WHAT IS A TANNERY?

Tanneries are leather processing units that comprise chemical and mechanical processes alongside waste treatment.

Tanneries can be classified by size

- **small**: up to 500 hides/day
- **medium**: 500 to 2,000 hides/day
- **large**: more than 2,000 hides/day

Types of tannery

- **Complete**: from raw to finishing
- **Tanning**: from raw to tanning (also called blueing; can also be white tanning and vegetable)
- **Wet End**: from tanned leather to crust (or to finishing)
- **Finishing**: from crust to finishing

THE DIFFERENT STAGES OF LEATHERMAKING

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw hide</td>
<td>fresh, brine cured or salted hide, wet</td>
</tr>
<tr>
<td>Tanning</td>
<td>hide stabilization by chrome, white tannage or vegetable, wet</td>
</tr>
<tr>
<td>Crust</td>
<td>leather processed after tanning to give color and properties, dried</td>
</tr>
<tr>
<td>Finishing</td>
<td>crust with coatings to change its properties; mechanical operations to change surface appearance</td>
</tr>
</tbody>
</table>
TYPE OF WORK CARRIED OUT IN A TANNERY

- **Leather processing** – conversion of hides into leather, grading, packaging and shipping
- **Product development** – new colors and leathers; fashion items and new products
- **Process optimization** – time, water, energy, chemicals and waste reduction
- **Environmental control** for liquid, solids, air
- **Safety of** equipment and of workers
- **Chemical hygiene plan**, proper chemical handling, including safety audits
- Physical and chemical **testing of leathers**
- **Maintenance of the equipment** – keeping it safe and functional
- **Production flow management** – optimization of time and resources
- **Quality control** of incoming raw materials, processes and finished products
Each stage of the process that takes raw hide to crust is done in batches. Wood and polypropylene drums offer the mechanical action needed for the chemicals to react with the hides or leathers. Mixers (‘Canbar®’) can be used in the beamhouse.
- The beamhouse drums can have **20 t** (20,000 kg) capacity; mixers up to **12 t** (12,000 kg)

- The wet end drums are **smaller, up to 10 t** (10,000 kg) capacity.

- **Modern tanneries have automation for dosing** cold and hot water and liquid chemicals. They also have automated process control: duration, drum rotation, drainage, opening and closing of the doors.
TYPICAL BEAMHOUSE (RAW TO TANNING) DIAGRAM

FULL SUBSTANCE

Soaking → Unhairing → Fleshing → Deliming → Pickling → Tanning → Wringing

LIME SPLIT

Splitting → Deliming → Pickling → Tanning → Wringing
TYPICAL BEAMHOUSE (RAW TO TANNING) PROCESS

- **Soaking**
  - Hides are cleaned to remove dirt, some fatty materials and soluble proteins

- **Unhairing**
  - This procedure removes the hair and epidermis. Also called 'Unhairing and Liming' because lime is used

- **Fleshing**
  - Mechanical process to remove the endodermis and fat from the inner part of the hide. Mostly fully automated

- **Deliming**
  - Chemical process to remove the alkalinity and lime. Enzymes are added for softening (bating)

- **Pickling**
  - Salt, organic salts and acids are added to prepare the hide for tanning

- **Tanning**
  - Chrome, vegetable and synthetic tanning agents (eg, glutaraldehyde) are added to convert the hide to leather

- **Set out**
  - Automated mechanical process that removes water and adjusts leather to 50% - 60% moisture
BEAMHOUSE MACHINERY

**FLESHING MACHINE**
This removes the endodermis and fatty material of the hide, preparing it for the next steps.

**SPLITTING MACHINE**
Equipment used to split the hide into a top part (grain side) and a bottom part (flesh split). This step is either carried out after fleshing (as in the photo), or after tanning.
<table>
<thead>
<tr>
<th>Process</th>
<th>Chemicals and Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soaking</td>
<td>- Soda ash, magnesium oxide, enzymes, bactericides, wetting agents and emulsifiers</td>
</tr>
<tr>
<td>Unhairing</td>
<td>- Sodium sulfide, sodium sulfhydrate, lime, enzymes, degreasers, emulsifiers, penetrants</td>
</tr>
<tr>
<td>Fleshing</td>
<td>- Mechanical process only</td>
</tr>
<tr>
<td>Deliming</td>
<td>- Ammonium sulfate or chloride, organic acids, carbon dioxide, acid salts, degreasers and enzymes</td>
</tr>
<tr>
<td>Pickling</td>
<td>- Common salt, organic acids, sulfuric acid</td>
</tr>
<tr>
<td>Tanning</td>
<td>- Mostly chrome (III) sulfate, tannins, syntans and glutaraldehyde. Fungicides are added here to protect leather against mold</td>
</tr>
<tr>
<td>Set out</td>
<td>- Mechanical process to adjust leather moisture to 50% - 60%</td>
</tr>
</tbody>
</table>
Tannage is essential for stabilizing the hides. After the first and main tannage the leathers can then be re-tanned with other chemicals to change their properties. Chrome leathers are commonly re-tanned with vegetable extracts.

**VEGETABLE**

This is the oldest method of tanning, dating back more than 2000 years. It uses only natural plant extracts. These leathers are light brown in color and dense, making them suitable for shoe uppers and soles, belts, handbags, watch bands, and leather goods. They keep their shape very well and age beautifully.

**CHROME**

Was developed in the 1900s. The process uses chrome (III) salts and produces leathers of a blue color that can be dyed to a range of other colors. Produces soft to medium temper leathers. Can be used for a variety of articles from garments, upholstery, shoes, handbags, to other leather goods. It is the most common tannage, accounting for about 80% of leather produced. The intermediate product of the leather is called ‘wet blue’.

**WHITE** (chrome-free)

Most white tannage is made using a synthetic product called glutaraldehyde. It produces a leather that has a light-yellow coloration. This leather needs to be processed further with other chemicals like vegetable extracts, syntans, acrylics to give a final level of finish and performance.
Chrome tannage uses mostly chrome (III) sulfate – the worldwide industry standard is a soluble green powder that contains 26% Cr₂O₃. Leather made with chrome has a distinct blue color and it is called ‘wet blue’ during the wet stage. Wet blue leathers can be packed wet and stored for long periods of time, up to six months. It is a widely traded valuable global commodity. A container can hold about 800 wet blue leathers (USA).

Chrome leathers need to be stored wet, at about 60% moisture. If it dries out it cannot be re-wetted for successful use. Storage is important to keep the leathers at a uniform level of moisture to avoid staining and a dried-out surface that will have different properties.
After liming, hides (full thickness or lime split) are treated with chemicals to remove the lime (deliming process), then treated for six to eight hours with a salt + acid solution called pickle to prepare them for tannage. Usually 6% chrome (III) sulfate is then added for the tannage that takes eight to 12 hours. An alkaline product is added during tanning to increase the pH to about 3.8. This increase in pH along with process temperature increase (up to 48°C) will complete the tanning reaction, optimizing the chrome fixation and reducing the amount of chrome in the effluent. After tanning, the chrome solution is usually recycled to minimize waste. The total tanning process takes 20 to 24 hours. The chrome tannage itself is relatively simple; the challenge is to be uniform from batch to batch.

When the tanning process is complete, a few pieces of leather are removed from the batch and put in boiling water for three minutes – the shrinkage temperature test that will determine if the tanning has been completed correctly. The leather should not shrink more than 5%. The pH is usually between 3.6 and 3.8; the color remains blue.

When the tanning is complete, the wet blue is dumped from the drum or mixer and put in boxes or on a chain that will bring it directly to the wringer. The wringer is a press felt machine that will squeeze the excess water out of the wet blue, leaving it with about 60% moisture. The leather will be flat and light blue in color, ready for further processing or packaging.
WET BLUE LEATHER CHARACTERISTICS

- Can be made with lime split hides or full thickness hides.
- Can be split after wet blue. Grain side and split can be sold separated.
- Can be sold by piece (based on type) or by area (m² or ft²)
- It is graded after production. See our section on grading.
- Sold as a whole piece or as sides (halves).
- Downgraded by natural defects, barbed wire cuts, wrinkles, fine hair, color, being misshapen, machine damage, grain damage, pigmentation.
- Leather needs to be treated with fungicide to avoid mold growth that will cause staining.
- Proper packaging and storage conditions are important to maintain the quality of the product to avoid stains and drying.
- Typical sizes are from 3.5 m² to 5 m² (38 ft² to 54 ft²).
Vegetable tannage is the oldest commercial method of making leather. Vegetable-tanned leather items have been discovered that date back 4,000 years. Only natural plant-derived materials, extracts called ‘tannins’, are used for the tannage: roots, leaves, fruits, bark, wood and seeds.

The chemical components from the plant extracts are called ‘tannins’, natural complex chemicals whose main function is plant protection. Common black tea (Camellia sinensis) contains tannins too; if you use enough, it can produce leather!

Today the majority of vegetable tannins are extracted from cultivated plants. Each tannin extract has its own properties of color, reactivity, softness, fullness, penetration, etc, and it is usual to use them in blends to achieve the leather properties required.

For industrial production, the plants are ground, and the tannins are extracted by hot water at low pressure, concentrated and then converted into powder (spray dried). Tara pods are dried and ground only. Factories are very modern and use raw materials from sustainable sources.

Typically, the tannins react slowly with the hides at a pH above 5. They are fixed to the hide at lower pHs of around 3.5.

For a full tannage, about 30% of powdered tannin (from quebracho, chestnut or wattle) is needed.

Tannins can be used as the main tanning and also the retanning agent, as we will discuss later in the Retanning slides.
MAIN SOURCES OF VEGETABLE EXTRACTS

<table>
<thead>
<tr>
<th>Plant part used</th>
<th>Countries</th>
<th>Chestnut</th>
<th>Mimosa</th>
<th>Quebracho</th>
<th>Tara</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>Italy (and across Europe)</td>
<td>Castanea sativa</td>
<td>Acacia mearnsii</td>
<td>Schinopsis lorentzii</td>
<td>Caesalpinia spinosa</td>
</tr>
<tr>
<td>Bark</td>
<td>Brazil, South Africa</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>Argentina, Bolivia, Paraguay</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pods</td>
<td>Peru and Bolivia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TRADITIONAL VEGETABLE TANNING IN TANKS

The oldest tanning system is these days mostly used for full thickness hides. The process consists of a series of tanks that start with a low concentration of tannins, gradually increasing to higher concentrations.

The hides are hung by the backbone to a rack (other parts of the hide can also be used for hanging them up, such as the croupon or shoulders). This rack of hides is transferred daily on a monorail from one tank to the next, which always has a higher tannin concentration. A tannery can have up to 100 tanks. Every day new hides are put in the first tanks, and leather is taken out of the last tanks. The process from first to last tank can take between 20 to 30 days.

Upon completion, the leathers are washed and lubricated with natural oils to increase their softness. If leathers are being made into shoe soles, then chemicals are added to increase density, water resistance and flexibility.

This system is still used in Italy and other parts of the world to produce the finest leathers. It’s a process that needs daily adjustments of the tannin concentration and its pH, seemingly simple but requiring much expertise and analytical work.

Very little waste is generated by this process.
After unhairing and fleshing, sometimes splitting in full or sides, the hides are transferred to a wooden or polypropylene drum. The first phase of this process is deliming to lower the pH and remove the lime, followed by pickling and conditioning, that reduces the affinity of the tannins to the hide.

Tannage starts by creating a slow reaction between the tannins and the hide. This reaction allows the augmented penetration and fixation of the tannins. This process can take 24 hours for thin leathers and up to four days for sole leather. The tanning needs to be slow to avoid drastic reactions that can be detrimental to the finished quality.

While the tannins can be a mixture of quebracho, chestnut and wattle, other auxiliary chemicals such as syntans are usually used, too. This process is faster than tanks, and also yields good quality leathers.

Technology is evolving. Today, vegetable leathers can be very soft, lightweight and high performing.
The manufacture of vegetable-tanned leathers is more complex than for chrome leather

The leathers produced using vegetables are usually heavier and firmer than chrome leathers. The reaction of the vegetable extracts to the hide must be very well controlled in order to produce the proper penetration and fixation of the tannins. If the reaction of the tannins with the hide is too quick it will induce a shrunken effect in the hide, making resulting leathers non-uniform and with a pebble effect.

The tannins react with metals creating colored compounds, dyes, that are often impossible to remove. Tanneries must be well managed to avoid staining. Drying vegetable leathers is also an art and most of the time natural drying is used as force-dried leathers tend to break when folded. Vegetable leathers can be dyed in light colors after re-tan with syntans and are excellent used for shoes, boots, leather goods, embossing, engraving, bookbinding, saddlery and crafts.
These are alternative tannages to chrome and vegetable. The main chemical used is glutaraldehyde; others are aluminum, zirconium, triazines, aluminum silicates and syntan-vegetable. Metal-free leathers as defined in EN 15987 are required to have less than 1000 ppm total metals (Cr, Al, Ti, Zr and Fe). The main objective of this tannage is to achieve enough thermal stability to be able to shave the leather. It is not a true tannage, and the process needs completing with a heavy re-tannage. These leathers are more expensive than chrome-tanned examples. In terms of waste and recycling this tannage has the advantage since there are no risks of waste converting into chrome (VI), while chrome is not a renewable material.

The main use of wet white is in the automotive industry, where leathers can be used in parts of the car that require thermal stability, mainly for dashboards and seats.
## DIFFERENT TANNAGE PROPERTIES

<table>
<thead>
<tr>
<th></th>
<th>CHROME</th>
<th>VEGETABLE</th>
<th>WET WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color of the intermediate</td>
<td>Blue</td>
<td>Light brown</td>
<td>Light yellow</td>
</tr>
<tr>
<td>Lightfastness</td>
<td>Excellent</td>
<td>Good/Fair</td>
<td>Good</td>
</tr>
<tr>
<td>Temper (softness)</td>
<td>Soft to medium</td>
<td>Medium to firm</td>
<td>Medium</td>
</tr>
<tr>
<td>Print retention</td>
<td>Poor</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Versatility</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Waterproofness</td>
<td>Possible</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Elongation</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Mechanical properties</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Soil resistance</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Washability</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
The hide (or leather) in the wet stage can be split horizontally after hair removal or tanning by a large ‘splitting machine’ making two uniform slices.

The top side is called ‘grain side’ and the bottom part is called ‘split’ or ‘flesh side’. The grain side is the most used, to make full grain leathers. The flesh side can be finished or used as suede leather.
MEASURING THICKNESS

The millimeter (mm) is the most common thickness unit for leather. Leather thicknesses usually have a range of 0.2 mm, for example: 1.1 to 1.3 mm, 1.2-1.4 mm; 1.4-1.6 mm; 1.6-1.8 mm; 1.8-2.0 mm, and so on.

The splitting process reduces the thickness. The shaving machine is used to uniformize leather thickness at the wet blue, vegetable or wet white (as in our photo) stage. Manual or automated thickness meters are used. They can be used as stand-alone instruments or be wireless or cloud-connected devices.

EXAMPLE OF OTHER LEATHER THICKNESS UNITS

<table>
<thead>
<tr>
<th>LETTER</th>
<th>OUNCE</th>
<th>INCHES</th>
<th>MILLIMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/64”</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>LL</td>
<td>2</td>
<td>1/32”</td>
<td>0.80</td>
</tr>
<tr>
<td>LM</td>
<td>3</td>
<td>3/64”</td>
<td>1.20</td>
</tr>
<tr>
<td>HM</td>
<td>4</td>
<td>1/16”</td>
<td>1.60</td>
</tr>
<tr>
<td>HH</td>
<td>5</td>
<td>5/64”</td>
<td>2.00</td>
</tr>
<tr>
<td>HHH</td>
<td>6</td>
<td>3/32”</td>
<td>2.40</td>
</tr>
</tbody>
</table>
TYPICAL FLOW DIAGRAM OF WET END

LEATHER

Splitting ➔ Shaving ➔ Wet end

CRUST

Drying ➔ Finishing

Neutralization ➔ Retanning ➔ Coloring ➔ Fatliquoring

Lime split leathers start here
## PROCESS FROM WET END TO FINISHING

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splitting</td>
<td>Mechanical operation to slice the leather into grain and split parts</td>
</tr>
<tr>
<td>Shaving</td>
<td>Mechanical operation to uniformize the thickness of the leather</td>
</tr>
<tr>
<td>Neutralization</td>
<td>Chemical step to reduce the leather acidity in preparation for retanning</td>
</tr>
<tr>
<td>Retanning</td>
<td>Natural and synthetic chemicals are added to improve/add leather properties</td>
</tr>
<tr>
<td>Dyeing</td>
<td>Dyes are added to give color to the leather</td>
</tr>
<tr>
<td>Fatliquoring</td>
<td>Oils and waxes are added for softening and lubrication</td>
</tr>
<tr>
<td>Drying</td>
<td>Natural or forced drying, these days using advanced machinery</td>
</tr>
<tr>
<td>Finishing</td>
<td>This is the process of converting the crust leather to finished leather</td>
</tr>
</tbody>
</table>
WET END PROCESSES

Wet end operations are chemical and physical processes that convert the wet blue (or wet white or vegetable) to crust, which is the dried leather. The typical steps are listed, and chemicals need to be properly selected and balanced to achieve the desired properties such as color, temper, elasticity, water repellency and softness; preparing leather for finishing.

WASHING
With water, degreaser and acid to uniformize the pH, moisture and remove salts and natural fat. Prepares the leather for the next steps.

NEUTRALIZATION (Deacidification)
Made with alkaline salts and water to increase the leather pH and prepare for subsequent steps.

RETANNING
Chemicals are added to bond to the leather structure to give properties of fullness, shape, color uniformity, temper, softness and stand. Phenolic, naphthalene, melamine condensate products are widely used (syntans), as well as acrylic solutions, natural vegetable extracts, polymers and biopolymers. Metal salts of chromium III, aluminum and zirconium can be used too.

DYEING
Dyes are added to give color and color uniformity to the leather. The dyes used are mostly acid dyes and metal complex dyes. Proper selection of dyes is an art, made by a professional called the Color Matcher. The dyeing can be superficial or struck through.
FATLIQUORING

Oil emulsions are added to improve the softness and mechanical properties of the leather. It is very common to use a mixture of different products to achieve the properties required. Shoe upper leathers may have from 6% to 15% of solvent extractable materials (oils); upholstery leathers may have 20%. The oils can be of vegetable origin (soy, rice, cotton, canola, coconut, etc.), animal (fish, tallow, lard) or synthetic (oil based and chemically modified). New polymeric materials have the properties of both retanning and fatliquoring, and their use is increasing.

DRIYING

Drying is one of the most important physical steps in leather production. The leather after wet end carries almost 100% of its weight in water and needs to be reduced to 12-14%, which is the typical moisture in crust and finished product. The drying starts with setting out the leather, a mechanical operation where leather is squeezed through rolls and a rotating blade to reduce moisture and stretch the leather before drying. The most common methods of drying are: air, toggling, vacuum, low temperature drying, tunnel. The slow process of air drying makes the leather softer and very natural. New technologies have been developed to improve the efficiency and uniformity of drying.
# Chemicals Commonly Used in the Wet End

<table>
<thead>
<tr>
<th>Process</th>
<th>Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutralization</td>
<td>- Organic and inorganic alkaline salts</td>
</tr>
<tr>
<td>Retanning</td>
<td>- Vegetable tannins, phenolic, naphtalenic and melamine resins, acrylic resins, biopolymers, fillers</td>
</tr>
<tr>
<td>Dyeing</td>
<td>- Mostly acid and metal complex dyes, synthetic</td>
</tr>
<tr>
<td>Fatliquoring</td>
<td>- Natural and synthetic oils and waxes. They are mostly chemically modified (sulfonation) so they can be emulsified in water</td>
</tr>
</tbody>
</table>
THE CHANGING APPEARANCE OF LEATHER as it goes through the wet end

**WASHING**
Cleans the tanned leather intermediate (wet white, wet blue), uniformizes the moisture and pH, removes some natural fats and salts.

**NEUTRALIZATION**
Reduces the leather’s acidity and prepares it for retanning: 1 to 3% of chemicals are added here.
Percentages are based on the shaved weight of the leather.

**RETANNING**
A combination of retanning chemicals is added to transform the leather’s properties. Typically, 10 to 30% chemicals are added at this stage.

**COLORING**
Dyes are used to give color. Usually a mixture of dyes is used to give the color. A typical amount is from 0.5 to 4%.

**FATLIQUORING**
Mixtures of natural and/or synthetic oils and waxes are added to soften the leather. Usually, the amount is between 6 and 20%.
**SET OUT**
Wrings excess moisture from wet leather, reducing it to 50-60% and preparing the leather for splitting (Photo: vegetable leather).

**SPLITTING**
This machine is used to divide the leather into two layers, to separate the grain from the split (not used if leather is lime split).

**SHAVING**
This makes the leather thickness uniform by shaving any excess away on the flesh side.

**SAMMYING**
The machine opens the leather after wet end processes and removes excess moisture, preparing it for the drying stages.
TYPICAL LEATHER DRYING METHODS

**TOGGLE**
Leather is hooked in a perforated screen that stretches to increase area. The screens are put on an oven for uniform drying.

**AIR DRYING**
Leathers are hung on moving racks below the tannery roof, providing the most natural form of drying.

**VACUUM DRYER**
Leather is stretched over a hot plate in a vacuum chamber and the water vapor is sucked out.

**OVEN DRYING**
Leathers are hung up on racks as they are for air drying, and these racks go inside a hot air tunnel for forced – and quick – drying.
TYPICAL FINISHING FLOW DIAGRAMS (UPHOLSTERY, SHOES AND LEATHER GOODS)

CORRECTED GRAIN FINISHED
- Softening
- Buffing
- Basecoat
- Middle coat
- Topcoat
- Emboss
- Dry mill
- Toggle

FULL GRAIN FINISHED
- Softening
- Basecoat
- Middle coat
- Topcoat
- Plate
- Dry mill
- Toggle

FULL GRAIN SEMI-ANILINE FINISHED
- Softening
- Aniline coat
- Middle coat
- Topcoat
- Plate
<table>
<thead>
<tr>
<th>Category</th>
<th>Chemicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliaries</td>
<td>- Surfactants, oil and wax emulsions, solvents, silicones. In some leathers. Oils and waxes can be used alone, without binders</td>
</tr>
<tr>
<td>Fillers</td>
<td>- Clays, silicas, organic polymer particles for filling or dulling</td>
</tr>
<tr>
<td>Pigments</td>
<td>- Organic and inorganic pigment dispersions, finely ground</td>
</tr>
<tr>
<td>Dyes</td>
<td>- Metal complex dye solutions</td>
</tr>
<tr>
<td>Binders</td>
<td>- Acrylic and PU (polyurethane) emulsions producing soft to hard films, natural proteins (eg, casein) and modified natural cellulose</td>
</tr>
</tbody>
</table>
FINISHING

Here we have a great variety of mechanical and chemical steps applied to the crust to make the leather ready for use. Finishing is a blend of artistry, chemistry and great skill. The process adds protection, color, gloss, texture, feel and appearance to the leather.

THE MAIN STEPS

BUFFING (Sanding)

Like wood, leather can be sanded with different grades of sandpaper to create different superficial textures. The degree of buffing can be minimal with fine paper to reduce surface imperfections or deep, where a strong buffing with coarse paper produces a nap effect, found in nubucks and suede.

OILING AND WAXING

Oils and waxes can be applied alone or combined. It is usual to apply it hot to one or both sides of the leather using a roll coater. The oils and waxes can add softness, color, feel, pull up effect and waterproofness to the leather. Oiled or waxed leathers can also take film forming treatments as an additional coating.
Leathers can have one or multiple coatings, depending on the properties required. **Most of the time the coatings are film forming;** typically, leathers have a pigmented base coat and intermediate coat and a transparent topcoat. **Oil and wax** coatings are not film forming.

Coatings are applied by spray, roll coaters and paper transfer and are mostly water based.

**Most of the finishes are made with binders** (acrylic or PU emulsions); these can be soft, medium hard and hard. Protection is built up in layers, starting with **soft coats for elasticity** and ending up with a **final hard topcoat.**

### THE BASIC COATING COMPONENTS ARE WATER-BASED

<table>
<thead>
<tr>
<th>Film-forming products</th>
<th>Pigments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Binders:</strong> acrylic and polyurethane water emulsions</td>
<td><strong>Very finely ground colored solid particles</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inerts</th>
<th>Softening agents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fillers and dullers used to modify the film, particularly the gloss</strong></td>
<td><strong>Oils and/or wax emulsions that soften the film and improve its elasticity</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feel modifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Additives that enhance the leathers’ haptic properties</strong></td>
</tr>
</tbody>
</table>
FINISHING
– continued

Dyes
Change the color of the leather, improving uniformity

Crosslinkers
Additives that react with the film forming products increasing the physical properties of the films

Solvents
Most of the coatings are made with water, but small amounts of solvent can be added to promote adhesion, penetration and compatibility

MECHANICAL OPERATIONS
These operations are part of the finishing process, and their aim is to improve surface properties. They can help produce a very smooth or a deep textured leather. Typical processes are plating and embossing; these are carried out either continuously with a roll plater or individually using a plating machine.

MILLING
Leathers can be further softened by putting them to be tumbled in a dry drum. Water and chemicals can be added to create additional effects.

STAKING
During this stage, the leather moves through a continuous machine that has moving pins. As these pins go up and down, they pummel and press the leather, so it is softened and flattened. The pressure applied through the pins can be adjusted for each type of leather.
COATINGS APPLICATION EQUIPMENT – SPRAYS

SPRAY MACHINES
Water- and solvent-based finishes are sprayed on to the surface of the leather, then dried. Machines are designed for high throughput while minimizing energy use and emissions.

Spray machines can be assembled in tandem with driers to maximize their efficiency, versatility and productivity.

SPRAY GUNS
High tech devices that work together with sophisticated sensors to read the leather’s shape correctly and trigger the guns to go on/off, minimizing waste and optimizing uniformity.

Systems may have up to 24 guns. They need to be calibrated and cleaned to maintain their performance.
COATINGS APPLICATION EQUIPMENT – ROLL COATERS

ROLL COATERS
Water-based finishes, melted waxes and oils are applied through engraved rolls with designs that allow light or heavy deposition. Waxes and oils can be heated to speed up absorption and improve distribution uniformity.

Two full size roll coaters working in tandem. Operators can feed in two sides or one full-sized leather at a time.

ENGRAVED ROLLS
Engraved rolls are engineered to produce a uniform finish distribution on the leather and to minimize waste. Depending on the roll, it’s possible to engrave from light to heavy finish depositions. Finish effects are also possible with design rolls.

Rolls can run in reverse for heavier depositions or directly for lighter depositions or effects.
This method produces uniform leathers with excellent mechanical properties, with little waste and low labor input.

The release papers can be used 20 to 40 times in this rapidly advancing technology.

**PAPER TRANSFER MACHINES**
An adhesive is roll coated to the leather; a release paper is roll coated with finish. The leather is pressed to the coated release paper to transfer the finish. After drying the leather is peeled off the paper release, leaving the finish in place.

**RELEASE PAPER**
Release paper can be smooth or textured to simulate leather or additional effects. The leather can be released from the paper manually or automatically. For re-use, the finish is removed mechanically from the areas without leather.
OTHER FINISHING MACHINES

**STAKING** *(Molisa™)*
Softens the leather by moving the leather continuously through vibrating pins.

**EMBOSSING OR PLATING**
Is used to smooth the leather, or create textures by embossing it. Deep embossing effects are possible with this machine.

**MILLING**
Is another way to soften the leather by tumbling it in dry drums. Water and chemicals can be added to produce further effects on the leather.

**ROLL PRESS**
Is a continuous machine that smooths the leather surface and can create light textures, gloss or embossing.

**BUFFING**
Is the superficial sanding of the leather to uniformize the surface, reduce defects and create effects.

**MEASURING MACHINE**
Is an electronic device that measures the area of each piece and stamps the measurement on the back of the leather.
HOW DIFFERENT STAGES OF FINISHING APPEAR from crust to topcoat
The finish coatings can be summarized in four types:

- **Aniline**: dye can be applied alone or with transparent finish, can be applied on the top of oils and waxes. Small amounts of pigments are added to the coating, reducing the transparency and uniformizing the leather. Most expensive leathers are in this category.

- **Semi-aniline**: more pigments are added to the coatings. The leather pores are still visible, and quality is still high.

- **Semi-pigmented**: when highly pigmented coats are applied to the leather and pores are not visible. Many automotive leathers are in this category.

- **Pigmented**: when highly pigmented coats are applied to the leather and pores are not visible. Many automotive leathers are in this category.

**DIEFERENCE BETWEEN DYE AND PIGMENT**

- **Dye**: (soluble in water or solvent, transparent)
- **Pigment**: (insoluble particles dispersed in water, non-transparent)

**BASIC TYPES OF FINISHES (REPRESENTATION)**

- **Aniline**
  - Transparent coat

- **Semi-aniline**
  - Low pigment coat
  - Transparent coat

- **Semi-pigmented**
  - Medium pigment coats
  - Transparent coat

- **Pigmented**
  - Full pigment coats
  - Transparent coat
### THE MAIN FINISHED LEATHER TYPES

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANILINE</strong></td>
<td>These leathers require the best grades and are the most expensive. They look very natural; dyes can be applied alone or with a transparent finish that may include oil and waxes. In the best examples all leather pores are visible. This leather type must not be sanded.</td>
</tr>
<tr>
<td><strong>SEMI-ANILINE</strong></td>
<td>Small amounts of pigments are added to the coating, reducing the transparency and uniformizing the leather to improving the cutting yield. These leathers are still high value and can be used in very expensive leather articles. The leather pores are still visible.</td>
</tr>
<tr>
<td><strong>SEMI-PIGMENTED</strong></td>
<td>More pigments are added to the coatings to improve the uniformity. The leather pores are less visible, and quality is still high.</td>
</tr>
<tr>
<td><strong>PIGMENTED</strong></td>
<td>Additional pigment coats are applied to the leather and pores are not visible. Stamps can give effects to simulate pores or other textures. These leathers have much better cutting yield and are still valuable. Many automotive leathers come from this category.</td>
</tr>
</tbody>
</table>

*Note: Crust type and quality, thickness, finish and mechanical operations dictate the price of the finished product. All these types can produce outstanding quality, high value leathers.*
EMBOSSING EFFECTS
– creating textures
THANK YOU FOR YOUR ATTENTION