

he had already answered a higher calling by taking holy orders. What answers did he seek in the aerial solitude that his own faith could not supply? I suspect that he conceived of the mountains and God as one inseparable unity, and saw himself as a pilgrim or disciple whose arduous climb to the summit was a metaphor for the road that led to Christ. Beyond the need to test himself both physically and mentally, climbing was a tangible way of communing intimately with God.

The duality of godhead and mountains, the hint of eternity and pantheist mysticism in the void that surrounds the highest peaks, has exerted a profound influence on mountaineers at all times. But the pragmatic Buzzetti penetrated beyond this commonplace by recognising the fact that true confidence in these hostile environments – as indeed in all walks of life – comes not from improved safety equipment or physical preparation, but from self-awareness and the ability to confront our own mortality with equanimity. This does not imply fatalism or sanction imprudence, but simply acknowledges that factors of safety cannot be generalised. Individuals possess their own unique set of cognitive values, which ultimately determine that person's vulnerability. Achieving a precise awareness of those values is the challenge that confronts us all in life, but is one from which most of us shy away.

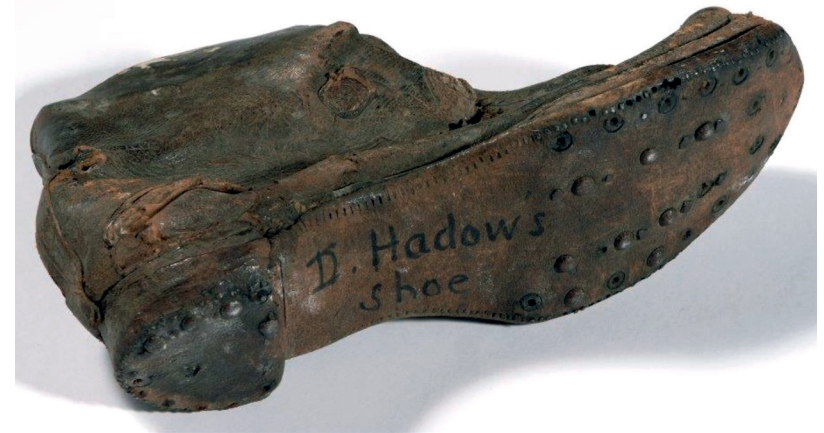
Buzzetti had already dinned into his young nephews a golden rule of mountaineering: fear nothing, except fear itself. His faith dictated that he take this maxim a step further, out of the physical dimension, aspiring to a state of grace that can only be attained when the individual is able to contemplate and gauge his own spiritual serenity. Buzzetti summed it up thus: *'L'alpinista, il vero e genuino, l'atleta dell'alto, scalatore di canaloni e strapiombi, vincitore di abissi e di vertigini, non solo accompagna il suo inflessibile volere contro il ghiaccio e la rupe, contro la tormenta e la valanga, ma egli ha vinto e vince qualcosa di più grande e forte delle montagne – ha vinto e dominato se stesso.* The true and genuine alpinist, athlete of the heights, he who scales couloirs and sheer cliffs, overcomes the abyss and fear of heights, not only imposes his inflexible will upon ice and cliff, upon tempest and avalanche, but has overcome something bigger and stronger than the mountain – he has prevailed over and dominated himself.'

*Postscript:* 'During an excursion at Predarossa on Wednesday, Aristide Gaggini and his wife came across an old boot containing the mummified foot of the owner, plus a femur and the remains of a forearm and skull. The objects have now been taken by the *carabinieri* to Ardenno, perhaps with a view to subsequent DNA analysis. Speculation is already rife as to whether they might belong to Don Buzzetti, the climber-priest who vanished without trace in the summer of 1934. The style of hobnailed footwear is certainly appropriate for the period and no other mountaineers were reported missing at the time. However the location where the macabre find was made does not correspond to the itinerary drawn up by Don Buzzetti, who was last seen heading southwest from the Punta Torelli towards the Porcelizzo pass. On the other hand, the clergyman was notorious for his stamina on wide-ranging climbs...' *La Provincia di Sondrio*, 12 August 2012

MARC KÖNIG

## Hadow's Sole

Mountaineering boots between the first ascents of the Matterhorn and Everest



Hadow's shoe worn on the Matterhorn in 1865. (Matterhorn Museum/Villars Grafic)

Alongside the snapped cord and other relics gathered in Zermatt's museum to tell the story of the Matterhorn's first ascent and its subsequent tragedy are the boots of Douglas Robert Hadow. Born in 1846 in London, Hadow was just 19 when he undertook his first Alpine season. On the recommendation of his mentor, Rev Charles Hudson, he was included in Edward Whymper's party for the Matterhorn, but during the ascent Hadow needed constant help and it was Hadow who fell as the team descended, dragging three men off the mountain after him.

A number of reasons are usually offered for the cause of his slip: first, he was an inexperienced and clumsy rock climber; he was exhausted from the fast ascent of Mont Blanc he'd made with Hudson a few days before; his footwear was hopelessly inadequate for such a climb. Looking at his boots in Zermatt, you can't help feeling that while they would be fine for climbing a flight of stairs, they were nowhere near sufficient for the Matterhorn, a simple leather shoe with a nailed sole for what was the equivalent in 1865 of Everest in 1953 as the measure of all things in mountaineering.

As early as 1770 the Dutch physician and comparative anatomist Petrus Camper acknowledged the problems associated with manufacturing

mountaineering boots. He saw that our feet are as important as the feet of horses, donkeys, oxen and other animals but that little effort or expense was invested for human feet. The design and manufacture of specialized boots to this point had been neglected and left to uninformed craftsmen.

Around 1850 the anatomist Hermann Meyer from Zürich addressed this point in his book *Procrustes ante portas: why the shoe pinches*. He focussed on detailed anatomical investigations of the feet. This article attracted little attention in Germany. Yet after translation into English in 1861 the practical English appreciated the suggestions and shoemakers began to construct shoes according to his new ideas. Most of the climbing boots worn by English climbers in the Alps were manufactured according to Meyer's pattern, including those of Douglas Hadow.

In 1876 Andreas Madlehner suggested in the *Mitteilungen des Deutschen und Österreichischen Alpenvereins* that one should, if possible, do without a heel. The trend was for a lace-up shoe without too high an ankle. In addition the sole was nailed all round with *Kappennägel*, literally 'capping nails'. In 1884 Pfeiffer described lace-up boots with a double sole consisting of four or five rows of nails, so called *Durchzugsflügelnägel* or 'wing nails'. Leather laces did not yet exist, but were instead of hemp or linen.

A large proportion of research on mountaineering boots was conducted by the military. Their big dilemma was that every single foot needs its own last. For reasons of cost, the military developed production of standard shoe lasts in different dimensions. They also developed hooks and eyelets for lacing.

In 1887 a medical review of the demands and requirements for climbing boots was published in the magazine of the German Alpine Club. It stated that the most necessary piece of equipment for climbing is a healthy foot and mountaineering boots should support this in every way. The optimum boot should give enough space for vulnerable toes, the heel of the boot should embrace the heel of the foot and the upper should hold and push the dorsum of the foot in such a way to prevent the foot sliding. Leather at the heel of the shoe should not move against the Achilles' tendon and irritate it, distortion of the foot should be prevented, and the heel of the boot should be low but not completely absent. It was generally accepted mountaineering boots should serve universally on ice, rock and mixed ground, saving the need for additional climbing shoes or crampons.

By the beginning of the 20th century mountaineering boots were being produced and sold in German sports shops. The 1900s catalogue of the sport shop of Schwaiger in Munich gives a good overview of the mountain boots and shoe nails available at that time. The Munich sport shop Schuster equipped, for example, the Kangchenjunga expedition of G O Dyhrenfurth in 1930 and the American K2 expedition in 1938 led by Fritz Wiessner.

Ideally mountain boots were made to measure; a worn shoe was frequently presented as a template. Delivery time was only six to eight days; the cost was 27 marks, equivalent to £70 today. Hand-forged shoe nails could be individually crafted on request. A hundred nails cost £3. For nailing, the shoe needed a protruding double or triple sole.

**Touristen-, Berg- und Jagdstiefel für Herren.**

— Façon 120. —  
Zu Hochtouren passend. Mit geschlossener Lasche, zweifachem Boden, nicht zu schwer und besten hierzu passenden Leder. Mk. 25.—

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Ohne Naht mit Kalblederfutter, geschlossener Lasche und Lodenansatz, um das Einrücken von Saiten und Wasser zu verhindern. Mk. 27.—

**Allgäuer Original-Schnürstiefel.**

Lieferzeit nach Mass 6-8 Tage.

NB. Bei Bestellung bitte entweder einen getragenen Schuh oder Massangabe nach umstehender Anleitung einzusenden.

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aus Delphinderleder mit Drahtspitzen Mk. —.75

**Allgäuer Griffseisen**  
als Ersatz der Nägel am Absatz des Bergschuhs. Auf steilen Grahäsen und vereisten Straßen ausgezeichnetes Tragen. Mk. 1.75

**Schuhnägel**  
hochstehendes, handgeschmiedetes Fabrikat.

Nr. 1. —.80  
Nr. 2. —.80  
Nr. 3. —.70 per Hundert.

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von Bergschuhs mit handgeschmiedeten, hochkantigen sogenannten „Nietnägeln“ in bester Ausführung Mk. 3.— mit T-Nägeln Mk. 3.50.  
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aus braunem Segeltuch mit Spagatsohle. Sehr leicht und klein, zusammenlegbar. Per Paar Mk. 2.— (Faustlinge erletet.)

Early advertisement for mountaineering boots and nails from the Sport Schwaiger catalogue for 1900.

**TRICOUNI S.A.**  
2 Fusterie,  
GENEVA.  
Only Manufacturers.

**Sold by all first class Sporting and Footwear Houses.**

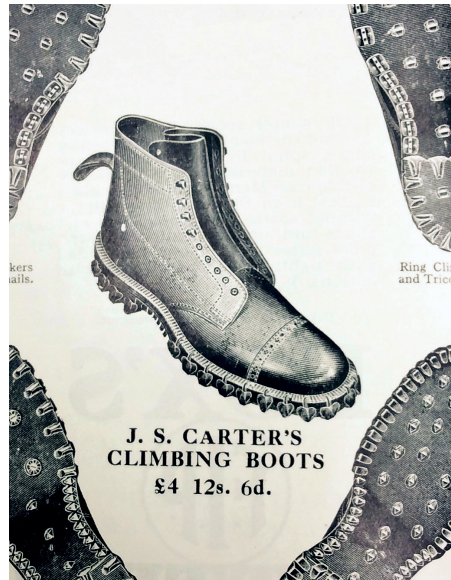
Write for *PRICE LIST* and *Catalogue*.

BREV. TRICOUNI N° 1

Advertisement for Tricouni. (*Alpine Journal*)



Above: The nails on Mallory's boots.  
(Rick Reanier/Archiv Jochen Hemmleb)



Right: Advertisement for Carter.  
(Alpine Journal)

Until about 1910 mountain-boot nails were as a single leaf wrapped externally around the sole and by then these bent nails were produced in different sizes. In 1912 the Swiss jeweller Félix-Valentin Genecand designed a new type of boot nail and a new nailing system. He was able to produce nails made from two pieces, one hard gripping part brazed to a softer malleable part, which was attached to the boot by two nails. He gave the nails his own nickname: 'Tricouni'. These nailed boots were very effective on ice-covered rocks. This slowed down the development and use of crampons.

After the First World War, in Germany mountaineering boots were produced double or triple stitched fashion. Manufacturers started avoiding a heel seam, to better protect the Achilles. Because of the lack of metal for nails and fittings, nails from the 1890s were still used. In England, there were two leading boot-makers and suppliers of equipment for climbers, James Carter and Robert Lawrie. In Carter's advertisement from 1924 you can see a climbing boot with ring clinkers, hobnails and tricounis.

Edward Norton, the British Everest, wrote in 1924: 'These boots are the result of years of experience. Their essential feature is the leather sole, which should be nailed (with the points of the nails turned down) before being attached to felt soles. Mr Carter supplied two members of last year's party with these particularly good boots of Lampar pattern, the boots were of a size to take stockings and two pairs of socks: the soles should be treated similarly to the above to avoid conductivity of nails and with a felt sole between the welt and the nailed sole if possible.'

This description illustrates clearly the boots George Mallory used. These were found in 1999 during the research expedition to Mount Everest supported by the historian Jochen Hemmleb. Mike Parsons and Mary B



George Mallory's boot from 1924. (Rick Reanier/Archiv Jochen Hemmleb)

Rose at Lancaster University evaluated the boots, which are today in the Royal Geographical Society in London.

Mallory's boots had novel hobnails attached through a 3mm calfskin leather sole but insulated from the feet by a 10mm felt. (See illustration above.) The weight of each boot was calculated to be 800g. He wore three layers of socks, worked in with three layers of long johns and military-style puttees. Altogether these weighed only 500g, for a total weight of 2.1kg. This pioneering equipment can be seen as the beginning of the current light-weight trend in outdoor gear.

At just 800g, these boots are likely to be the lightest ever worn on Everest. Early on the English had recognized that weight savings on the boots provides a huge performance advantage at heights. For this reason, compromising the stability of the shoes was accepted. Some of the boots fell apart during the expedition, according to Mallory's climbing partner Sandy Irvine.

After the British Expedition of 1922 to Everest, George Finch described in the *Alpine Journal* the equipment for high-altitude mountaineering with special reference to climbing Everest. He proposed that leather is too good a heat-conductor and it should not be relied on for warmth. The uppers of the boots should be of felt, strengthened where necessary to prevent stretching by sewn-on leather stripes. The felt should be covered by Duraprene canvas. Toe and heel caps must be hard and strong; the former should be high. The sole should consist of thin leather, a layer of three-ply wood hinged in two sections at the instep, and a thin layer of felt. The boot should be large enough to accommodate in comfort two pairs of thick socks. Ten tricouni nails per boot should be sufficient. These should be fastened by screws,


Advertisement viii

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Above: (Wayfarers' Journal 1935)

Right: Mountaineering boot c1930.  
(German Alpine Club Archives, Munich)

passing through the leather sole and entering into, but not penetrating, the three-ply wood. Short-length ankle putties would prevent ingress of snow into the boots. Crampons were unnecessary. This is a good description of the 1924 boots, apart for the wooden sole, which was never used.

In the 1930s, Robert Lawrie brought out a new high-altitude design with several novel elements including interior felting and a lambskin inner sole. He would be the only supplier of boots to Everest climbers from the 1930s until 1953.

Similar models were also used in Germany and Austria. In this picture from around 1930, above right, iron fittings on the sole are easy to see, resulting in a nearly flat bottom surface without heels.

A critical issue with this type of boot sole was insulation; nails were the perfect conductor for drawing heat away from the feet. So the next revolution was in the development of a new shoe sole, not from three-ply wood as Finch suggested, but from rubber. This development came from the development of ski boots and was described in 1931 in the *Mitteilungen des Deutschen Alpenvereins*. In 1936 the Italian Vitale Bramani further enhanced this sole, in the aftermath of an accident blamed on inadequate footwear that killed several of his friends. His 'Carrarmato' sole went into production with financial support from Pirelli. He used a combination of his first name and surname to create his company name: Vibram, still the outstand-

Thermal Conductivities of Various Insulating Materials

Material	Description	Temp (°F)	Density (lb./cu ft)	Thermal conductivity in gals feet sq. cm for a temp. gradient of 1°C per inch (x 10 <sup>4</sup> )	Source of data.
Rubber.	light sponge	90-95	12-31	1.2-2.5	BRM EA.
	Cellulose.	90-95	2.6-9	0.9-1.2	
Fida. down	-	300	6.8	<del>0.46</del> 1.5	H.C.P. (Pocket 1878)
			0.1	1.5	
Cotton wool.	Gunpowder	-	-	1.0	S.P.T.
	-	-	-	0.43	H.C.P. (47 Jambes)
	Felted	-	-	0.33	"
	-	-	-	0.40	P.H.R.
Felt.	-	-	-	0.87	H.C.P.
	† -	68	<del>11</del>	0.90	N.P.L.
		15	-	0.78	
	Hair felt.	† -	11	0.58	H.C.P. (Nat Bus Stds)
			13	0.58	
	Hawcloth, felt.	-	-	0.42	H.E.P.
Kapok	-	68	1	0.54	N.P.L.
			6	0.45	
		15	1	0.45	
Kapok between kapsa paper (Dry Zero)	"Dry Zero"	† -	1	0.54	H.C.P. (Nat Bus Stds)
			2	0.56	

would be required to give an opinion.  
Since it was not practical to use more than 3/8" of cellulose  
rubber & 3/8" of felt extra insulation was introduced in the  
form of a single layer of Tropical and a woven vinylidene mesh  
Details of these are given later.

Research results on thermal insulation of different materials.  
(SATRA Technology Centre)

ing brand in the outdoor footwear world.

After the Second World War, the political scene changed. Nepal opened up and the French mounted an expedition to Dhaulagiri and Annapurna in 1950. Their success in putting Maurice Herzog and Louis Lachenal on the summit of Annapurna was extraordinary, but came at a high price: both men suffered frostbite to their feet from inadequate boots. The British had made seven expeditions to Everest from the Tibetan side before the war. Now, with Tibet closed following China's occupation, they also turned

their attention to Nepal. Eric Shipton led a reconnaissance to the Khumbu in 1951 but the Nepali government chose to award the permit for a full attempt in 1952 to Switzerland. Raymond Lambert and Tenzing Norgay fell short of the summit by only 150m. The Swiss, and Tenzing, wore reindeer skin boots made by Bally. The British physiologist Griffith Pugh tested these boots, found them excellent and wanted them for Everest but they were too expensive.

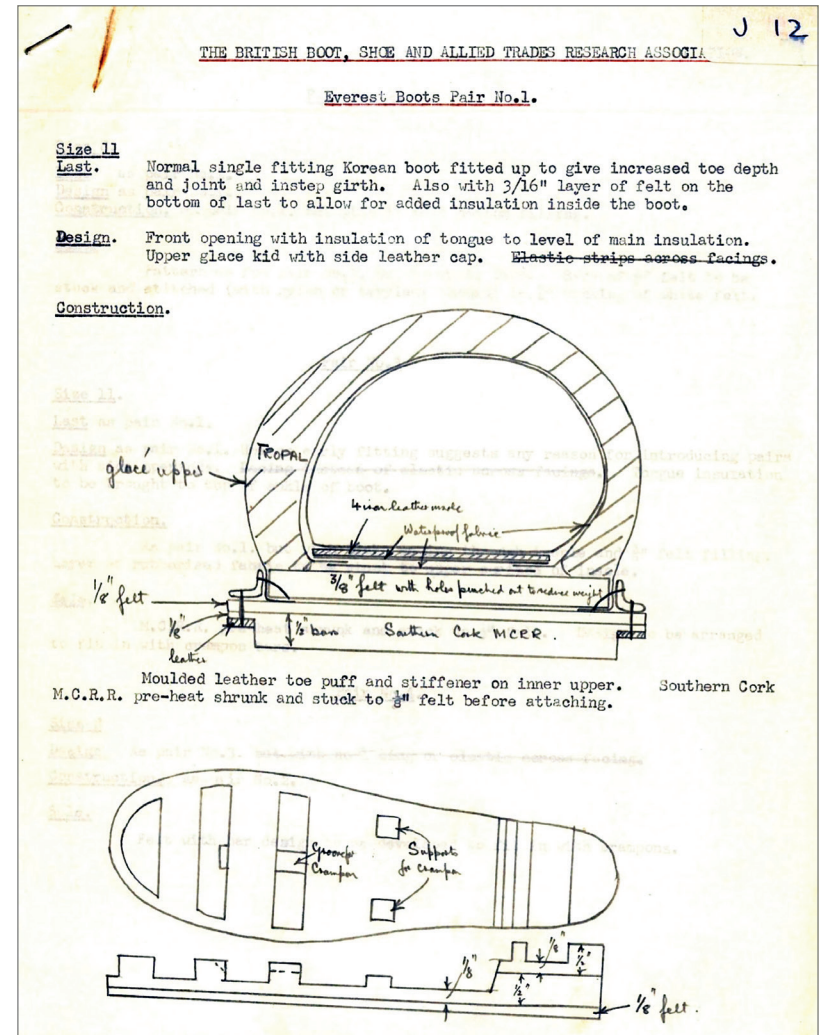
So in October 1952, Harry Bradley, director of research at the British Boot, Shoe and Allied Trades Research Association (SATRA), was asked to submit trial samples of boots suitable for use in the final stages of the assault on the mountain at heights above 7,000m. The specification for the boots seemed straightforward: lightweight, with very high thermal insulation, while at the same time sufficiently strong and well fitting for climbing. They also had to take a lightweight crampon. Durability was not important since the boots would only be required to last a few days. Scientists developed several concepts to solve these challenges; 30 companies of the SATRA association were involved in improving materials.

Little information was available on how to maintain a satisfactory temperature for the feet under conditions at high altitude. The image above shows studies to estimate the amount of thermal insulation required. In the early stages of development it was postulated that with expected temperatures waterproofness was unimportant since water was unlikely to be encountered. After the first tests in the Swiss Alps in November, it became obvious to the designers that during the day wet snow would be an issue and the boots needed to be waterproof to some degree.

Climbing boots had traditionally been made from deerskin cocoons, which were bulky and rather cumbersome to move in. SATRA used leather with a lightweight rubberized fabric backing selected for the insoles. The linings were also made from rubberized fabric, all seams being sealed with latex. A light and flexible leather with reasonable water repellence was used for the uppers, which were made larger than the linings to allow ample amounts of kapok fibre insulation. The boots were designed to have room for two pairs of wool 'duffle' socks. A vapour barrier allowed sweat to disperse from the socks, preventing feet and boots becoming soaked and freezing, and an integrated rubber outer gaiter prevented melting snow soaking into the boot itself. Since the toecaps of the boots might often be used for kicking steps in frozen snow they were reinforced to withstand the wear.

The outer sole was not the Italian Vibram, but was made by Dunlop from micro-cellular rubber to further improve insulation and decrease weight: one boot was 1.01kg or 1.09kg with the disposable waterproof cover. It was still a significant difference compared to the 800g of Mallory's boot.

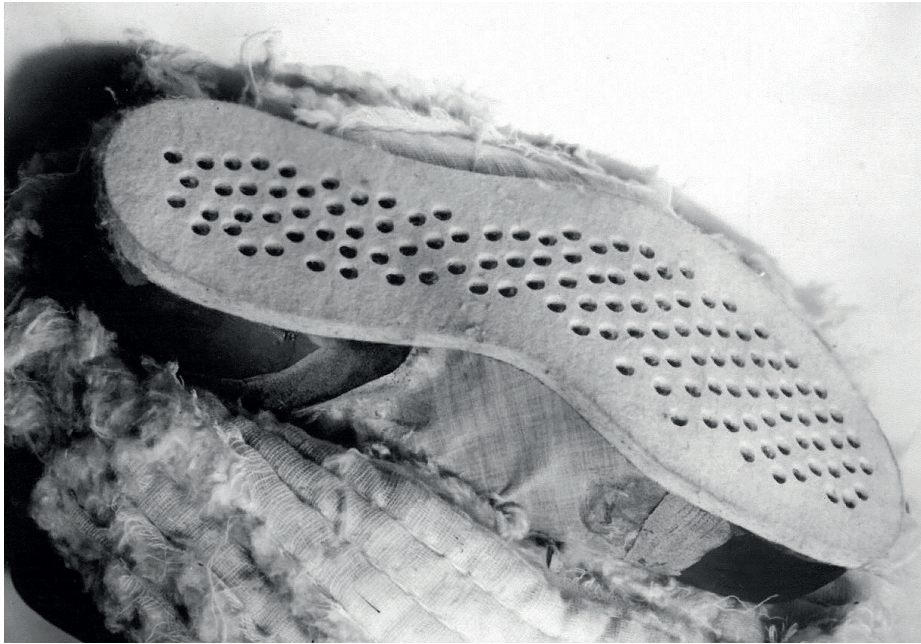
In only 14 days SATRA had presented their first prototype. There were ultimately four different models, which were tested in early December in the Alps. Cold weather tests at minus 40°C were performed at the Royal Aircraft Establishment at Farnborough. The boot proved so successful that on 11 December 35 pairs were ordered. All were handmade to fit the



Cross-section and sole of SATRA boot for Everest expedition in 1953 (SATRA Technology Centre)

individual foot sizes and exact measurements of each member of the expedition. Sizes varied from UK 6 for some of the Sherpas to UK 12 for Hillary's feet. Special lasts had to be made for the Sherpas from diagrams and foot measurements sent by the Himalayan Club in Darjeeling.

The boots were delivered on 16 January 1953, just five weeks later. After the successful ascent, John Hunt wrote to Harry Bradley to tell him that the boots had been a great success and had been worn by all members of the party at altitudes above 6,100m. Unlike any previous Everest expeditions, no member of the British team had suffered from frostbite of their feet.



Manufacturing the inner sole and insulation material. (SATRA Technology Centre)

In fact, no one on Everest had suffered cold feet let alone frostbite. It was a far cry from Hadow's street shoes.

It had been a long way from Hadow's street shoes to Hillary's SATRA mountain boots. A great deal of experience had had to be collected in the Himalaya and implemented at home by scientists, technicians and shoemakers to end up with the successful result.

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### Thanks to:

Edy Schmidt, president of the Zermatt museum, Jochen Hemmleb, Jake Locke, SATRA head of communications, Tadeusz Hudowski, Glyn Hughes, Martina Sepp, German Alpine Club, Mike Parsons and Mary B Rose.