



These exotic leathergoods were designed and crafted locally to suit the individuality of the different types of fish skins. This operates as a cottage style industry centred around Atlantic Leather.

Tannery of the Year: Atlantic Leather, Saudarkrokur, Iceland

It suits Atlantic Leather to have a small coastal town in the far north of Iceland as its base. Not only does it have easy access to clean, renewable energy and an abundance of water in this location, but also a plentiful supply of its most important raw material: fish skins.

There has been a tannery in Atlantic Leather's home town, Saudarkrokur, since 1969 when four local entrepreneurs, who had been successful in business in Iceland's capital, Reykjavik, decided they wanted to give something back to the community in the north that they had come from. They concentrated on producing double-face leather from local sheepskins, lamb being the most important source of meat in the Icelandic diet. In time, the country's slaughter of lamb reached around one million head per year and there was a sufficient supply of skins to support two tanneries in this singularly scenic, but isolated country. Government quotas between 1980 and 1990 gradually drove lamb slaughter down to nearer 500,000 head per year (the meat is high in quality but expensive because the local climate means sheep have to be housed and fed for much of the year) and now Atlantic Leather is the only remaining leather producer.

Strength in diversity

So as not to become too reliant on sheepskin, the company began trying to diversify its output in the 1990s and, unusually, has found success by making leather from the skins of Iceland's other important source of protein, fish. "We have the capacity to process between 500,000 and 600,000 fish skins per year, mostly salmon and wolffish from Icelandic waters," explains Gunnsteinn Björnsson, the company's chief executive. Small, but strong and versatile, the fish skins colour beautifully and, with the unusual pockets left when the scales are removed, have a texture that Mr Björnsson insists is impossible to replicate. The material lends itself well to an exotic look that high-end designers of shoes, garments and accessories love.

Fish is available all year round in Iceland. There is a high season and a low season depending on the species, but Atlantic Leather faces more of a challenge when the fish that is landed, particularly salmon,



is sold with the skins on. Mr Björnsson explains that the recent popularity of sushi has helped because Icelandic fish distributors export sushi-ready salmon directly to wholesalers or restaurant chains. Sushi-ready means the skins are a waste product that must be removed at source and, as tanners everywhere have always done, Atlantic Leather believes its mission is to collect that waste product and turn it into versatile, durable, beautiful leather.

Attempts across the world to produce fish leather on an industrial scale have often faltered because tanners were unable to come up with exactly the right adjustments to their existing processes to handle the skins correctly. Atlantic Leather took plenty of time and made mistakes of its own as it worked out a solution to the problem.

Gunnsteinn Björnsson started working there in 1991 after spells working on fishing boats and he recalls the idea of trying to make fish leather resulting from a team discussion not long after that. Part of the company's inspiration was the knowledge that early settlers in Iceland had used dried (not tanned) wolffish skins to make a kind of moccasin. "Most of our early attempts ended up like a kind of fish soup," he says now. Nevertheless, trials continued and shortly after Mr Björnsson became chief executive in 1999, a breakthrough came and Atlantic Leather established the technique that has allowed it to make fish leather its main focus in the years that have followed.

Project in Africa

Cod and Nile perch make up the balance of fish leather production. The first is easy to explain because cod has always been an abundant and important export product for Iceland; it famously went to the brink of war with distant neighbour the United Kingdom in the 1970s over cod fishing rights. The processing of cod skins at the tannery only really began in large volumes three years ago, but is a growing category now. Nile perch skins, from which the company can produce some of its most exotic-looking leathers, come from Africa as part of a project Atlantic Leather has put in place with an Icelandic aid agency called Friend of Africa. This has involved training fishing communities in Kenya to process Nile perch skins to crust for export to Iceland for finishing. "It's a good project," Mr Björnsson says. "We know the director of Friend of Africa very well; he always comes to see us



The tannery is ultimately dependent upon the success of the fishing vessels that supply the local fish processing plants.

when he comes home to Iceland. Those communities are fishing 300,000 tonnes of Nile perch every year from Lake Victoria. They used to dry the skins and eat them, as a kind of last resort if no other food was available, but to make them into crust and export them to us for money is a much better way for them to add value to the raw material at their disposal."

In season

For lambskin, which is still very much part of the company's product mix, the situation is different because there is a fixed slaughter season, the months of September and October. Asked what proportion of a year's worth of skins Atlantic Leather has to buy and preserve in those two months, the chief executive says it's 99%. The old restrictions no longer apply as the government is no longer directly involved. Sheep farmers can raise and slaughter as many lambs as they believe the global market will take and annual slaughter rates have now crept back up to around 600,000 head per year. Icelandic lamb is sought after in high-end restaurants and retail outlets in markets as diverse as Spain, the US and Russia, but most of the meat is still consumed at home. Gunnsteinn Björnsson believes the average Icelandic family eats lamb two or three times every week (as frequently as fish).

Each week Mr Björnsson's company processes between 800 and 1,000 lambskins to make double-face and around 300 to

make wool-on rugs. The market for the first has not been easy in the first half of 2015, even for high-quality material such as Iceland's climate helps produce. A number of good buyers remain, including long-standing customers, mainly making leather garments, in the US, the UK and Italy. Mr Björnsson believes the double-face market will come back, but is unlikely ever to go beyond the limits the industry has known historically. "Unfortunately the throw-away culture is strong in the clothing industry," he says. "If we want people to buy double-face jackets, they have to make a decision to buy a jacket that they will keep for a long time." As far as the rugs are concerned, though, demand far outstrips supply of the special skins required. The main markets for them are in the Scandinavian countries and Germany, although here, too, there is interest in the US.

The importance of by-products

In the course of the last ten years, a big change has taken place in the economics of Iceland's fishing industry. A decade ago, fillets, which constitute about 45% or 50% of the weight of the fish, accounted for more or less 100% of the value. "Most of the by-products were just thrown away," Mr Björnsson says. "Now we are close to using 95% of each fish and we want to get to 98%." By-products include dried fish heads, which are a popular food source in Africa and in other parts of the world. Fish oil from



From a technical point of view

(1) Overview of operations

Atlantic Leather is situated at Saudarkrokur on the north coast of Iceland, where the tanning of Icelandic sheepskins as double-face started in 1969. Investigations and trials began into the processing of fish skins in the 1990s but the techniques took a long time to perfect so that significant production only started around the turn of the century, being followed by steady growth and range expansion. Today, manufacture comprises a balance of sheepskins and fish skins at an approximate 1:1 ratio as input loads. Twenty-five people are involved in direct manufacture and at the factory shop where a wide range of finished fish skin leathers, goods, wool skin rugs and finished articles are available for tourists (who are coming in increasing numbers) to buy. The tannery also receives Icelandic bovine hides and sheepskins from surrounding abattoirs for salting, which are subsequently exported.

(2) Manufacture and processing

Four different types of fish skins are manufactured and comprise approximately 40%-60% salmon, wolffish at 25%, the balance being cod and perch. These ratios vary according to the skin off-take from local fish processing companies, which is itself dependent upon the local fishing fleet and season. The production is supported by Nile perch, which are purchased from Kenya in the crust state and processed to Atlantic Leather's specification. There are also occasional purchases of frozen fish skins from the Faeroe Islands.

The input load sizes vary according to availability, but the maximum load per drum can be stated as 4,000 skins at 330 kilos in weight. When the salmon skins – the fish being mainly used for sushi consumption – are cut from the fish, a significant layer of deep fat remains which is machine fleshed from the skins as the first operation.

The outline process is a short soak with sodium carbonate and wetting agent, followed by a six-hour liming only swelling process that is free of sulfide. Here, the fish scales are not dissolved, but are released from the skins. This is followed by deliming, the whole process being based on a one-day



Sheepskins placed on this conveyor belt are spread by the two rotating brushes before automatic salt application. This is followed by sorting and grading on the conveyor, the machine being built to Atlantic Leather's design and specification.



Both sheepskins for rugs and the shearlings as shown are processed in a pair of mixers.



All of the fish skin leathers are chrome-tanned, with the residual chrome-containing wastewaters segregated and precipitated within the tannery building.



The load sizes for dyeing and retanning the fish skins tend to be small, as a wide range of dyeings are required for the many varieties of fish that are processed.



turnover in a conventional wooden drum.

The pickling operation uses salt and formic acid, with a small amount of chrome added to this bath after a period, taking a total time of 24 hours. The chrome tanning process follows on the third day, with the tanning agent added directly to the pickle bath taking a further 24 hours to complete. Sodium bicarbonate is used for basification and takes a further 24 hours, followed on the fifth day by retanning and fatliquoring to complete a five-day processing cycle.

After washing off, the skins are allowed to drain, and are then dyed to shade with 100% dye penetration. Standard dyeings form the basic colour range, although this is extended according to the customer demands. This is mainly performed in small scale plant with a common input of 40 skins per load (up to 3,000 skins per load is possible). After dyeing the skins are unloaded and allowed to drain, then lightly hand stretched and fixed onto wooden boards using power-assisted stapling guns. This operation is followed by drying at ambient temperature in custom-built cabinets. The skins are then buffed on the flesh side, and finished as required.

Fish skins are thin, and the thickness can be as low as 0.4 mm. Because of the low angle of weave of the structure they are, however, both flexible and very strong with a tear strength that can be as high as 90 newtons. Moreover, each type of fish skin carries its own strong characteristics, for example:

- Salmon skin is the classic fish leather because it can be dyed uniformly, and has a smooth and refined appearance.
- Wolffish is a deep-sea species that is caught around Iceland. It carries a dark spotted pattern within the skin, but is also scale-less thus producing a smooth leather.
- Cod leather shows a delicate scale pattern but with a rough texture, making it ideal for small leather articles.
- Perch leathers are large in area, relatively thick in substance with a rough course texture.

Although the leathers are often used dyed and without any finish, light finishes can be applied even on the more irregular perch skins. Metallic finishes can be used to highlight the



After wet processing, all of the fish skin leathers are stapled onto wooden drying boards before drying in drying cabinets made by Atlantic Leather.



Because of the distance from services, almost all of the maintenance is performed in-house. This includes the reblading and balancing of shaving and other helical bladed cylinders.



Both the shearlings and wool skins for rugs are dried tension-free on the overhead conveyor system.



The fish skin production is very dependent upon accurate dyeings, but many other finishing effects are created including the use of foil laminates.



distinctive grain appearance, and perforation combined with natural dappled effects produce softer leathers while still retaining strength. The leathers can be made washable, and can be readily stitched together in panels of unique colour and texture combinations before pattern cutting.

In addition to the manufacture of fish skin leathers, an irregular flow of about 200 bovine hides and some horse skins (all free of insect bites because of the location) are received each week from the local abattoirs for salting and export. Similarly, in season, in September and October, as many as 10,000 sheepskins can be received each day for salting and sorting. Throughout the rest of the year up to 1,000 of these skins are processed by Atlantic Leather each week as double-face production and a further 300 sheepskins each week for rugs.

The outline process for sheepskins selected for double-face is to first mechanically shear, then after washing in a paddle the skins are fleshed. This is followed by a soak and pickle for 24 hours in a processor, then a 14-day period where the skins are stacked down, then returned to the processor for chrome tannage and fat liquoring. After unloading and draining the skins are dried tension-free using an overhead line-conveyor set in the roof area. This is followed by buffing, shearing to precise wool length and wool polishing. The processing of sheepskins for rugs is similar, but with the laying time after pickle reduced to two days only. After drying the skins are mechanically combed, trimmed, then a final hand carding at the point of packaging for dispatch.

Because of the isolation of Atlantic Leather there are several examples of innovation that have been managed in-house. These are as basic as filter baskets used to entrap fish scales and fish skins that wash through the perforations in the draining systems, but the drying units for fish skins have been made in-house, and the small and larger size milling drums for the double face production. Almost all of the maintenance is based around self-sufficiency including the skilled reblading and balancing of helically bladed cylinders.

(3) Solids management

- Flesh from fish skins has been investigated successfully as a food supplement for sheep, but because of legislation that restricts the use of waste from the tannery this route cannot progress commercially. However, it would be feasible if green fleshing can be performed within the fish processing plant before delivery to the tannery. Farmers would be allowed to feed the fleshings to their sheep if they came from the fish factory rather than the tannery.
- If a pallet is placed on top of a second pallet, these are sufficiently strong for the transport and sale of stacked hides and sheepskins after salting at the tannery.
- All of the wool from shearing sheepskins for double-face production is compacted and baled and exported for carpet manufacture.
- All trimmings are sold wherever possible for making small leather items.
- All packaging, containers, cardboard and paper are sorted and recycled with domestic packaging by the municipality.
- All other waste is limited by legislation for landfill.



Final wool shearing of the double face shearlings.



Hand carding to tidy the edges of the woolskin rugs is the final operation before dispatch.



All of the hot water used by Atlantic Leather is provided by a geothermal bore-hole that provides water at 65°C and located in a small wood nearby the tannery.



(4) Water and environmental management

[a] WATER

All water used within manufacture is provided by municipal supply.

[b] EFFLUENT TREATMENT

All of the wastewaters from leather processing are discharged using common drainage, and screened before discharge from the tannery to the municipal sewage treatment plant. The volume and strength of the effluent is low compared to the domestic and other industrial discharges, and this is all mixed together before treatment, with charges levied according to volume, biochemical oxygen demand and suspended solids. The treated effluent is finally discharged to the sea via a pipeline.

Fish scales from loosening in soaking and liming are collected at the point of discharge from the processing vessels. Here, the float is screened by delivered directly into stainless steel perforated open boxes placed over the main drainage channels. These are emptied manually and reduce the load on the main screening equipment. All of the chrome-containing discharges are first coarse-screened through a plastic basket to recover any fish skins that have not been retained in the drums during drainage and washing cycles. The wastewaters are then retained in one of two plastic holding containers that are used alternately. Once full, a batch is dosed with lime to precipitate the chromium salts, which are allowed to settle, and the supernatant pumped away for discharge to the sewer. The chrome precipitate is retained in the container, and the cycle repeated until there is sufficient build-up of sludge for disposal.



As a first stage of effluent treatment, all of the pre-tanning floats from the fish skin production are coarse screened on discharge from the drums to remove fish scales using easily moved stainless steel perforated baskets.

[c] ENERGY

Hot water is provided to the tannery at 65°C from a bore-hole supply. This geothermal source of energy is managed by the municipality, with a reservoir of hot water stored in a tank adjacent the tannery. This is first used via hot water radiators for space heating and for heating drying units. After this primary use the cooled but still hot water is used within chemical processing. All of the electrical energy is provided by the national grid, and generated from hydro-power. ☉

the liver and other organs is an increasingly popular food supplement all over the world and it's also possible to extract protein or make meal from the bones. "It won't be long before the value of the by-products is greater than the value of the fillets," he adds. Skins are also part of this, of course. Some skins go into pet food or into gelatin production and a medical technology company in Iceland has developed a treatment for wounds using cod skin.

And then there's leather. "The national catch is 500,000 tonnes of fish per year," the Atlantic Leather chief executive continues. "From that we can generate around 40,000 tonnes of fish skin. The skin is about 8% of the weight. Some of the skins are too small for us to use and some of the fish are sold with the skin on, but if we could make leather from even 50% of Iceland's fish skins, this country's fish leather industry would be worth \$10 billion per year. This isn't a calculation based on theory or a laboratory experiment or a one-off concept product. We are making this leather already and we can scale up any time. We are ready to go."

Calculating raw material and finished fish leather by weight rather than by number of fish skins is normal practice at Atlantic Leather. The way things normally work out, 1,000 kilos of skins will yield 350 kilos of workable material after fleshing. Another helpful calculation is that 4,000 decent-sized Icelandic fish skins will typically yield about 90 kilos of finished leather.

The biggest market for Atlantic Leather's fish leather is Italy, then the US, followed by other European markets. Most of it goes into bags, but small leathergoods is another popular area and there are what Mr Björnsson calls "interesting openings" in furniture and interior decoration. Wall panels covered in wolffish leather are eye-catching, not least because the distinctive markings on the skin are similar from fish to fish, but never exactly the same. Then there are shoes, another growing market. Fish leather works in shoes, Atlantic Leather insists. It's like other thin leathers in that footwear manufacturers will usually need the backing of another substrate when using it, but it's unlike them in that it has

ten times the tensile strength of materials such as sheep and goat leather.

Energy boost

Iceland has an unusual landscape thanks to high levels of volcanic activity (past and present). Many in the global leather industry will remember the travel disruption that Eyjafjallajökull caused in 2010 when ash from an eruption caused flight cancellations for several weeks. This is far from the highest level of disruption an Icelandic volcano has caused: in the 1780s, the Skaftáreldar eruption led to the death of around 20% of Iceland's population and ash in the atmosphere led to such harsh weather conditions and such severe crop failures that it can claim to have been one of the causes of the French Revolution.

A less violent revolution has taken place in Iceland's use of energy. In keeping with 99.9% of communities across Iceland, the tannery is able to use only green energy in its production. A bore-hole two kilometres from the site is the local source of geothermal energy, naturally hot water comes into the tannery through a pipe



network at a temperature above 60°C and provides not just hot water for production, but everything the company needs to dry its leather and heat the building. Electricity for lighting and to power the tanning machinery and a cooling unit in the storage area for lambskins comes from hydroelectric sources. Iceland also has plenty of water. Saudarkrokur's population is only 3,000, but its existing domestic water supply is enough to meet the needs of a town six times that size, and it could increase that capacity quite easily if it had to.

Shared benefits

If fish leather has the potential to be worth \$10 billion per year for Iceland alone, the potential in the fish leather segment, globally, is enough to have sparked interest in what Atlantic Leather is doing from as far afield as Brazil, Peru and the US as well as many parts of Europe. The Icelandic tanning company says it wants competition and is willing to set up partnerships in these locations, sharing its know-how and allowing others to learn from its experience, its successes and the mistakes it made along the way. "I am absolutely serious about this," Gunnsteinn Björnsson insists. "I am ready to share my knowledge, perhaps for a share in the equity of new fish leather producers around the world. I know they would then compete with Atlantic Leather, but that's fine as long as they do it properly and don't hurt the market."

Hurting the market would be to try to produce leather from fish skins without taking into account the particular requirements for working with this raw material. "If they produce something that's stiff and smelly," Mr Björnsson continues, "they will give customers the idea that fish leather is rubbish. This is a common mentality among users of leather and one I have spent a decade working hard to change. There is still a long way to go, but Atlantic Leather turns up at the main industry fairs time after time, we are reliable and we have the capacity to follow big companies if they choose to use fish leather. I market fish leather all around the world and it's very time-consuming and expensive to do that. If other tanneries were to share that burden, I would be very happy, as long as they make the proper product. We'd all sell more fish leather; we would all benefit, perhaps Atlantic Leather more than anyone else."

He says again that fish leather is destined



This is a remote location for both the supply of chemicals and the specialised infrastructure often required by tanneries.



The harsh environment creates both long outer wool for shedding water, and fine dense wool for insulation for the Icelandic sheep.

to make a big impression on the global market. People are going to become more reliant on the oceans for food as meat production and consumption stay steady or increase at a slower rate than the world population and its appetite for protein. Leather from land animals will become more expensive and less widely available, he believes, especially if projections of increasing demand from automotive companies for bovine leather prove accurate. Industry experts have predicted that the current rates of growth in the production of vehicles,

particularly of premium cars (which use a lot of leather), could lead to automotive's consumption of finished bovine leather increasing from around 2 billion square-feet per year at the moment to as much as 3 billion square-feet per year by 2020, while global availability of hides is likely to remain at around 275 million per year.

Leather producers, whether they work with fish or flesh, have a duty to educate consumers "about what leather really is", Mr Björnsson says. "We are not poisoning people or the planet. Nothing bad happens



when we make leather and our product lasts a long time. People don't know that, so we have to market leather better. We, the leather sector, have sat for too long letting people outside the industry create negative propaganda about us. We have to rise up and say we are people who make use of a by-product. But we never speak with one voice. Every other industry seems to be able to do that, but we never do. We also need to tell the truth about our products. Tanners who use a little chrome to stabilise their hides and skins must not say their leather is 'chrome-free', or make a big thing of being chrome-free if they are using titanium or another metal instead. Is that better than chrome? Not in my opinion. Nothing is black and white when it comes to sustainability. All we can do is choose the best solution."

Supplier stories

Good suppliers in Gunnsteinn Björnsson's book are the ones who are willing to consider his particular needs. He acknowledges that Atlantic Leather is "different" and will never be a regular customer for mainstream suppliers of leather chemicals and machinery. In spite of this, some have responded very positively, he says. Chemical firms have come up with innovative suggestions of products to try in fish leather production, sometimes looking beyond their normal leather industry offerings into the ranges they manufacture for other markets altogether. And sometimes this has worked. One of the larger leather chemicals manufacturers in mainland Europe, whom he prefers not to name, has particularly impressed Mr Björnsson with its willingness to help Atlantic Leather seek fish-specific solutions, offering on several occasions space at its laboratories and hands-on help from its leather experts to allow Atlantic Leather's technical director, Mr Björnsson's brother Siggí, to work particular problems out. "They've been really helpful," the chief executive says. "Maybe they see the same huge potential for fish leather as we do. They've not said that, but maybe they see it. In any case, they have been extremely helpful."

On the machinery side, the company has been able, with some effort, to source narrower fleshing machines, but the best example of attentiveness to Atlantic Leather's special needs has probably come from one of the drum manufacturers. In regular tanning drums, the holes inside for the water system are large enough to swallow up fish skins.



In addition to leathergoods, tourists visiting the tannery often purchase finished fish skins as souvenirs and for small-scale leathercraft.

"We don't want the skins circulating with the water," Gunnsteinn Björnsson says, "so we convinced one supplier to make a drum for us with smaller holes. I really appreciate this and I can tell you that the next time I need to invest in a new drum, that same supplier will be my first port of call."

Investment in people

The company spends time and money on training courses for its employees (on subjects as diverse as workplace safety and Iceland's pension system) and on social events. Morale is good, the chief executive says, and, in an economy in which "you could almost walk out the door and find a new job", the turnover of staff is small, with most members of the workforce already having at least ten years under their belts. Twenty-five people are directly employed in Atlantic Leather, coming from a radius of around 30 kilometres from Saudarkrokur. Forty other people are dependent on the tannery for all or an important part of their income; they use the leather the company produces to make handcrafts. Some of these people live on farms and have built up small handcraft businesses to help them supplement their income and to keep busy during Iceland's long winters.

Public engagement

Gunnsteinn Björnsson is an elected councillor in Saudarkrokur; this is a recent development, but he says the relationship

between the town and the tannery has always been positive. His ties extend beyond this small (if important) town in the north of the country. A good relationship with Iceland's prime minister, Sigmundur David Gunnlaugsson, who is knowledgeable of and enthusiastic about Atlantic Leather's innovative way of adding value to waste from the country's fishing industry, led recently to an invitation for the company's chief executive to attend the assembly of a new, Reykjavik-based international not-for-profit organisation, Arctic Circle, which seeks to foster dialogue about the economic, environmental and social needs of the peoples who live or work in the far north. There was plenty of interest among fellow delegates, Mr Björnsson relates, in fish leather with, as mentioned, senior political representatives from the US paying particular attention. If fish leather has the potential to be worth \$10 billion a year for Iceland, the US's added value could be high too.

"This is about approaching raw material for leather in a new way," Gunnsteinn Björnsson says. "We use a by-product from an industry, fishing, that is going to become more and more important so the material is there and will continue to be there. The market for fish leather may be smaller than for other types of material, but we don't mind. Our customers are people who care and we simply want to do the best we can for them." 🌐