More Serviceable Leather

JOSEPH NAGHSKI *and* EDWARD M. FILACHIONE

Leather is a very unusual fabric. It is strong, supple, soft, warm, and porous. It is also a product with beauty and appeal. These properties arise because of leather's unique structure.

A microscope reveals this structure to be a network of intricately interwoven fibers.

The animal hide—or skin—itself is endowed with this same complex structure. In fact, the native skin is even more complicated. It contains hair, epidermis, and numerous other tissues and constituents. We recognize two general regions through the thickness of the skin. The portion next to the hair is called the grain while the deeper portion extending to the flesh is the corium. The demarcation zone between these two structures lies in the region of the hair roots.

In converting the pelt to leather, the tanner removes the hair, epidermis, and other constituents, thereby exposing the grain. The grain becomes the surface of the leather and contributes to its beauty and appeal.

Other properties, such as strength and suppleness, arise from the corium structure. This organization of interwoven protein fibers is stabilized by tanning so that the leather product is no longer putrescrible and will remain soft and flexible.

Today there is practically no end to the variety of leathers commercially available. This is due in large part to new technological developments. However, another important factor is that for his raw material, the tanner can draw on hides and skins of different origins and from all over the world.

Practically all the world's supply of animal hides and skins is tanned into leather. Although many features are common to all skins, a number of characteristic differences determine the particular use.

Some of these uses as related to skin structure are outlined below.

Cattle hides are our most important raw material for leather production. The United States produced about 36 million hides in 1966, of which about 23 million were tanned domestically. Cattle hides are quite thick, usually over a quarter of an inch in the shoulder area and along the backbone where the fiber structure is coarsest yet most compact.

When tanned in their full thickness, cattle hides are used mostly to make soles, insoles, belting, and packings. In the belly area, the hides are much thinner, and the fiber weave is more open. The resulting leather is more flexible and best suited for work gloves, linings, and insoles.

In current practice, most cattle hides are split parallel to the surface to produce two pieces a little thicker than calfskins. The most valuable portion contains the grain and is known as top grain cowhide or steerhide leather. This is used for shoe and boot uppers,

JOSEPH NAGHSKI *is Chief of the Hides and Leather Laboratory, Eastern Utilization Research and Development Division, Agricultural Research Service, Philadelphia.*

EDWARD M. FILACHIONE *is Head of the Chemical Modification Investigations of the Hides and Leather Laboratory.*

patent leather, garments, upholstery, belts, luggage, cases, and sporting goods. The flesh portion is less valuable and is known as split leather. This is used to make all kinds of lower priced leather goods containing an embossed artificial grain or a sueded surface.

Calfskins are intermediate in thickness between goatskins and cattle hides. The fiber bundles are heavier than in goatskins. Calfskins can be made into leather that is quite firm or quite flexible as the use demands. So they are ideal for shoe uppers, slippers, handbags, and billfolds.

Sheep and lamb skins are quite thin with a comparatively thick grain layer. The fiber bundles are quite loosely packed. Therefore, sheep and lamb skins can be made into very soft and flexible leather suited for garments, shoe linings, slippers, dress and work gloves, hat sweatbands, bookbindings, chamois, and novelties.

Goat and kid skins are also thin, but the grain layer is a smaller part of the total thickness. The fiber bundles are larger and more compactly woven. Goatskins have more strength and elasticity than sheepskins and are very suitable for making leather for shoe uppers, as well as for linings, dress gloves, garments, and handbags.

Pigskin has a very characteristic appearance with a well-marked grain pattern and perforations, which are due to the hair follicles extending through the full thickness of the skin. The grain layer is very firm and tough yet the fiber bundles of the corium are loosely woven. Pigskin leather goes into sueded shoe uppers, dress and work gloves, billfolds, and fancy leather goods. Production of domestic pigskin leather has never been very great because of the difficulty and economics involved in removal of the skin by the meatpacker. Mechanical methods for flaying pigskins have been developed, and these are increasing the supply.

Deerskins are similar to calfskins except for a thinner grain. Deerskin leathers are also very porous and exceptionally supple, which makes them very attractive for garments, dress gloves, and moccasins.

Horsehide is similar to cattle hide, except for a region in the rump called the shell where the grain is deeper and the fiber bundles are very small, quite regular, and very compactly

Clothing manufacturers are adding style to a variety of new leather garments and accessories including ladies' suits, boots, handbags, and gloves.

Leather is a popular and durable fabric for sportswear, *above*. Jackets, coats, boots, and ice skaters' shoes can be made from leather that is tanned with glutaraldehyde. Golfer, *right*, shows off golf glove tanned by this USDA-developed process. It makes leather more resistant to perspiration and laundering, and allows golf gloves to be used for an entire season.

woven. This area yields leather known as cordovan, which has exceptionally good wearing qualities. The exceptionally soft leather made from horse fronts finds uses in jackets, gloves, shoe uppers, straps, and sporting goods.

Reptile skins include snake, lizard, and alligator. These have special surface characteristics which produce interesting designs. These leathers go mainly into shoe uppers, handbags, and other high-fashion leather goods.

Leather is hard to beat for comfortable, healthful footwear; for rich soft garments; and for accessories of beauty and durability. This does not mean that leather cannot be improved. Most leathers today are difficult to launder or dryclean and are susceptible to deterioration by prolonged exposure to perspiration. These and other limitations are yielding to research by Agricultural Research Service chemists at the Eastern Utilization Research Laboratory in Philadelphia, where a new process for the tanning of leather was developed.

These scientists discovered that glutaraldehyde, a comparatively simple petrochemical related to formaldehyde, was a very efficient and effective tanning agent. This new tanning agent is most easily used, and to its best advantage, with chrome—a tanning agent used by practically all tanners.

Besides working out the process for using glutaraldehyde in tanning, the ARS chemists also showed how it improved the leather and extended its utility. Glutaraldehyde gives a pleasing softness to the leather. This property is responsible for its use in tanning of certain types of sheepskins into garment-leather.

Glutaraldehyde makes the leather easier to lubricate, color uniformly, and finish in the normal finishing operations. For this reason many tanners

Trimmed sheepskins make bedpads that protect hospital patients against bedsores. Tanned with glutaraldehyde and chrome, the sheepskins are now easy to machine launder. A doctor, *left,* at Chestnut Hill Hospital, Philadelphia, discusses tanning process with William F. Happich of USDA, who helped develop it.

use it today in the tanning of many kinds of hides and skins into leather.

Glutaraldehyde greatly improves leather with regard to two of its deficiencies, resistance to hot soap solution and resistance to perspiration. A service test demonstrated that golf gloves made from glove leather tanned with glutaraldehyde had marked superiority in their resistance to deterioration from perspiration and from washing in soap and water.

The greatest success of all, however, arose because of this new leather's remarkable resistance to perspiration, which is especially desirable in footwear. This notable property led first to commercial use of glutaraldehyde for tanning workshoe uppers. Field tests substantiated the ARS findings. Workshoes made with this leather gave excellent as well as comfortable service to workers in dairy barns, papermills, cement plants, and other places where perspiration and alkaline agents rapidly deteriorated normal leather. Use of glutaraldehyde was soon extended by many tanners to the tanning of upper leather for dress shoes as well.

Today glutaraldehyde is probably most widely used by tanners who produce shoe upper leather from cattle hide. We estimate that approximately 75 million square feet of such leather, valued at over $45 million, was produced in 1967. In recognition of this successful research, ARS chemists M. L. Fein, E. H. Harris, Jr., Joseph Naghski, W. Windus, and Edward M. Filachione received the U.S. Department of Agriculture's Group Award for Superior Service in 1963.

This research suggested glutaraldehyde be used in tanning shearlings. Shearlings are sheepskins with the wool trimmed but not removed and are used in hospitals to prevent bedsores and to aid in curing them. Shearlings were not easily accepted for this purpose because they were not able to withstand the rigorous conditions of laundering and sanitizing. ARS chemists found that shearlings tanned with glutaraldehyde and chrome could be successfully laundered and disinfected. Good results have been obtained in a number of hospitals experimenting with these bedpads.

Shearlings once were used widely as paint roller covers. But with the advent of water-based paints, they gave way to synthetic roller covers which were more resistant to chemical attack.

The glutaraldehyde-tanned shearlings, being more resistant to attack by such chemicals, can be used effectively with water-based latex paints. This added bonus from shearling research has resulted in the gradual regaining of a lost market.

Leather fibers have a strong affinity for water, and this phenomenon is the basis for maintaining foot comfort. Perspiration released by the foot is absorbed by leather in the shoe and passed to the surface, thus keeping the foot dry and comfortable. Paradoxically, this quality of leather is also one of its greatest weaknesses. Leather is rather ineffectual in keeping water from entering the shoe when worn in rain or snow. Much effort has been spent to develop processes for making leather waterproof. The more effective treatments are relatively expensive.

ARS chemists have also been concerned with the development of more economical processes. Their research has resulted in a process for making water-repellent agents more effective and better suited to tannery practice. The process involves use of an alkenyl succinic acid as a leather lubricant, which proved to be compatible with silicone and other types of water-repellent agents. The chemists found a way to apply the lubricant to leather in a conventional drumming process.

Chrome-tanned leather lubricated this way requires only half the usual amount of silicone. The leather can be retanned with glutaraldehyde to achieve even better repellency. This new process promises to be helpful in making leather more competitive with its many substitutes. Most of these have been promoted for their weather and water resistance compared with leather's easy wettability.

More Serviceable Leather

JOSEPH NAGHSKI *and* EDWARD M. FILACHIONE

Leather is a very unusual fabric. It is strong, supple, soft, warm, and porous. It is also a product with beauty and appeal. These properties arise because of leather's unique structure.

A microscope reveals this structure to be a network of intricately interwoven fibers.

The animal hide—or skin—itself is endowed with this same complex structure. In fact, the native skin is even more complicated. It contains hair, epidermis, and numerous other tissues and constituents. We recognize two general regions through the thickness of the skin. The portion next to the hair is called the grain while the deeper portion extending to the flesh is the corium. The demarcation zone between these two structures lies in the region of the hair roots.

In converting the pelt to leather, the tanner removes the hair, epidermis, and other constituents, thereby exposing the grain. The grain becomes the surface of the leather and contributes to its beauty and appeal.

Other properties, such as strength and suppleness, arise from the corium structure. This organization of interwoven protein fibers is stabilized by tanning so that the leather product is no longer putrescrible and will remain soft and flexible.

Today there is practically no end to the variety of leathers commercially available. This is due in large part to new technological developments. However, another important factor is that for his raw material, the tanner can draw on hides and skins of different origins and from all over the world.

Practically all the world's supply of animal hides and skins is tanned into leather. Although many features are common to all skins, a number of characteristic differences determine the particular use.

Some of these uses as related to skin structure are outlined below.

Cattle hides are our most important raw material for leather production. The United States produced about 36 million hides in 1966, of which about 23 million were tanned domestically. Cattle hides are quite thick, usually over a quarter of an inch in the shoulder area and along the backbone where the fiber structure is coarsest yet most compact.

When tanned in their full thickness, cattle hides are used mostly to make soles, insoles, belting, and packings. In the belly area, the hides are much thinner, and the fiber weave is more open. The resulting leather is more flexible and best suited for work gloves, linings, and insoles.

In current practice, most cattle hides are split parallel to the surface to produce two pieces a little thicker than calfskins. The most valuable portion contains the grain and is known as top grain cowhide or steerhide leather. This is used for shoe and boot uppers,

JOSEPH NAGHSKI *is Chief of the Hides and Leather Laboratory, Eastern Utilization Research and Development Division, Agricultural Research Service, Philadelphia.*

EDWARD M. FILACHIONE *is Head of the Chemical Modification Investigations of the Hides and Leather Laboratory.*

patent leather, garments, upholstery, belts, luggage, cases, and sporting goods. The flesh portion is less valuable and is known as split leather. This is used to make all kinds of lower priced leather goods containing an embossed artificial grain or a sueded surface.

Calfskins are intermediate in thickness between goatskins and cattle hides. The fiber bundles are heavier than in goatskins. Calfskins can be made into leather that is quite firm or quite flexible as the use demands. So they are ideal for shoe uppers, slippers, handbags, and billfolds.

Sheep and lamb skins are quite thin with a comparatively thick grain layer. The fiber bundles are quite loosely packed. Therefore, sheep and lamb skins can be made into very soft and flexible leather suited for garments, shoe linings, slippers, dress and work gloves, hat sweatbands, bookbindings, chamois, and novelties.

Goat and kid skins are also thin, but the grain layer is a smaller part of the total thickness. The fiber bundles are larger and more compactly woven. Goatskins have more strength and elasticity than sheepskins and are very suitable for making leather for shoe uppers, as well as for linings, dress gloves, garments, and handbags.

Pigskin has a very characteristic appearance with a well-marked grain pattern and perforations, which are due to the hair follicles extending through the full thickness of the skin. The grain layer is very firm and tough yet the fiber bundles of the corium are loosely woven. Pigskin leather goes into sueded shoe uppers, dress and work gloves, billfolds, and fancy leather goods. Production of domestic pigskin leather has never been very great because of the difficulty and economics involved in removal of the skin by the meatpacker. Mechanical methods for flaying pigskins have been developed, and these are increasing the supply.

Deerskins are similar to calfskins except for a thinner grain. Deerskin leathers are also very porous and exceptionally supple, which makes them very attractive for garments, dress gloves, and moccasins.

Horsehide is similar to cattle hide, except for a region in the rump called the shell where the grain is deeper and the fiber bundles are very small, quite regular, and very compactly

Clothing manufacturers are adding style to a variety of new leather garments and accessories including ladies' suits, boots, handbags, and gloves.

Leather is a popular and durable fabric for sportswear, *above*. Jackets, coats, boots, and ice skaters' shoes can be made from leather that is tanned with glutaraldehyde. Golfer, *right*, shows off golf glove tanned by this USDA-developed process. It makes leather more resistant to perspiration and laundering, and allows golf gloves to be used for an entire season.

woven. This area yields leather known as cordovan, which has exceptionally good wearing qualities. The exceptionally soft leather made from horse fronts finds uses in jackets, gloves, shoe uppers, straps, and sporting goods.

Reptile skins include snake, lizard, and alligator. These have special surface characteristics which produce interesting designs. These leathers go mainly into shoe uppers, handbags, and other high-fashion leather goods.

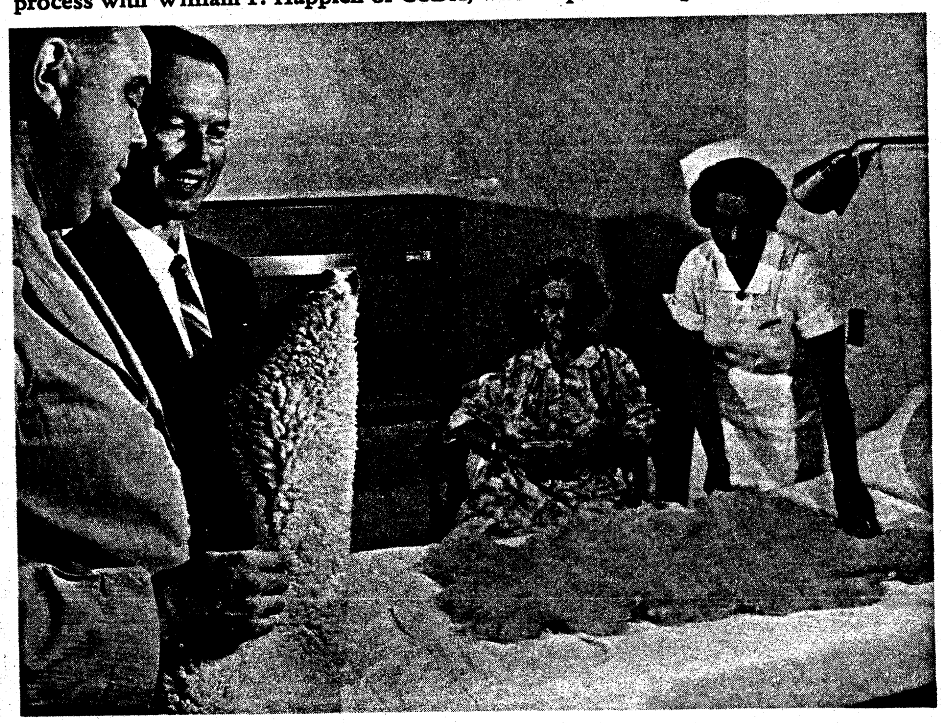
Leather is hard to beat for comfortable, healthful footwear; for rich soft garments; and for accessories of beauty and durability. This does not mean that leather cannot be improved. Most leathers today are difficult to launder or dryclean and are susceptible to deterioration by prolonged exposure to perspiration. These and other limitations are yielding to research by Agricultural Research Service chemists at the Eastern Utilization Research Laboratory in Philadelphia, where a new process for the tanning of leather was developed.

These scientists discovered that glutaraldehyde, a comparatively simple petrochemical related to formaldehyde, was a very efficient and effective tanning agent. This new tanning agent is most easily used, and to its best advantage, with chrome—a tanning agent used by practically all tanners.

Besides working out the process for using glutaraldehyde in tanning, the ARS chemists also showed how it improved the leather and extended its utility. Glutaraldehyde gives a pleasing softness to the leather. This property is responsible for its use in tanning of certain types of sheepskins into garment-leather.

Glutaraldehyde makes the leather easier to lubricate, color uniformly, and finish in the normal finishing operations. For this reason many tanners

Trimmed sheepskins make bedpads that protect hospital patients against bedsores. Tanned with glutaraldehyde and chrome, the sheepskins are now easy to machine launder. A doctor, *left,* at Chestnut Hill Hospital, Philadelphia, discusses tanning process with William F. Happich of USDA, who helped develop it.



use it today in the tanning of many kinds of hides and skins into leather.

Glutaraldehyde greatly improves leather with regard to two of its deficiencies, resistance to hot soap solution and resistance to perspiration. A service test demonstrated that golf gloves made from glove leather tanned with glutaraldehyde had marked superiority in their resistance to deterioration from perspiration and from washing in soap and water.

The greatest success of all, however, arose because of this new leather's remarkable resistance to perspiration, which is especially desirable in footwear. This notable property led first to commercial use of glutaraldehyde for tanning workshoe uppers. Field tests substantiated the ARS findings. Workshoes made with this leather gave excellent as well as comfortable service to workers in dairy barns, papermills, cement plants, and other places where perspiration and alkaline agents rapidly deteriorated normal leather. Use of glutaraldehyde was soon extended by many tanners to the tanning of upper leather for dress shoes as well.

Today glutaraldehyde is probably most widely used by tanners who produce shoe upper leather from cattle hide. We estimate that approximately 75 million square feet of such leather, valued at over $45 million, was produced in 1967. In recognition of this successful research, ARS chemists M. L. Fein, E. H. Harris, Jr., Joseph Naghski, W. Windus, and Edward M. Filachione received the U.S. Department of Agriculture's Group Award for Superior Service in 1963.

This research suggested glutaraldehyde be used in tanning shearlings. Shearlings are sheepskins with the wool trimmed but not removed and are used in hospitals to prevent bedsores and to aid in curing them. Shearlings were not easily accepted for this purpose because they were not able to withstand the rigorous conditions of laundering and sanitizing. ARS chemists found that shearlings tanned with glutaraldehyde and chrome could be successfully laundered and disinfected. Good results have been obtained in a number of hospitals experimenting with these bedpads.

Shearlings once were used widely as paint roller covers. But with the advent of water-based paints, they gave way to synthetic roller covers which were more resistant to chemical attack.

The glutaraldehyde-tanned shearlings, being more resistant to attack by such chemicals, can be used effectively with water-based latex paints. This added bonus from shearling research has resulted in the gradual regaining of a lost market.

Leather fibers have a strong affinity for water, and this phenomenon is the basis for maintaining foot comfort. Perspiration released by the foot is absorbed by leather in the shoe and passed to the surface, thus keeping the foot dry and comfortable. Paradoxically, this quality of leather is also one of its greatest weaknesses. Leather is rather ineffectual in keeping water from entering the shoe when worn in rain or snow. Much effort has been spent to develop processes for making leather waterproof. The more effective treatments are relatively expensive.

ARS chemists have also been concerned with the development of more economical processes. Their research has resulted in a process for making water-repellent agents more effective and better suited to tannery practice. The process involves use of an alkenyl succinic acid as a leather lubricant, which proved to be compatible with silicone and other types of water-repellent agents. The chemists found a way to apply the lubricant to leather in a conventional drumming process.

Chrome-tanned leather lubricated this way requires only half the usual amount of silicone. The leather can be retanned with glutaraldehyde to achieve even better repellency. This new process promises to be helpful in making leather more competitive with its many substitutes. Most of these have been promoted for their weather and water resistance compared with leather's easy wettability.