

CHAPTER 15

FROM THE WHEEL TO TWITTER: WHERE DO INNOVATIONS COME FROM?

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<A-HEAD> INTRODUCTION

One of the most pressing questions managers face today is how to beget innovation in their enterprise. Several factors, including the increasingly global character of competition, the increasingly rapid diffusion of information and technology, and the increasingly professional administration of business, are converging to make the need for innovation ever more salient. Whereas successful new products once ensured companies a lengthy period of relatively uncontested profit, today rapid imitation by competitors means that resting on laurels ensures accelerated profit erosion and obsolescence. Managers are acutely aware of the increasingly Darwinian nature of the marketplace and recognize that the future of their organization depends on their ability to innovate.

As a consequence of the resulting thirst for insights on innovation, hundreds of books and thousands of articles have been written on how managers might foster innovation. Indeed, the number of books and articles issued on the topic appears to be proliferating exponentially. Most

tend to focus on a small number of innovative companies, typically those in the technology or design space, such as Google or IDEO. The articles and books attempt to understand how those companies have successfully innovated and to abstract some general lessons on innovation from the experience of the examined companies. Although these insights can often be useful, it is often unclear whether the anecdotal experience of specific companies can be applied to other companies or contexts. For example, Google has been a phenomenal commercial success despite the lack of an initial revenue or business plan, but it is hard to extrapolate the value of having a business plan solely from Google's experience. It might be that for every company that succeeds without a business plan, many more tend to fail because they lack a business plan, a phenomenon that might not be appreciated from examining a single or small sample of companies.

This chapter examines how managers can foster innovation in the enterprise in a novel way, by abstracting insights from Jared Diamond's sweeping overview and analysis of the history of innovation in his book *Guns, Germs and Steel*. From this broad historical view of innovation, it is hoped that new insights into innovation in the corporate context will emerge.

<A-HEAD> INSIGHTS FROM *GUNS, GERMS, AND STEEL*

Guns, Germs, and Steel is a 1997 book by Jared Diamond, a professor of geography and physiology at the University of California–Los Angeles.¹ Diamond's book attempts to provide a high-level historical account of human history from the emergence of agriculture to the modern era, with the main goal of explaining why civilizations thrive or fail. One chapter of the book, "Necessity's Mother," details Diamond's account and analysis of the history of innovation and is particularly pertinent to this chapter.

In “Necessity’s Mother,” Diamond uses the historical record to challenge much of the conventional wisdom regarding the nature of innovation. Here, we distill some of Diamond’s conclusions that are of particular relevance to innovation in a corporate context.

<B-head> Invention is the Mother of Necessity

Diamond’s most counterintuitive observation is that, in contrast to the conventional wisdom, most major historical inventions were not invented to fulfill a pressing need but instead were developed by tinkerers and hobbyists who developed their inventions due to their own curiosity, rather than with regard to customer demand or profit. Diamond provides the automobile as an illustration. At the time the automobile was invented, horses had been accommodating people’s land transport needs for thousands of years, and railroads for several decades. There was no sudden shortage of horses or dissatisfaction with rail transport that precipitated the invention of the automobile. Indeed, from Nikolaus Otto’s invention of the gas engine in 1866, it took more than 50 years of improvements by a series of tinkerers and hobbyists followed by improvements by entrepreneurs before widespread adoption of automobiles started to take hold. Many other well-known inventions in history, including the airplane, the computer, the camera, the typewriter, the television, and the Yahoo! Internet search engine,ⁱⁱ can similarly be credited to the efforts of hobbyists and tinkerers.

Diamond also observes that most inventions find their greatest use for a different purpose than that for which they were originally invented. Diamond provides the example of Thomas Edison’s phonograph. When Edison invented the phonograph, he listed ten potential applications it might serve. Of this list, playing music was ranked lower than preserving the final words of the dying, announcing the time, and recording books for the blind. Initially, Edison concluded that

the phonograph had no commercial value. A few years later, however, he found that the phonograph had commercial potential as a business dictation device. Accordingly, when entrepreneurs developed jukeboxes based on the phonograph to play music, Edison was concerned that it would detract from the serious business purpose of the device. Only many years later did Edison finally concede that playing music was indeed the phonograph's major application. Diamond also provides the example of the steam engine, which was initially invented to remove water from coal mines, later used to power cotton mills, and ultimately found its greatest commercial value powering locomotives and steam boats.

Although Diamond focuses mostly on inventions that preceded the twentieth century, examples of inventions finding their greatest commercial value in a different application than that for which they were initially intended are just as abundant in contemporary times. For instance, Viagra was initially developed by Pfizer as a treatment for angina until it was incidentally noted by patients that it improved their erectile dysfunction symptoms and was subsequently developed for that indication.ⁱⁱⁱ YouTube was created on February 14, 2005, by guys with no Valentine's Day dates who thought the service would be a great video dating site. The founders posted ads on Craigslist hoping to attract video daters to the site. However, soon users co-opted the site to post all manner of videos to share with their friends and strangers. By July 2006, over 65,000 videos were being posted to the site per day.^{iv}

Similarly, Jack Dorsey, one of the inventors of the micro-blogging service Twitter, commented—tongue in cheek—in mid-2009 about the unexpected uses of his invention: “Twitter was intended to be a way for vacant, self-absorbed egotists to share their most banal and idiotic thoughts with anyone pathetic enough to read them. When I heard how Iranians were using my beloved creation for their own means—such as organizing a political movement and

informing the outside world of the actions of a repressive regime—I couldn't believe they'd ruined something so beautiful, simple, and absolutely pointless.”^v

Diamond also argues that most major inventions tend to find their greatest use for applications that did not even exist and were not imagined at the time of the inventions. That is, in contrast to the conventional wisdom, individuals do not realize there exists an application that requires an invention until after it has been invented in the first place (hence the title of Diamond's chapter). To illustrate, Diamond provides the example of gasoline. In the nineteenth century, the middle distillate fraction of petroleum was used in oil lamps, whereas gasoline, the most volatile fraction, was discarded. Only after the invention and adoption of the internal combustion engine was it recognized that this waste product was an optimal fuel for engines. A more recent example is the Internet, whose early predecessor was a U.S. Department of Defense network for linking radar stations.^{vi} Who would have imagined that the Internet would ultimately be used for downloading music, blogging, social networking, and instantly communicating with people all over the world?

<B-head> Invention is Cumulative

Diamond's second major conclusion contradicts the “heroic theory of invention”—the hypothesis that unique “great” inventors and scientists are responsible for generating the most significant advances. In fact, Diamond argues, invention is a cumulative process where most inventions are simply incremental but ultimately important contributions to existing inventions, and that the milieu in which innovations arise is often more important for the genesis of an invention than the specific inventor.

As an illustration, Diamond traces the history of the steam engine, which is typically credited to James Watt in 1769. Diamond documents that Watt's steam engine was an improvement of a similar engine developed by Thomas Newcomen 57 years earlier (of which 100 units had been sold), which itself was inspired by Thomas Savery's 1698 steam engine, in turn inspired by a 1680 design of Denis Papin, who had developed his designs from the ideas of Christiaan Huygens. Likewise, Diamond argues that Edison's "invention" of the incandescent light bulb followed 40 years of other incandescent light bulbs developed by other inventors. Similar histories can be traced for the cotton gin, the airplane, and the telegraph.

Although not discussed by Diamond, it is similarly remarkable to reflect on the many scientific discoveries credited to sole geniuses that were discovered more or less contemporaneously by others. Among these are calculus (Isaac Newton and Gottfried Leibniz),^{vii} special relativity (Albert Einstein and Henri Poincare),^{viii} evolution (Charles Darwin and Alfred Russel Wallace),^{ix} the inverse square law of gravitation (Isaac Newton and Robert Hooke),^x and the structure of DNA, which many groups were racing to uncover before being preempted by Watson and Crick.^{xi} These observations truly highlight the verity of a quote famously attributed to Newton: "If I have seen far it is by standing on the shoulders of giants." Ironically, the phrase itself, though indeed used by Newton in a correspondence with Robert Hooke, was in common usage in the seventeenth century and had been used at least 500 years earlier by Bernard of Chartres.^{xii}

<B-head> The Diffusion of Innovation

In addition to observing *how* specific inventions arise, Diamond also addresses the question of *where* most innovations within a particular society arise. Diamond's answer is that most

inventions used by a society come from other societies: most do not invent the majority of innovations that they use, but instead adopt them from other societies.

For example, the alphabet, the water wheel, tooth gearing, the magnetic compass, the windmill, door locks, pulleys, the rotary quern, and the camera obscura were each invented independently only once or twice in world history in Eurasia, and then diffused across the continent. An illustration of this phenomenon, Diamond cites the history of the wheel. Evidence shows the first instance of the wheel occurring around 3400 B.C. near the Black Sea, with subsequent appearances over the next several hundred years across all of Eurasia. The single independent origin of the wheel is attested to both by its rapid spread after its initial occurrence (too rapid to be accounted for by independent inventions) and by the fact that all the wheels had the same design, consisting of three wooden boards fastened together.

Thus, diffusion of innovation occurs because innovations that give sufficient advantage to a society are observed and adopted by other societies. Further diffusion occurs when societies that refuse or are unable to adopt the innovation are ultimately replaced by those that have adopted it.

Diamond cites two main means through which innovations diffuse: the first is through the equivalent of detailed blueprints for recreating an invention, whereas the second is simply through inspiration and models of existing inventions. That is, once a particular innovation is observed, the knowledge of what can be invented and models of how the invention operates can allow other societies to imitate or reverse-engineer those inventions.

In the case of acquiring “blueprints” for an invention, Diamond cites four main contexts in which such transfers are likely to occur. The first is *peaceable trade*, for which he cites the acquisition of transistors by the Japanese from the United States in 1954. The second is

espionage, for which he cites the appropriation by Arabs of silkworms from Southeast Asia in 552 A.D. The third is *emigration*, for which Diamond cites the displacement of The Huguenots from France in 1685 and the subsequent spread of their clothing-manufacturing and glassmaking technologies. The fourth is *war*, for which Diamond cites the defeat of the Chinese by the Arabs at the Battle of Talas River in 751 A.D, after which the Arabs took advantage of Chinese captives who were experts in paper-making to develop an indigenous paper-making industry.

<A-HEAD> IMPLICATIONS FOR CORPORATE INNOVATION

There are several important insights from Diamond's book that can be applied to the understanding of innovation in a corporate setting.

<B-head> Invention versus Innovation

What can be learned from the observation that most inventions are not invented to fulfill a specific need? Often, the conclusion is that the ultimate commercial value of most inventions cannot be determined *a priori*, and so companies should promote invention without regard to specific commercial applications. Because of the serendipitous nature of invention and discovery, companies often surmise that they should create an environment that allows serendipity to operate by directing resources toward inventions without defined commercial applications.

In many discussions of innovation, the Post-it Note is often cited as a prime example to support this line of thought. The story of the Post-it Note is that a scientist, Spencer Silver,

working in 3M's labs in 1968, accidentally discovered a reusable, pressure-sensitive adhesive, which ultimately became the adhesive used in 3M's Post-it Notes.^{xiii} Companies then conclude that because the discovery of the adhesive required serendipity, they should promote open-ended research in order to realize serendipitous discoveries.

However, it can be argued that this conclusion is a false one. The reality is that basic research (or research that is otherwise not directed at a specific application) is much more likely to yield commercial failures than successes, and is thus unlikely to provide a sufficient return on corporate investment. Rather, it is precisely *because* of the unpredictable nature of invention documented by Diamond that commercial rewards tend to flow toward *innovators* rather than *inventors*. Indeed, an innovation can be distinguished from an invention in that the former refers to a new concept, whereas innovation involves the commercial application of an invention. Inventions are relatively numerous, whereas innovations are relatively rare.

To illustrate this point, the U.S. Patent and Trademark Office issues around 100,000 patents annually, with only a small fraction ultimately leading to successful commercial products.^{xiv} Likewise, university technology licensing offices have drawers filled with unlicensed patents as well as technologies they did not even bother to patent; major research universities consider themselves fortunate if they are able to recoup 5 percent of their research budgets via licensing of their inventions.

It is also the case that successful inventors are often unsuccessful innovators. Consider Bell Lab's inventions of the transistor and UNIX operating system and Xerox PARC's invention of the graphical user interface, Ethernet, and the laser printer; all these inventions were adapted by subsequent innovators who realized most of the profit potential of these inventions.

To understand why this is the case, we return to the example of the gas engine. Otto's gas engine was seven feet tall, heavy, and produced little power, making it not particularly useful for a commercial product. Only after many generations of improvements by hobbyists and tinkerers (who received no commercial benefit from their inventions) did the automobile become refined enough by entrepreneurs to be a useful commercial product that provided a reasonable return on investment. Similar stories can be documented for the early versions of most major innovations.

Unlike hobbyists, tinkerers, government, and university-funded R&D labs, corporations do not have the liberty of spending 50 years to develop a technology that does not have clear commercial potential. This lesson has been internalized by many large corporations, such as General Electric (GE), where corporate R&D once managed autonomous projects but where projects are now required to be funded by specific business units.^{xv}

Because inventions that ultimately lead to useful innovations are rare, relatively unpredictable, and developed cumulatively over long periods of time, the focus of corporations needs to be on *innovation*: that is, on the translation of existing inventions to *specific commercial applications*. This does not mean companies should not invent, but emphasis should be placed on improving existing inventions for a particular application; i.e., for innovation.

Indeed, the serendipitous discovery of the adhesive that gave birth to the Post-it Note serves to illustrate this point well. Despite its promotion by its inventor, Spencer Silver, development of the adhesive did not proceed until another 3M researcher, Art Fry, recognized an application for the adhesive six years later. After the application was identified, it took several more years of research, development, and refinement before the Post-it Note product was successfully launched.^{xvi} Thus, it was the *innovative application* of an invention, rather than the invention itself, that was the major factor behind the commercial success of the Post-it Note.

<B-head> Anticipating Customer Needs

Assuming we accept that companies should put emphasis on innovation rather than invention, *how* should corporations focus on innovation? From the observations that 1) most inventions ultimately find their greatest use in applications they were not invented for, and 2) that most of these applications themselves arise only after the inventions arise, we can surmise that the focus of a successful innovation strategy should be on *creative applications for existing inventions* and combinations of inventions. Thus, the hallmark of successful innovation is the imagination of applications that do not yet exist for inventions that do exist (either in full or partial form).

More specifically, the observation that most inventions do not arise to fulfill a pressing consumer need highlights the role of identifying customers' needs before the customers can identify those needs themselves. Indeed, it is now widely accepted among marketing researchers that customers often have little insight into their preferences, and thus are typically unable to spontaneously express a need for products that do not yet exist. This is particularly true in the case of discontinuously innovative products (i.e., products that offer a discontinuous leap in the value proposition for customers). Stated in the words of Henry Ford: "If I had asked my customers what they wanted, I would have built a faster horse."

Nintendo is an example of a company that successfully identified an application that met customer needs before the customers anticipated those needs themselves. In an era where video-game users and other manufacturers were focused on making ever more powerful machines, Nintendo was able to identify a need for a game system that offered the opportunity for more intuitive controls via physical interaction. Had Nintendo given video-game customers what they were demanding, it would have simply built a more powerful machine with better graphics.

However, the interactive Nintendo Wii fulfilled a need that gamers and non-gamers alike had not (and likely could not have) articulated. Thus, Nintendo emerged from being an also-ran in the video-game console market to the industry leader following the introduction of the Wii. Seeking to imitate the success of Nintendo, the head of Sony's gaming unit, Kazuo Hirai, declared at the 2009 Tokyo Game Show: "We want to build controllers you can't even begin to imagine could exist."^{xvii}

Other examples of innovators who identified new applications for existing inventions before those applications existed or were demanded by customers include the developers of the Post-it Note and the entrepreneurs who connected Edison's phonograph to a coin slot and a music collection, creating the jukebox. Conversely, when Honeywell developed a home computer in 1969, the only applications the company conceived of for the device were balancing checkbooks and managing recipe cards. They thus marketed the Honeywell Kitchen Computer for over \$10,000 to housewives—and did not sell even one unit.^{xviii} As these examples illustrate, identifying applications to fulfill customer needs that do not explicitly exist (and that the customer cannot articulate) is central to successful innovation.

<B-head> Looking Outside the Organization

Diamond's observation that most innovations within a society come from other societies is highly relevant to corporate innovation: most innovations that are adopted by successful companies will arise outside the company. This is true because no matter how brilliant and creative the company's employees and how conducive to innovation the corporate culture, the sheer number of brilliant and creative people outside the company will necessarily be greater. Outside innovations will come from multiple sources, including the company's customers, other

companies in the same industry, or other industries entirely. Therefore, successful innovation is often about how successful a company is at identifying, adopting, adapting, improving, and integrating outside innovations.

Examples of companies that have successfully adopted and adapted externally developed innovations abound. For instance, Capital One, the credit-card issuer, is well known for its innovative information-based marketing strategy. Prior to the emergence of Capital One, credit card companies traditionally served only the prime market (i.e., consumers with high credit ratings), and all credit cards had a \$50 annual fee and carried a 19.9% APR. Capital One transformed the market by using information to identify narrow consumer segments and target them with highly customized offers.^{xix} However, Capital One's innovation is really an adaptation of traditional segmentation and targeting strategies, enabled by improvements in information technology.

Likewise, Harrah's was inspired by Capital One to create its own information-based marketing strategy in a completely separate industry, casinos and resorts. Thus, Harrah's became a highly successful innovator in its industry by adopting and adapting an innovation used in the credit card industry.^{xx}

AOL provides another example of the adaptation of an existing innovation to a new context. AOL became the largest U.S. Internet service provider largely through a strategy that emphasized getting disks with a 30-day free trial of the program directly into people's hands. Free AOL disks were given away at many large retailers, such as copy store Kinko's, and were also frequently inserted into daily newspapers. On certain days, every major newspaper in the country had an AOL disk inserted in the paper.^{xxi} Of course, as in the case of Capital One's

information-based strategy, AOL's basic approach was not new, but it represented an instance of sampling, a marketing practice with a very long history.

Likewise, Xerox did not invent the concept of leasing, but when the company failed to both license its technology to large technology firms such as IBM and failed to convince customers to make the upfront investment required for its copiers, the company adopted a business model based on leasing that ultimately formed the basis of Xerox's successful marketing efforts.^{xxii}

Many other successful companies have adopted innovations either directly from other companies or acquired them. For instance, Google's AdWords program, the company's auction-based keyword advertising program and the source of almost all the company's revenues, was adopted from competitor Goto.com, which featured a similar program.^{xxiii} Goto.com's founder, Bill Gross, had in turn been inspired to come up with this innovation from the traditional paper-based Yellow Pages. Moreover, Google's second-most-popular application after its search engine, Google Maps, was the result of the acquisition of an Australian company that has subsequently been adapted, improved, and integrated with other features. An acquisition is also the source of the fastest-growing consumer product of the Dutch electronics giant Philips, which bought the Sonicare brand and technology for toothbrushes from a Washington-based startup.^{xxiv}

Many companies have recognized the importance of outside innovations as an important source of innovation for their own organizations by explicitly identifying, evaluating, and acquiring large numbers of outside technologies. For example, the network equipment manufacturer Cisco bases its innovation strategy on acquiring outside startups and often acquires more than 50 such startups in a year.^{xxv} Cisco thus outsources basic R&D to the startup community and is able to focus on identifying key innovations and then acquiring, adapting,

improving, and integrating those innovations into its portfolio. Likewise, in 2001, Procter & Gamble CEO Arthur Lafley initiated a program dubbed “Connect and Develop.” As part of the program, P&G has 75 technology scouts that scour the globe in pursuit of new innovations that P&G can use and adapt.^{xxvi}

Other companies have excelled in integrating a number of externally developed innovations into an innovative product. Apple invented neither the MP3 player nor the smart phone, but the company is particularly skilled at integrating many different inventions to make innovative products, such as the iPod and iPhone. Another example of successful integration of innovations to produce an innovative new product is the recently introduced Jet drink fountain developed over a four-year period by Coca-Cola. The fountain allows for the distribution of 120 drinks from a machine 40 percent smaller than traditional soda fountains, which typically only allow for the distribution of six to eight drinks. Coca Cola’s new Jet fountain incorporates micro-dosing technologies adopted from the pharmaceutical industry, an operating system used for smart phones, and styling from Italian automakers.^{xxvii} Similarly, the Elliptigo device developed by California startup combines the mechanics of an elliptical machine with those of a bicycle, allowing exercisers to perform elliptical movements on a machine that can be ridden outdoors like a bicycle.^{xxviii} Thus, as all these examples serve to illustrate, a critical component of a successful innovation strategy is the identification, adoption, adaptation, improvement, and integration of existing innovations to new, often previously unidentified, applications.

<A-HEAD> SUMMARY

This chapter summarizes some of Jared Diamond's observations about the history of innovation in the book *Guns, Germs, and Steel* and attempts to identify relevant insights from these observations to the context of corporate innovation. Of course, this chapter is not intended to offer a comprehensive treatment of how managers can foster innovation in the enterprise, a task that is well beyond the scope of a single chapter. However, based on Diamond's observation, we can conclude that the answer to the focal question raised in the title of this chapter is that innovations arise from (1) novel applications of existing inventions and (2) from outside the organization. Thus, the chapter highlights three key insights about innovation in a corporate context:

- The focus of corporate innovation should be on the novel application of existing inventions rather than on invention.

- The hallmark of innovation in a marketing context is the identification of unarticulated customer needs and the imagination of applications to fulfill those needs.

- Most useful innovations will arise outside the organization (and even outside the industry) and their identification, adaptation, and integration are the foundation of a successful innovation strategy.