Sources and Patterns of Innovation in a Consumer Products Field: Innovations in Sporting Equipment

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Abstract

Academics and practitioners alike express interest in uncovering, explaining, and potentially manipulating the sources of innovation. There is empirical evidence that innovations can be developed by those holding any of a number of functional relationships to them, such as manufacturers, users, or materials suppliers. Past studies focused on industrial products; this study represents the first documentation of the sources of innovation in a consumer goods category – sports equipment.

In this study we investigate the innovation histories of 57 important skateboarding, snowboarding, and windsurfing equipment innovations. We find that, contrary to conventional wisdom, equipment for new sports was not developed by existing sports equipment manufacturing companies. Innovations were instead developed by a few early and active participants in the new sports – lead users who built innovative equipment for themselves, their friends, and often built businesses focused on producing such equipment in order to appropriate benefit from their innovations and establish a lifestyle around the sport.

We argue that the pattern of innovation observed in these fields makes sense for two reasons – the allocation of "sticky" information between lead users and manufacturers, and the relative expectations of innovation-related benefits held by users and manufacturers.

Sources and Patterns of Innovation in a Consumer Products Field:
Innovations in Sporting Equipment

1.0: Introduction

To date, empirical research into the functional sources of innovation has explored only industrial products and processes. In this research, we provide the first exploration of the functional sources of innovation in a category of consumer durables. Specifically, we explore the innovation and commercialization histories of 57 equipment innovations developed for three relatively new sports: skateboarding, snowboarding, and windsurfing.

In each sport studied, we found the same general pattern of innovation activity. Equipment for the new sport was not developed by existing sports equipment manufacturing companies – even ones in closely allied fields (e.g., snowboarding equipment was not developed by makers of other winter sports equipment such as skis or sleds). Instead, innovations in skateboarding, snowboarding and windsurfing equipment were typically developed by a few early expert participants in those sports, lead users, and also by some of those same lead users after they founded small companies to produce their innovations for sale.

The innovating users in these sports were generally very young – in their teens or early twenties – and technically unsophisticated. They evolved their innovations via learning-by-doing in their novel and rapidly evolving fields. They would begin by building a prototype using simple tools and materials, immediately try it out under real field conditions, discover problems, make revisions within hours, and then try again. The small companies founded by some of these innovators began as lifestyle firms, in which expert users supported their primary activity of playing at and refining their sport by making and selling copies of the sporting equipment they had developed from their basement or spare room or garage. Over time, some of these firms closed as the interests of their founders changed, but others survived and evolved into major producers of equipment for the sport.

We will argue that the pattern of innovation by users makes sense in these fields for two reasons – the allocation of "sticky" information between lead users and manufacturers and the relative expectations of innovation-related benefits held by users and manufacturers. With respect to "sticky" information, the rich and complicated

information regarding what is “fun” is generated by lead users of the sports that we studied and is not easily transferable to manufacturers. With respect to expectations of innovation-related benefits, consider that, in the early days of each sport, the sport's potential broad-scale appeal was by no means clear. For example, when skateboarding first emerged it was by no means clear that millions of users would eventually find it rewarding to do tricks standing precariously on a rapidly-moving small board with wheels. This meant that manufacturers contemplating innovating were considering the eventual potential of a small and uncertain market. In contrast, lead users were gaining great and certain personal satisfaction from innovating in and playing at their new sport.

We will also argue that the pattern of commercialization observed -- in which innovating users often found lifestyle firms to sell their innovations makes sense. In the fields we have studied, innovating users have only a very limited ability to appropriate benefit from their innovations by other means such as patenting and licensing their intellectual property to others.

In this paper we first describe our research sample and explain our research methods (section 2). Next, we report our findings with respect to the functional sources of innovation (section 3); the lead user status of the users observed to have developed important innovations (section 4); and the means used by innovators to appropriate benefit from their innovations (section 5). Finally, we discuss the implications of our findings (section 6).

2.0: Research Sample and Study Methods

2.1: Sports selected for study

Our study of innovation in sporting equipment focuses on equipment used in three sports: skateboarding, snowboarding and windsurfing. We elected to study these sports because they met two key criteria: (1) they were developed relatively recently, almost all of the innovations for each sport were developed within the last 40 years, and (2) they have grown to significant size, each having at least a million participants and having equipment sales in the range of $100 million annually by 1998.

Recent development of key innovations was important to us because it meant that we could collect accurate and detailed data: information about the histories of the

innovations could typically be obtained by interviewing the innovators and others who were also present when the innovation was being developed or commercialized. Significant market size was important to us because it meant that both users and manufacturers should in principle have an interest in participating in the development of innovations in the sport – users because of the attractiveness of the activity; manufacturers because of the commercial attractiveness of the market. Each sport we studied has a group of serious enthusiasts and a contingent of professional racers, as well as mass-market recreational participants. In general, the innovations identified in this study began among enthusiasts and migrated to the mass market over time.

Several additional sports, such as mountain biking and rollerblading, also met the two criteria just noted. We selected skateboarding, snowboarding and windsurfing from the list simply because the student researchers on our team of data collectors were most familiar with these sports[1]. We are aware of no bias in our innovation pattern findings resulting from the selection of these particular sports.

Table 1: Participation and Expenditures in Markets Studied

Sport	Founding Date	1998 U.S. Sports Participation Data for frequent participants in parenthesis (1)	1998 U.S. Consumer Expenditures Data for units in parenthesis (2)
Skateboarding	Early 1900s	5.8 MM participants (30+ days/year: 2.5 MM)	Skateboards (1997): $72.5 MM (1.5 MM units) *1998 data unavailable.*
Snowboarding	1965	3.6 MM participants (10+ days/year: 1.4 MM)	Boards: $77.0 MM (0.310 MM units) Boards, Boots & Bindings: $163.9 MM
Windsurfing	1964	1.214 MM windsurfers, growing at a rate of 6.9% a year. (79.1% windsurf at least once a month) *Source: www.awia.org*	Boards 20,000 units Sails 29,000 units Masts 30,000 units Booms 22,000 units Mast Bases 10,000 units *Source: www.awia.org*

Source: Source: National Sporting Goods Association (NSGA) unless otherwise noted

(1) Frequent is defined differently for each sport by the NSGA.

(2) We have included market estimates in terms of consumer expenditures and/or units sold, when available, for each sport.

[1] Additionally, the company Rollerblade, a pioneer in in-line skating equipment, does not grant interviews for research purposes.

2.2: Samples of important innovations

We identified a sample of "important" equipment innovations for each of the three sports in our study as follows. First, we contacted individuals who we had reason to believe had expertise in each sport. Those contacted included editors of well-known sport-specific magazines; authors of books that discussed the history of each sport; and experts at leading equipment manufacturers. We asked each of these individuals to identify people they judged to have excellent knowledge of the innovation history of each sport. These experts were contacted in turn and asked the same question. We eventually ended up identifying between three and five experts with very good information on the histories of important equipment innovations in each sport – a few being innovators themselves. Next, we asked each of these individuals to list "the important equipment innovations in the history of the sport." We then compared the lists of innovations independently generated by these experts. All innovations nominated by two or more experts (not including the inventor if he was also a nominator) were included in the sample.

Via this process we identified a sample of 10 important equipment innovations for snowboarding, 7 for skateboarding, and 40 for windsurfing. The greater number of innovations in windsurfing is most likely due to the greater number of parts on a windsurfer – snowboards and skateboards consist primarily of a board; a windsurfer of a board (with a fin and often a daggerboard attached), a sail, a mast, and a boom. Each of these parts, as well as the interfaces between parts, can be the object of design work and improvement. All innovations in the sample are listed in Appendix A.

2.3: Data collection

Development and commercialization histories were collected for each innovation identified. Data collection was accomplished primarily through one-on-one telephone interviews with industry experts – the founder(s) of the sports, those responsible for key innovations, designers, early manufacturers, current manufacturers, and occasionally professional competitors in the sport. Magazine editors and book authors were consulted as well. Interviews were semi-structured and were designed to collect detailed

innovation and commercialization histories for all innovations in our sample. Whenever possible, the innovator was interviewed to get a better understanding for the local information employed and the specific circumstances, needs, and problem solving methods surrounding the innovative activity. Information used in tables was always verified using either a second interview source, published magazine articles, patent applications, old equipment catalogues, or dated photographs, drafts, and sketches[2].

2.4: Key definitions

An innovator is defined as the firm or individual that first develops a working prototype of an equipment innovation that is used in the sport by the inventor or others. In cases where more than one individual independently developed an innovation, all innovators are credited. In cases where groups of people worked on an innovation, all individuals are credited.

The functional locus of innovation is defined in terms of the means used by an innovator to derive benefit from the innovation at the time the innovation was made. Specifically:

> User innovation: An innovation developed by an innovator who, at the time the innovation was developed benefited only from using it is classified as a user innovation.
>
> User-manufacturer innovation: An innovation developed by one or a group of lead users who benefited both from use and from participation in a small lifestyle firm (10 full time employees or less at the time of innovation) which produced and sold innovative equipment for their sport.
>
> Manufacturer Innovation: An innovation developed by any type of manufacturing firm (including lead user-founded lifestyle firms that grew to exceed 10 employees in size at the time of the innovation).

[2] Note that the information presented in the tables was always verified or is in the process of being verified. However, some qualitative information regarding specifics of the innovation process and where *ideas* came from is not verifiable.

Other: Instances where an innovator does not belong in any of the categories just listed. Example: innovations developed by members of two or more of the categories described above working jointly are coded as other.

NA: Instances where the developer of an important innovation could not be determined were coded NA (Not Available)

To our knowledge, the user-manufacturer category defined above has not been used before in studies of the functional locus of innovation. We employ it here because it accurately characterizes the nature of the benefit obtained by the several innovators in our sample who were both (1) lead users and avid practitioners of their sport, and (2), also made and sold small amounts of equipment to others in order to support their sport-centered lifestyle.

3.0: Findings: Patterns in the sources of innovation

Our study of innovation histories showed that sports equipment users developed 100% of the first of type innovations in each of the three sports that we studied. We also found that, taken together, innovating users and user-manufacturers (user-founded lifestyle firms) developed 58% of all major improvement innovations in our sample. Manufacturers developed 27% of the major improvement innovations in our sample, and the remaining 15% were developed by other functional sources of innovation (Table 2).

On the basis of this data we can strongly reject the conventional wisdom derived hypothesis that *existing* manufacturers of sporting equipment of any type will be the dominant developers (responsible for greater than or equal to 90% of innovations) of innovations in novel sports [3]. We can even go further and reject the hypothesis that

[3] We used a binomial distribution to test the null hypothesis that that *existing* manufacturers of sporting equipment will develop greater than or equal to 90% of the innovations in novel sports (i.e. that probability [innovation by an existing manufacturer of sports equipment] ≥ 90%). With 0 of 48 innovations being developed by such manufacturers of sports equipment, this hypothesis is rejected with the probability of type 1 error being less than 1%. Testing a hypothesis in this way requires that each data point be an independent Bernoulli trial. However, because the same innovator or group of innovators often innovated multiple times, this assumption is not readily met. Removing all but one innovation by innovators with two or more innovations in any given sport leaves us with 0 of 22 innovations being developed by such manufacturers. Therefore, the null hypothesis is also rejected under the independence considerations discussed above with the probability of type 1 error being less than 1%.

manufacturers in general (existing manufacturers, component suppliers, and manufacturers organized to produce specifically for the sport in question) will be the dominant developers of innovations in novel sports [4].

Table 2: Functional Source of Innovation

Sport	Innovation Type	Percentage of Innovations Developed by Users and User-Manufacturers	Number of Innovations Developed by:					TOTAL
			User	User-Manufacturer	Manufacturer	Other	Unknown	
Skateboarding	First of Type	**100%**	1	0	0	0	0	1
	Major Improvement	**67%**	0	4	2	0	0	6
Snowboarding	First of Type	**100%**	1	0	0	0	0	1
	Major Improvement	**67%**	2	4	3	0	0	9
Windsurfing	First of Type	**100%**	1	0	0	0	0	1
	Major Improvement	**53%**	2	14 (a)	7	7 (b)	9	39
TOTAL			7	22	12	7	9	57
% of First of Type Innovations (c)		**100%**	**100%**	**0%**	**0%**	**0%**		
% of Major Improvement Innovations (c)		**58%**	**9%**	**49%**	**27%**	**15%**		

(a) 13 of these are attributed to the firm Windsurfing Hawaii.
(b) 2 of these are partially attributable to the firm Windsurfing Hawaii
(c) Innovations for which the developer is unknown have been excluded from percentage calculations

We can also conservatively consider each innovator rather than each innovation as a statistically independent event. To do this we construct a subsample consisting of only the first innovation developed by each innovator (Table 3). Both null hypotheses are still rejected under this constraint; allowing us to soundly reject the conventional wisdom derived hypotheses [5].

[4] We used a binomial distribution to test the null hypothesis that any manufacturer will develop greater than or equal to 90% of the innovations in novel sports. With 12 of 48 innovations being developed by *any* manufacturer (existing manufacturers, component suppliers, or manufacturers organized to produce specifically for the sport in question), this hypothesis is rejected with the probability of type 1 error being less than 1%. Testing a hypothesis in this way requires that each data point be an independent Bernoulli trial. However, because the same innovator or group of innovators often innovated multiple times, this assumption is not readily met. Removing all but one innovation by innovators with two or more innovations in any given sport leaves us with 7 of 22 innovations being developed by such manufacturers. Therefore, the null hypothesis is also rejected under the independence considerations discussed above with the probability of type 1 error being less than 1%.

[5] The results of all the hypotheses tested are also valid if we conservatively assume that manufacturers in general will develop greater than or equal to only 75% of the innovations in novel sports. If we go so far as to assume that manufacturers in general will develop greater than or equal to only 50% of the innovations in novel sports, the first hypothesis is upheld with the probability of type 1 error being less than 1%, but the second is not; however, the second hypotheses can be rejected at the 7% level.

Table 3: Functional Source of Innovation – First Innovation by Each Innovator Only

Sport	Innovation Type	Percentage of Innovations Developed by Users and User-Manufacturers	Number of Innovations Developed by:					TOTAL
			User	User-Manufacturer	Manufacturer	Other	Unknown	
Skateboarding	First of Type	**100%**	1	0	0	0	0	1
	Major Improvement	**67%**	0	2	1	0	0	3
Snowboarding	First of Type	**100%**	1	0	0	0	0	1
	Major Improvement	**67%**	2	2	2	0	0	6
Windsurfing	First of Type	**100%**	1	0	0	0	0	1
	Major Improvement	**40%**	2	2	4	2	9	19
TOTAL			7	6	7	2	9	31
% of First of Type Innovations (a)		**100%**	**100%**	**0%**	**0%**	**0%**		
% of Major Improvement Innovations (a)		**52%**	**21%**	**31%**	**37%**	**11%**		

(a) Innovations for which the developer is unknown have been excluded from percentage calculations

3.1: Sources of first-of-type innovations

In all of the three sports studied, users developed the initial first-of-type innovation. Skateboarding began in the early 1900s, when children often played and rode on wooden scooters, often homemade, consisting of a board with roller skate wheels attached underneath and handles attached for control. Over the next five decades, adventurous users removed or did without the handle, thereby creating the first skateboards. In the case of snowboards, children have slid down hills standing up on various vehicles ranging from sleds to garbage pail lids and cafeteria trays for ages. Sometimes, as in the case of sleds or toboggans, they held onto a rope attached to the front of the vehicle as an aid to balancing.[6] In the case of windsurfing, the innovation was specific to an individual user, Newman Darby. Darby was the first to put a universal joint at the base of a mast on a floating platform (1964), so that the user could directly manage the direction of sail by standing up and holding the boom and tipping the mast.[7]

[6] "The truth is, no one person did it. People have been trying to stand up on their sleds forever, or at least as long as their have been sleds. But the surf fantasy of the 60's encouraged the entrepreneurial spirit of all kinds of inventors to take surfing's essence to different mediums. (Howe, 6)"

[7] Newman S. Darby, a Pennsylvania sailboat enthusiast who had been building boats as a hobby for over a decade and a commercial artist by trade, built a functioning prototype of a sailboard in 1964. In 1965 he published his design in Popular

3.2: Sources of major improvement innovations

As was noted earlier, *users and user-manufacturers* developed 58% of all improvement innovations. We join the user and user-manufacturer categories because the firms in the user-manufacturer category were really lifestyle firms. By lifestyle firm, we mean a firm with ten or fewer employees that is used to "hold body and soul together" for innovating users while they innovate and advance their skills in their sport (at the time important innovations were being made by user-manufacturers, these firms were run out of a garage, small storefront, or spare room; had no capital equipment beyond portable power tools; and produced products in small lots).

A description of innovation activities among "the Hawaiians"[8] conveys the flavor of innovation and fun and competition intermixed with small-scale manufacturing that characterized these user-manufacturers. The Hawaiians were a group of 4-7 people in their early 20s who lived together in a house in Kailua, Hawaii. They windsurfed daily off the beach near their house and developed innovative techniques of sailing in high wind and wave conditions. As they experimented and created various windsurfing techniques, tricks, and tried to go faster and faster in high wind and wave conditions, new needs emerged – needs that the existing equipment could not fulfill. They created innovations in windsurfing equipment in order to tailor the equipment to the techniques and conditions they were experiencing. As people who saw or heard about their advanced sailing techniques and equipment asked to purchase the equipment, they made and sold handmade copies of their innovative equipment from their house (for the first 3 or 4 years) and then from a small storefront.

Science (August), and he and his brother set up a small facility in Western Pennsylvania to build and sell sailboards. They sold approximately 80 of these sailboards during 1965-1966 and gave away several on the television program *The Price is Right*. The Smithsonian Institution considers Newman Darby to be the "true founder" of windsurfing. We agree, in that all the key elements of a windsurfer were present in Darby's design. However, Jim Drake independently designed and prototyped a windsurf board which was much closer to current windsurfing designs than was Darby's design. Drake first sailed his design in Marina del Ray, California on May 23, 1967. Many experts in the windsurfing industry today credit Jim Drake for designing the windsurfer "as we know it" and credit Hoyle and Diane Schweitzer for actively marketing the sport and being the first to organize the manufacture of windsurfers on a relatively large scale.

[8] "The Hawaiians" were a group of active windsurfers in Kailua, Hawaii on the island of Oahu in the 1970s; the group includes Mike Horgan, Pat Love, Larry Stanley, Ken Kleid, and Andy Chaffee. Dennis Davidson and Colin Perry were members as well, but they did not live with the group; they lived nearby and were daily contacts, both at the house and at the windsurfing sites. Members of this group were responsible for many innovations in high performance windsurfing and founded the firm Windsurfing Hawaii.

Manufacturers developed 27% of the major improvement innovations in our sample. Seventy-five percent of these innovations (n=9) were developed by existing sports equipment component suppliers. These innovations involved transferring specific technology and know-how from an existing sport to the novel one. For example, a maker of fins for surfboards was asked to design a fin that would solve some windsurfer-specific problems. Similarly, a producer of shoe-bindings for bicycles (used to connect bicycle pedals firmly to bicycle riders' shoes) adapted their technology to attach snowboarders' boots firmly to snowboards. In all but one case, the manufacturers who developed these innovations were small craft shops run by their founder-owners – large firms with product development did not develop these innovations departments. The remaining 25% (n = 3) of innovations in our sample attributable to manufacturers were made by manufacturers organized specifically to produce for the sport in question. Two of these innovations were developed by employees of Burton Snowboards – one of the user-founded firms in our sample – after it grew beyond the 10-employee level and moved from the category of user-manufacturer to manufacturer according to the coding criteria described earlier (section 2.4).

Although existing toy and sports equipment companies were not significant innovators in the new sports we studied, some such companies did play a significant role in aiding the diffusion of the sport. After market take-off, some existing toy and sports equipment companies began producing copies of the equipment developed by the innovators. Sometimes they refined the equipment in minor ways; more often they simply cheapened it to lower the price for mass-market consumers. These manufacturers also contributed to the diffusion of each sport by engaging in major promotional efforts.

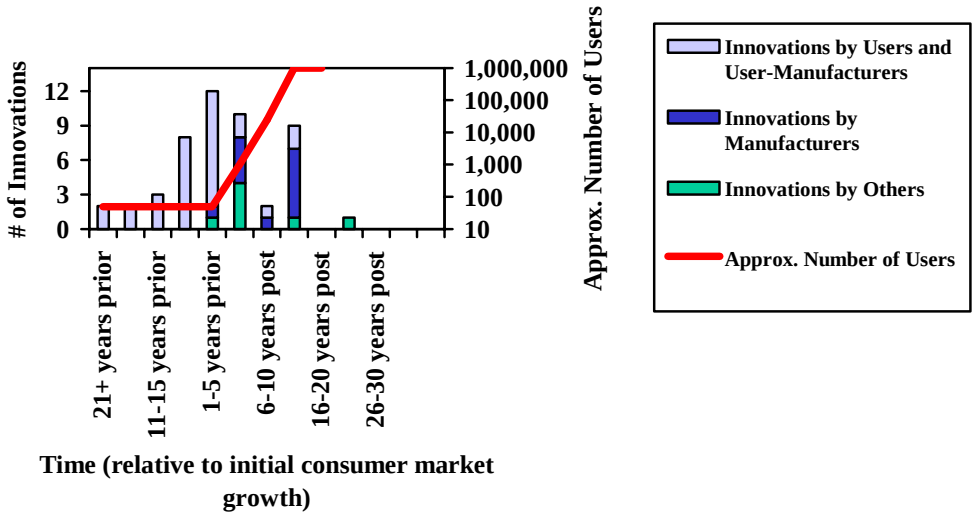
4.0: Findings: Users and User-Manufacturers as Lead Users

The users and user-manufacturers who developed improvement innovations were largely lead users. Lead users are defined as users who exhibit both of two characteristics: they have a high need for an innovation and they experience that need ahead of the bulk of the target market.

Most of the user- and user-manufacturer-innovators whose innovations we studied were early participants in their sport and their innovations often led the emergence of the mass-market by a number of years (Figure 1). Interview data indicate that they were

passionate users of the sporting equipment and were eagerly seeking and developing new techniques that required related innovations in equipment. They are in some ways the sports equivalent of software hackers, always trying to test and push the limits of their sport via innovations in technique and equipment. Many of these same individuals were also responsible for other types of important innovations not included in our sample and engaged in promotional activities that also resulted in the growth and development of the sport. For example, some introduced new riding techniques, or developed early skateboarding parks and various types of skateboarding ramps such as halfpipes.

Figure 1: Innovations and Market Growth Over Time [9, 10]



[9] According to industry experts, mass consumer market participation in "standard" windsurfing begins in 1973; in high performance windsurfing in 1981; in snowboarding in 1986; and in skateboarding in 1963.

[10] Source of data: published market data estimates are not available for the early phases of these markets. Data based on interviews with expert manufacturers and users active in the field at the time.

4.1: Lead user Learning and Development Process

The learning process engaged in by the lead user innovators was very much a learning-by-using process involving repeated trial-and-error. Consider the following description given by windsurfing innovator Larry Stanley:

> "… it [innovation] was happening daily and we were all helping each other and giving each other ideas, and we'd brainstorm and go out and do this and the next day the guy would do it a little better, you know, that's how all these things came about. I would say a lot of it stemmed from Mike Horgan because, if something didn't work, he would just rush home and change it or he'd whip out the saw and cut it right there at the beach."

Consider the following specific example – the development of foot-restraints for windsurfing, which in turn enabled jumping and "the whole sport of high-performance windsurfing."

> In 1978 Jurgen Honscheid came over from West Germany for the first Hawaiian World Cup and discovered jumping, which was new to him, although Mike Horgan and Larry Stanley (members of Windsurfing Hawaii) were jumping in 1974 and 1975. There was a new enthusiasm for jumping and they were all trying to outdo each other by jumping higher and higher. The problem was that, like in the past, the riders flew off in mid-air because there was no way to keep the board with you – and as a result you hurt your feet, your legs, and the board. Then Larry Stanley remembered the Chip [a small experimental board built by "the Hawaiians"] with its footstraps and thought "it's dumb not to use this for jumping." "And that's when we started jumping first with footstraps and discovering controlled flight (Winner, 120)." "I could go so much faster than I ever thought and when you hit a wave it was like a motorcycle rider hitting a ramp – you just flew into the air. We had been doing that but had been falling off in mid-air because you couldn't keep the board

under you. All of a sudden not only could you fly into the air but you could land the thing and not only that but you could change direction in the air! The whole sport of high performance windsurfing really started from that. As soon as I did it, there were about 10 of us who sailed all the time together and within one or two days there were various boards out there that had footstraps of various kinds on them and we were all going fast and jumping waves and stuff. It just kind of snowballed from there."

5.0: Findings: Patterns in the appropriation of innovation-related benefits

Innovators may capture benefit from their innovations in a number of ways. First, and most directly, if they are users they may benefit from personal use of their innovation in the practice of their sport. Less directly, anyone or any firm, whether user, manufacturer or other, may benefit from the reputation increase associated with having developed an important innovation, and possibly related success when the innovation is found to be a factor in winning contests, etc. If innovators wish to capture monetary profits from their innovation, they must somehow first protect it via intellectual property law and license that protection to others. Alternatively, they must produce the innovative equipment for sale to others and obtain innovation-related rents during the time period when they still have an advantage over would-be imitators.

Manufacturers who patented innovations generally did not license to others – they benefited from their patented innovations by producing and selling them. Individuals and firms in the sports fields we studied sometimes patented their innovations (Table 4), but innovators did not find this patenting and licensing a very successful route to capturing innovation-related benefits. To our knowledge, there is only one case in which a patent was successfully licensed by an innovator to a manufacturing firm for the life of the patent. In a second case, licensing fees were briefly obtained by one innovator – but then the patent in question was overturned in court. In a third case, the innovator received royalty payments for a few years while maintaining a close consulting relationship to the manufacturer, but the payments stopped when the manufacturer's management changed and the consulting relationship ended, despite subsequent legal intervention.

Table 4: Patenting and Licensing Activity of Non-Manufacturer (User, User-Manufacturer & Other) Innovations

Sport	Number of Non-Manufacturer Innovations (1)	PATENTED Innovations (2)		LICENSED Innovations (2)	
		Number	Percentage	Number	Percentage
Skateboarding	5	1	20%	0	0%
Snowboarding	7	1	14%	1	14%
Windsurfing	24	6	25%	2	8%

(1) Excludes the nine windsurfing innovations for which the innovator is unknown
(2) Percentages based on the number of non-manufacturer innovations in the entire sample (column 2)

There are a number of possible reasons for the low level of patenting observed. Sometimes the technical novelty of the innovation did not rise to the level of being recognized as a patentable innovation. Sometimes innovators simply were not interested in patents and licensing; sometimes they could not afford the costs of obtaining a patent; sometimes their immediate public use of their innovations made patenting legally impossible (United States patent law states that an innovator has one year from the date an "enabling disclosure" is made to file a patent application. An enabling disclosure is one that enables an expert in the same field to use the innovation; an offer for sale is equivalent to an enabling public disclosure in the United States. Patent law in other countries is not so lenient and, in virtually every developed country other than the United States, dictates that an innovator may not apply for a patent after an enabling disclosure has been made). Innovators in this field also did not have the ability to protect their innovations as trade secrets, because innovations are openly displayed during use.

Of all the expert practitioners who innovated, 71% sought to profit from their innovations by forming small, lifestyle firms that would produce their innovations for sale to others (Table 5). This was by far the most frequent mode of obtaining financial benefit used by the innovators in our sample.

Table 5: Methods by Which Non-Manufacturers Appropriated Benefits

Sport	Locus	Method by which Benefit Appropriated (1) (2)			TOTAL
		No Financial Benefit, Consulting Fees, Patent Licensing or Sale Fees	Profits From Own Manufacturing Firm	Unknown	
Skateboarding	Users & Other	1	0	0	1
	User-Manufacturer	0	4 (1)	0	4
Snowboarding	Users & Other	3 (1)	0	0	3
	User-Manufacturer	0	4	0	4
Windsurfing	Users & Other	6 (4)	2 (1)	2 (1)	10
	User-Manufacturer	0	14	0	14
TOTAL		**10 (29%)**	**24 (71%)**	**2**	**36**

(1) Number of patented innovations falling into each category in parenthesis.
(2) Explanation of coding categories:
No Financial Benefit - innovators received no financial benefits that we know of from their innovation
Consulting Fees - innovators in this category were often professional competitors with strong ties to manufacturers or innovators who were hired for product design consulting by manufacturers.
Patent Licensing Fees - innovators who patented their innovations and then licensed them to manufacturers.
Profits from Own Manufacturing firm – user-manufacturers engaged in the sale and production of their innovation – they often established a firm to produce and sell their equipment innovations.

6.0: Discussion

In this study we have begun to explore the patterns of innovation in a consumer goods market. We have seen that expert practitioners of the new sports, young men in their teens and twenties, developed most of the innovations in this field. We have also seen that many of these innovators founded lifestyle companies to manufacture their innovations for sale to others. In this discussion, we explore these two findings in more depth. We then conclude by discussing the possible generalizability of our findings.

6.1: Why was innovation concentrated among lead users?

Recall first that we have found that most of the important equipment innovations developed in snowboarding, skateboarding and windsurfing were developed by expert practitioners of the sport – practitioners who fit the definition of lead users. At the time they developed their innovations, these practitioners were either individual users or founders of a firm intended to produce their innovations for sale. In sharp contrast, we have seen that existing sports equipment firms – even those producing products closely related to snowboarding, skateboarding and windsurfing were not present as innovators in these new fields.

This finding is certainly contrary to conventional wisdom. There is a vast marketing and product development literature devoted to helping manufacturers better understand consumer needs. This literature generally assumes that it is the manufacturer's role to understand and identify market needs, engage in research and development as well as prototyping activities, and then commercialize and diffuse the resultant innovation.

It is useful to consider why the innovation pattern we have observed is so at odds with this conventional wisdom. We think that the pattern can be explained in terms of both the relative expectations of innovation related benefits held by users and manufacturers and the allocation of sticky information between lead users and manufacturers. With respect to the first issue, it has been shown that expectations of innovation-related benefit held by would-be innovators is positively associated with the likelihood they will innovate (Mansfield 1968, von Hippel 1988). In consumer goods fields, one might on the face of it assume that this type of calculation would predict a pattern of innovation by manufacturers. After all, each of the fields we have studied has grown to have millions of practitioners of the sport who purchase equipment. In contrast, we have seen that an individual user who innovates will be able to obtain benefit only from his own use and/or from founding a small firm that will enable him to sell – at least initially – only a relatively few handmade copies of his innovations.

A possible explanation of this puzzle is suggested in models developed by Stern and Gans (1998) and Harhoff and von Hippel (forthcoming). In essence, these models find that innovations by lead users make sense when the market for products or services is very small and when the ultimate size of the market is very much in doubt. Under these conditions, lead users get significant personal benefits from innovating in their chosen sport; benefits that can be sufficient to drive innovation. In contrast, manufacturers of existing sporting equipment, observing a very small marketplace made up of lead users with an uncertain appeal to future mainstream users, may decide that there is not sufficient incentive to induce them to innovate.

The conditions just described do appear to apply to the fields that we have studied. During the time the innovations were being made by lead users, knowledge of skateboarding, snowboarding and windsurfing was not widespread, and the market for

innovative equipment in these fields was indeed very small. The lifestyle firms established by innovating users who sold handmade copies of their equipment to their friends were most likely tapping much of the potential market available at that time.

At the same time, lead users found sufficient incentive to innovate because the personal benefits were great from the point of view of these enthusiasts, while the costs of developing prototypes was low. All three types of equipment could be and were developed using easily available hardware, lumber, and fiberglass fabrication kits. Only cheap, standard tools such as saws and hammers were needed, and the construction techniques required were also simple and known to any reasonably "handy" person. Specifically, simple carpentry, sewing, and fiberglass fabrication techniques (such as are commonly used by hobbyists to patch autos and boats) were sufficient to prototype almost all of the innovations studied.

On the other hand, sticky information considerations meant that the costs of innovating would be lower for expert users than for manufacturers. Lead users had made very heavy time investments in the technique of the sport. These investments were necessary to get them to the level of skill needed to engage in learning-by-doing at the outer edges of what was possible in their sport. Also, it allowed them to test solutions under field conditions in ways that could not be done by less experienced users or manufacturer personnel (learning-by-doing was the only feasible method of innovation and test since information about the skills involved and conditions of use could not be easily modeled and brought into a manufacturer's lab – the information was indeed sticky).

Manufacturers who wished to innovate would have had to invest in acquire this sticky use-related information that was already in the possession of the lead users. In principle, they could do this by hiring expert lead users to work in their product development activities and/or they could invest in enabling some of their existing R&D personnel to become very proficient in the new sports. Neither possibility, however, would be easy to accomplish. The former would likely be culturally difficult for most established firms. The user-innovators in these fields were both young at the time they were innovating and they typically had no college or technical education. With respect to the latter, it would be very difficult for manufacturer development personnel to become

accomplished in the sport at the level of lead users – the sports were very physically demanding and probably best practiced by people who were quite young. A partial solution used by some manufacturers was to hire lead users as consultants and/or to hire teams of gifted sports practitioners who would tour the country to demonstrate the sport – and who could also test any new equipment models developed by the manufacturer.

6.2: Why were new firms founded by lead users?

The next element we wish to explore in more detail is the choice of most of our innovating expert practitioners to form small firms to exploit their innovations. Other studies of innovations by individual users, such as studies of users of scientific instruments and studies of innovations by firms that are users of process equipment (von Hippel, 1988), show evidence of this pattern, but the pattern is not as strong as it is here. Why?

It is reasonable that innovating users would adopt the role of manufacturer if that role promised greater innovation-related profit after switching (start-up) costs had been factored in. The ability to capture innovation-related benefit will only differ among functional roles if innovators cannot license their innovation effectively and at low cost (if effective and low-cost licensing were possible, innovators could license to someone already occupying the favored role, and avoid the switching costs involved in adopting a new role themselves).

In the fields we have studied, manufacturing innovative equipment offers an opportunity of greater monetary gain than does simple personal use by an innovator (also, an innovating user does not lose the opportunity to benefit from use by adding on the role of manufacturer – he simply gains a pathway to additional benefit). Our analysis of patenting and licensing patterns makes it appear that effective and low-cost licensing is not possible in this field (only 17% of the non-manufacturer innovations in our sample were patented, and only one was successfully licensed). Taken together, these two conditions suggest that innovating users would have an incentive to adopt the role of manufacturer if this could be accomplished at a cost commensurate with the expected benefit.

In this field, the cost to a user of adding on the role of a small scale producer relying on relatively low-tech, low-cost, and easily accessible methods of production was often very low. Innovating users were already building prototype equipment that incorporated their innovations for their own use. Adding on the role of manufacturer simply required making additional copies of the equipment for purchase by others using the same methods used in prototyping (acquisition of expensive capital equipment, such as production tooling required to produce plastic parts in volume, was never done by these firms during their early stages, which is when all but three of the innovations we studied were made). Advertising was done via word-of-mouth and was a costless consequence of the innovating user being known among peers in the sport as an expert in that field [11].

Given the low cost associated with manufacturing on a small scale, it is reasonable that innovating users would tend to adopt the role of manufacturer as well. Innovating users in our present field of study were young sports enthusiasts who had typically chosen to pursue their sport and the associated lifestyle. Many either did not attend college or attended for only 2-3 years; only a few had college degrees[12]. Most had carpentry or basic woodworking skills and often described themselves and others as self-taught or "seat-of-the-pants" engineers. They might be characterized as being equivalent to “ski bums” who move from ski resort to ski resort, taking ski instructor jobs or lower-wage jobs in order to have constant access to the opportunity for good skiing. Since the sports of our innovating users were new, there was no commercial infrastructure in place that could offer expert practitioners the equivalent of ski bum jobs in skateboarding, snowboarding, or windsurfing. The alternative that existed was to shift their own activities from making prototypes only for themselves to also making handmade equipment for others using the same simple tools and techniques[13]. Even small returns from this enterprise would be enough to support a young “sports bum’s” sport-centered lifestyle at the beach or on the streets or in the mountains. As we saw from our data, this

[11] Increased demand later led some of these firms to outsource production or invest in capital equipment.

[12] Newman Darby, inventor of the windsurfer, commented at the Smithsonian in April 1999 that, "You have to keep trying...You don't have to have a college degree to be an inventor. Kids invent things in their bedrooms."

alternative was indeed seen as attractive and taken up by a number of our innovating users.

In other innovation categories where this matter has been studied, innovators who wished to add on or switch to a different role with respect to an innovation (for example, from user to manufacturer) generally had to incur more significant costs to do so and often also had more attractive alternative investment opportunities as compared to the innovators in this sample. For example, imagine a scientist who has developed an innovative instrument and is considering adding on the role of instrument manufacturer to her activities. The scientist would find the need to make significant new investments in appropriate assets specific to that new activity. Similarly, a firm that has developed a new process machine would face the need to make a series of new investments in complementary assets in order to enter the new business of process equipment production and sale. A great deal of work and effort would be required in order for the firm to appropriate benefit from the innovation through manufacturing. Both the scientist and the user firm might find that competing opportunities to invest in the existing business might yield more attractive and less risky returns and therefore be reluctant to add on or switch to the role of manufacturer (and in addition, they might be able to appropriate benefit through some form of intellectual property protection).

6.3: Likely generalizability of our findings

We reason that the patterns of innovation by lead users observed in this study of innovation in a category of consumer goods is likely to be repeated in product categories where appropriability and sticky information considerations similarly favor user innovation. We think that the formation of firms by users is an independent phenomenon that will be encountered whenever licensing of intellectual property is costly and/or ineffective and where barriers to entry are low enough to make the transition feasible for individual users. Further research to test these hypotheses would be useful.

[13] Interview data suggests that some of these individuals saw the market potential for their devices, most if not all of these innovators were approached at some time by other sports enthusiasts who saw their equipment and desired that equipment for themselves.

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Numerous web sites and sport-specific magazines and newsletters were also used

Interviews Conducted

- Bill Bahne, fin maker
- Larry Balma, involved in skateboard truck developments
- Peter Bauer (e-mail), a snowboard legend – one of the first snowboard stars
- John Chao, editor of American Windsurfing magazine
- Jim DeSilva, owner of Can-Am sports; evidently he seems to hold a sail patent or two.
- Dave Dominy, Tracker and Streamlined. Made innovations in skateboarding and windsurfing equipment.
- Jim Drake, inventor (or refiner) of the windsurfer, worked with Hoyle Schweitzer
- Curtis Hesselgrave, fin maker
- Mike Thor Horgan, Windsurfering Hawaii, important innovator in high-performance windsurfing
- Tom James, editor at Windsurfing magazine
- Greg Johnson (e-mail), head of the IJC – International Judges Commission – founder of the freestyle system as used today mystyflip@aol.com
- Guy Laroux, the "encyclopedia of windsurfing history", board designer, etc.
- Jeff Magnan, credited with developing the camber inducer and the ADTR
- Paul Maravetz, Burton Snowboards
- Frank Nasworthy, credited with first using urethane wheels for skateboards
- Neil Pryde, founder Neil Pryde (huge sail manufacturer)
- Nevin Sayre, pro-competitor and co-inventor of the carbon fiber mast
- Hubert Schaller, Burton Snowboards
- Scott See, head of American Windsurfing Industry Association
- Eric Skemp, long time industry veteran
- Barry Spanier, sailmaker – Maui Sails, Neil Pryde, Gaastra
- Larry Stanley, Windsurfing Hawaii, important innovator in high-performance windsurfing
- Bethany Stevens, author of snowboarding book
- Larry Stevenson, innovator of the kicktail and the "father" of skateboarding
- Larry Tuttle, developer of the fin box, has made many contributions to sailing and windsurfing
- Ken Winner, innovator and pro-sailor

Appendix A: Sample of Innovations

Sport	Year	Innovation	Innovator	Affiliation	Locus of Innovation
Skateboarding	Early 1900s	Putting skates on a 2x4	Many children	None	Users
	Late 1960s	Kicktail	Larry Stevenson	Makaha Skateboards	User-Founded Firm
	1970	Urethane Wheels	Frank Nasworthy	None	User-Founded Firm
	Between 1973-1975	Precision Ball Bearings	Jay Shuirman	NHS	Existing Manufacturer
	1973; 1976	Wider Boards/Laminated Plywood	Lonnie Toft & Willie Winkel	Pro-skater for Sims & Wee Willi Winkel Skateboards	User-Founded Firm
	Between 1975-78	Lighter Boards/Laminated Plywood	Wes Humpston and Jim Muir	Dogtown Skates	User-Founded Firm
	1978	Truck Developments	John Hutson, Jay Shuirman, Rich Nokak	NHS (marketed as "Independent")	Existing Manufacturer
Snowboarding	Early 1900s (or earlier)	Standing up while sledding	Many children	NA	Users
	1965	Snurfer	Sherman Poppen	None	User
	1970	Metal/Steel Edges	Dimitrije Milovich	Winterstick	User-Founded Firm
	Mid-1970s	Huge Side Cuts	Chris Sanders; Mike Olsen; Dimitrije Milovich	Gnu Snowboards; Avalanch; Winterstick	User-Founded Firms
	1978	Rubber Bindings/Footstraps	Jake Burton; Willi Winkel	Burton Snowboards; Wee Willi Winkel Skateboards	User-Founded Firms
	Pre-1980	Polyethelene Base	Burton Snowboards; Dimitrije Milovich	Burton; Winterstick	User-Founded firms
	1983	Hybak	Jeff Grell	None (bindings first used on Flite snowboards and later developed for Sims snowboards)	User
	1995	Central attachment of the binding/central disk system	Burton employees; F2 employees	Burton Snowboards; F2	Manufacturers
	Approx. 1995	Flap Ratchet	Burton employee - David Dodge	Burton Snowboards	Manufacturer (in-industry user founded firm)
	Mid-1990s	Step-in Binding	Engineer at Shimano & K2 employees	Shimano & K2	Existing Manufacturers
Windsurfing	1964	First of Type Windsurfer (the Universal Joint)	Newman Darby	Darby Industries	User
	1967	Wishbone booms used for windsurfing	Jim Drake	None (joint patent with Hoyle Schweitzer of Windsurfing International)	User
	Early 1970s	Eliminating the Daggerboard	The Hawaiians	Windsurfing Hawaii	User-Founded Firm
	1975	Retractable Daggerboard	Mike Horgan	Windsurfing Hawaii	User-Founded Firm
	1975	Full View Windows in Sails	Pat Love & Mike Horgan	Windsurfing Hawaii	User-Founded Firm
	1975	Volcano Pads	The Hawaiians	Windsurfing Hawaii	User-Founded Firm

	1976	Shoulder and Chest Harness	Ken Kleid & Pat Love & Larry Stanley	Windsurfing Hawaii	User-Founded Firm
	1976	Bungied Uphaul	Mike Horgan	Windsurfing Hawaii	User-Founded Firm
	1976; 1987	Boomstraps (Powerstraps Boom Straps – 1976; For N' Aft Adjustable Boom Straps – 1987)	Dennis Davidson & Pat Love – 1976; Larry Stanley & Pat Love – 1987	Windsurfing Hawaii	User-Founded Firm
	1977	Footstraps	Larry Stanley	Windsurfing Hawaii	User-Founded Firm
	1977	High Clew Surf Sails/High Wind Sails	Pat Love & Larry Stanley & Mike Horgan	Windsurfing Hawaii	User-Founded Firm
	1979	Higher Aspect Sails	Barry Spanier & Jeff Bourne	Maui Sails	Existing Manufacturer
	1979	Adjustable Booms	Larry Stanley & Ken Winner	Windsurfing Hawaii & Pro-windsurfer (affiliated with multiple manufacturers)	Other (user-founded firm & pro)
	1979	Spreader Bar, Stainless Steel and Plastic	Mike Horgan	Windsurfing Hawaii	User-Founded Firm
	Late 1970s	Fully Battened Sails (NS)	Pat Love	Windsurfing Hawaii	User-Founded Firm
	1980	Polyurethane Universal	Dave Dominy	Streamlined	User-Founded Firm
	1980	Forefin	Larry Stanley	Windsurfing Hawaii	User-Founded Firm
	1980	Adjustable Mast Base	Larry Stanley & Mike Horgan	Windsurfing Hawaii	User-Founded Firm
	1981	Adjustable Mast Track	Ken Winner; unnamed North shore boardshaper on Oahu	Pro-windsurfer (affiliated with multiple manufacturers); Independent board shapers	Other (pro; user-founded firm)
	Approx. 1981	Cutaway Fin	Graham Allen	None	User
	1981-2	"Hybrid" Harness	Barry Spanier (pure hip harness); Larry Stanley ("Add-On Speedseat/Shest Harness Combo - a combination of hip, waist and chest harnesses to create the hybrid type of harness that is used today)	Maui Sails; Windsurfing Hawaii	Other (existing manufacturer; user-founded firm)
	1982	Sail Materials: Laminated Fibers	Barry Spanier & Jeff Bourne	both with Maui Sails and Neil Pryde	Existing Manufacturer
	1984	Clamp-on Boom Front End	Barry Spanier	both with Maui Sails and Neil Pryde	Existing Manufacturer
	1984	RAF Sails	Barry Spanier & Jeff Bourne	both with Maui Sails and Neil Pryde	Existing Manufacturer
	1984	Camber Inducers	Jeff Magnan; Thomas Nishimura; Jeff Belvedere	Gaastra; none; none	Other; ?; ?
	1985	ADTR	Jeff Magnan & Chuck Stahl	Consultants for Gaastra	Other (consulting for an existing manufacturer)
	1985	Fin Boxes	Larry Tuttle	FinWorks	Existing Manufacturer
	1985	Carbon-Fiber Masts	Peter Quigley & Nevin Sayre	Fiberspar	?

	1986	Boom Materials - Carbon Fiber	Peter Quigley & Nevin Sayre	FiberSpar	?
	Approx. 1988[14]	Sail Materials: Polyester Film	Peter Brockhaus	F2	Manufacturer
	1980s (verify with notes)	Flapper/Anti-Ventilation Device	Ken Winner	Pro-windsurfer (affiliated with multiple manufacturers)	Other (Pro)
	late 1990s	Beginner Board/Windglider	Ken Winner & Dave Johnson	Pro-windsurfer & North Sports (verify)	Other (in-industry manufacturer & a pro)
	Approx. 1998	Sheer-Tip Rigs/Flex Top Sail	?	?	?
	?	High Performance Fins	Bill Bahne & Curtis Hesselgrave	Bahne	Existing Manufacturer
	?	Wingmast	Dimitrije Milovich; Ernst Meyer (Swiss)	?	?
	?	Lighter Boards/Sandwich Construction	John Parton & Ian Pitkairn	ProTech	?
	?	Boom Materials & Design – Aluminum	?	?	?
	?	Blade Fin	?	?	?
	?	Short High Performance Boards	?	?	?
	?	Kitesurfing	?	?	?

[14] 1986 according to Neil Pryde, 1988 according to Barry Spanier.