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How Do Revolutions Emerge?

Lessons from the Fosbury Flop

Abstract: *In 1968, a young high jumper named Dick Fosbury revolutionized his field by winning the Olympic gold medal with a back-first flop that he himself had invented. Through an in-depth analysis of the case of the Fosbury flop, we explore the process through which radical innovations can be achieved. Observations relating to the evolution of radical innovations are highlighted, and similarities between this case and a variety of well-known business cases are discussed.*

The year 1968 is remembered as a phenomenal year in athletics. In the high altitude and thin air of Mexico, introducing a radical innovative style, Dick Fosbury won the gold medal with a back-first flop that he himself had invented. Fosbury used a technique that had never been seen before. Though he did not set a world record with his jump, he revolutionized the sport. In less than 10 years, virtually all high jumpers had adopted his style, and the old technique was rendered passé. This newly embraced technique was dubbed the "Fosbury flop" after its inventor.

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Through an in-depth case analysis of the flop's development process, this article aims to suggest that even radical and discontinuous innovations that can revolutionize their field can be devised through an incremental and continuous process. Furthermore, this case suggests that to achieve revolutions, firms may want to consider antiquated and even abandoned routes as potential outlets for their ideas, especially when such routes present a good fit with the firm's capabilities and overarching philosophies.

The significance of Fosbury's unusual invention is best described in the publications of the Olympic Movement and *Encyclopedia Britannica*:

> Dick Fosbury . . . owed this fame not only to his victory, which was also an Olympic record (2.24 m), but specifically to the way in which he achieved it: the style—the "Fosbury flop." A real *revolution* . . . an athlete will *never again* invent such a revolutionary style. Since this high jump approach, all specialists have adopted the "Fosbury flop" and the world record of the time, held by Soviet Valery Brumel (2.29 m) was quickly broken. (Olympic Movement 2002, emphasis added)

> Richard Douglas Fosbury. American high jumper who *revolutionized the sport* by replacing the traditional approach to jumping with an innovative backward style that became known as the "Fosbury flop." (*Encyclopedia Britannica* 2002, emphasis added)

Fosbury invented an entirely new concept that gave him an edge over jumpers using the traditional approach to the bar. Such extraordinary inventions are frequently seen in, and always sought by, competitive organizations. In fact, R&D departments are often devoted to the goal of devising radical innovations that will provide their organization with the advantage it needs to compete and to win (Urban and Hauser 1993). Firms may sometimes change strategies in order to develop radical innovations (Ettlie and Subramaniam 2004). Little is known, however, about how real revolutions are devised, partially because their occurrence is so rare. Do they require the unique brilliance possessed only by geniuses? Are they the product of a mysterious and untraceable process? Under what circumstances are they most likely to emerge? In an attempt to shed some light on these issues, this article examines the rise of Fosbury's revolutionary invention.

The management literature often distinguishes between incremental and radical (also known as discontinuous, revolutionary, or breakthrough) innovations. The latter generally involve methods and materials that are novel to individual or organizational users (e.g., Hage 1980; Hill and Rothaermel 2003; Tushman and Anderson 1986). In light of this distinction, a growing number of studies have prescribed different managerial strategies and practices on the basis of the innovativeness (i.e., incremental vs. radical) of the organization's product (e.g., Dewar and Dutton 1986; Ettlie, Bridges, and O'Keefe 1984; Van de Ven et al. 1999).

The common conception is that the two forms of innovations are devised via qualitatively different routes (Goldenberg, Mazursky, and Solomon 1999; Veryzer 1998). Incremental innovations, by their very nature, come about through a serial, step-by-step process. Revolutionary ideas, however, are said to originate in a sudden stroke of ingenuity, followed by an extraordinary style of thought (Weisberg 1992). The purpose of this study is to suggest that even radical and discontinuous innovations can be formulated through an incremental, step-by-step process.

Contrary to the purely positivistic approach, it is not our intention to provide a rigorous test of hypotheses. Rather than setting out to prove an idea, we wish to introduce a number of important possibilities for managers to consider when examining routes for innovation development through the analysis of a remarkable case of radical and discontinuous innovation. We aim at drawing managers' attention to possible variations in the innovativeness process. The use of an in-depth analysis of a specific case is quite common in the creativity literature (Boden 1996; Weisberg 1992) and is especially valuable in the search for in-depth understandings of complex phenomena. The case of the Fosbury flop is particularly suitable for our thesis because, in addition to the thick descriptions that it provides, it offers two measures of success: information regarding adoption rates and information on performance rates.

Theoretical background

Definitions of radical innovations most frequently involve a departure from existing technology that is "so significant that no increase in scale, efficiency, or design can make older technologies competitive with the new technology" (Tushman and Anderson 1986, 441). We identify three primary dimensions regarding such technological breakthroughs that the literature on innovations has addressed. First, innovations can be discussed in reference to products' components, where these can be either entirely new or new just to the user population (Chandy and Tellis 2000). A second dimension involves products' configuration, where either old or new components can be configured in a novel form. Incremental innovations are viewed as innovations that generally maintain both the components of existing technologies as well as their configuration. Innovations that involve familiar components that are originally configured are referred to as *architectural innovations*. Henderson and Clark (1990) offer the example of portable fans, as constituting an architectural innovation compared with ceiling fans; their components remain generally the same, but the ultimate architecture of the portable fan is substantially different. At the same time digital telephones, where novel components are used to create familiar forms (i.e., the product's architecture remains relatively unchanged), constitute a *modular innovation*. Lastly, *radical innovations* are considered those that present significant departures in both the components and their configuration.

An important difference between the two extreme forms of innovation—incremental and radical—involves the extent to which the innovation enhances or destroys previous competencies (Tushman and Anderson 1986). Whereas incremental innovations are based on previous technologies and therefore improve performance when existing competencies are applied, radical innovations render

previous competencies useless because they introduce an entirely new approach to the problem at hand.

Similar observations can be drawn from the cognitive psychology literature that asserts that creative thinking, in many cases, is related to everyday cognition (Smith, Ward, and Fink 1995). Though some scholars think that creativity is related to original behavior, they also acknowledge that creativity is a complex process, requiring substantial system flexibility (Albert and Runco 1989; Mumford and Gustafson 1988; Runco and Richards 1997).

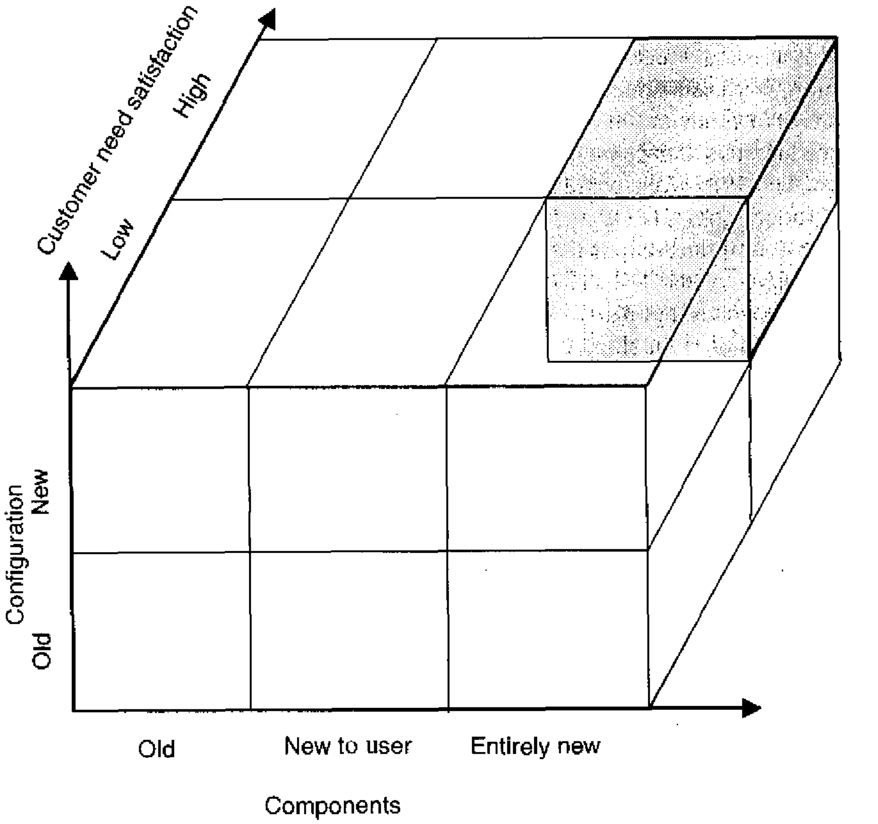
Product components and configuration can be complemented with a third dimension of innovations that involves bettering their ability to meet consumers' needs. Chandy and Tellis (1998) collapse components and configuration into one category, which they label "technology." They classify innovations based on the dimensions of technology and markets as the extent to which the new product fulfils key customer needs better than existing products. These two dimensions determine four classes of innovations: (1) incremental innovation (old technology; low customer need fulfillment), (2) technological breakthrough (new technology; low need fulfillment), (3) market breakthrough (old technology; high need fulfillment), and (4) radical innovation (new technology; high need fulfillment) (for a similar classification, see Veryzer 1998).

A framework that incorporates all three dimensions of components, configuration, and customer need satisfaction, produces twelve forms of innovation (see Figure 1). Of those, the most revolutionary is the one that involves entirely new components that are combined in a new configuration and that greatly satisfy users' needs. Such radical innovations, besides being interesting phenomena, frequently reshape markets; they change the dynamics between consumers and firms, and they set high goals and standards that future development (even incremental innovations) will have to meet (Tellis and Golder 2002). Hence, despite being small in number, radical innovations are important forces that govern progress and development. This is why firms delve even into unfamiliar territories that involve high investments and risks in order to develop such radical innovations (McDermott and O'Connor 2002). In this article, we postulate that the Fosbury flop constitutes an extreme case within this innovation category and therefore provides an excellent example for the discussion of revolutionary innovations.

The literature on institutional change offers additional insights for understanding the process through which revolutionary innovations may come about. While institutional theorists (e.g., DiMaggio and Powell 1983; Meyer and Rowan 1977) focus on the forces that maintain and duplicate current understandings, structures, and technologies, they also discuss the conditions and processes that can ultimately lead to radical transformations in organizational and technological forms.

Based on an analysis of the potentials and limitations of current forms, Benson (1977) argued that once a particular form has been consolidated, internal contradictions or inconsistencies in current forms constitute the factors that ultimately lead to a creative transformation and reconstruction. This reconstruction process,

Figure 1. **An innovation typology**



termed "praxis," involves actors' critical understanding of the existing conditions in which their needs or goals are unmet (Seo and Creed 2002). It further involves their active attempts to change existing arrangements and themselves in order to satisfy these unmet needs. Such a process is part of the functional pressures that have been indicated as one of the primary sources of institutional change (Dacin, Goodstein, and Scott 2002; Oliver 1992). Ultimately, the inappropriateness of existing modes of action for attaining particular organizational goals set in motion the process of institutional and organizational change.

Because primary actors within a given framework are deeply embedded with current modes of action, the initiation of radical change is most likely to come from outsiders. Outsiders will often advocate changes that are consistent with their own interests and needs, and counter to those previously established in the field (Kraatz and Moore 2002). Often, their initiatives stem from being unaware of, or indifferent to, the implications of their proposed changes and from a relatively technical perspective on the problem with which they are dealing. Rather than possessing an unreflective, habitual, and past-directed mode of thought, they tend to be present-directed and to concentrate on the viability of imagined alternatives given the present problem with which they are dealing (Seo and Creed 2002). Although theories of institutional change generally consider agents at the collective level, many of their formulations parallel processes that take place at the individual level. As we aim to demonstrate through this case study, the invention of the Fosbury flop fits within such an approach to understanding institutional changes.

In addition to the context in which changes and innovations come about, to better understand the innovation process, one should also consider the particular mechanisms that take place. A common assumption is that whereas incremental innovations are developed incrementally, revolutionary innovations are discovered through an almost instantaneous spark of genius (Goldenberg, Lehmann, and Mazursky 2001). One of our purposes in this article is to question this assumption by exploring whether a revolutionary innovation can result from a continuous and evolutionary process. If so, this would indicate an additional, and sometimes superior, route to the development of radical innovations.

Creating a revolution: A giant leap or step by step?

Technological change is generally viewed as an evolutionary system punctuated by discontinuous change (Christensen 1997; Tushman and Anderson 1986). According to this view, most innovations are incremental, and only infrequently does a radical innovation erupt and revolutionize our perspective until, gradually, a new incremental process forms, based on the new understandings. As Gersick (1991) noted in her review of revolutionary change theories, systems do not move from one point to another through incremental changes but rather through large disruptions. An accepted view of these seemingly punctuated revolutions is that by nature they are spontaneous, unpredictable, and rare, and are based on individual genius.

A key factor in the evolution of radical innovations is often the idea itself. Creative ideation is considered one of the most interesting puzzles in cognition, which is sometimes difficult to formalize and control. Although there is general consensus regarding the distinctive nature of the creative product (e.g., paintings, poems, or ideas), researchers are divided over the extent of this distinctive nature (Goldenberg and Mazursky 2002; Maymon and Horowitz 1999) and its transparency to researchers. Boden (1996), for example, notes that although creativity is occasionally viewed as a novel combination of old ideas (see also Hargadon and Sutton 1997), inventors, scientists, and artists rarely know how their own original ideas arise. Intuition is mentioned in most cases of discovery, but little is known of its precise role in the process. There are different ways to describe, or define, intuition: a way to protect individuals from making poor decisions that can be a result of both internal and external causes (Weintraub 1998) or a perception that is beyond physical sensors that are supposed to assist individuals (Zukav 1990). Here we refer to intuition as a way to get an idea, not through logical arguments, but rather by getting seemingly out-of-the-blue information (Weintraub 1998). Boden (1996) therefore refers to creativity as a puzzle, a paradox, and even a mystery.

This vagueness of the creative process led some researchers to maintain that the creative thinking process is qualitatively different from ordinary day-to-day thinking (see Guilford 1950; Koestler 1964; Wallas 1926). In contrast, a more recent trend in creativity research views the creative process as a reproducible, learnable, and in some cases even a systematic thought process (see Dasgupta 1994; Maymon and Horowitz 1999; Perkins 1996) or everyday necessary activity (Runco and Richards1997). The latter suggests that a more structured process takes place but still suggests that the revolutionary idea will derive through a "giant leap," except that this leap can be achieved through systematic thinking.

Because novelty and original ideas differ from those arising under normal conditions, researchers often believe that creative ideation requires conditions dramatically different from those generally prevailing. The notion that one must overcome mental obstacles or barriers in order to produce creative ideas has often led to the belief that a total lack of structure must be ensured by eliminating directional guidance, constraints, criticism, and thinking within a bounded scope (Csikszentmihali 1996). In fact, in line with studies that demonstrate links between organizational climate and innovativeness, organizations often strive to design the "right" kind of climate that will remove obstacles to creativity and foster discovery (e.g., Abbey and Dickson 1983; Amabile et al. 1996; Scott and Bruce 1994).

A different approach views creativity as the outcome of a channeled process that forces individuals to be resourceful in a way that diverges from traditional problem solving. Boden (1996) summarizes this view, stating that counterintuitive constraints make creativity possible and that removing all constraints may have an adverse effect on creative thinking. Other researchers in this stream adopted a reductionist view of the creative process, suggesting that creative products are the outcome of ordinary thinking, hence are only quantitatively different from everyday thinking (Perkins 1981; Weisberg 1992). In addition, as posited by several researchers (e.g., Dominowski 1995; Perkins 1981; Weisberg 1992), an unstructured representation does not promote a solution to a problem if it is formed on an implicit and unstructured basis (Dominowski 1995). Furthermore, Simon (1979), Boden (1996), and Finke, Ward, and Smith (1995) suggest that many creative achievements involve exploration and perhaps tweaking of conceptual space, rather than a radical transformation of it. In light of these perspectives, we raise the following question: Can revolutionary concepts be devised through a set of incremental changes?

We approach our research question by way of a case analysis that facilitates richer insights and understanding of the phenomena studied (see, for example, Boden 1996; Dasgupta 1994; Perkins 1996; Weisberg 1992). We first wish to establish that the Fosbury flop indeed provides a good choice of a radical and successful invention. We then examine its process of development. Finally, we

draw parallels from this case to a variety of business cases with respect to the emergence of new products.

Fly high: The case of the Fosbury flop

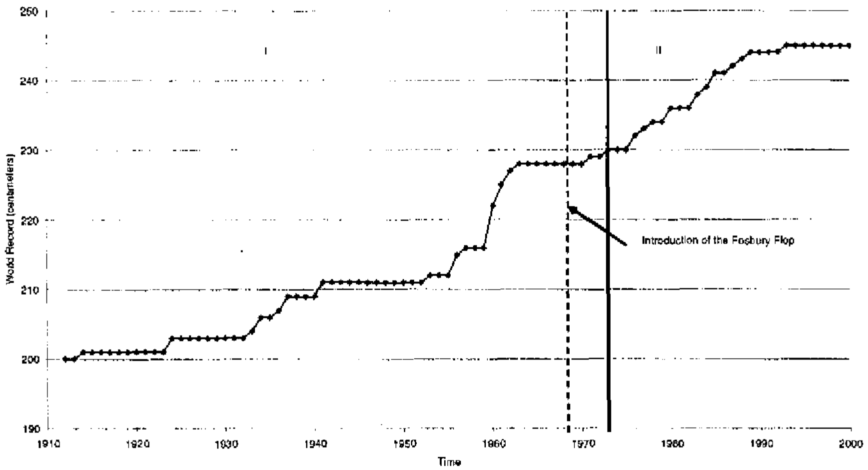
To explore our research question through a case analysis, we require an extreme, perhaps indubitable, case of a revolution. Accordingly, we have chosen a case that is well-known and perhaps one of the most radical innovations, which utterly changed the face of the high jump, the Fosbury flop.

Without advance notice, during the 1968 Olympics, an unknown high jumper named Dick Fosbury literally jumped backward compared with all the other jumpers: instead of approaching the bar face first, Fosbury did so with his back to it. The significance of this event, however, was not Fosbury's winning of the gold medal; rather, within only a few years, the old jumping style had been abandoned completely, and all high jumpers adopted the new style. Nothing about the Fosbury flop appeared similar to anything ever before seen in the high-jump field. The flop involved a set of entirely new maneuvers (i.e., components) that combined to create an entirely new form (i.e., configuration) and that ultimately proved very useful to athletes (i.e., high customer need satisfaction). In these respects, the Fosbury flop undoubtedly constituted a revolutionary approach to the high jump (see Figure 1).

Before examining the process through which the Fosbury flop was devised, we wanted to establish that the flop was indeed as revolutionary and successful as it would seem to be. As a first step, six experts[1] from various domains of the sports world were interviewed and asked to assess innovations in the general area of sports. Specifically, these experts, who were uninformed as to the topic of our study, were asked to list the most important innovations in the history of sports. Five of the six judges suggested the Fosbury flop as one of the most significant sports innovations of all time (see the Appendix). As a second step, another group of 23 judges were asked to rate a large variety of sports innovations (the game of soccer, swimming techniques, the Tsukahara twist, the fiberglass pole, the synthetic track, running shoes, the establishment of the Olympic movement, participation of women in sports, and the Fosbury flop) on a range of innovation dimensions (e.g., originality, simplicity, and usefulness). Among the nine inventions rated, the flop was rated highest on its impact on sports, originality, and revolutionary nature. An ANOVA revealed a significant difference between the judges' ratings of the Fosbury flop and the other innovations on the various innovation dimensions. The aggregate value across innovation dimensions was 5.70 (on a 7-point scale), and the second highest aggregate rating was 5.22 for the fiberglass pole (data not shown). It is thus apparent that Fosbury's innovation can be considered revolutionary, both when viewed as a stand-alone innovation and in relation to other innovations.

Next, we wanted to show that the flop was not only radical in its originality, but that it was extremely useful and involved a dominant advantage over other techniques. One thing to note is that in the 1968 Olympics, where Fosbury won

Figure 2. **Progression in high-jump world records**



I: Era 1—World records with various jumping styles
II: Era 2—World records using the Fosbury flop

the gold, he was the only jumper using his technique; but in the next Olympic games in 1972, virtually all the high jumpers had already adopted Fosbury's flop. Moreover, every male Olympic champion since 1968 has used the flop technique. Furthermore, in a comparison of the pace of world record improvements using the Fosbury flop as against all previous styles, including its predecessor, the *straddle,* the flop yielded a significantly faster pace of record-setting. The progression of world records is presented in Figure 2. As can be seen, the progression of records, starting in 1912, is divided into two sections: section I includes high-jump world records with all jumping styles prior to Fosbury's flop, and section II includes world records achieved by using the flop. The dashed line represents the introduction of the Fosbury flop in 1968 and the solid line the point where the flop has brought about the breaking of the world record. A regression analysis applied to the world records yielded a parameter value of 0.84 for the flop compared with 0.60 for all other styles. The regression values represent the annual improvement (in centimeters) in world records and are significant at $p = 0.00011$. It is therefore not surprising that the International Association of Athletics Federations (IAAF) named the flop as one of the three landmarks in high-jump history (IAAF 2002).[2]

The development of the revolution—An introspective report

Fosbury's technique in the high jump began as a result of first having learned, at the age of ten, an antiquated, inefficient technique called the "scissors" (all the information regarding the development of Fosbury's technique was provided via personal communications with Richard Fosbury in February 2002). He had copied it from some children who had been using it. At the age of eleven, when in the fifth grade, Fosbury's physical-education teacher and coach taught the children trying out for track to jump using the classic style of the time: the straddle or "Western roll." He also allowed the children to use the scissors if they preferred it, as Fosbury did. Fosbury used that old style until he reached high school, mainly because he did not do very well with the more advanced straddle.

An examination of the case thus far leads us to our first observation: Fosbury used an old-fashioned style, refraining from adopting the dominant method because of his personal inclinations.[1] This parallels Benson's (1977) praxis process in which agents identify the misalignment that exists between prevailing structures and their own, unmet, needs. In this case, the transformation that Fosbury initiated began with a step backward by him reverting to an obsolete form. This leads us to our first observation:

> *Observation 1: Radical inventions can derive from antiquated or apparently obsolete forms.*

In high school, Fosbury Switched to the straddle and began practing virtually from scratch. His achievements distinctly fell behind those of his teammates. In fact, in his first competition in 1963, at the age of sixteen, Fosbury was the first jumper to be eliminated, failing to clear the low opening height of 1.52 meters. After about six meets, Fosbury had managed to clear 1.63 meters, which was his personal best of the year before, and about 20 to 25 centimeters lower than the other competitors in his district. Fosbury was very frustrated and felt that the straddle technique simply didn't fit his abilities or personal style. He therefore asked his coach if he could revert to the old scissors style, both to improve his performance and to boost his confidence. Although his coach encouraged Fosbury not to give up on the straddle, he was sympathetic to Fosbury's difficulties and agreed to let him try the scissors. Fosbury went back to the technique with which he felt comfortable, even if it was much older and less efficient. Instead of adopting the widespread style, he looked for a familiar style that felt safer to him. As Fosbury himself recalls: "What did I have to lose?"

> *Observation 2: Radical inventors may prefer familiar rather than popular starting points.*

While on a bus trip to a meet, Fosbury resolved to try his old style again, and he used it to warm up before the competition. Feeling awkward yet persistent, Fosbury managed to clear his previous best jump of 1.63 meters, and then, facing a new height, he knew he had to adjust something. With the scissors style, the jumper typically knocks the bar off with his/her behind, and sometimes with the movement of the legs. To avoid this, Fosbury began to try lifting his hips higher, which also made him drop his shoulders. Fosbury cleared the next height as well. He continued this raising of his hips until he eventually cleared an additional 15 cm, breaking a new personal record. This achievement even placed him fourth to score points on his team. No one knew what Fosbury was doing as he transformed this old technique into something new, as each attempt was a little different than the previous. Coaches from opponent teams consulted with the rulebook to check whether Fosbury was breaking any rules since Fosbury had unexpectedly begun to beat their jumpers. Thus, after reverting to his high-jump roots, Fosbury continuously worked to modify the jump in order to solve the disadvantages of his style. Exploration, imagination, and persistence were essential components of this process. Therefore, our third observation perfectly accords with Von Hipple and Katz's (2002) notion of lead users as well as with the literature on creativity that discusses inventors' exploratory styles:

Observation 3: When confronted with obstacles, reverting to previous forms and tailoring products to meet specific customer needs provide a means of making progress.

Fosbury's coach, Dean Benson, was pleased with Fosbury's success and asked to see him at practice the next Monday. At Monday's practice, he explained that he was not sure exactly what Fosbury was doing, but he thought that perhaps they could study some films he had of high-jumping techniques. Perhaps there was a similar model that has proved successful and that Fosbury could adopt. Despite the fact that they did not find anything similar, they took a session or two practicing these other techniques. This presented the high jumpers with an enjoyable break from their routine. Ultimately, Fosbury and his coach were open-minded and tried to fiddle around with the new form and compare it to other familiar techniques. At this time, no distinct new style had been developed but, rather, attempts were made to develop a hybrid technique.

In the following week, there was a district meet at Fosbury's school. Fosbury used his new style to clear the same height as before. He did not place at the meet because the competition was tough, but he did make the same height. This convinced him that his new style put him in a reasonable position to compete, and he resolved to continue using it in the future. Fosbury felt he was "back in the game." This corresponds with indications in the literature on the value of planning, monitoring, and revising throughout the idea implementation process (Mumford et al. 1991). In the Fosbury case, the different meets provided monitoring and revision points for the implementation of the flop. This further highlights the incremental process through which the flop was devised.

The next two years, 1964–1965, involved a continuous slow evolution in the technique. Using his curved approach to the bar, Fosbury intuitively began to turn his inside shoulder away from the bar, to get his head over the bar earlier. Thus, the following year, pictures show Fosbury clearing the bar with his body at a 45-degree angle to the bar, no longer parallel to it. By the second year, Fosbury had fully evolved to clearing the bar with his back to it, arching his hips over, then straightening back to kick his heels over the bar and land on his

back in the pit. In other words, two years of small incremental changes were required for Fosbury to come up with the final, apparently radical, version of his jump.

Observation 4: Radical innovations can result from a lengthy sequence of incremental steps.

An interesting point was that the entire evolutionary process took place solely at competitions. During practice, Fosbury never worked on his emerging style. This was due, primarily, to the fact that he did not have a model to follow. Fosbury reports that he was much more intense during the competition; more focused on getting over the bar (the objective). Consequently, his body was searching for the best way to clear the bar, being driven by his desire not to lose to the others. It was a spontaneous reaction in a competitive environment.

Observation 5: Radical innovations can evolve even without any explicit intention to revolutionize.

At the same time that Fosbury practiced this sport, the high jump and pole vault landing areas were changing, beginning in 1964. That year, Fosbury's high school changed the landing pits by adding chunks of foam (cut up mattresses) under a net, and bordering the pit with bales of straw. This was to be an improvement over the wood chips that were used previously. Several years later another improvement was introduced, consisting of the "Port-a-Pits," constructed of foam under a fitted cover. This allowed for some improvement in results, as jumpers were less concerned about the landing and could focus more on clearing the bar.

Furthermore, high-jumping shoes in the late 1960s transformed from regular running spikes to specialized high-jumping shoes with spikes at the heel. The high-jumping shoes are slightly elevated (1 cm) under the ball of the foot and have a heel spike to keep contact as the foot rocks from heel to toe during the takeoff. The other primary environmental improvement was the development and proliferation of artificial surfaces. Most universities in the 1960s, into the 1970s, had cinder or clay running surfaces. Synthetic running surfaces (such as Tartan) were only used in the major stadiums for the elite level competitions. This type of surface provided a consistent, smooth, and fast running surface, which promoted performance.

Observation 6: A combination of external developments with unique timing creates a critical mass through a synergetic effect: the new technique suddenly becomes mature and superior over extant ones.

Fosbury had never envisioned being an Olympic athlete, even up until the 1968 Games. He had always been more focused on the immediate, local, goals for the next competition. Fortunately, with his competitive nature, as the competitions became tougher, so did his performance. Fosbury maintains that he did not set out to change anything—in his own words: "I just wanted to play the game." This clearly echoes Seo and Creed's (2002) perspective on outsiders' role in advancing institutional transformations: Fosbury, who started off as an amateur jumper, was completely unaware of the implications of his developments and maintained a present-directed focus in order to overcome his personal obstacles at the high jump. It was this present- and self-directed focus that ultimately led to the revolutionizing of the entire field.

Footprints of the Fosbury flop in innovation management

The evolution and sudden emergence of the Fosbury flop can teach us something about possible mechanisms in the evolution of radical innovations. In this section, we examine a number of cases for which the Fosbury case appears to be relevant. In the general spirit of our article, our aim is to emphasize our overarching arguments and to highlight some of the observations we raised, rather than to quantify their occurrences. Surely not every aspect of the Fosbury case is manifested in each of the following cases. Nevertheless, each highlights angles and sequences of events that can be seen in the Fosbury flop.

In all of these cases, the idea for the radical innovation was a result not of a sudden stroke of ingenuity, but rather of a gradual, incremental, process. This process was often accompanied by the act of stepping away from the crowd and adopting abandoned or antiquated technologies or concepts (equivalent to the scissors jumping style as the starting point for the development of the Fosbury style).

Emergence of the rollerblades

The evolution of the rollerblades presents a classic case that closely resembles that of the Fosbury flop. It all began with the attempt to adapt ice skating to non-ice surfaces. People have been ice skating for hundreds of years, yet only in the 1700s did an amateur ice skater come up with the idea to replace the blade on the ice skates with a set of lined-up wheels. The Dutch, the British, and the Scotts, who established a skating club in 1742, quickly adopted the new invention. The name of the invention was in-line skates. Word of the invention spread quickly, and in-line skates could be found in almost every household.

However, the days of the in-line skates were numbered since James L. Plimpton came up with a new approach to skating. His idea involved skates that had two sets of wheels, parallel to each other, on each skate. The new design provided increased stability and the ability to adapt a pair of skates to different foot sizes. The use of new technology made the invention friendlier than extant in-line skates, and since 1863, the new design, called "roller skates," began to take over the market and to marginalize the in-line skates. As the years passed by, skating with roller skates had become very popular throughout the world and in-line skates had become practically extinct.

Our story comes to play when two twenty-year-old brothers named Scott and Brennan Olson found an old pair of in-line skates as they were cleaning the shed of the toy store in which they had been working. The antiquated design captured their imagination, and they started to develop a new brand of skates, based on the in-line design. To their advantage were the new materials and new technologies that allowed for the design of lighter skates that offered the skater higher speeds than those made possible with roller skates. They called their new invention "Rollerblades" because of the blade-like shape of the set of wheels. Interestingly, they knew nothing of the name "in-line skates." After a somewhat rough beginning, together with a businessman by the name of Naegele Jr., they began to manufacture and market the product, and by 1992, rollerblades had become a $22.5 million industry.

The case closely echoes the Fosbury flop, whereby in line with our first observation, an old and inferior technology was modified to become a dominant design after it had been practically extinct. This case also reflects our sixth observation, by portraying contextual effects and the availability of new materials. Without getting into too many details, another case that supports our first proposition involves the case of the disposable diaper. In 1961, Proctor and Gamble took on an idea that was abandoned more than a decade earlier, to manufacture and market a disposable diaper. Despite the idea's earlier failure, Proctor and Gamble's act of separating from the crowd, which at the time had focused on the regular cloth diaper, and incrementally improving on the original idea that had long been abandoned, has ultimately led to a breakthrough.

Emergence of the Macintosh computer

In the mid- to late 1970s, Apple was by no means a struggling company—the Apple II was a big success and made Apple one of the strongest competitors in the market. In 1977, three personal computers dominated the market: the Apple II, the Commodore PET, and the TRS 80 (Tandy). The market leaders were Apple and Commodore. In response, IBM initiated "Project Chess" and marketed the IBM PC, which used Microsoft's MS-DOS operating system. Over the next couple of years, the IBM PC became the industry standard. Commodore, Tandy, Victor, and Zenith all started to manufacture IBM compatibles. Practically anyone who did not conform to the IBM standard ceased to exist.

The Apple III was supposed to present the answer to the IBM PC. However, it failed miserably. It lacked unique features and was not reliable enough. It had become clear to Apple that it needed something new if it wanted to stay in the game. At the same time, the company was already in the process of learning about the graphical user interface (GUI) technology.

During the 1970s, Xerox developed the Alto computer. It was the prototype of the Xerox Star (workstation model 8010), which was launched in May 1981 and failed, primarily due to its high price. At that time, Xerox had been investing in Apple in return for gaining access to Apple's GUI technology. Opportunities to access the GUI technology were readily available, yet IBM and the manufacturers of the IBM compatibles maintained their focus on their way of doing things. Apple, by contrast, chose to pursue the GUI direction as it presented a natural fit with its well-known emphasis on graphics. After yet another failed attempt, with the Apple Lisa computer, Apple finally found a way to make a GUI-based machine at a reasonable price: the Macintosh. Although the Apple II was a big success, the Macintosh is still considered Apple's greatest breakthrough.

Aspects of Observations 1, 2, and 4, all appear to be manifest in the case. Like in the Fosbury case, Apple's shift to technology that appeared to have failed (Observation 1), its preference for a nonconventional direction that fit with its personal style and philosophy (Observation 2), and the gradual and incremental process through which it ultimately developed the Mac (Observation 4) were what ultimately led to the evolution of a breakthrough product.

The invention of aspirin

As in some of the other cases we have mentioned, nobody knows for sure when exactly the compounds in aspirin have been discovered, and several records suggest that the invention dates back as far as 400 B.C.E., when Hippocrates recommended a tea made from willow leaves (which contains salicylic acid, the backbone of the molecule that constitutes aspirin). However, salicylic acid also had several side effects such as upset stomach and nausea. In 1853, Charles Friedrich Gerhardt modified the salicylic acid and came up with an impure form of the compound we know today as "aspirin." However, because of its impurity and the difficulty in manufacturing the compound, the product was abandoned. As the years passed by, scientists were still looking for a solution to fevers. Some have specifically tried to solve the problems that accompanied the intake of salicylic acid, and it was in 1897 that Felix Hoffman, a chemist at Bayer labs, studied Gerhardt's earlier work and through his own improvements and incremental variations on Gerhardt's solution managed to come up with a stable form of aspirin that made Bayer the company it is today.

In this case, we see evidence for the arguments we make in Observations 3 and 4. Obstacles led scientists to revert to previous forms, and through a gradual incremental process, they were able to come up with what proved to be a revolutionary solution. In all of these cases, as in the Fosbury case, wherever a particular product dominated the market, separating from the crowd, adopting an antiquated or inferior idea, and adapting it to available technologies, customer needs, and current trends has enabled a market breakthrough and control of the market. In each of the cases, firms chose a direction that presented good fit with their capabilities and philosophies. Furthermore, as we suggest in Observation 5, none of the firms had speculated a priori that their inventions would revolutionize the market.

Discussion

According to Pulitzer Prize winner Jared Diamond (1999), too many examples deceive us into a conception that great inventions emerge as responses to perceived needs. A closer look at reality reveals that most inventions have been developed by people driven by curiosity or a love of tinkering, without an initial demand for the particular product they had in mind. It may come as a surprise to learn that this framework includes most of the major technological breakthroughs of modern times, ranging from the airplane and automobile, through the internal combustion engine and electric light bulb, to the phonograph and transistor.

Invention is often the mother of necessity, rather than vice versa. To illustrate this, consider the case of the motor, the uses of which seem obvious. It was not invented in response to any demand. When Nikolaus Otto built his first gas engine in 1866, horses had been supplying people's land transportation needs for nearly 6,000 years; steam-powered railroads had steadily supplemented them for several decades. There was no crisis in the availability of horses and no dissatisfaction with railroads. Because Otto's engine was weak, heavy, and seven feet tall, it did not present a viable alternative to horses. Not until 1885 did engines improve to the point that Gottfried Daimler installed one on a bicycle to create the first motorcycle. Even then, Daimler waited until 1896 to build the first truck (Diamond 1999).

Another interesting observation is that the inventors themselves often underestimate the potential of an invention. A good example is Thomas Edison's phonograph, the most original invention of the most prolific inventor of modern times. When Edison built his first phonograph in 1877, he published an article proposing ten uses for his invention. They included preserving the last words of dying people, recording books for the visually impaired, announcing the time, and teaching spelling. Reproduction of music was not high on Edison's list of priorities. Several years later, Edison told his assistant that the invention had no commercial value. Within a few years, he changed his mind and started selling phonographs for use as office dictating machines. When other entrepreneurs created jukeboxes by setting up a phonograph to play popular music at the drop of a coin, Edison objected to this debasement, which apparently demeaned the serious office application he had in mind for his invention. Only twenty years later did Edison reluctantly concede that the foremost use of his phonograph was to record and play music.

The Fosbury flop is perceived as one of the most radical, and beneficial, innovations in sports. Indeed, the high jumper Dwight Stones, three times world record holder and two times Olympic gold medalist, indicated that the Fosbury flop "revolutionized the event. . . . A good many athletes and coaches owe their careers to Dick Fosbury, including myself" (Dwight Stones, personal communication, 2001). At the same time, Fosbury himself did not perceive his technique as radical at all and considered the flop simply a "fancy scissors jump." How can it be, then, that an incrementally devised technology, which was not designed to affect anyone but the inventor himself, and which is not perceived as revolutionary even by the inventor himself, is still considered so radical?

Schaffer (1996) warns us against retrospective stories that may play a decisive role in our models of discovery. Such imaginative hindsight distorts our perception of revolutionary discoveries. The result is a biased focus: once a winner among rival theories (or techniques in our case) is chosen, the history of the competition may be restricted to the early stages of explicit deduction, where idealized experimental descriptions are used (Laymon 1978). Schaffer (1996) concludes that the production of parables of discovery is connected to the acceptance of these events as discoveries. The revolution, therefore, appears to be in the eyes of the beholder.

Let us return to the definition of a radical innovation: a departure from existing technology that is "so significant that no increase in scale, efficiency, or design can make older technologies competitive with the new technology" (Tushman and Anderson 1986, 441). Indeed, the difference between the straddle and the Fosbury flop is overwhelming. However, two factors create the incongruence between how the flop is perceived and what we know about its development process. First, whereas the common and familiar jump at the time was the straddle, Fosbury was working on improving the scissors technique. Ultimately, one of the reasons that the Fosbury flop is so radically different from the straddle is because it is not its derivative. If, however, one examines the difference between the scissors and the Fosbury styles, it is easier to see (as Fosbury himself had argued) how the two styles are similar. The Fosbury flop is nothing but a scissors jump with a flattened back and elevated behind.

Nevertheless, the difference is still uncanny, which leads to the second factor. The inventor, hidden from the public, is merely testing ideas and is sometimes obsessed with a notion that leads him or her to embark on a long journey of invention. At the end of the journey, the inventor seems to appear suddenly, with a complete and working technique, which is then judged based on its performance and its adoption rates. In Fosbury's case as well, most people were only exposed to the flop's final version. If observers who were familiar with the scissors jump had accompanied Fosbury throughout his development journey, they, like Fosbury himself, would probably not perceive the flop as radical.

In line with this notion, Tellis and Golder (2001) note that many radical innovations crystallized several decades after other commercial versions had already existed. A stagnant, seemingly mature, technology may create an opportunity for new inventions. Furthermore, in a competitive environment, stagnation in performance exerts pressure on those who want to improve their position. A new technology or product draws attention, and a willingness to experiment is shared by additional potential adopters. The first adopters, as reported in Fosbury's case, were novices. This is consistent with Kuhn's (1970) writings that help explain why it was Fosbury, a relatively anonymous jumper at the time, who created the revolution that ultimately broke Brumel's dominance of the field. Kuhn (1970) suggested that when scientists are faced with problems that apparently cannot be solved, some individuals break through by inventing a new paradigm. It is interesting, and perhaps counterintuitive, that these individuals are most often not leaders in their field. Rather, they are often

> either very young or very new to the field whose paradigm they change. . . . These are the men who, being little committed to prior practice to the traditional rules of normal science, are particularly likely to see that those rules no longer define a playable game and to conceive another set that can replace them. (Kuhn 1970, 90)

Numerous studies have been devoted to identifying the particular climate that fosters the emergence of radical innovations (e.g., Abbey and Dickson 1983; Dahlgaard and Dahlgaard 1999; Jassawalla and Sashittal 2002). These studies suggest that the creation of radical innovations requires a unique atmosphere that furthers a distinct and revolution-prone type of thinking. While we do not deny that this may be one way to achieve radical innovations, and that indeed some radical innovations can be created through giant leaps, through the case of the Fosbury flop we aimed to demonstrate that this is not the only way to introduce revolutions. Companies striving to maintain a competitive advantage can come up with radical ideas by persistently taking small steps and improving on current, or even previous, products. If, above and beyond the objective advantages in performance, the perception of a revolution is desired, all a company needs to do is to keep a low profile and only sporadically reveal its progress.

To acknowledge that revolutions can be created through incremental steps is important not only for the inventing firm, but also for the potential adopting firms. Christensen (1992) describes how disruptive technologies, which render the previous technology obsolete, develop in an S-shaped process. Once these technologies become dominant, firms that have not already adopted the technology find it very difficult to remain in the race. Based on the case analysis we provided here, we argue that companies should not take their competitors' incremental innovations too lightly; they may be the harbinger of tomorrow's revolution.

Lastly, it should be noted that innovation, in many cases, involves the implementation of ideas and, therefore, might be considered a multifaceted process. The case presented in this paper indicates that external factors can influence the ultimate implementation of new ideas. An example would be the progression of the technology of the high-jump landing areas (i.e., wood chips, then adding foam chunks to the landing pits, and later adding a layer of foam under a fitted cover). Such progressions add to the implementation of the innovation.

The current study involves a qualitative case-based investigation that includes one particular innovation. As such, it limits our ability to make large-scale generalizations. It was not our intent to come up with detailed strategies that organizations should adopt, but rather to try and invoke new thinking and to describe possible adaptations that organizations may consider for enhancing the innovation process in the organization.

Another issue to be considered involves the particular nature of the innovation in this case study. It is clearly different from the typical innovation with which organizations deal. Unlike the Fosbury flop, organizational innovativeness typically involves more than one individual and often results from an interactive discourse among organizational members. Furthermore, in most cases, organizational innovations require more financial resources and involve bureaucratic restrictions. Nevertheless, as we hope to have demonstrated, we believe that several of the processes that were used to establish the flop could quite naturally translate to the innovation process in organizations.

Notes

1. These experts comprised two sports historians (both Ph.D.s), a political science researcher studying political influences on sports (Ph.D. candidate), a sports' commentator specializing in track and field (Ph.D.), the director of the department for competitive sports, and the head of the sports department at a broadcasting authority.

2. The other two being Valery Brumel's set of world records and Javier Sotomayor as the only man who has cleared 8 feet.

3. Because of the qualitative nature of our study, we make observations rather than hypotheses.

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Appendix

Expert Assessments of Sports Innovations

Item	Frequency of appearance
Synthetic track	3
Running shoes	2
Fiberglass pole for pole vault	3
Fosbury flop in high jump	5
Swimming techniques	1
Spinning technique in throwing areas	1
Low jump for sprinters	1
Inventions of new games (e.g., basketball, volleyball, badminton)	1
Sports equipment	1
Tsukahara twist in gymnastics	1
Inflated ball	1
Establishment of the Olympic movement (1886)	2
TV broadcasting	1
Murder of athletes at the 1972 Munich Olympic games	1
Participation of professional athletes in Olympics (early 1980s)	1
Commercialization of sports (mainly in the early 1980s)	1
Establishment of soccer in 19th century	1
Introduction of women sports	1
Use of steroids	1