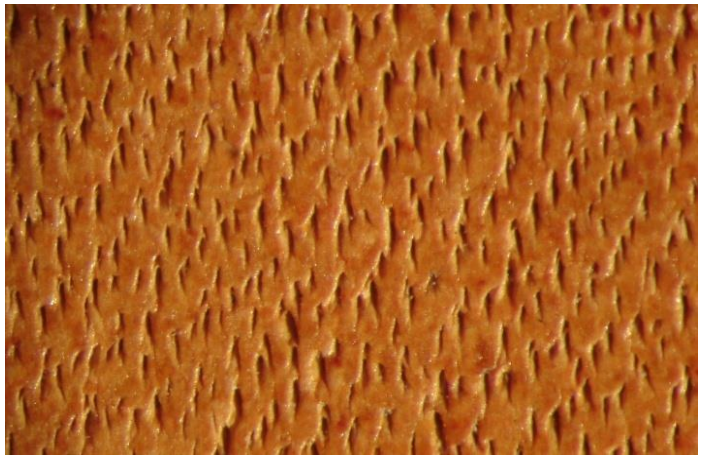
Examples follow showing the structures and grain surfaces of leathers made from bovine hides, and goat and sheep skins:

Leather made from bovine hide

Cross-section of bovine leather ***(x20 mag).***



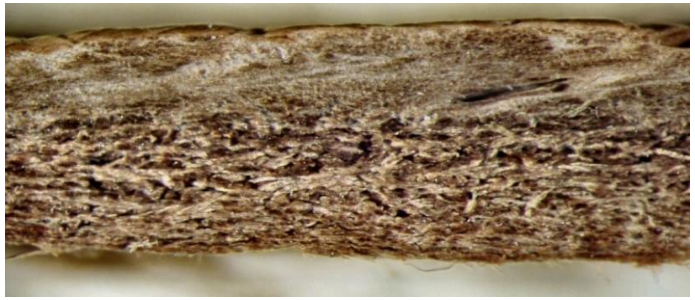
Grain surface of bovine leather ***(x20 mag).***



- **The section shows the isolated and tanned fibre matrix at the end of leather making.**
- **The dense top layer is the grain layer.**
- **The more open structure is the corium.**
- **This intricate structure is central to strength and comfort in use.**

Leather made from goat skin

Cross-section of a goat skin ***(x20 mag).***

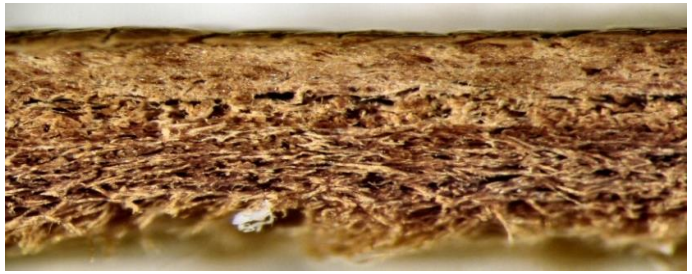


Grain surface of a goat skin ***(x20 mag).***

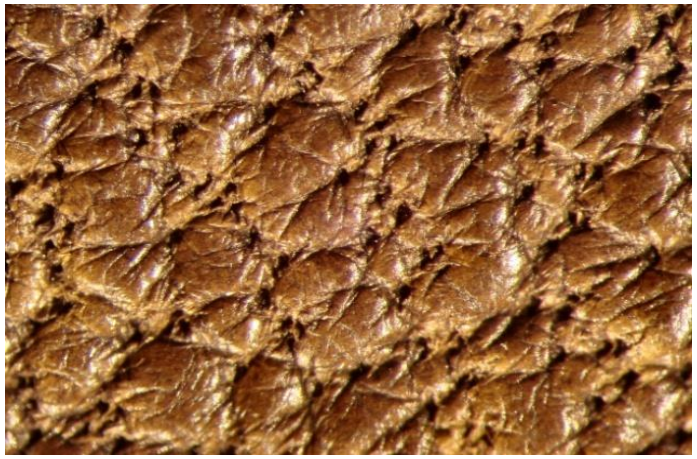
- **With goat skins, the grain layer is particularly tough and fine, and the corium more dense than a bovine structure.**
- **The grain surface is well defined and carries a characteristic pattern.**
- **This is a very tough product ideally suited for the wear and tear required of small leather goods.**

Leather made from domestic sheep skin

Cross-section of a domestic sheep skin *(x20 mag)*.



Grain surface of a domestic sheep skin *(x20 mag).*



- **Domestic sheep skins are similar in size to goat skins, but the structure is less compact.**
- **This is due in part to the high level of natural fat contained throughout the skin.**
- **After fat removal in leather making this leaves voids throughout the structure.**
- **Also, the animal has been bred to provide wool, and the structure reflects this role.**
- **Can result in very soft leather but with lower tensile strength.**
- **The skin structure/hair of hair sheep is more similar to a goat than domestic sheep.**

Hide and skin variations

There are many variations found within hides and skins prior to leather processing.

These differences are due to species, environment, welfare, age and post-mortem damage.

They affect the potential use of each hide and skin in leather making.

Zebu cross breed cattle in Brazil.

Dairy cattle Sweden.

- Variations and uniformity are dependent on the breed, geo-climatic conditions, husbandry, type of feed stuff, time of year, sex and age of the animal.
- Also veterinary attention, health and general husbandry.
- All these factors influence the quality and texture of meat, but also the quality and properties of the skin structure.
- This influences the suitability of each hide in leather making, and the potential end-use.

Flock of hair sheep and goat, Eritrea.

Wool sheep, Iceland.

- This applies to sheep and goat skins too.
- Goat and hair sheep – bred for milk and meat - are very similar in appearance, and skin structure.
- Wool sheep – bred for the quality of wool and for meat – are clearly different to both goat and hair sheep.
- This is reflected in a higher grease content, and more sensitive, thicker, and open skin structure.

Every skin is unique, each with its own characteristics and structural differences.

And there are variations across each individual skin too. The butt area is relatively thick with a densely woven fibre structure, whereas the belly and shoulder areas are thinner, less dense and will stretch more readily.

With bovine hides and goats the natural fat contents are relatively low, say 2 – 4%, but with sheep the fat content can be more than 20%.

When this fat is removed weakened spaces are left within the structure.

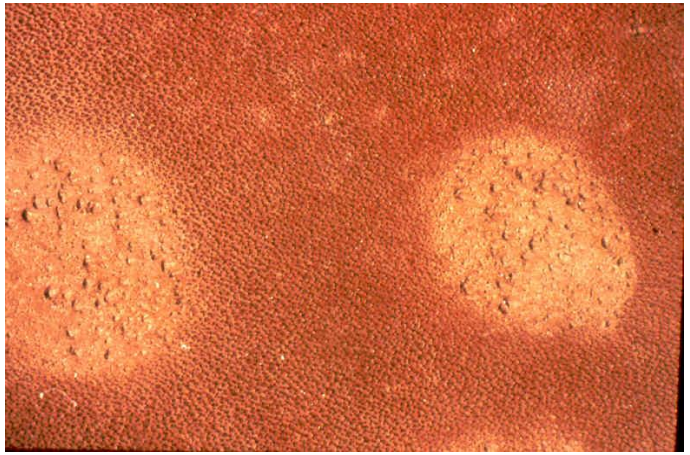
The quality and uniformity of these materials can be reduced by many factors.

Damage from protective horns.

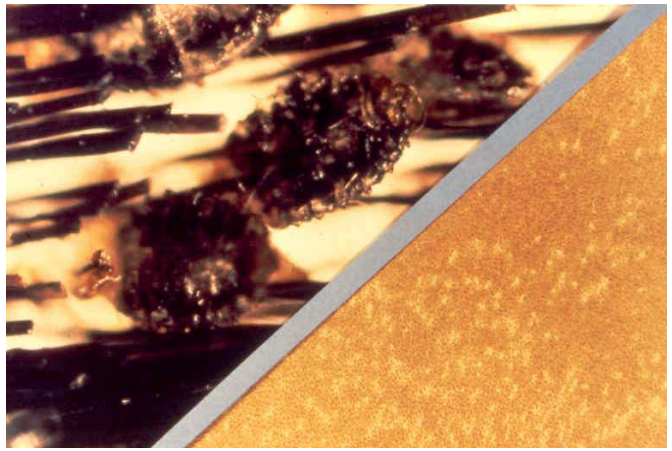
Scarring from branding.

- There is also life damage to take into account.
- This can be due to many causes - natural defence, thorns and general abrasions.
- But there can also be damage caused by their management - branding, prod marks, barbed wire, transit and lairage.

Grain damage by ringworm.



“White-spot” infestation/damage.



- And there is damage from disease and infestations.
- Veterinary services and good animal welfare can minimise these forms of damage.
- All influence the potential quality, cutting values and utilisation of the finished leather.

(Images: credit unknown)

Hide and skin preservation

As part of meat production, the carcass is hoisted by the hind legs and bled from a throat incision. This improves the colour of the meat, but it also removes a component from the skin that can readily putrefy.

Cuts, or markings, are carefully made in the skin to assist in flaying *(stripping)* the hide from the carcass, and to maintain a uniform hide/skin shape. The hide is then removed from the carcass by mechanical pulling or by hand.

Skin damage can result from excessive tension caused by pulling smaller carcasses, while hand flaying requires a considerable amount of lateral cutting in separating the skin from the meat and fat. Flay damage can include deep cuts, gouges and holes in the flesh side of the skin, affecting the potential thickness *(substance)* obtained from the final leather.

Hides and skins are susceptible to putrefaction after animal slaughter.

Over and above processing fresh hides, there are four main options available to prevent decay, and to preserve the integrity of this complex protein structure.

Preservation by wet salting

Application of salt on small scale.
(Usually a mechanical operation)

Hides can be stored for long periods.

- **Ideally, hides are washed, chilled, and the surplus flesh removed by a fleshing machine.**
- **They are preserved by applying salt to the flesh side, then stacking in piles.**
- **The salt absorbs water from the skin, which drains away as a brine solution over many days, causing partial drying.**
- **A liberal application of salt ensures good water removal and inhibits bacterial activity, thus safeguarding the skin against further bacterial action**
- **Wet salted hides can be stored for long periods of time under cool and dry conditions.**

Wet salted domestic sheep.

Storage times may be long.

- Similarly, small skins can be preserved by wet salting.
- The use of sheep and goat for human consumption often varies, according to times of fast and feasting.
- Accordingly, there are periodic shortages and oversupplies of small skins.
- For this reason long storage times are common to regulate supply and manufacture.

Preservation by brining

Raceway for brine preservation.

Brined hides awaiting process.

- Strong salt solutions can be used for preservation.
- Brine curing is a fast technique suited to high volume throughput and is commonly used in the USA.
- Immersion in concentrated brine solution is required until penetration throughout the structure is achieved.
- Rotating paddle blades keep hides/skins and solution in motion.
- Removal from raceway is by movable conveyor.
- Once drained, goods can be lightly salted.

Preservation by air drying

Hides air dried under light tension.

Cutting away residual tissue on drying frames.

- If salt is not available hides and skins can be stretched on a frame and dried in the shade.
- This is particularly successful for smaller enterprises in hot climates.
- The taut vertical presentation during drying allows careful removal of any residual flesh.
- This improves drying and provides a very clean structure.
- Delays before preservation, or a slow drying rate, increase risks of bacterial damage, especially to the sensitive grain layer.
- Air drying ensures very long storage times.

Preservation by dry salting.

Air drying lightly salted skins.

Example of dry salted small skin.

- **Dry salting is another method of preservation used in hot climates.**
- **As the first step in preservation hides and skins are lightly salted to stop putrefaction.**
- **They are then air dried, where the loss of water ensures long term protection.**
- **Wet salting produces the best result, but air drying and dry salting are very useful techniques.**

Processing fresh hides

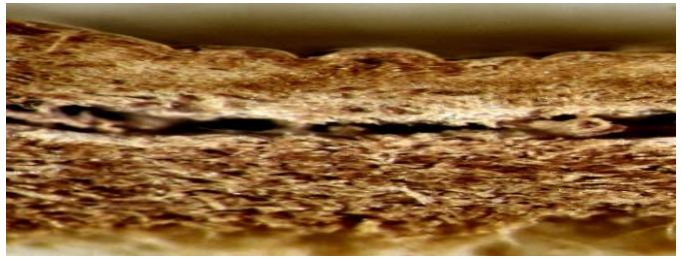
Packaged and palletised fresh hides.

Line-conveyor receipt of fresh hides.

- **Hides are increasingly processed without preservation.**
- **Fast reliable transport and close liaisons between abattoir and tanner are essential to avoid putrefaction.**
- **Ice chilling is often part of these systems.**
- **High level of organisation at the tannery required for receipt, assessment, gradings, and input.**
- **Avoids use of any preservation – saves materials, labour, and waste.**

Putrefaction damage: extreme example showing delamination.

Breakdown of grain and corium junction with domestic sheep skin.



- Poor preservation can cause many problems in leather making.
- Often not obvious in the preserved state, this is exposed in process.
- It may lead to holes throughout the structure or delamination of the grain from the corium.
- There may be more subtle fringe effects that remain undetected until manufacture is complete.

Heavily finished leather with good grain characteristics.

Heavily finished leather with poor grain break.

- **Low level putrefaction may result in a scuffed grain appearance that is not detected until leather is dyed or even finished.**
- **Damage within the main structure can lead to poor appearance on folding *(break)* or flexing.**
- **All a loss of potential and a down grade of quality for end use.**

Review:

Hides and skins are putrescible waste from the meat industry.

There are limited uses for this material apart from leather manufacture.

Each skin has an intricate structure that can be converted into a wide range of leathers.

Continues as:

Making Leather

AN OVERVIEW OF MANUFACTURE

Part 2 of 10

The removal of unwanted materials and extension of the structure