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Abstract

This article explores lead user innovation in the UK outdoor trade since 1850. The long term perspective allows an analysis of the changing role and impact of lead user sports people on clothing and equipment for mountaineering and other outdoor activities. Lead user innovation is where the users themselves, as those with the best understanding of their demands, innovate to produce what they need. They benefit from using rather than selling the product in the first instance. Long term perspective demonstrates significant changes in sporting needs, technology, manufacturing organization, business methods and communications. It highlights the importance of shared practice, learning by doing and learning by using in the innovation process where sometimes disruptive innovation occurs where communities of practice meet. This article traces the relationship between the development and impact of lead user innovation and the way these were shaped by sporting and business changes.

Lead User Innovation and the UK Outdoor Trade since 1850

Introduction

Innovation can take place at any point in the supply chain and is an evolutionary, learning process. It depends on knowledge and experience, which builds and shifts through time and most often occurs when boundaries are crossed and expertise and knowledge are combined. A growing body of research led by Eric von Hippel, from the 1980s onwards, has highlighted the importance of users and lead users in particular, in the innovation process. Lead user innovators may either be businesses or consumers who, through operating at the 'leading edge' of activity, face new needs significantly earlier than the majority of the customers in the market segment.ⁱ They are motivated by the benefits they will reap from a solution to a user problem, not initially by the sale of the product.ⁱⁱ This approach to innovation, which challenges conventional approaches to innovation, has been applied, over the last twenty years to both industrial and consumer lead users.ⁱⁱⁱ

Lead user innovation is where the users themselves, as those with the best understanding of their demands, innovate to produce what they need. They benefit from using rather than selling the product in the first instance. Recent research on lead user innovation has demonstrated its potential for improving innovation success rates and for maintaining market leadership. This

approach seriously challenges conventional wisdom, where innovation occurs within companies and especially within large corporations. Instead lead users emerge as the principal sources of many major innovations.^{iv} Studies of lean manufacturing highlight the shift in control of the production process from manufacturer to production line worker. Similarly research on lead user innovation places innovation in the hands of the user, rather than the manufacturer, whose principal interest is in selling.

'Designing for use and testing by use are the essential characteristics of user innovators: they may subcontract production and parts supply, but they cannot subcontract the innovation's design or testing and be user innovators...'^v

Lead user innovation has a long history and occurs whenever new needs, whether those of manufactures or those of consumers, are not met by conventional products or services. In the United States there were no specialist textile machine makers before 1820, so that all machinery development was lead user innovation.^{vi} There is extensive evidence of this kind of activity in the British cotton industry in the eighteenth and nineteenth centuries, where lead user activity often initiated innovation and contributed to the eventual commercialization of inventions. Machine tool innovation is another example of lead user innovation, this time by specialist machine

makers.^{vii} Similarly, LEO, the first business computer was developed for use by Lyons, the British food brand in the 1940s and 1950s.^{viii} There has also been extensive research highlighting the importance of industrial lead user innovation in scientific instruments and other specialist industrial sectors since the Second World War.^{ix}

Lead user innovation has not, however, been confined to business users and consumers are seen as an increasingly important source of innovation, an interest stimulated by the emergence of open source communities in software development.^x Recent research has revealed the importance of lead user innovation in a range of outdoor sport equipment and the strong links between tacit knowledge and the development of sports goods in the United States and Continental Europe. Innovations have been developed to handle particular sporting challenges and to enhance performance. There is also evidence of knowledge sharing and enhancement within sporting communities.^{xi}

Our study of lead user innovation in UK outdoor products brings several new dimensions. The development of the UK outdoor clothing and equipment trade provides an ideal laboratory to study the changing nature of consumer innovation from the nineteenth to the twenty-first century. We trace the shifting role and experience of lead user innovation in UK outdoor products, over a 150 year period. This long term perspective demonstrates significant changes in sporting needs, technology, manufacturing organization, business methods and communications. This paper traces the relationship between the

development and impact of lead user innovation and the way these were shaped by sporting and business changes.

Leading sports people link their practical knowledge, derived from use, to innovation. However neither use nor innovation are isolated activities, but are shaped by shared practice. The communities of practice literature provides an exciting bridge between entrepreneurship, innovation and networks and one which is underpinned by historical path dependency models of 'learning by doing'. This makes it ideal for looking at user innovation.^{xii} A model of learning, based on participation rather than theory, communities of practice emphasizes the way in which learning is a social rather than an individual activity.^{xiii} In this article we explore the shifting interface between users and manufacturers and the extent to which shared communities of practice and knowledge have influenced product development and have been shaped by the innovations themselves. We explore the extent to which the role and impact of lead user innovation has shifted through time and the way in which this co-evolved with changes in technology, materials, institutions, markets, business structures and social attitudes. This long term perspective is linked to shifts in the building and functioning of communities of practice among outdoor sports people and between sports people and business. The article will be divided into three substantive sections. A first section will summarize research on lead user innovation and explore the historical evidence of lead user innovation in UK industry generally. A second section summarizes the changing relationships between outdoor sports people and

clothing and equipment suppliers since the nineteenth century. It will explore the changing role and experience of lead user innovation across a range of products, including climbing equipment, rucksacks and clothing through time. The approach is co-evolutionary and is underpinned by an analysis of shifting communities of practice through time. In a final section conclusions will be drawn.

The pioneer Victorian Alpine lead users

Modern mountaineering began in the 1850s and 1860s, when elite British mountaineers went to the Alps for science and recreation, establishing the Alpine Club in 1857. The coming of the railways in the 1860s and the first Cook's tours in 1862 widened participation. Between 1850 and 1865 most of the Alpine 4000 metre peaks had been climbed, 70% involving UK climbers in partnership with their professional guides. Yet, while the English pioneered mountaineering as a sport, they did not initiate the production of mountaineering clothing or equipment, especially mountaineering hardware which was produced in the Alps, based on indigenous craft blacksmithing skills.^{xiv} For other equipment, such as tents, sleeping bags, burners for heating water and food, mountaineers often designed their own, either making

them themselves or entering into dialogues with other mountaineers and with craftsmen in the UK. Some of these innovations emerged as dominant designs, impacting on what was taken for granted in mountain equipment for many years.

Three Victorians, Francis Tuckett, Edward Whymper and Fred Mummery stand out as exceptional mountaineers and designers and can all be categorized as lead user innovators.^{xv} They were pioneers in an emerging sport and were unsupported by established manufacturers or retailers. Before the Alpine hut network was developed in the 1860s and 1870s, the climbers and their guides had two choices. They either bivouacked under rocks or they pounded up and down from the valley below, using candle lanterns at the beginning and the end of a long day. There were no purpose made tents – those that were manufactured in this period were large, bulky military style tents which were not designed rock, snow and ice or for high winds. There were no purpose made sleeping bags, or portable cooking equipment.^{xvi} Our ancestors may have lacked much of what we deem essential in the mountains, but they possessed a greater natural awareness of how to survive and move around on frozen or mountainous terrain. Many early climbers were intensely practical men who had a typical Victorian fascination with ingenious and extraordinary devices. They had sufficient wealth and leisure to pursue ideas which might make their hobby more pleasurable. They were part of an elite community of practice centred on the Alpine Club and, through a combination of the *Alpine Journal*, Alpine Club equipment exhibitions, of the 1890s and early 1900s the Royal Geographical Society *Hints for Travellers* they shared user experience.^{xvii} They used what was available and improved

and adapted it to meet changing aspirations and solve new problems, working with craftsmen and developing patterns. Whympers and Mummery developed outstanding tents and Tuckett, the typical Victorian tinkerer, designed a revolutionary blanket sleeping bag and a burner for heating food and liquids. All three of these lead users worked with craftsmen to develop prototypes, which were then tested and their functionality adjusted. Of the three, Whympers is the best known example. However, both Tuckett and Mummery also fulfil the criteria of the lead user innovator and both developed designs which diffused widely and had a lasting impact on what emerged as standard for outdoor activity.^{xviii}

Work on modern lead users has shown that a proportion of lead user innovators do set up their own companies. Some of these are lifestyle businesses, but a few may challenge established manufacturers, even emerging as disruptive innovators.^{xix} None of the Victorian lead user Alpinists saw their innovations as a platform for their own business, even though in some cases, as with the Whympers tent, their innovations became the dominant design for decades. Thomas Hiram Holding was, however, different from the Alpinists. By 1900 he had established a prestigious reputation as tailor, but was a pioneer canoe and cycle camper.^{xx} His tailoring knowledge undoubtedly influenced his design styles for tents and enhanced his knowledge of fabrics.^{xxi} His innovations were, however, classic lead user innovations. He combined technical and practical knowledge with sporting expertise to make his sport more pleasurable. Holding was founder of the

Bicycle Touring Club in 1878, the Association of Cycle Campers (1901) (forerunner of the Camping and Caravanning Club) and the National Cycle Camping Club 1906. ^{xxii} He had an enduring passion for outdoor living and self propelled activity, which he recognised was only pleasurable or indeed sustainable with compact, lightweight kit. He was convinced:

'that the lighter the weight and the smaller the bulk, the happier will the canoeist be...if he intends to stay in a hotel or seek shelter in a house, there is small need to take anything but his bacca box and cane; but if he goes in for camping, and therefore for enjoyment and independence, for economy and health and for self reliance – all these things being inseparable from camping – he must necessarily take that which will protect him from inclement weather and keep up temperature during the cold hours of the nigh.' ^{xxiii}

In common with the Victorian Alpinists, this inventor of the sport of cycle camping , found nothing suitable to meet his needs on the market from established manufacturers :

'When I made cycle-camping possible I found nothing, adaptable to it, and therefore designing and actually making or instructing others to make such things as would suit the sport' (Holding 1908 +++ I think this is from Refined Camping)

He designed tents, including super lightweight silk one, panniers for bicycles and used the bicycle as a platform for related portable equipment design. In

1908 he even designed an 11 cwt one horse caravan.^{xxiv} Several of his lightweight innovations – especially the baby primus- endured as a dominant design until after the Second World War. The Primus stove was the first pressure stove and fuelled with paraffin was developed in Sweden by Franz Wilhelm Lindqvist and appeared first in 1892.^{xxv} It was used for self propelled travel, but was heavy and bulky for cycling. Just a year after these had been introduced Holding began experimenting:

'Three years to get a smaller size – 5 inches across – made and then it had projecting legs. So I devised a second model and had the feet set right underneath, the projecting pump shortened and changed the valve from the side to the top, christening it the 'Baby Primus' which is the best of all the Primus models . Still pursuing my Spartan notions re compactness, space and solid packing, I designed the So-Soon pans for taking the Primus stove inside.'^{xxvi}

From the start, Holding shared his ideas with Club members through his books *Watery Wanderings* and *Cycle and Camp in Connemara* published respectively 1886 and 1898. Before the First World War, he and other user innovators shared their experiences through a range of specialists cycling and camping club magazines including the Cycle Touring Club (CTC) *Gazette*, *Cycle Camping*, *Camping*, *Campers' Quarterly*, and the Association of Cycle Campers *Handbook*. *The Campers' Quarterly*.^{xxvii} In 1908 Thomas Holding published *Campers' Handbook* which was described by the *Daily News* as the 'Campers' Koran', because it was so comprehensive and authoritative. These publications were full of users' designs and advice on how to make kit and the

clubs, for a while, were a vital mainspring on innovation. By then Holding had become a lead user entrepreneur, diversifying his tailoring businesses into supplying camping equipment, through an advanced, informative catalogue, *Refined Camping*.

Designing for use became embedded in the ethos of the camping clubs. The Association of Cycle Campers (ACC) exhibited at the Travel Exhibition in 1906 and at the Ideal Home Exhibition in 1908.^{xxviii} Lightweight tent and equipment design undoubtedly evolved significantly through lead user innovation by pioneer campers. Holding himself developed a number of designs including an A style tent and a Gipsy tent, but his favourite was a small A style called the Wigwam made in silk. Weighing just 11 oz it fitted in a coat pocket. Unfortunately it came with heavy steel pegs as, he found aluminium pegs bent. However, in common with Mummery's ice axe tent, walking sticks were used as tent poles.^{xxix} Following Holding's resignation as President, the ACC established a Supplies Department, sourcing camping equipment in 1911-after parting company with Thomas Holding. In 1919 Association of Cycle Campers (ACC) became the Camping Club of Great Britain and moved into manufacturing in 1920 period by setting up Camp and Sports Co-operators with the trademark Camtors producing what have been described as the Rolls Royces of the camping world, including the Itisa, a single pole tent based on a 1916 member's design.^{xxx} Lead user innovation therefore became the basis of the Camtor brand, which survived until the 1960s.

Characteristics of Victorian and Edwardian lead user innovators

Whymper, Tuckett and Mummery are the most famous lead innovator mountaineers of their generation. They developed their innovations to meet their own personal needs rather than with an intention to commercialise them. Yet, some at least of their designs became enduring mountain classics. They had little choice than to develop their own kit, as they were pioneers in an emerging sport that predated the development of a specialist outdoor trade in the UK. They were practical men able to build a dialogue with the craftsmen who developed their products for them. Their sporting experience was enhanced by the kit they developed, which in turn shaped what they designed. This was especially noticeable for Mummery's tent and his desire for a lightweight approach, but in all cases their leisure activity was improved by their own innovative activity. These men also understood materials and their innovations reflect technological capabilities of the period. Victorian lead users were part of an especially close knit network based around the Alpine Club which enhanced knowledge sharing. Apart from in its very early years, the *Alpine Journal* did not contain specialist equipment articles, but in telling their expedition stories the climbers also revealed how they solved their equipment problems. They also shared knowledge through the Alpine Club Exhibitions in the 1890s, which included exhibits from the Alpine outfitters alongside those from innovative members. While none of them were aspiring entrepreneurs, all of them produced designs which set a lasting standard and at least some of their products – especially the Whymper and Mummery tents

were later factory produced and distributed through large scale retailers, such as Benjamin Edgington, well into the twentieth century.^{xxxii} The lasting impact of Victorian lead user innovators on the design of mountain equipment cannot be understood simply by looking at nineteenth century experience. Interwar retailing developments made tents more widely available to the growing number of outdoor enthusiasts. The shift to factory production of tents by firms like Benjamin Edgington reduced the cost of tents while helping to perpetuate 19th century designs.^{xxxii}

It is interesting to compare lead user innovation from within the Alpine Club and the camping clubs in a similar period. In both, lead user innovation was a necessity because established manufacturers did not make the required products. In both, communities of knowledge and practice built up, linked to club membership, shared activity and disseminated through Club publications. Yet there were differences- not least the size of the clubs – both the Alpine Club and the cycle camping clubs were middle class but cycle camping, even before the First World War, lacked the social and sporting elitism of Alpine climbing. But there is another difference, because user equipment development became embedded in cycle camping as a sport, with competitions and regular equipment articles in ways that it did not in the Alpine Club. The reasons are not immediately clear. Judging by the contents of the *Alpine Journal*, climbers preferred reading about climbing than equipment, and there were remarkably few designated equipment articles until the second half of the twentieth century.

By contrast, cycle campers, perhaps initially inspired by the founder of their sport Thomas Holding, were as interested in the development of kit as they were in the sport. In addition, members of the Alpine Club were public school educated professionals. The Camping Club members, before the First World War, came more generally from a lower middle class trading and industrial background, with higher levels of technical knowledge and skill. In addition, while the Alpine Club had its kit exhibitions from the 1890s, they would have never contemplated contributing to the Ideal Home Exhibition. That the Camping Club set up a Supplies Division and a manufacturing co-operative is indicative of a strikingly different culture born in part of the rapidly growing membership and differing origins of the two clubs. It is interesting that what began as need driven innovation, to fill gaps left unfilled by established craft manufacturers, had evolved into an almost self sufficiency culture among some self propelled campers after the Second World War. Hazel Constance, author of the official history of the Camping and Caravanning Club, and her husband Pat, have been members since 1960. They have written extensively on camping and making camping equipment. Their enormous and varied collection of camping artefacts is a testament to their fascination with equipment-something for them inseparable from their sport. ^{xxxiii}

Several changes began in the interwar period which were eventually (though not immediately) created a distance between manufacturers, retailers and their consumers for camping and hiking clothing and equipment. The growth of consumer income encouraged manufacturing and retailing changes which

made it easier to buy reasonably priced gear, often on 'easy' hire purchase terms. Certainly, compared with the growth of the outdoor trade after 1960 choice remained limited. However, the expansion of Blacks as an outdoor store, which combined factory manufacturing with its growing number of retail branches and a mail order catalogue, was inseparable from the hiking and camping craze and represented the beginnings of a shift away from the small scale specialist suppliers of the nineteenth century.^{xxxiv}

In its early years when the 'camping Blacks' were involved the company remained close to customers' needs as reflected in its innovative and informative catalogue aimed primarily at hikers and campers. They out-competed Camtors in the 1930s, while supplying major expeditions gave them contact with mountaineering lead users. When contact with both types of customer was lost in the 1960s and 1970s, market research did not provide a good substitute for understanding customer needs. Blacks, as a result lost competitive advantage in the outdoor market.^{xxxv}

The Himalayas, Everest and lead user innovation

The interwar period clearly witnessed changes in the hiking and cycling market, but at the very top of the market craft production and customisation remained crucial. The quest for the summit of Everest, during the interwar period, became a Holy Grail for Britain's top mountaineers from 1921 until 1953. Before the First World War, Polar exploration and Alpine climbing had

stimulated innovation and knowledge building among both lead users and the companies and craftsmen supplying them and, as today, climbers built strong relationships with their suppliers.^{xxxvi} It has already been demonstrated that a number of goods including tents, stoves and rucksacks were factory produced, though sourced through specialist suppliers, while others were produced through small craft workshops, sometimes attached to retailers. Tailoring and boot making skills remained vital for windproof outerwear and mountaineering footwear. In the 1920s expedition members approached specialist manufacturers, tailors and boot makers such as Benjamin Edgington, James S. Carter and Silver and Co. with their personal kit needs. Climbing suits were of a standardized design adjusted to the personal measurements of the climber.^{xxxvii} The 1924 climbing team were instructed, when they went to Messrs Burberry in Haymarket to ask for Mr. Pink for a careful fitting. This was crucial if the outer garment was to fit over multiple layers. This dialogue connected the climbing community to their suppliers and indeed to knowledge built on earlier polar expeditions. Himalayan climbing was in its infancy, but mountaineers understood that they would experience similar climatic conditions to the pole, dry, cold and windy. But there was the additional consideration of altitude and this produced several equipment and clothing challenges which were addressed primarily by lead user innovators, including especially George Finch.

An Australian born, Swiss educated scientist, George Finch had a formidable pre-war climbing reputation and emerges as perhaps the most important of the inter-war Everest lead users. His combination of sporting, practical, scientific skill and curiosity proved an extraordinarily powerful mix and he

developed clothing, oxygen, stove and footwear innovations.^{xxxviii} Much of the lead user innovation, associated with clothing for Everest in the 1920s, was incremental building on Polar knowledge of layering and windproofs. And as with Polar explorers some of innovation took place during the expedition. Like many lead user innovators George Finch became expedition mechanic during the 1922 Everest expedition, adjusting, testing and improving during the long walk across Tibet.^{xxxix}

The interwar Everest expeditions provide vital insights into lead user innovation and emphasise the role of learning by doing and learning by using. They also illustrate the evolution of knowledge that developed between 1921 and 1953 with links back to the nineteenth century. John Hunt, the leader of the 1953 Everest expedition, paid especial tribute to George Finch whose practical approach to Everest, he believed, was vital to later expeditions. There was, he said, 'a pyramid of knowledge [and experience] from every attempt, each adding to the last until the puzzle was solved,' He saluted George Finch for his contributions to footwear, oxygen and clothing.^{xi}

This pyramid of user knowledge shaped what was taken to the mountains and contributed to the development of mountaineering as a sport. While the building of climbers' knowledge was evolutionary, what was chosen and what was developed also linked to changes in materials, technology and indeed science. This was especially clear with respect to the use of oxygen. But how far did this lead user knowledge influence suppliers of clothing and equipment and were the innovations commercialised?

During the interwar period, suppliers of major expeditions, whether craft boot makers like Robert Lawrie, or small workshop producers like Robert Burns or factory producers and mass retailers like Blacks, were able to derive significant marketing advantage from the association. But this is not the same thing as saying that these companies embedded lead user knowledge in their products. Both Lawrie and Burns were climbers themselves which made it easier for them to discuss designs with their lead user clients. As a result they did make use of lead user knowledge to develop and perfect their designs. Robert Lawrie, leading interwar mountain boot maker, had supplied the 1930s Everest expeditions and designed a general climbing boot weighing 1700 g 'lined with opossum fur between two layers of leather with a woollen felt sole' – as used in 1924 – but with a thin rubber sole.^{xli} These drew on George Finch's 1922 designs.^{xlii} Other elements, particularly the outer protective layer, look remarkably like a predecessor to the high altitude SATRA boot used in 1953.^{xliii} As Charles Wylie of the 1953 expedition observed: 'We enjoyed the advantage of light boots throughout the expedition and there were no cases of frozen feet.'^{xliv} This boot was, however, never commercialised. Ideas and innovation certainly transfer best where there is shared understanding, based on experience.

Robert Burns, the Manchester mountain equipment manufacturer, himself an enthusiastic climber, built a genuinely strong relationship with Himalayan lead user Frank Smythe. He developed sleeping bags rucksacks and an Everest tent for the climber in the 1930s and the two enjoyed a lively and creative dialogue.^{xlv} Burns is in no doubt that the knowledge he gained from supplying

high altitude expeditions improved the design of the products he made for the average consumer.

‘Great expeditions, record breaking and even stunts, almost always influence the design and construction of equipment or machines used afterwards in everyday affairs and the Everest Expedition of 1933 [shows this].’^{xlvi}

This is especially interesting since, unlike the earlier generation of UK Alpine craft suppliers, Burns had built his original business around the interwar hiking and camping movement, not elite mountaineers.^{xlvii} Indeed in 1927 his advertising included the slogan ‘The man who made sleeping out safe for democracy.’^{xlviii}

Climbing Hardware during the 1960s and 1970s

Before 1960, the only outdoor products for which UK companies had international competitive advantage were textile based- clothing and tents. In 1953 anything remotely technical, from rucksacks, through ice axes, crampons and climbing hardware and technical boots were sourced in Continental Europe. This section of the paper explores the causes and consequences of the emergence of lead user innovation in more technical products in the UK.

Although mass participation in outdoor activities, such as hill walking and cycling, grew strongly in the inter war period, this did not result in a mass market, since incomes were low. A range of forces, including increasing leisure time, greater mobility and changing access laws, made outdoor

activities more popular. The first ascent of Everest in 1953 made mountaineering more visible and, through its leader John Hunt, provided a vital boost to outdoor education in the UK. The outdoor education centres became a crucial bulk market for UK outdoor companies in the 1960s and 1970s. Demand continued to rise in the 1970s and 1980s, bolstered by the development of activities like backpacking, Scottish ice climbing and skiing.

^{xlix} Rising demand created growing opportunities for innovative outdoor companies which became inseparable from the changing needs of a new type of user.

The Peak District was the heart of the growing level of urban climbing and outdoor activity and this was crucial to lead user innovation and design after the Second World War. The Derbyshire Peak District, with its proximity to Manchester and Sheffield, became increasingly popular with working class and lower middle class urban dwellers, during the interwar period. 10,000 walkers visited Derbyshire, mainly from the neighbouring conurbations, on a typical weekend in 1931, many becoming involved in the access movement and the Mass Trespass of 1932. British mountaineering had its origins in the nineteenth century among the moneyed, public school educated professional elites. It was these elite who contributed to the inter-war and indeed the 1953 Everest expedition. The Peak climbers were a new breed who pursued very different 'rules of the game' and had different knowledge and skills. The slump, which devastated industries like cotton and steel in the interwar period, led to a sharp rise in unemployment in both Manchester and Sheffield. Many of them flocked to the Gritstone edges of the Peak District.

*'Peakland mountaineering did not share the upper class origins of the sport elsewhere in Britain and the district surrounded by the great industrial masses of Sheffield, Nottingham, Derby, the Potteries and Manchester and its neighbours has been primarily a working-man's playground, while Wasdale and Ogwen remained for a long time in the leisured atmosphere of the traditional climbing families and their friends, there grew up in the Peak District an independent tradition of hard walking and hard climbing that owed little to external influence.'*ⁱ

After the Second World War this group emerged at the leading edge of British climbing and formed the crucial bridge between regionally based industrial skills and the design of innovative outdoor products. The emergence of this new group of climbers altered the profile of British climbing and influenced equipment development fundamentally. The Peak District climbers shared the outlook and background of Continental climbers who, in the late nineteenth and early twentieth centuries, had developed technical rock climbing in both the Western and Eastern Alps.ⁱⁱ In the Alps, the combination of industrial, practical and climbing knowledge influenced innovative design of mountaineering hardware and other equipment. This trend was replicated in the areas bordering the Peak District.ⁱⁱⁱ The emergence of communities of practice, where lead users innovate to meet their own personal needs, sometimes becoming lifestyle entrepreneurs, has been identified in other outdoor sports.ⁱⁱⁱⁱ (Shah, 2000; Von Hippel, 2005:19) What is significant, in the case of the emergence of the British outdoor trade, was the extent to which this activity mapped onto the region's industrial past. This manifested itself in

a number of ways, including people who combined the knowledge of materials, manufacturing and craft processes with the demands of sport. Lead user innovators are involved in the dance of two questions: what is needed and what is possible. The combination of the knowledge of the capabilities of materials, industrial processes and sporting needs was a creative mixture. It played a fundamental role in the innovation and design process in mountaineering and climbing equipment and in the raising of climbing standards in the UK from the 1950s onwards. Being entirely separate, socially and geographically, from the traditions of British mountaineering, the working class climbers 'did not know what they were not supposed to do.'^{iv} However, they recognised that their gritstone rocks needed technical climbing equipment. In other words, the distinctive physical geography of the Peak, differed from the Lake District and North Wales, where the mountaineering elite typically climbed. This had a significant impact on equipment development after the Second World War.

UK textile- related equipment for climbing and mountaineering was well developed by the 1960s and often many years in advance of Continental Europe. Climbing hardware, on the other hand, was 50 years behind.^{iv} Part of the reason for this lay in the ethics of the British climbing establishment, which abhorred artificial aids. Another factor is the physical difference between most of the climbing areas favoured by the British climbing establishment and the Eastern Alps with its big walls, where many of the major climbing hardware innovations originated. However, the creation of a new device-the nut, which did not damage the rock, had a lasting impact on the development of climbing hardware design in the UK. The device was called a nut simply because the

initial inspiration was an engineer's nut with the thread removed.

The sporting origin of the removable nut, to replace the piton (which was left on the rock face), came from the British practice of threading the rope through a small rock, which was naturally jammed in a crack. Many of the peak climbers worked in engineering workshops and collected Whitworth nuts, filing the threads from the inside, threading a nylon cord through them and using them instead of stones. The first manufactured nut, the Acorn, was made by climber John Brailsford, a one-time Sheffield steel apprentice and blacksmith, who was by 1961 working as a craft teacher in Derbyshire. By using aluminium die casting, Brailsford went on to develop the much improved MOAC nut, one of the crucial innovations on which the UK mountain hardware industry was based. John Brailsford was not the only innovator in UK mountain hardware, but he became supporting master craftsman for many who came later.^{lvi} This, combined with his move into outdoor education and later mountain guiding, meant his knowledge had a disproportionate impact on developments in the 1960s and 1970s.

The nut was initially sand cast but, once the concept was established, many different lead users and lead user manufacturers explored the 'design space', to use a variety of different production techniques from extrusion to forging to die casting. As has been the case in other sports, a number of lead users became new entrants into manufacturing, subsequently developing companies with a worldwide reputation.^{lvii} The physical environment around the companies was very important to their founders, however. It meant they were able to climb in evenings, rather than waiting until the traditional free-time of weekends.

The interplay between practical manufacturing knowledge, craftsmanship and sport is not the only source of path dependence of design in UK outdoor products, however. The Peak District was the playground of outstanding working class climbers, who emerged as lead user innovators. Of these the best known were Don Whillans and Joe Brown, whose climbing expertise captured the nation's imagination during the 1950s and 1960s. Intensely practical and trained as a plumber, Don Whillans had an 'analytical attitude to gear.' according to Pete Hutchinson, owner of Mountain Equipment. He was a typical lead user designer- looking for the solutions to his own particular climbing needs.^{lviii} His classic designs included the Whillans Box, a high altitude tent developed for him by Karrimor and the Whillans sit harness developed with Troll, both of key importance to his move into high altitude climbing in the Himalayas in the 1960s.^{lix} Some lead users, like Whillans, were not remotely interested in the business side of innovation. The comparatively few who do are often life-style entrepreneurs, using their business to support their climbing. Joe Brown, the post war working class climber was quite clear that for him climbing came before his business.^{lx} Some lead user innovators have challenged established manufacturers in the outdoor trade over the last 150 years. Worldwide these include Vitale Bramani –the Italian who developed the rubber Vibram sole in the 1930s. Yvon Chouinard was the American founder of Chouinard Equipment and in the 1970s he set up the international brand Patagonia.^{lxi} In the UK of course the Camtor brand was established in the 1920s by a lead user co-operative. Rab Carrington, who emerged in the 1970s as a leading edge climber, with a reputation for hard,

lightweight routes in the Alps, South America and the Himalayas, is another example. In many ways he shared a 'life-style' entrepreneur's attitude to his business. When he started Rab

in 1981 he commented:

'I was under the impression, when I went into business, that I would only have to work six months of the year that I could have every summer off, but, unfortunately, that soon changed.'^{lxii}

Carrington was clear that his standing as a leading climber gave his Rab brand credibility and his designs for sleeping bags and down clothing informed by his knowledge as a lead user. This does not make him a lead user innovator as none of his designs were developed eventually for his own use. But his deep mountaineering knowledge and concern for functionality over style meant his products were highly respected and he overtook the UK market leader Mountain Equipment in 1992.^{lxiii}

There were others, such as Tony Howard, one of the founders of Troll Products. He was a lead user, an innovator and subsequently a manufacturer.^{lxiv} The company derived its name from the Troll Wall in Norway, climbed by Tony Howard and his climbing partners in 1965.^{lxv}

Troll Products was located in a small wooden shed in Greenfield, West Yorkshire. Greenfield is a small ex-textile town on the Lancashire side of the

Pennines. Historically, its industrial significance lay in its location at the intersection of roads from Manchester to Huddersfield and Holmfirth, and the Huddersfield Narrows canal with its technologically impressive 5km Standedge tunnel that provided the key transport link across England from the Mersey to the Humber estuaries. Waist belts, Troll's first products, were a direct response to the technical climbing development taking place on Peak District Gritstone from the 1950s onwards. The shift toward aid climbing meant that climbers were carrying more gear and were tying a rope around their waist. The waist belts replaced this and allowed them to carry more. The design of these simple belts was also linked to the decline of the textile industry, because they were made of old leather belting from local textile mills, although later on this was replaced by nylon webbing.^{lxvi} By 1968 Troll Products' workshop comprised three small-interconnected sections, each about 8 ft (2.5m) square: office, machine shop, and store/polishing room. The business's products around 1968 mainly comprised: 'chocks' (a wide range of metal wedges used in safety protection by climbers), etriers (short ladders for climbers made of nylon tape and stiffened with polystyrene cement), cagoules (knee length waterproof smock made from polyurethane coated nylon with stitched and glued seams). In 1969 Troll was approached by Don Whillans about the development of what became the sit-harness for high altitude resting during climbs.

'There were no sit-harnesses on the market and Don came up with the idea of a fabric seat linked into the waist belt. We played around with Don's idea and took the fabric out and replaced with web. Eventually we came up with the

basic Whillans harness still using mill belting. Although it was initially criticised by the journalists it took off and nothing replaced it until 1978'.^{lxvii}

During this period the company did modify and improve the sit harness and it became the dominant design internationally, as well as in the UK. Troll and Karrimor, the rucksack manufacturers, were among the pioneer UK outdoor companies in the 1960s who worked with lead user innovators, but they shared another characteristic. They were among the suppliers of Chris Bonington's 1970 expedition to Annapurna, an expedition which was a turning point for both British mountaineering and British outdoor companies. In climbing terms, the techniques of big wall and technical climbing developed in Continental Europe and America had been further improved by Britain's new breed of climbers. But the high profile media coverage turned the suppliers into international brands overnight. In a retrospective interview, Tony Howard confirmed he saw Annapurna South Face as the key turning point for his company's development through the high profile of the sit harness on photographs, on TV and in the lectures.^{lxviii} But this was not just publicity hype, as the sit harness was a break through which started a whole new level of safety and performance in climbing. Bonington described it as: 'An outstanding success, for it enabled one to rest back in the seat while jumaring up snow slopes.'^{lxix}

Annapurna 1970 had a similar impact on Karrimor. The company supplied the expedition with rucksacks, the Whillans box – the special aluminium framed high altitude tent designed to Whillans' specification and made by Karrimor using pack frame technology- and the Karrimat. So great was the level of

publicity that followed that the company struggled to keep up with demand.^{lxx} Neither company could have survived long had their only market been just leading edge climbing, however high profile. The market is tiny and some of the innovations –such as the Whillans Box- did not diffuse. However, the expeditions enhanced the companies' reputation for functionality and usability, crucial in the emerging bulk markets linked to outdoor education and backpacking during the 1970s.

Karrimor and lead user innovators

Founded in 1946 as a cycle bag company, Karrimor emerged by the 1970s as the UK's leading rucksack brand, securing 80% of the UK market and exporting 50% of its output.^{lxxi} The company developed a strong reputation for innovative products- deriving in part from working with leading edge sports people. As supplier of major expeditions and an active outdoor sportsman, Mike Parsons was able to build strong relationships with many lead user innovators Don Whillans, Joe Brown, Dougal Haston, Joe Tasker, Peter Boardman, Peter Habeler, Chris Bonington, John Cleare, and Alex Macintyre. One of the most promising relationships was with Alex Macintyre who became a Karrimor technical advisor in the early 1980s.^{lxxii} For Alex, going lightweight was less about weight than about commitment and a way of thinking:

Above all cunning is the lot of the Alpinist. The term "lightweight" is not enough to describe his activities for it encompasses a much wider brief than

he entertains. The key to this Alpine Style is the intent with which the Alpinist approaches his proposed route, the intention to climb it in one single push without previous knowledge or camps placed prior to the final venture. The commitment is total, the calculations crucial, the freedom exhilarating and the weight of the sac still crippling!^{lxxiii}

He climbed with great audacity developing a whole new style and philosophy of Himalayan climbing. His dialogue with Mike Parsons began in the early 1980s, as he attempted ever more difficult routes. Mike gave him access to the development staff:

'No-one else previously had ever had the ability to get stuck in, let alone willingness to do it....Quickly he developed a very large 80 litre capacity or lightweight pack which we named the Mac pack. After several trips the pack became a well sought after requirement by many leading expeditions of different nationalities. The only problem being that they wanted them all giving and that there was no real commercial market for such product.^{lxxiv}

This can of course be the problem with lead user innovation, when needs and uses are too extreme for the average user. But the diffusion of innovation to a wider market is about imagination, adaptation, incremental innovation and combinations of technologies and ideas. Sporting needs and technologies

change and knowledge developed in one set of circumstance can be combined to develop new innovations. This was the case with the understanding Parsons gained from Alex on the Mac Sac :

'To date there is the possibility that this market will begin and some of the lessons I learned with Alex will be put into the new OMM lightweight pack range.'^{lxxv}

Having worked with most of the top mountaineers of his generation including as well as Alex Macintyre, Parsons was clear how important this kind of interchange was to his ability to innovate. But the trauma of Alex's death in 1982 left Parsons convinced that he had to move away from the kind of close individual relationship he had had with lead users. During the 1980s he was also keen to build the scope of the company without losing touch with users, as so often happens when businesses grow. The best innovations often involve boundary crossing and there is evidence in sports good innovation that the most innovative users are multi sport.(Lüthje,2004).Parsons' own multi sport activity placed him in a position to devise a 'Think Tank 'of lead users, including mountain photographers, polar explorers, as well climbers, mountain guides.^{lxxvi} He met with them quarterly to brain storm on product innovation. As he said:

:

I am not in that category myself [lead user] as you know, but did pride myself on having the widest spread of outdoor activity competence, there being few outdoor professionals even with my spread. It was probably for this reason

that I ensured there was leading edge representation from almost all sports outdoor sports on my Think Tank.^{lxxvii}

Lead user outdoor innovation in 2009

Lead user innovation is derived from knowledge built from using, and is becoming increasingly important in the 21st century. This paper has shown that historically, lead users have played a vital role in innovation in outdoor products. In some cases lead user innovations, such as the Whymper tent, have emerged as dominant designs. In other cases lead user innovators have adjusted and tinkered with their clothing and equipment, to make it fit for their particular purpose. This incremental innovation often played a crucial part in the success of their chosen activity. This was undoubtedly easier in the nineteenth century. The industrial processes for the majority of outdoor products were craft based and materials easy to work with. Users were, therefore, in a position either to make their own or talk directly to a craftsman who could make it for them. As the scale and complexity of industrial production accelerated over the last century, users have found it harder to get hands-on experience to achieve whatever innovations they wish to make. In addition, the spread of off-shore manufacturing since the 1980s has created a physical gap between designers and manufacturers. However for knowledge, as opposed to physical products, research has demonstrated that the

accessibility of Open Source software has led innovation to shift to individual users and to user communities.^{lxxviii} With physical products lighter weight materials have made customisation easier, whereas the Internet has enhanced information exchange within user communities and between users and businesses.

This is illustrated in Mike Parsons' current business, Original Mountain Marathon Ltd (OMM Ltd) where lightweight products, fabrics and components make it easy for users to customise their clothing and equipment. Indeed the very philosophy of the brand is flexibility and customisation, with the user making decisions on what they need for a particular activity. The OMM product platform is designed to meet a range of specialist markets including adventure racing, climbing and mountain backpacking. Users share a need for lightweight products, but require differing weights and functionality. The equipment is designed for customisation and can be stripped down to what is described as the 'leanweight'. Unusually among outdoor manufacturers, the OMM Product Manual encourages customisation, while the OMM website illustrates how to strip down and customise each pack:

<http://www.theomm.com/products/keyFunctions.html>

By actively encouraging customisation and lead user innovation, Parsons is able to reinforce knowledge exchange relationships with his lead user customers. This close user contact, in turn, helps him to develop new gear as he commented recently on ideas sent by one lead user :

'Gives me much food for thought as we are looking ahead now. ... there is

always something in looking at what keen users want to do to customise and indeed that's the source of some of my ideas so far; interpreted of course.^{lxxix}

Since the nineteenth century origins of mountaineering and outdoor activity, communities of users have shared knowledge. Modern internet communications including web fora, shared social web space and blogging widens awareness of what people use and how they adapt it. There is of course a wide variation in the quality of knowledge shared and the potential insights gained. But, at the very least these sources, centre around a range of specialist sites give insight into what is going on and what is being used and adapted. For a micro-business such as OMM, engagement through the open source collaborative space Google Groups since 2007, has created an online multi-sport lead user group of 14 members spanning climbing, mountaineering, adventure racing, fell running, orienteering and mountain-biking. Some of these are self-selected, some invited to join and all actively involved at the highest level of outdoor activity and in adapting their own equipment to meet their specific needs. This group of people physically meet infrequently, but display a similar community of shared practice, trust and knowledge as the climbing teams discussed earlier in the paper. Their sustained interaction with each other and business owner, Mike Parsons has led to far more than simple incremental innovation. The knowledge shared reduced the development time for a new product range from 18 months to just 9 months in 2008-9.^{lxxx}

Conclusions

This 150 year overview has demonstrated the importance of lead user innovation in UK outdoor products. It has shown that a number of the major innovations were not developed within companies, but by users operating at the leading edge of their sport. Mountaineers had little alternative in the nineteenth century, their sport was new and there were no specialist suppliers. They had to innovate because their needs were not met by any established UK craft suppliers. Craft-based products were developed through face to face dialogue informed by use. Lead user innovators, like Edward Whymper, Francis Fox Tuckett and Fred Mummery designed prototypes and usage encouraged further incremental innovation. While none of these men ran outdoor businesses their designs all emerged as the dominant design for their particular product category. These men were part of a small group of climbers, centred on the *Alpine Club*, where knowledge and experience was exchanged through the club journal, meetings and crucially through shared experience. Changes in both manufacturing and distribution meant that these designs reached a wider audience. Nevertheless the UK climbing community was tiny until after the Second World War, and there was nothing resembling a modern outdoor trade. Mountaineers were not, however, the only source lead user innovators in outdoor sports before the First World War. Sports, such as cycle and canoe camping witnessed similar levels of user knowledge

and innovation. , Innovation by users remains embedded in the culture of self propelled camping to the present day.

Lead users' ability to innovate is based upon the knowledge which comes from practical use and need. It is often enhanced by belonging to a close community of practice which makes it easier to exchange and understand knowledge. Some communities of practice, like any networks, become inward looking and this happened in the UK climbing community from the late nineteenth century to the Second World War. Yet the overlap of knowledge and communities of practices in Britain's declining industrial regions with a new generation of post war climbers shaped innovation in UK outdoor products from the 1960s to the 1990s.

If relatively few lead user innovators set up leading outdoor brands, it should not be concluded that lead user innovation has little business significance. Lead user innovation involves innovating ahead of market trends. Certainly some innovations designed for extremes –such as the Whillans box- were never commercialised. However, the evidence from this article demonstrates that many lead user innovations diffuse within the market. In addition the article has shown has shown that the knowledge derived from developing leading edge products informs all kinds of product development at all levels by improving quality and functionality and anticipating average user needs. Collaboration between established companies and lead users undoubtedly

bring benefits to the established company in future product development. Innovating entrepreneurs are engaged in a dynamic dance of two questions, what is needed and what is possible. Collaborating with lead users can enhance both elements of that dance. One of the keys to successful relationships between lead users and established businesses lies in shared understanding. If relatively few lead users found successful businesses, many outdoor businesses have been set up by skilled users. They are close enough to their lead users to appreciate their needs and identify how they can be combined with what is possible.

The implications for businesses of engaging with lead user innovators go beyond product development to embrace the wider diffusion of innovation. The position of lead users as early adopters whose needs typically pre-date that of the normal user by 5 years makes them important for first mover advantage of businesses. It also makes them 'trusted' champions of products which can encourage the early majority to try a new product.^{lxxxix} A classic example of this is of course mountain biking, a massive sector and a disruptive innovation, originated by passionate users outside established cycle sector. More generally it has been claimed that in active sports 57% of innovations come from lead users.^{lxxxix} Where lead users are drawn from a range of activities this brings with it the potential for combining skills and knowledge leading perhaps to disruptive innovation.

This article shows that lead user innovation has been very strong in the development of outdoor products in the UK for 150 years. There have been successive waves of lead user innovation, linked to new (and old) technologies and sporting development. The article has, however concentrated on UK experience with only passing international perspective. Shared communities of practice lies at the heart of lead user innovation, within and between sport and business. Innovation tends to occur at the interstices of communities of practice which bring the opportunities for boundary crossing. The breaking down of geographic barriers in mountaineering and business since the Second World War provided the opportunity for both sporting and design boundary crossing. Future research will explore international patterns in lead user innovation where geographical, sporting and skill differences have contributed to shifting waves of lead user innovation in down clothing, footwear, crampons and mountain hardware, especially during the twentieth century. Technological and business change has altered the nature and impact of lead user innovation through time. Overall this article has demonstrated the shift from craft to mass production, from natural to synthetic materials. It has also highlighted the significance of lead users in new product development in established businesses. Rapid manufacturing techniques, where Computer Aided Design (CAD) systems are combined with three dimensional copying have already been used in the development of customised designs in a range of sports. The falling price of this technology has the potential to shift both design and manufacture to the level of the individual user, leading to disruptive process innovation. ^{lxxxiii}

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