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PREDICTING THE "UNPREDICTABLE"

ANTICIPATING DISRUPTIVE INNOVATION

The key to avoiding the negative effects of disruptive technologies is to focus on what is happening with customer and operational needs.

Jay Paap and Ralph Katz

OVERVIEW: *Organizations in today's hypercompetitive world face the paradoxical challenges of "dualism," that is, functioning efficiently today while innovating effectively for tomorrow. Corporations, no matter how they are structured, must manage both sets of concerns simultaneously. To do this, organizations have to understand and learn to manage the dynamics of innovation that underlie both disruptive and sustaining innovations. Most analyses have been flawed by giving too little weight to the interactions between needs and technologies. Based on a dynamic model of these interactions, three distinct patterns of substitution are identified that illustrate how these two forces intersect.*

Recent empirical studies have convincingly demonstrated a consistent, albeit disturbing, pattern of results with respect to the management of innovation. In almost every industry studied, a set of leading firms faced with a period of discontinuous change fails to maintain its industry's market leadership in the new technological era.

Tushman and O'Reilly nicely summarize this point in their research (*1*). They describe how W. E. Deming, probably the individual most responsible for jump-starting today's quality revolution, highlighted this recurring theme in a long list of diverse industries, including watches, automobiles, cameras, stereo equipment, radial tires, hand tools, machine tools, optical equipment, airlines, and color televisions. What Deming was trying to point out was that in each of these industries the most admired and most established firms rapidly lost their coveted market positions. It is indeed ironic that so many of the most dramatically successful organizations become so prone to failure.

This pathological trend, described by many as the *tyranny of success*—in which winners often become losers and firms lose their innovative edge—has been a worldwide dilemma, exemplified by the recent struggles of firms such as Xerox in the U.S., Michelin in France, Philips in Holland, Siemens in Germany, and Nissan in Japan. It seems that the very factors that lead to a firm's

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success can also play a significant role in its demise. The leadership, vision, strategic focus, valued competencies, structures, policies, rewards, and corporate culture that were all so critical in building the company's growth and competitive advantage during one period can become its Achilles heel as technological and market conditions change over time.

This pattern was highlighted in a notable 1963 public presentation by Thomas J. Watson, Jr., IBM's chairman and CEO. According to Watson:

Successful organizations face considerable difficulty in maintaining their strength and might. Of the 25 largest companies in 1900, only two have remained in that select company. The rest have failed, been merged out of existence, or simply fallen in size. Figures like these help to remind us that corporations are expendable and that success—at best—is an impermanent achievement which can always slip out of hand.

Sustaining and Disruptive Innovations

It is important to recognize, however, that this pattern of success followed by failure—of innovation followed by inertia and complacency—is not deterministic. It does not have to happen! Success need not be paralyzing. To overcome this tendency, especially in today's rapidly changing world, organizations more than ever before are faced with the apparently conflicting challenges of *dualism,* that is, functioning efficiently today to *sustain* the success of their business models while also incorporating the *disruptive* innovations that will enable them to be competitive in the future (*2*). Not only must business organizations be concerned with the financial success and market penetration of their current mix of products and services, but they must also focus on their long-term capabilities to develop or commercialize what will emerge as the most customer-valued technical advancements into future offerings in a quick, timely and responsive manner.

Corporations today, no matter how they are structured and organized, must find ways to internalize and manage both sets of concerns simultaneously. In essence, they must simultaneously build internally contradictory and inconsistent structures, competencies and cultures: fostering more efficient and reliable processes while encouraging the experiments and explorations needed to re-create the future. The challenge is that such innovative activities are all too often seen by those running the organization as a threat to its current priorities, practices and basis of success.

While it is easy to say that organizations should internalize both sustaining and disruptive innovations in order to transform themselves, it is a very difficult thing to do. There is usually much disagreement within a company operating in a highly pressured and competitive marketplace as to how to carry out this dualism. Amidst the demands of everyday requirements, decision-makers representing different parts of the organization rarely agree on the relative merits of allocating resources and management attention among the range of competing projects and technical activities; that is, those that directly benefit the organization's more salient and immediate needs versus those that might prove important sometime in the future.

Consider, for example, the experience of Procter & Gamble several years ago. In the beginning, the analysts claimed that P&G was doing a very good job of managing its existing businesses but unfortunately was not growing the company fast enough through the commercialization of new product categories. P&G subsequently introduced a number of successful new products (Swiffer®, Whitestrips®, Thermacare®, and Febreze®—just to name a few) that collectively brought in considerably more than a billion dollars per year in added revenue. The analysts soon claimed, however, that while P&G had managed to introduce some exciting and impressive new products, in doing so it took its eye off the existing brands and lost important market share to very aggressive competitors. It is not particularly surprising that these same analysts now wanted P&G to de-emphasize its new venture strategies and investments in order to concentrate on protecting and strengthening its bedrock major brands. The pendulum just seems to keep on swinging!

Innovation Pioneers and Competitive Advantage

In a well-designed set of studies, Tellis and Golder systematically studied the first-mover advantage in a sample of some 50 consumer product categories (*3*). According to the researchers, the failure rate of the market pioneers in their study was almost 50 percent while the mean market share of the pioneers was only 10 percent. More alarming, the market pioneers were current leaders in only 11 percent of the categories while the median period of market leadership was only five years. The implication of these results, as well as the previously mentioned studies, is simple: the basis of competitive advantage changes over time. Since innovation essentially involves the integration of technical and market information over time, it is possible that either (a) the organization leaders failed to detect changes in the technologies or (b) the organization leaders failed to detect changes in consumer needs and/or market conditions.

Interestingly, most studies of innovation show that incumbent leaders were very aware of the new technologies that eventually disrupted their business successes (*4*). In fact, the incumbents not only invested in the development of these technologies, they were often the creators or the technical pioneers of them. The watch industry provides one of the most vivid examples. The Swiss companies invested in and invented the disruptive technology—quartz batteries and digital watches—that the Japanese companies eventually commercialized to supplant them.

As another example, Tellis and Golder recount how Gillette introduced the safety razor in 1903 and then proceeded to dominate the razor market for a half century with a peak share of 72 percent in 1962. At the height of this success, Gillette suddenly found itself seriously threatened by Britain's Wilkinson Sword, which introduced a stainless steel blade that lasted three times longer than Gillette's carbon steel blade even though Gillette was well aware of this new stainless steel technology. Ever since this unfortunate episode, Gillette has marshaled its efforts to introduce new technologies in its razors even at the cost of cannibalizing its own established products. If, in fact, established companies are not really blind-sided by the development of new technological capabilities, then it is likely they fail to link the development of such technological advances to changes in the marketplace, i.e., changes in consumer needs or market conditions.

The Challenge of Disruptive Technologies

In an effort to avoid the "tyranny of success" described above and maintain their competitive position in the face of innovation, major players are increasingly focusing their energies on anticipating "disruptive technologies," new technologies that may affect their competitive position. While the term disruptive technology is a relatively new addition to management jargon (*5*), the challenge facing technology managers is not new and has a long record of coverage in the technology management literature (*6*). More importantly, reflecting on some of these earlier discussions of technology change and innovation provides new ways to view disruptive technologies and gives firms useful frameworks to effectively anticipate and minimize the impact of potential disruptions.

Since the term has entered mainstream management usage, too often technology managers have focused on a search for the "next" disruptive technology by focusing primarily on new technologies. While such a search is important and should be part of an overall technology positioning strategy, we argue that the key to avoiding the negative effects of disruptive technologies is to focus primarily on what is happening with customer and operational needs. The basis for this argument is grounded in both an understanding of the dynamics of innovation first articulated several decades ago by Meyers and Marquis (*7*), and the experience of many firms that have successfully introduced potentially disruptive technologies into their business.

Disruption Defined

The disruption in the term "disruptive technologies" is not an attribute of technology. Rather, it describes the effect that some technologies appear to have on markets affected by technology-based innovation and the frequent downturn in the success of major firms that compete in those markets when they fail to adopt the new technology in a timely way. It is a disruption in the business model: what do we sell; how do we make it; how do we sell, distribute and support it; to whom; and against whom? It often is accompanied by a disruption in the fortunes of firms using the old business model, because they, and often their customers, fail to recognize that new needs are driving the business. However, as Christensen points out in his recent work (*2*), it is possible for firms that are dominant players to identify and exploit potential disruptions.

Return on technology is not just a function of the investment but of the impact of the change that investment creates.

There are numerous examples of dominant firms that somehow managed to identify and exploit a potentially disruptive technology before the technology could be used by others to disrupt their competitive position. Drawing from both our own experience and from published reports, the following are examples from multiple industries over the last several decades:

- Whirlpool—wash-and-wear cycles.
- Maytag—Neptune front load washer.
- Allen-Bradley—electronic controls.
- Warner-Lambert—breath strips.
- Baxter—ATC 212 Automated Medication Dispensing System.
- Hewlett Packard—HP-35.
- Sony—Walkman.

While the circumstances in each case are slightly different, one theme flows through all the examples: someone in the firm focused on the underlying dynamics of innovation, the link between needs and technologies, and drove the firm to adopt a new technology despite internal and external challenges to the new product concept.

The Dynamics of Innovation

Meyers and Marquis' seminal article on industrial innovation presented a model of innovation based on a study of several hundred industrial innovations over the previous several decades (*7*). Many authors have expanded or refined the model; probably the best known are Robert Cooper, who drew on the last part of the model as the basis for his Stage Gate® process (*8*), and Edward Roberts, who presented an expanded flow chart complete with feedback loops in his often-cited retrospective article on the nature of Technology Management (*9*). However, we find the simplicity of the original model appealing and will use it as the basis for exploring when and why disruptions take place (Figure 1).

Innovation begins with the connection between a need and the technology to address that need. These combine to form an idea, which in turn is screened, tested, developed, scaled up, and then used and diffused. It is the interplay between new and old needs, and new and old technologies, that we refer to as the "Dynamics of Innovation." While there have been numerous efforts to connect the investment in technology to the ultimate benefits to an organization (*10*), most of these analyses are flawed in that they give too little weight to this interaction between needs and technologies. A return on technology is not just a function of the investment, but also of the impact of the change created by that investment. This is graphically depicted in the top of Figure 2. The terms used in discussing the framework are summarized at the bottom of Figure 2.

Change—Not Technology—Creates Value

Technology does not directly lead to a return; all it does is create change, in processes, materials, functionality, or the utility of a product or service. The ability of the technology to make these changes is referred to as its *Productivity.* The extent to which a change is valued by internal operations (for process innovation) or the external customer base (for product or service innovations) is referred to as its *Leverage.*

The middle of Figure 2 illustrates how these two dimensions work together to create the conditions for the introduction of a new technology:

- An investment in technology creates a change (lower-right S–curve).
- That change has an impact on the internal or external customer (upper-left S–curve).
- The change has to take the performance to a minimum level before the customer (internal or external, current or prospective) responds—this is the *leverage minimum.*
- At some point the customer no longer values improvements, and further investments to create change provide no return—this is the *leverage limit.*
- The *driver* in a particular market segment is the performance characteristic whose leverage is the greatest and thus represents the major consideration potential customers use when selecting a process, product or service. (In most products and services there are multiple drivers, each of which must be addressed in concert).

The Nature of Technology Substitution

Understanding when and how new technologies are adopted can help us anticipate future technology introductions, some of which may represent potentially disruptive technologies. First, it is important to recognize that technology substitution occurs only when there is *both* an unmet need in a dominant driver *and* the current technology is incapable of competitively addressing it.

Using the Dynamics of Innovation framework, we can identify three distinct patterns of substitution where these two forces lead to pressure for substitution:

- The old technology matures relative to the dominant driver (Case 1).
- The previous driver matures, a new driver emerges and the old technology is unable to meet unmet needs of the new dominant driver (Case 2).
- The environment changes creating a new dominant driver (Case 3).

Case 1: The old technology matures (Figure 3)

This is probably the most common form of substitution, and the one with which most technology managers are familiar. While many technologists monitor the technology landscape for clues that their technology is about to

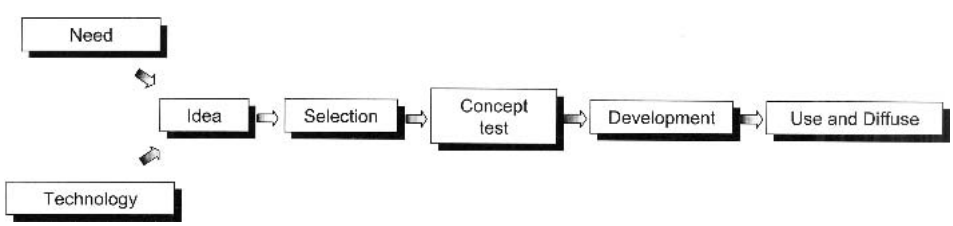
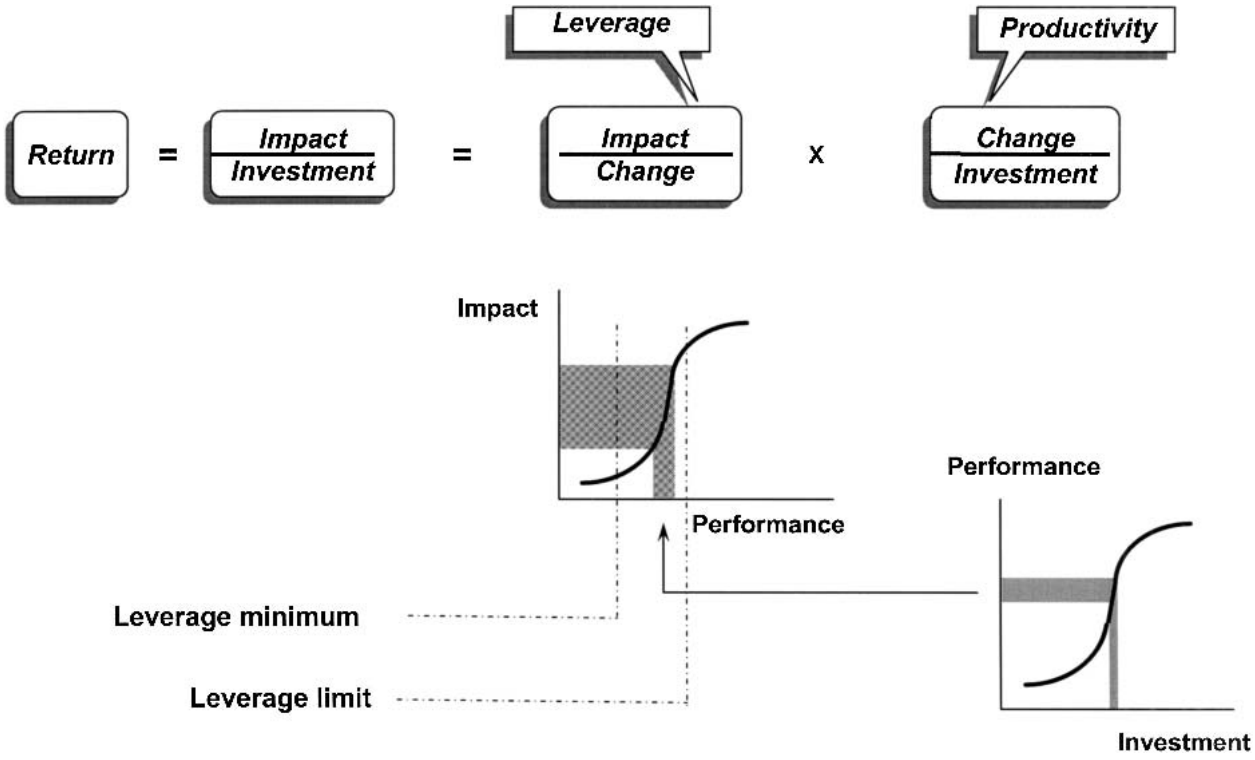


Figure 1.—Model of Innovation adapted from Meyers and Marquis Successful Industrial Innovation *(7).*



Key terms used in the Dynamics of Innovation model

Innovation	The use of an old or new technology to meet a new or old need for improving the performance of a process, product or service that is sufficiently valued by potential users that they will adopt it.
Productivity	The extent to which an investment in a technology will yield a measurable change in a performance characteristic of a process, product or service.
Leverage	The extent to which an improvement in a performance characteristic will be perceived as having value by the user, purchaser or influencer.
Leverage minimum	The point at which the user, purchaser or influencer of a process, product or service first values performance improvements.
Leverage limit	The point beyond which the user or purchaser of a process, product or service no longer values performance improvements.
Driver	The performance characteristic whose leverage is the greatest and thus represents the major consideration by potential customers when selecting a process, product or service.

Figure 2.—Model of the dynamics of innovation demonstrates that generating a return on a technology investment requires both the ability of the technology to create a change and the change to create an impact on the targeted customer.

become obsolete, they often fail to see the signs in time and this relatively straightforward substitution can lead to business disruptions. This occurs when those using the old technology refuse to recognize that their technology base has lost its ability to make meaningful changes required by its customers; i.e., its technology no longer can meet the dominant driver of the business. In example after example, we see that if an alternative technology exists that can be used to meet those unmet needs, it will be introduced, and those practicing the old technology will find themselves unable to compete successfully.

Henderson and Clark profiled the failure of leading optical photolithographic alignment equipment firms to detect that the technology that had served as the basis of their market success had matured relative to the market drivers (*11*). In turn, five different firms relinquished their market lead to another firm because they failed to recognize that their technology had matured and a newer technology could better meet their customers' needs. Fairchild Semiconductor refused to accept the viability of MOS technology as a threat to its bipolar technology base, forcing MOS adherents to leave Fairchild and form rival Intel (*12*). More recently, writeable DVD technology is replacing CD technology as users continue to demand greater storage capacity for the backup and archiving of their files, and wideband technologies are replacing dial-up technologies for

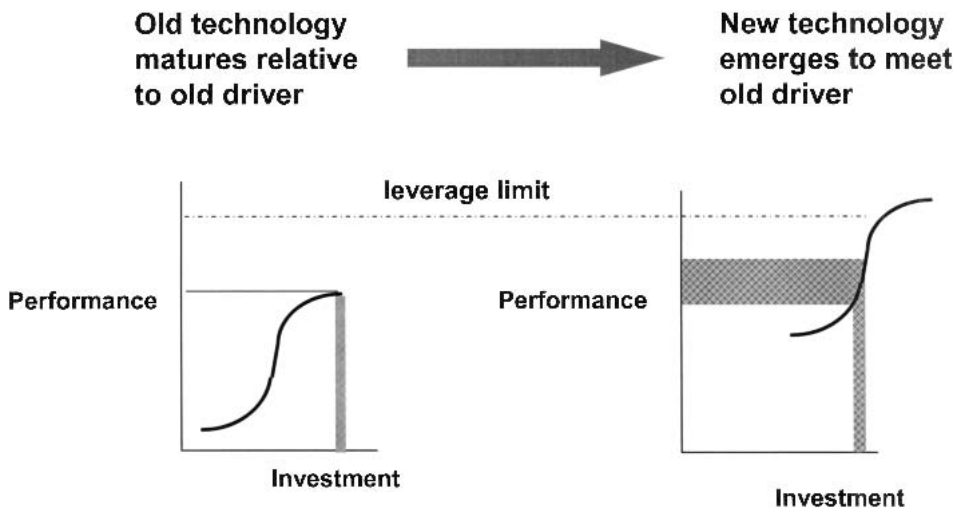


Figure 3.—In Case 1, substitution most often occurs when the technology used to support the dominant driver matures and a new technology is adopted to continue making improvements desired by the target customers.

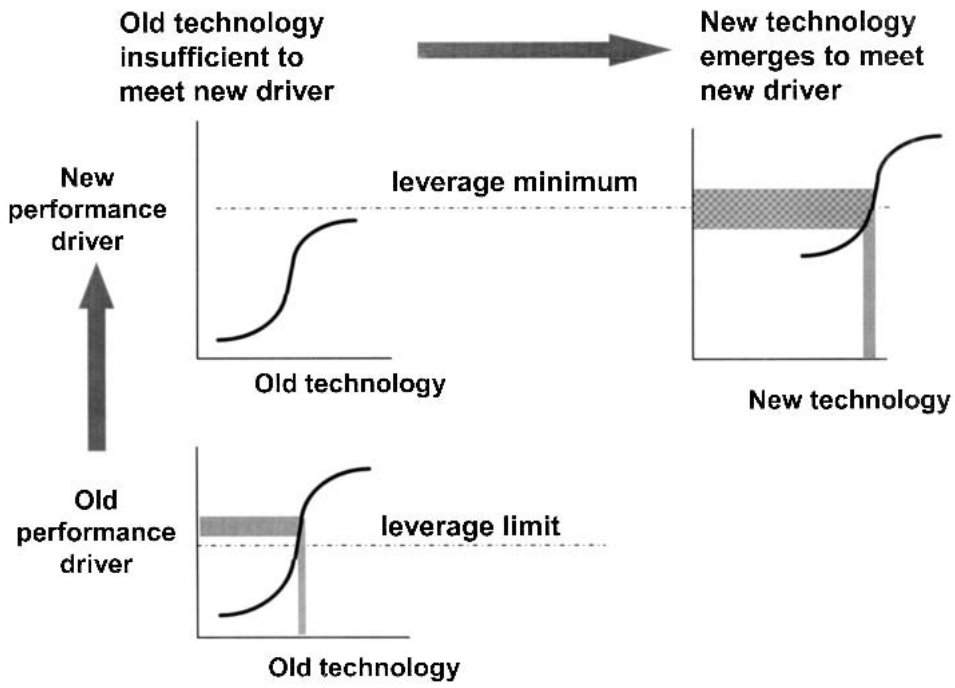


Figure 4.—In Case 2, one form of substitution occurs when the dominant driver in a market segment matures and the customers shift to another "lower order" need to drive their purchase decisions, and the old technology cannot competitively address the new driver.

access to the Internet. In each case, the driver has remained constant; only the technology changes.

The lesson: continually monitor the outside technology landscape, in your own industry and in those working on related problems, to identify technologies that can address your current customers' drivers better than your own technology.

Case 2: The old driver matures (Figure 4)

This is more subtle, and many of the examples often cited of disruptive technologies fall in this category. In an effort to follow the *voice of the customer* by understanding current customer demands, suppliers often focus solely on leveraging their technology to improve the current demands—or drivers—for product or service

enhancements. However, when the *leverage limit* is reached, customers no longer value improvements in the performance of the old industry driver, even though they may not have yet articulated which of their remaining needs will next drive the business. Because there is often significant *technology productivity* remaining in the old technology, firms tend to continue to use that technology to make even greater improvements in the performance of the old driver. They think in terms of, "We can!" not in terms of "So what?"

Unfortunately, further investments are unlikely to provide meaningful returns—customers just do not care because what they have now is "good enough." When this happens, a new driver emerges, usually from *the needs that customers have,* even though they may not have articulated those needs. A new need is not created; rather, a new driver is created from existing "lower order" needs. This new driver may be another functional requirement or, when all opportunities for performance enhancement have reached their limits (or the ability to address them is not available), price becomes the driver. In the latter case, we think of a product or service becoming a commodity.

To compound matters, customers are often unaware that they really do not need more of the old until they can actually touch, feel and use a product or service that addresses one of their other needs. Thus, firms that address what their customers are asking for often miss the next wave of innovation—the classic problem outlined in *The Innovator's Dilemma* (*13*).

The battle between 3½-inch and 5¼-floppy drives in the home computer market provides a dramatic example of how poorly recognized shifts in drivers often precede a technology change. (See "The Battle of Floppy Disks," page 21). Did 3½-inch drive technology change customers' needs? No, the needs were there in the beginning and fairly stable in their importance. However, the need serving as the dominant driver did change, reflecting the relative importance of each need, the *leverage limit* of former drivers, and the emergence of less important needs as dominant drivers. When the old driver (i.e., storage density) reached its *leverage limit* (i.e., 2.5 Meg), existing, albeit less important, needs (i.e., durability and size) emerged to drive future customer behavior.

When viewed from a purely technology standpoint, it is tempting to assume that the technology came first, especially when customers are often aware that further advances have little value until after they have passed their *leverage limit.* However, had the need for greater density not reached its saturation point, it is unlikely the advantages of the newer technology would have become important.

Focus on understanding the leverage of needs and drivers, not on hunting for a technology that changes everything.

The lesson: Focus on understanding the leverage of needs and drivers, not on hunting for a technology that will change everything.

The Dynamics of Innovation model also provides a way to think about the changes in file transfer that took place years later as floppy drives of all sizes were replaced with ZIP drives, flash memory cards, and network file transfer, both wireless and LAN-based. The following list of all the possible ways to transfer files could have been made several decades ago: human re-entry from printouts, punch cards, magnetic tape, magnetic disk, writeable solid-state devices, writeable optical storage devices (CD and DVD), electronic transfer over LANs and WANs, and wireless.

All of these technologies were known when Atari introduced its first cassette recorders. However, lack of infrastructure (e.g., for LANs, WANs, and Internet), immature technology (e.g., CDs and DVDs, and also wireless), or cost (e.g., solid state) confined the early battles to magnetic tape and disks of varying formats. If 20 years ago an assessment had been made of the extent to which the underlying needs might best be met by any known technology, it might well have identified those technologies now being used as those with the best long-term viability, once the challenges of cost and infrastructure were addressed.

If technology planning is to anticipate "disruptive technologies," it must not start with technology but with needs, and assess how current and future customers' needs will evolve into different generations of drivers. This is done by considering the driver's *leverage,* not just its importance. Further, the technology assessment must attempt to identify alternative technologies that might be used to replace maturing current technologies or replace technologies that are still quite strong when used to

address old drivers, but are not well-suited to addressing potential emerging drivers (*14*).

Apple is a company that has repeatedly shown it understands the dynamics of innovation, and continues to introduce technologies that eventually become standard despite the lack of strong customer requests (or even support) when first introduced. When Apple launched the iMAC it was met with surprise (and in some cases anger) by many users because it did not come with a 3½-inch floppy drive. Apple had predicted—as it had when it used the 3½-inch drive on the first Mac instead of the accepted 5¼-inch drives—that the 3½-inch floppy technology used for file transfer would soon be irrelevant with the emergence of newer technologies such as optical storage and network transfer capability. Apple knew more about its customers' needs than most of its customers did, and today few computers of any make are sold with 3½-drives as a standard component.

Case 3: The environment changes (Figure 5)

The last situation is where a new need actually emerges, rather than just a new driver from an old "lower order" need. This can result from changes in the economic or regulatory environment, the development of a new technology that allows new things to be done, changes in how your customer uses your product or service, adoption of new technology by your customers, or shifts in customers' activities, goals or preferences. Often when this happens, the old technology is able to satisfy the new needs and no technology substitution occurs. There may be a shift in the way in which the products are made, sold or distributed, resulting in a modified business model, but this happens without any impact on the technology, other than on which features it is focusing on improving.

Of greater interest is when the new driver cannot be well served by the existing technology. In such cases there is pressure for a new technology that will satisfy the new drivers. An example is when Dick Davis, former head of the Whirlpool Information Network, accurately forecast the emergence of new fabric technology, Burlington Industries' wash and wear fabric blend (*15*). This created a need for washing machines to have a "cool down cycle," which would optimize the performance of the new fabrics. Davis' forecasts influenced Whirlpool engineers to redesign their machines with new features before the fabrics reached the market and before customers were asking for them. The result was that Whirlpool emerged as one of the early winners in a market that was faced with a whole new set of customer demands. Had the company not forecast the shift in drivers, and had a smaller niche player capitalized on its stubborn adherence to the old technology and accepted drivers, this could have been a classic case of *disruptive technology*. However, while the technology was new and the innovation real, a major player, i.e., Whirlpool, anticipated, responded and adopted new technology, and no disruption occurred.

The lesson: disruptions are often a function of actions or inactions by dominant competitors—not of the technologies associated with major innovation.

Beating the Odds

Recognizing new technologies that may cause disruptions is a challenge, particularly when your customers

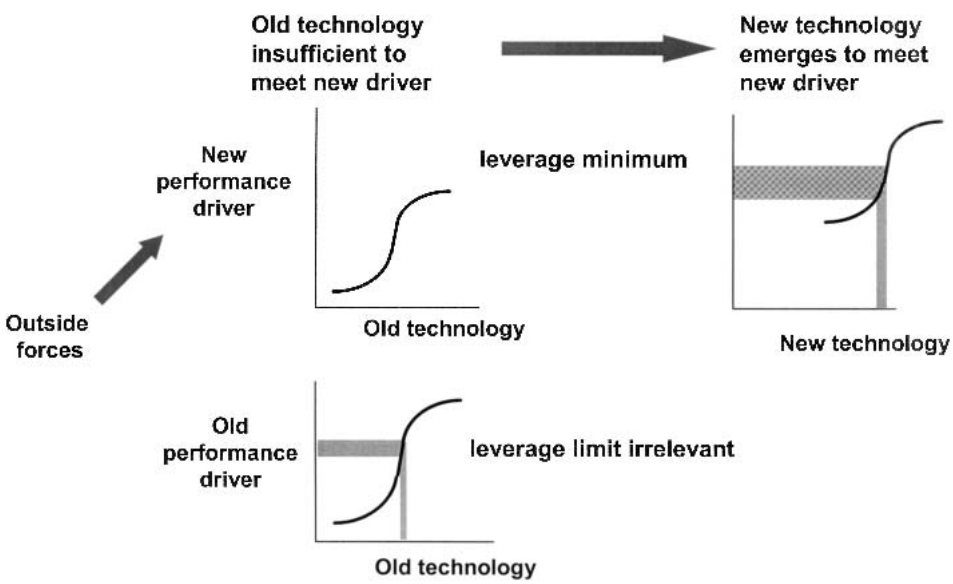


Figure 5.—In Case 3, when outside forces create new needs, new drivers usually emerge to replace the old drivers. If the old technology is unsuited for the new customer demands, it will be replaced by a new technology.

The Battle of Floppy Disks: How Maturing Drivers Led Technology Disruption

The substitution history of hard drives has been well documented (*13*), but here we would like to look at floppy drives in the home market. When home computers were introduced several decades ago, there was a need for transferring files between computers, or archiving large files to free up limited hard drive storage. If you pushed users of these early computers to articulate their needs, they would likely have come up with a list such as the following:

- Reliability—the stored data can be reliably retrieved over time.
- Speed—fast enough to be used without inordinate wait times.
- Density—sufficient capacity to store user files.
- Durability—the storage medium is resistant to damage.
- Size—can be easily carried and stored in a purse or pocket.
- Compatibility—works with multiple platforms.
- Equipment size—mechanism for facilitating data transfer is small.
- Cost—it has to fit the budget.

There may have been others, but this list is fairly representative.

One of the first data transfer devices introduced by Atari and other early home computer pioneers in the late 1970s used cassette tapes. The system was cheap, held most programs then available for the primitive 8-bit machine, but was woefully weak in terms of reliability, speed and compatibility. However, low cost was probably the major driver in the primary market because early generations of floppy drives exceeded the budgets of most home users. Also, early adopters of these home or hobby computers were willing to tolerate the limits in speed and reliability as the machines were primarily used for learning about computing, entertainment and children's schoolwork. However, once the price of disk drives came down, floppy drives emerged as the standard because of their overall better functionality in speed and reliability.

Using the Innovation Dynamics framework, the situation could be restated in the following terms: The dominant driver initially was price, with secondary considerations of speed, reliability and storage density. However, once the floppy drive price dropped below the *leverage minimum* demanded by home consumers, they flocked to the floppy disk technology and never looked back. Compared to floppy disks, tapes failed to match the performance offered by disks in terms of reliability and speed.

This sets the stage for the next substitution (Figure 6, below). For the next several years, the dominant driver was storage capacity, with each generation of floppy drives increasing the size of the files that could be stored. It was about the time that 5¼-inch drives were moving to the area of 750 K and were looking for even greater capacity when the 3½-inch drives appeared. Knowing that the dominant driver was capacity, and that 5¼-inch disks would always have greater capacity than their smaller counterparts, the makers of 5¼-inch drives were not impressed with the challenge.

However, the need was not for an unlimited capacity but for the ability to transfer files, few or any of which were above 1.5 Meg. So when the 3½-inch drives hit their now-standard 1.44 Meg, the tide changed. This proved to be the *leverage limit* for floppy drives. When it was reached, the users looked to other, in this case already existing, needs and "graduated" some of their lower-order needs to the status of being dominant drivers. Once users had the desired price, reliability, speed, and capacity, they demanded better durability and size. When the 5¼-inch drives were compared to the 3½-inch drives on these new drivers, the rest was history.

There are three important lessons from this story:

- The new technology of 3½-inch drives did not create the new needs for durability and small size—it exploited the emergence of those existing needs as new drivers.
- Until customers saw the opportunity for greater durability and smaller size, these unarticulated needs were not often mentioned; customers spoke instead about their biggest concern: improving the capacity of the disks so they could hold any of their files.
- The key is to think in terms of the needs that customers have (whether articulated or not) and not just those attributes or features they ask for.—**J. P. and R. K.**

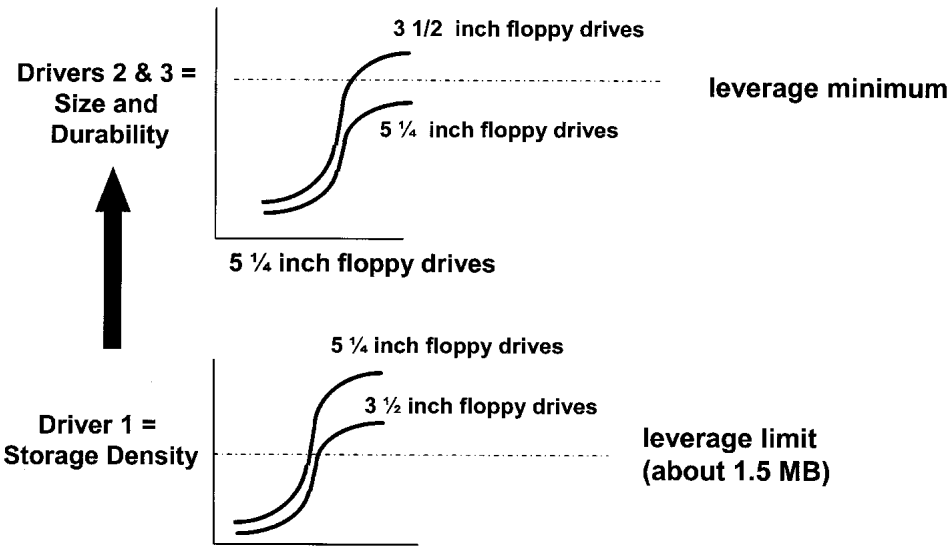


Figure 6.—When the leverage limit *for the old driver of storage density was reached by all competing technologies, less important needs such as size and durability became the new drivers and the newer 3½-inch floppy drive technology replaced 5¼-inch drives.*

may not recognize that the performance requirements that drove their past decisions are not going to drive their future ones. It is a challenge, but it can be met. The key is to:

■ Understand the dynamics of innovation and substitution. There are reasons that new technologies emerge: there is an unmet need (new or old) and the technology currently in use (if any) is unable to meet that need.

■ Do not ignore your customers (current or potential). However, do not focus solely on what your current customers ask for. More important, focus on what they need. The issue is to identify the drivers of the future, those that emerge when old drivers reach their *leverage limit,* and those that emerge when your customers' environment changes.

■ Do not abandon an old technology just because it appears mature. Unless there are significant unmet needs in the drivers it was addressing, there may be no benefit to the new "better" technology.

■ At the same time, do not focus solely on how you can use your current technologies to address emerging drivers. Moving to newer technologies that can deliver performance at the *leverage limit* of the old drivers (even though below your technology's performance level) may be necessary to meet the *leverage minimum* of a new driver.

■ Implement processes that help anticipate and manage change.

• Collect intelligence on changing needs, technologies, customers, and competitors.

• Use planning frameworks that consider the leverage of a need—not just its importance, and that take into account technology maturity and substitution.

• Ensure that project approval frameworks promote the disciplined early-stage exploration of the viability of potential new technologies.

• Adopt development mechanisms that promote the dualism mentioned at the beginning of this article: e.g., use internal ventures and external alliances to complement more traditional development routes.

The conclusion is simple: "Disruptive Technologies" do not have to disrupt your business success. While you cannot predict the future, you can anticipate change and prepare for it by focusing on the drivers of the technology.

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