Innovation and the Interrelatedness of Core Competencies: How Taiwan's Giant Bicycles broke into the US *Bicycle Market*

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I argue that capabilities and barriers to entry are, in certain circumstances, interconnected in such a way that sacrificing one of them can lead to the subsequent vulnerability or erosion of another capability or barrier to entry. I illustrate this through a study of the US bicycle market in the 1980's in general, and Schwinn Corporation and Giant Manufacturing in particular, arguing that both the barriers to entry and the firm capabilities were interrelated. A specific set of decisions by Schwinn had broad and unanticipated effects that went beyond the capacity they explicitly relinquished. In this case manufacturing and distribution were tightly linked in such a way that without some form of tight link between them successful incremental innovation became difficult. Seemingly unrelated capabilities and strengths become mutually reinforcing or interconnected. Instead of being able to choose to add a single capability, or choose to discard one, companies may instead be choosing between sets, groups of interlinked, or patterned capabilities. A seemingly small change may require a major reorganization of other core capabilities that its ostensible status belies.

Key Words: international strategy, outsourcing, capabilities, barriers to entry
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Introduction

On a sunny day in 1972 in Tachia, a port city in western Taiwan, a new bicycle company called Giant Manufacturing officially opened its doors. Back then, the vast majority of the world bicycle market was dominated by established brands such as Schwinn Corporation, Derby Cycle, and Huffy Corporation. A handful of domestic US brands controlled 76% of the US market. These firms had an enviably entrenched industry position in the US. From the industry perspective, bicycles were a hard market to break into indeed: the level of technological expertise was high,

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the name brand crucial, the distribution painstakingly complex, and, perhaps most importantly, the distribution networks of specialty shops were relationship-based and complex (Porter 1980; Porter 1996). When these hurdles are combined with the high efficiencies of scale intrinsic to bicycle production, the barriers to entry in that industry were indeed substantial and Giant's obstacles were great.

Given this, the rise of the bicycle maker Giant Manufacturing has been surprising. By 1980, Taiwan was the largest exporter of bicycles in the world and today with over $ 400 million in total sales; Giant Manufacturing is one of the largest bicycle producers in the world. Indeed, in 2001, Giant was named one of *Fortune Magazine's* '20 best small companies in the world' (http://money.cnn.com/magazines/fortune). Perhaps almost as surprising as Giant's rise is the fall of the old guard of bicycle producers. Derby Cycle had gone into bankruptcy and was largely broken up, Schwinn had been sold out of bankruptcy to Pacific Cycle for a mere $ 86 million and then acquired by Dorel Industries in 2004, and Huffy went into bankruptcy in 2004 for restructuring, emerging in 2005. All this was during a period of 30 years of healthy growth in the bicycle industry as a whole.

What happened? The answer to this puzzle lies in an examination of the bicycle industry and a close study of the actions of bicycle producers in the 1980s – actions which, in combination with market changes, ultimately led to the erosion of the bundle of capabilities which were responsible for their initial dominance. We will frame this more theoretical discussion in a reified examination of how these firms allowed an upstart in Taiwan to gain the capabilities to topple them and take an industry leadership role (Porter 1990).

While discussions of core competence and capabilities can be traced back to Porter in the 1980s, it is only recently that the idea has emerged that capabilities may be interrelated (Baldwin and Clark 2001; Levinthal 1997; Porter 1980; 1985; Porter 1996; Shane 2001b). In this case we believe manufacturing and distribution in high- and middle-end bicycle production became tightly linked due to industry changes in the 1970s and 1980s (Shane 2001a). Bike shops were increasingly demanding a fast turnover and a constant innovation in the product line; they wanted fast-paced and incremental improvements to move expensive bike inventories. The tight link between manufacturing and distribution encouraged incremental innovation and an understanding of industry trends. Bikes became items of prestige and fashion with an emphasis on excellence

of craftsmanship rather than utility. A slow new product introduction, occasional radical innovations, and a less than perfect control over production were not sufficient for this market. In this shifting context, and despite a healthy overall demand, the actions of US bike makers in the 1980s caused them to under perform.

We will examine the barriers to entry of the bicycle industry, the resources at Giant's disposal, and the exogenous changes in the industry that may have made a difference. This is not a case study that indiscriminately criticizes outsourcing or unambiguously praises the advantages of cheap labor and efficient production methods. Instead, it is a tale of the interconnectivity of core capabilities, complementary competencies, and interlocking barriers to entry that, once breached, began to gush. It is a case study that, we hope, will do more service by attempting to complicate existing paradigms rather than challenge them.

And now the 'child is father to the man' (Wordsworth, 'My heart leaps up when I behold'). In a situation that is in many ways reminiscent of that of the 1970s, Taiwan began to manufacture in China. King Liu, Giant's founder and chairman, has recognized that production in China, where wages are low and the potential for sales is high, would be more efficient. But is he aware that he has helped teach US bicycle producers to struggle over the last 30 years? He claims he is consciously shifting production into China through a very different model than US firms did into Taiwan 50 years ago. What lesson has this modern day David learned now that he has grown to be the Giant himself? But first let us explore the two major players in this story: Schwinn Corporation and Giant Manufacturing.

Schwinn – Company History

Schwinn/GT Corporation, bankrupt and sold to Pacific Cycle and later to Dorel Industries, was founded in 1885 by the German immigrant Ignaz Schwinn and Chicago investor Adolph Arnold. At the time it was called Arnold, Schwinn & Company, but Arnold sold his portion of the company back to the Schwinn family in 1908. Schwinn sold quality bikes, at first in retail locations such as Sears, Roebuck and Co., which accounted for 75% of Schwinn sales by 1917. Ignaz's son invented the air filled balloon tire for bikes before World War II, receiving only laughs from his competitors until the tire became a financial success in the children's bike market during the Great Depression. By 1950, Schwinn was making 25% of the bicycles sold in the US. Schwinn came out with another tech-

nological breakthrough in the 1960s when it introduced a gear-shifting derailleur, which allowed the bicycle to more easily navigate hills.

Schwinn began to miss market trends as the European style of faster, lighter bikes became popular in the 1970s and 1980s, and as the mountain bike craze of the 1980s and 1990s grew. In 1981, the workers of Schwinn Corporation's largest factory in Chicago went on strike. Workers were demanding to be paid the same rate as auto workers. Schwinn closed its three Chicago factories and moved production overseas.

In 1992, Schwinn filed for bankruptcy. It was revitalized for a time under the new owner Zell/Chilmark who bought the company for $ 43 million and proceeded to make a number of expensive acquisitions of smaller, elite bike producers. By 1996, Schwinn again climbed the ranks in terms of volume and became the No. 2 US bicycle maker. In addition, it launched a very successful line of spinning machines (stationary bicycles) for health clubs. In 1998, Schwinn bought bike maker GT Bicycles for $ 170 million, thus gaining control of high-tech manufacturing facilities for the first time since the 1980s, something which had been lacking for decades. Perhaps it was too little too late, in 2001, Schwinn/GT again filed for bankruptcy. It was sold for $ 86 million to the bicycle importer Pacific Cycle which planned to bring the Schwinn brand down market by, for the first time, selling an inexpensive version of its products in large-retail outfits such as Wal-Mart. In 2004, Pacific Cycle was purchased by the conglomerate Dorel Industries.

Giant – Company History

Giant Manufacturing began in 1972 as a low-end manufacturer and exporter of bicycles. It received its first large break in 1981 when the largest US bike maker, Schwinn, hired it to produce bicycles. Giant provided engineering, technology, and volume sales, and Schwinn received bicycles that were less expensive than those produced in the US, and sold them under its own name in the US. By 1984, Giant was producing 700,000 bicycles a year for Schwinn.

When in 1985 Schwinn and Giant ended their partnership, it was only a partial break, since Schwinn continued to outsource to Giant, though not to as great an extent as before, but it was nevertheless a significant break. This acted as a catalyst for Giant, who was at this point outsourcing for many US bicycle producers, and was therefore spurred to create its own brand. Giant began selling its own brand of bicycles first in Europe and then, in 1987, in the US. It routinely offered bike distributors

a 15% discount on bikes identical to those sold by Schwinn without the name brand and could afford to gradually build volume since it had its supporting production for the US companies.

Back in the 1970s Giant did something very surprising (the significance of which will be addressed later). It reversed the trend of outsourcing to markets where labor was cheap, and built a factory in the Netherlands. It chose this location, we believe, because the Netherlands is considered a trendsetter in European design and because of the excellent Rotterdam port and a large nearby airport. Indeed, the Netherlands is also one of the largest recipients of US foreign direct investment. This factory was meant to pick up on ideas and trends in the European racing bike tradition. One of the interesting aspects of Giant product line was that only 75% of it was standard, the remaining 25% was designed by regional managers to have local appeal. Giant has designers in the US, Europe and Asia and, twice a year, gathers them all together at its factories in Taiwan to work out ways to lighten the frame, increase strength, etc.

Giant has recently begun establishing factories in China. In 1996, for example, it produced 2.02 million bicycles, of which 1.5 million were produced in Taiwan, 550,000 in China, and 300,000 in the Netherlands. Currently they are the biggest bike sellers in China, accounting for 3% of all bike sales in this growing market. The Olympics taking place in China in 2008 are likely to strengthen that market.

Historical Overview of the Bike Market 1970–1989

From the 1950s through the early 1980s, Schwinn was one of the largest bicycle makers in the US and one among an exclusive club of bicycle makers in the US who had a virtual lock on the upper- and middle-level bicycle market. Other major US bicycle manufacturers at the time included Derby Cycle and Huffy. For these three companies, 1981 marked an important turning point – within a few years each of them would outsource either all or most of their basic manufacturing to Asia without maintaining much control over production.

Difficult labor relations in the US, combined with high domestic wages were causing a flood of companies to outsource to Asia (as well as, to a more limited extent, South America). Taiwanese companies were already exporting a large number of low- quality $ 40–50 bicycles into the US. But the high- and middle-quality bike market was not like some other US goods, such as VCR's and TV's, which were judged largely on simple price/quality ratios and 'gee-wiz' features. High-quality bike making

was more and more becoming an art which required a close connection to enthusiasts, an insight into trends, and craftsmanship. The high-end ($1,000–4,000) bike market was growing at double-digit rates.

In 2000, for example, 60% of bikes were sold thorough mass merchant channels such as Toy's-R-Us, Wal-Mart, Kmart, Target, and Sears. The average price of these bikes was $75. Meanwhile, there were about 6,300 specialty shops selling middle- and high-quality bikes, accounting for about 31% of the market. The price for these bikes started at around $200 with the average at around $360. The rest of the market (9%) was represented by sporting goods stores which typically sell middle price bikes for something between the mass retailers and specialty shops. Furthermore, specialty shops dominated the parts, accessories, and repair market. Bike companies that sell to mass merchants and the ones that sell to specialty shops were highly delineated. Huffy began as a high quality maker of bikes and has since become a mass merchant supplier. Others, such as Schwinn, Trek, Giant, and Derby typically sell at specialty shops.

Before the 1970s, the majority of the US bike market had been one of style and fun. Bikes had sci-fi names like the phantom (1950s), and the banana seated Sting Ray (1960s). In the US, two factors changed this: technology and oil. In the 1970s, OPEC induced oil shocks that led to a dramatic increase in the use of bikes for transportation, and ingrained the bike in the imagination of the mainstream population. Bike lanes were placed on the streets of many US cities in order to help accommodate their use. In Europe, with its more condensed cities and higher gas taxes, bicycles had long enjoyed this sort of utilitarian use. Secondly, derailleurs, or gear-shifts, were first mass manufactured by Schwinn in the 1960s, and by the 1970s they were standard. These derailleurs allowed bikes to climb hills much more easily, giving the bike an extended range of terrain and usefulness. These changes were important to the future of the bicycle. Still, the predominant use for the bike continued to be for recreational and fitness reasons. Recent figures from the Interbike Directory (www.interbike.com) show that 94.5% of bike riders ride for recreation or fitness, while 5.2% do so for transportation, and 0.03% for racing.

By the 1980s, bikes had enormous enthusiast support. Specialty bike shops, the prime retailers of high quality bikes, were demanding better and lighter bikes along the European tradition. Numbers hint at this change but do not tell the whole story, in the US, for example, 8.9 million adult bikes (with 20" and up wheels) were sold in 1981, 11.4 million

in 1985, 12.6 million in 1986, and 10.7 million in 1989 (a slight drop). But these modest increases do not show the quality of bikes sold. The average price to manufacture a bike in 1985 was around $ 40, but this number shot up to around $ 80 in 1989, a change not explained by inflation. Bike manufacturers were rushing upstream to develop sophisticated bike technologies only dreamed of a decade before (primarily in materials of production, lightness of the frame, and detailing of the bike in manufacturing). In the 1980s bikes would attain a sort of status symbol, with low-use buyers paying top prices for whatever enthusiasts determined were top-of-the-line bikes. A few ounces less weight in the frame, a bit more stability, a slightly better torque in the gears, these were significant differentiators. As one would expect, this change in preference led to a related change in the bicycles production cycle.

Whereas in the 1960s it was common for a company to put out a few new bikes a year, by the late 1980s competitive companies were releasing a few new models every few months. These changes dramatically affected the bike industry where the core capabilities of the bike producers lay. Previously, large technological leaps, distribution networks and name brand had been paramount in the bicycle market, but later, technology, fast production, and small and constant technological improvement became just as important. And these capabilities were, arguably, exactly those that the bike companies shipped, along with their trade secrets, their machines and their best engineers to Taiwan in the 1970s.

The Strategy Problems in Outsourcing in the Bicycle Industry

We will attempt to explain this concurrent rise and fall by synthesizing three areas of the strategic literature: that of competencies, that of R&D, and that of barriers to entry. This synthesis is meant to illuminate the importance of thinking about core capabilities in a multi-dimensional way, especially as related to risks of outsourcing. Management scholars often view a firm's competitive advantage as centering around core competencies (Burgelman 1996; Pennings et al. 1994; Prahalad and Hamel 1990; Siggelkow 2002). In the short run, price and performance measures determine who is the winner or loser, but in the long run being competitive along these two metrics is only a necessary and insufficient precondition to success. Prahalad and Hamel (1990, 81), for example, argue that 'in the long run, competitiveness derives from an ability to build, at lower cost and more speedily than competitors, the core competencies that spawn unanticipated products. The real sources of competitive advantage are

to be found in management's ability to consolidate corporate wide technologies and production skills into competencies that empower individual businesses to adapt quickly to changing opportunities'.

The Tight Fit between Production and Distribution

But as we shall see, by outsourcing production completely, Schwinn and others compromised a core competence in their market with unexpected results. Of all bikes now sold in the US, 93% are produced abroad and imported, and virtually all of these are outsourced. The bicycle market in the 1980s increasingly began to have closer and closer links between production and distribution. Production cycles shortened and constant small improvements in design became necessary in order to be competitive. These improvements were, it turned out, just the sort of incremental improvements that are discovered while making a product on the factory floor – a slightly lighter frame, a cap over the joints, a slightly better gear/wheel alignment (Henderson and Mitchell 1997; Henderson and Clark 1990). They are the sort of improvements one hears about from hobbyists and then must try to execute through a deep understanding of what it takes to make the bicycle. Driven by detail-oriented bicycle hobbyists, the middle- and high-end bike market was not the one which would coast on name or distribution networks. This set the stage for the potential entrance of competitors into the bicycle market.

The CEO of Giant, Anthony Lo, says he believes bicycles are more than machines. 'Bicycles are as much a fashion item as a piece of machinery. We sell bikes in several thousand variations. In the early 1990s we introduced up to three new products per year, today, however, that figure has grown to between five and ten, reflecting increasing sophistication in the demand for bicycles'. Furthermore, each of these models usually implemented a small improvement which made the bike more competitive and helped stores move the inventory by touting the latest innovation/improvement.

Schwinn and other bike manufacturers, driven to cut costs, outsourced broadly. In 1988, for example, when Giant first introduced its own bike with its own label on it, Schwinn, despite having broken its partnership with Giant in 1985, still manufactured 80% of its bikes through Giant. At that time, Giant was also producing practically all the bikes for Treks, Fisher, and Specialized, as well as other US bike sellers. As Prahalad and Hamel (1990, 84) point out, 'the embedded skills that gave rise to the next generation of competitive products cannot be 'rented in'

by outsourcing and OEM supply relationships'. After all, while outsourcing can provide cheaper supply and delegate much of the headache of production to another company, it does not build up the skill base that is needed to maintain one's engineers at the cutting edge, nor does it provide the company with the sort of know-how that comes on the factory floor (Henderson and Clark 1990).

If there is one example that most clearly shows that production and distribution are tightly linked, it is a look at the Giant's factory in the Netherlands. It is strange indeed that Giant, which, at least initially, depended on cheaper labor costs to make cheaper bikes, would open a factory where labor costs were 70% higher than at home. At exactly the same time as US bike manufacturers were outsourcing most or all of their bikes, Giant was investing heavily in building a new state-of-the art factory in Europe. What was its logic? Lo, the current CEO argues that this factory was critical in promoting and speeding up innovation. With the European racing bike market becoming more and more influential, Lo believes that keeping production next to the customer is crucial both to keep up with fashion and also to have faster and more responsive innovations. Giant's ability to produce, and its emphasis on producing specialized bikes for regional managers based on local demand necessitated such a close connection with production. The differential success created through this experimentation ultimately generated many new ideas for new products and kept Giant abreast of changing needs and fashions. The tight fit between production and manufacturing in the bicycle market was a key interrelation for innovation and competitiveness. While Schwinn might have seen this outsourcing as merely cutting a cost center, in fact the consequences of this decision were broad. Due to the demand for fast customer responsiveness, the detail-oriented nature of bike enthusiasts, and the highly incremental nature of progress in bikes in the 1980s and 1990s, bike manufacturing of today is tightly tied to technical competence, innovation, and customer satisfaction. In other industries, where the dynamics of demand and the interconnections between capabilities are differently strung, this relationship changes.

Prahalad and Hamel (1990, 84) stated it well by saying 'there are two clear lessons here. First, the costs of losing a core competence can be only partly calculated in advance. The baby may be thrown out with the bathwater in divestment decisions. Second, since core competencies are built through a process of continuous improvement and enhancement that may span a decade or longer, a company that has failed to invest in

core competence building will find it very difficult to enter an emerging market, unless, of course, it will be content simply to serve as a distribution channel'. And this is exactly what Schwinn and others have become. When Schwinn attempted to build a factory in Greenville, Mississippi a few years after outsourcing to Giant, it failed to produce bikes of sufficient quality. Similarly, when Schwinn later tried to buy a factory in Hungary and produce bikes cheaply there, it failed to produce bikes suitable for import (Brown and Duguid 1991; 2001). Schwinn had lost the capability to produce high-end bikes. It never regained that capability until 1998 when it bought GT Bicycles for $180 million; GT did indeed have excellent manufacturing capabilities.

The Tight Link between Understanding Customer's Needs and Production

This leads to a related part of the literature which delves more deeply into the specific costs of outsourcing to essential knowledge bases (Barney 1999; Poppo and Zenger 1998). Cohen and Levinthal (1990) argue that R&D spending can add to a company's essential abilities to understand and advance in the field. In the case of middle- and high-end bicycle production, R&D comes in two components: periodic and punctuated (Levinthal 1998; Romanelli and Tushman 1994; Siggelkow 2001; Tushman and Anderson 1986). Despite periodic huge leaps in the bicycle market, such as inflatable tires in the 1930s, gear shifts in the 1960s, both pioneered by Schwinn, there are also the small, steady and very production-based advances. These advances are focused on small increases in performance in highly competitive situations. The European market, infatuated with grueling and highly competitive bike races, set the trends in the 1980s. Enormous importance was put on small incremental changes in order to gain a slight edge in such races. A passage from a bike aficionado's web page called Bike Magic (www.bikemagic.com), detailing the production in a Giant factory, serves as an example:

> Start by taking a look at Giant's frames. Giant Chromoly bikes are fully butted with all butting done in the factory. Not only do many of Giant's competitors not butt their own tubing, but they will cut corners by not butting a top tube, down tube, seat tubes or seat stay like Giant does every time. Giant ovalizes its frame tubing at the factory. Again, very few companies do this. Ovalized tubing provides a larger weld area which serves to

> strengthen the frame. Ovalization also reduces the weight by controlling wall thickness where it's needed the most.
>
> All Giant ATB's and cross bikes have mono stay seat stays. The result is better rear braking power and control due to reduced flexing. Giant's aluminum frames are custom welded by hand, just like the expensive custom frame makers. Giant has never had a reported aluminum frame failure. Giant uses all heat treated 6000 series aluminum. Heat treating is one extra step that Giant takes to ensure frame strength and reliability . . . Giant produces everything under one roof – from drawing, butting, and swagging to welding, heat treating, painting, decaling, assembly and final shipping. All other bicycle manufacturers source out one or many of these production phases. Not Giant. Giant stands alone.

One can see that R&D improvements in the bicycle industry would necessarily have a lot to do with the details, care and quality of production rather than only with large technological leaps (Levinthal 1998). Thus, investments into this sort of capability will serve much the same sort of knowledge-based ability to understand and respond to the complaints and concerns of one's customers (Siggelkow 2002). It is not easy for a company that does not produce its own tubing to absorb and address information concerning larger weld areas that increase frame strength or weld problems on aluminum frames. To turn customer information into innovation, a manufacturing technical capacity is needed. This allows a firm to turn information from distributors and enthusiasts into real improvements on the factory floor. Cohen and Levinthal (1990, 150) point out that 'absorptive capacity is more likely to be developed and maintained as a byproduct of routine activities when the knowledge domain that the firm wishes to exploit is closely related to its current knowledge base'. After all, they point out (1990, 140), 'the ease of learning is in turn determined by the characteristics of the underlying scientific and technological knowledge'.

Therefore, we see that cost considerations that drove Schwinn and other bike manufacturers might have led to problems both in coming up with new products, innovating, and in understanding customers desires and complaints. In an industry as demanding and with as much obsession for detail as the middle- and upper-end bike industry, these factors were crucial in eroding the strength and capabilities of the entrenched

US industries. But while this analysis might go toward explaining some of the reasons for the weakness of Schwinn and other US firms, and it points to where some of their mistakes might have been, it does not yet give an accurate picture of the whole story.

Bicycle Market Barriers to Entry: The Interconnected Nature of Barriers to Entry in the Bike Market

It is sometimes known as the problem of the commons. Some resources are precious for a group of people but very hard to guard from the exploitation of any one member. As a whole, and even individually, it would be very well if no one ever exploited this resource. But given that at any time one member can exploit it, and that this decision would put cooperating members at a disadvantage, it is rational for all members to exploit. Above we have described the weakening of core competencies of the US bicycle firms and the undermining of their capacity for knowledgeable relationships with their customers. But there remain significant barriers to entry that the US firms enjoyed in the middle- and upper-level bike market in the 1980s:

1. Distribution networks: While less expensive bikes were sold through large retail stores such as K-Mart and Wal-Mart, middle- and upper-echelon bikes were sold predominantly through specialized retailers. The US bike firms had hard-to-crack relationships with these smaller retailers. It would take years for a new entrant to crack enough of these stores to gain large numbers of bike sales.
2. The middle and upper quality bicycle market enjoyed enormous efficiencies of scale to be economical. To run a full bike factory, which can produce hundreds of thousands of bikes each year, requires enormous overhead as exemplified by Porter (1985). The combination of 1) a complex distribution system with 2) the need for large scale production in order to sell at a competitive price makes the market extremely difficult to crack. The paradox is apparent: you need to sell enough to be able to lower costs enough to sell. But with a distribution network that takes a decade to crack, a decade of steep losses is needed, during which the producer subsidizes cost in order to build volume and market share.
3. In the middle- and upper-end bicycle market there was an additional hurdle. The technical ability to make good bikes was orders of magnitude more difficult than the challenge of making cheap bikes

(a market in which Asian firms had long ago become major players). It required an intimate connection with enthusiasts, practiced engineers, and long ingrained know-how. Numerous essays on organizational learning emphasize how complex tasks become engrained into the workers who do them and cannot be easily transferred or re-learned (Brown and Duguid 2001; Cohen and Bacdayan 1994).

Porter (1975) outlines the potential barriers to entry in an industry just after he notes that '[the five forces] reflect the fact that competition in an industry goes well beyond the established players. Customers, suppliers, and potential entrants are all "competitors to firms"'. He lists these barriers as:

- economies of scale,
- product differentiation,
- capital requirements,
- access to distribution channels,
- cost disadvantages independent of scale (such as proprietary technology).

As argued above, from an industry perspective the US quality bike market had a strong position in at least four, perhaps five of these five areas (the possible exception being capital requirements since a bike factory can be inexpensive if it is designed to make only a small number of bikes).

The problem arose from a prisoner's dilemma (Cable and Shane 1997; Kogut and Zander 1996; Radner 1992). In an oligopoly, a company can pursue its own self-interest by undercutting its competitors, knowing that this will start a war, or it can pursue the interests of the group and forgo the short-term benefits of defection. By 'cooperating' or acting in the interests of the group, the firm may maximize its long-term interests. As Porter (1980, 88) says 'the dilemma arises because choosing strategies or responses that avoid the risk of warfare and make the industry as a whole better off ... may mean that the firm gives up potential profits and market share'.

Schwinn was the first of the major bike producers to move significant portions of its middle- and upper-end bikes abroad through outsourcing. It had very strong competitive reasons for doing this, even if its Chicago factory strike had not exacerbated the problem. In 1996, wages in Taiwan, in the relevant norm, were below average: 5.41 $/hour vs.

13.22 $/hour in the US. Production of this sort, furthermore, was something at which Taiwanese firms had proven very adept. Schwinn had every expectation that their bikes from Taiwan would be less expensive and better.

But to produce bikes in Taiwan, Schwinn had first to teach the Taiwanese how to produce such high quality bikes. Therefore, in 1981, it shipped its best engineers and its most sophisticated machinery to Taiwan and began training the workers at Giant plants in the art of making fine bicycles (which involved the use of both machine and hand labor). The organizational routines were actually handed over to Giant voluntarily (Nelson and Winter 1982). This decision undermined the barrier of proprietary technology and product differentiation – remember that a few years later Giant was able to build distribution by offering bike shops exact replicas of Schwinn bikes at a 15% discount. The barriers of know-how and efficiencies of scale in turn undermined the barriers of product differentiation and access to distribution channels and capital requirements. Prahalad and Hamel (1990, 85) predicted the possibility of a transition from supplier to competitor, since once 'Asian competitors have built up advances in component markets first, they have then leveraged off their superior products to move downstream to build brand share. And they are not likely to remain the low-cost suppliers forever. As their reputation for brand leadership is consolidated, they may well gain price leadership'.

The numbers support this speculation. In 1984, Taiwan was exporting 6,328,000 bikes with a total value of $ 281,596,000 and an average cost of $ 44.5. The majority of these were low-cost bikes for large retail outfits. By 1990, Taiwan was exporting 8,942,000 bikes with a total cost of $ 909,937,920 and an average cost of $ 101.76. This was the period in which Taiwanese firms (led by Giant) began to produce high-end bikes for US bike companies. In 1996, 9,692,000 bikes were sold for $ 984,185,670 at an average price of $ 101.55. It is interesting to notice that no significant change in the average value of bikes exported occurred between 1990 and 1996. What happened was rather that Taiwanese companies acting as outsourcers decided to sell their own brand. From when Giant launched its own brand in 1985 to today, it has gone from producing all subcontracted bikes for others to doing this with only a third of their production – with the other two-thirds produced for their own label.

Despite a bad performance of US bike companies in the last decade, the bike industry as a whole did relatively well in the 1990s. In 2000,

the industry as a whole (including retail value of bicycles, related parts, and accessories) was worth about $ 5.0 billion. In 1995, it was worth $ 5.2 billion, in 1994, $ 5.0 billion, in 1993, $ 4.3 billion, in 1992, $ 4.5 billion, in 1991, $ 4.0 billion and in 1990, $ 3.6 billion. These numbers suggest that the industry is mildly healthy with a general trend of growth. But despite these seemingly placid numbers, the bicycle industry was undergoing dramatic changes.

We argue that the major barrier to entry in the bicycle industry was the interconnection between cutting edge technology, economies of scale, and large distribution networks (Cohen and Levinthal 1989; Herriott, Levinthal, and March 1985; Levinthal 1997). In many cases, under normal circumstances, it would be prohibitively expensive to do all three from a standing start. In order to sell the bikes at a competitive rate, a company would have to produce a large number of them. Yet it would take years for a company to crack a complex decentralized distribution market like the market for bike retailers in the US. Thus, an entering bike company has to rely on producing extremely high quality hand-made bikes and slowly increase distribution as it moves down market; otherwise it risks losing money for years if it attempts mainstream distribution. Not all markets have this dilemma. Inexpensive bikes, for example, are sold largely by large retail chains such as K-Mart and Wal-Mart that could be negotiated with for large quantities of bikes. Taiwanese and other Asian firms were therefore able to crack that market in the 1970s without too much difficulty. These markets truly did compete for the lowest price in a relatively static technological environment.

But the specific nature of the outsourcing that Schwinn and others did with Giant allowed Giant to crack the middle- and high-quality US bike market despite barriers to entry. Economies of scale were not an issue for Giant or a few other outsourcers in Taiwan (Makadok 1999; Raff 1991; Wernerfelt and Karnani 1987). Giant was already producing millions of bikes for export to US companies; it was therefore able to divert excess capacity after Schwinn scaled back manufacturing in 1985 by introducing its own line first in Europe, and, in 1987, in the US. It was able to produce, with maximum cost efficiency, even when it was selling only a few bikes under its own brand because its factories were running at near full capacity for others. Today, after over a decade of double-digit growth, two-thirds of Giant bikes are produced under its own brand. Schwinn began a trend which led to the erosion of barriers to entry in the industry as a whole. This effect was not achieved by a destruction of any specific

barrier listed by Porter (1975); instead it consisted of undermining the relationship between barriers. The barriers seemed to be interrelated in this market in such a way that giving up production in the way Schwinn did may have led to the erosion of all other barriers.

Giant's Decision to Manufacture in China – What are the Alternatives to Outsourcing?

Nevertheless, Schwinn's decision to manufacture in Asia seems to have been in some way inevitable sooner or later. Once any major bike maker had outsourced, taking advantage of cheaper wages abroad, then, in order to keep up with their competitors in a cost/quality calculation, all major middle- and upper-end bike makers were also pressured to manufacture in a low-cost nation in order to continue to compete on cost (with the exception of a few specialty bike producers within niche markets). While collusion (which is illegal) might have avoided this problem if enough major players agreed not to move manufacturing abroad, other, legal options, could have been taken when faced with such a dilemma. Economists often argue that manufacturing in Asia ensured a better allocation of resources. Cheaper labor comprised a comparative advantage in Asia, allowing US workers to focus on their own comparative advantages. These arguments, however, can be strengthened by including a more thoughtful arrangement of outsourcing contracts, incentive structures and relationship management.

What else could Schwinn or others, looking to outsource in the middle- and high- quality bike market, have done? The most obvious place to look for such a strategy is in the Giant's recent move to produce in China, the new low-cost center for global production, where wages are 1.16 $/hour (5.41 $/hour in Taiwan). This is a 1 : 0.21 Taiwan/China wage ratio, higher than the 2.44 : 1 US/Taiwan ratio (13.42 $/hour vs. 5.41 $/hour). Bike production in China is growing; China is currently producing 21% of all bikes sold in the World. Giant's founder King Liu has committed himself to producing and selling bikes in China. In 1996, Giant made 550,000 bikes in China; in 2001, it was expecting to make 3.2 million bikes there, two-thirds of them for export. But rather than hiring Chinese firms to produce their bikes, Giant and other Taiwanese bike firms opened fully-owned subsidiaries in China. In a recent board meeting, Liu, standing in front of pictures of racing bikes, said the following about the recent competition in production and distribution in China:

'A lot of the competition there has actually been companies backed by Taiwan. It's just that they're over in China now'. Continued production in Taiwan and in Denmark has maintained Giant's closeness to other core markets and designed an advantage.

Giant produces each and every one of its top bikes in Taiwan, not China, by the same group of highly skilled engineers. Its design teams in the US, Europe, and Asia are constantly working on improving design, trying out new designs in Giant factories, and responding to demands of regional managers by creating whatever these managers believe will be popular for sale in that region. While manufacturing in China makes sense, especially with Giant in complete control of the factories, Giant has no plans to close down its factories in the Netherlands or Taiwan. Giant has in fact recently invested in a new 11,520 sq. meter facility in Europe. These factories, which are close to their markets, are seen as valuable resources for innovation and learning. Making bikes in Europe may not be cheap, but it is the only way to truly understand and respond to European demands and to pick up tricks that are then brought back to Taiwan in the bi-annual meeting of designers and engineers from around the world. Innovations are then spread throughout the company.

By expanding into China, Giant is less likely than Schwinn to erode its core capabilities. In fact, since China was the source of over half of Giant's profits in 2000, it seems likely that Giant will use its manufacturing capacity in China to link itself tightly with the needs and dynamics of that market. With 3% of the bike market in China, Giant and its local partner, Phoenix, plan on expanding. Chinese factories will increasingly become more than just centers for producing bikes to be exported; they will increasingly become linked sales in China and will use production to fuel innovation for Chinese factories. The close link between production and innovation will be crucial. As information and demands from Chinese distributors are instantly transformed into products that can hit the market, Giant is likely to turn its Chinese factories into more and more valuable centers for capabilities and innovation.

What, in hindsight, could the US have learned from this model? A blanket government regulation or bans on imports against outsourcing would not have led to optimal results either for consumers, who would pay a needlessly high price, or for companies, who would not be spurred to be competitive in the global marketplace (Banerjee 2001; Jensen and Ruback 1983; Wheelock and Wilson 1995). Instead, as a start, bicycle mak-

ers could have reflected more carefully on the core capabilities of the bike industry and acted to help maintain them (Porter 1996; Porter and Siggelkow 2000).

However, options are easy to spot in hindsight and much harder at the time when information is more ambiguous, outcomes are less clear and trends harder to spot. Even so, such analysis might be helpful in generating options to consider and could act as a warning in future decisions. In this case, even if some part of production had been outsourced (a result that appeared all but inevitable in the market conditions at the time) at least some proportion of high-end production centers for key competitive parts (frames and perhaps derailers) might have been produced by the company, probably in the US closest to the core market. Further, an attempt to open a company or joint venture subsidiaries in Asia might have been advantageous in this case. Despite slightly higher costs, perhaps the production of its best models should have been, for strategic reasons, done exclusively in-house, protecting this core capability jealously. Further, small but high-tech factories could have been placed in core markets (Europe, the US) in order to keep a tight link between production and distribution. Lastly, any outsourcing should have been spread among small Taiwanese firms rather than lumped into one or two, if possible fragmented so that neither company possessed a full bundle of core capabilities. This way, original companies could have maintained some control over their potential foreign rivals. If possible, contractual agreements limiting suppliers' ability to compete directly could have been demanded.

The most essential part of the capabilities of production, once reflected upon, might have been maintained in-house (Wernerfelt 1984; Wernerfelt 1995; Wernerfelt and Karnani 1987). Their ongoing technical knowledge would have allowed US bicycle manufacturers to maintain a high level of absorptive capacity to suggestions and needs realized through their distribution networks. This strategy might have allowed them both to keep their finger on the latest trends and to maintain a steady stream of eclectic improvements.

Conclusion: The Potential Interconnectivity of Capabilities and Interconnectivity of Barriers of Entry

In certain circumstances, both capabilities and barriers to entry are interconnected in such a way that sacrificing one of them or some necessary but insufficient component of them can lead to the subsequent vulner-

ability or erosion of many others (Cohen and Levinthal 1989; Levinthal 1997; 1998). In this model, some company's capabilities are like the foundational pillars of a house. Some pillars can be knocked down without any other consequences. But there are other pillars, which are crucial to the structural support of the house. Thus, a company's core capabilities are not all equal, nor are they additive – adding one and subtracting another may not result in a wash. Similarly, certain capabilities allow access to others, while others do not.

We have argued that in the case of the bicycle industry, of Schwinn Corporation and Giant Manufacturing in particular, both the barriers to entry and the firm capabilities were interrelated in certain ways. We suggest it is the interconnectivity of barriers to entry and core capabilities that are the key to the puzzle. Perhaps, in this case, a loss of manufacturing capabilities led to a loss of the 'organizational learning' barrier to entry which in turn ricocheted to knock down the core capability of technical absorptive capacity (Herriott et al. 1985). In the case of Schwinn, one decision regarding one core capability had broad and unanticipated effects which went beyond the capacity they relinquished. It does seem that interrelated, interlocking barriers to entry and capabilities tell this story. In this case, we have argued that manufacturing and distribution were tightly linked in such a way that without this tight link, successful incremental innovation would have become extremely difficult.

Stalk et al. (1992, 57) illustrate well how an advantage in one dimension can fan out and create other previously unrelated strengths. 'Companies that compete effectively on time – speeding new products to market, manufacturing just in time, or responding promptly to customer complaints – tend to be good at other things as well: for instance the consistency of their product quality, the acuity of their insight into evolving customer needs ... or [the ability to] generate new ideas and incorporate them in innovations'. In some cases, instead of being able to choose to add a single capability, or to choose to discard one, companies may instead be choosing between sets, groups of interlinked or patterned capabilities. Seemingly, unrelated capabilities and strengths become mutually reinforcing or interconnected. A small change may require a major reorganization of other core capabilities which its ostensible status belies.

It is said that Hannibal, the Carthaginian general, was having a hard time capturing a particularly well-fortified Roman city. The city had high walls surrounding it and an inexhaustible supply of water from a river flowing through it. After a long siege Hannibal finally dug a new riverbed

for the river and diverted its flow. This left a wide gap under the walls of the city, where the river used to flow, through which he marched his army and captured the city. For this city, its barriers to entry were interconnected in such a way that removing one quite literally undercut the other. Success and failure, in business as in siege, may depend on understanding how core capabilities are interconnected and how barriers to entry are interdependent.

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