

THE PERFECT STORM FOR DISRUPTIVE TECHNOLOGIES

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Executives' ability to distinguish between nascent technologies that will displace existing technologies and those that will not is central to firms' success. The displacement process can be better predicted by understanding which market elements to monitor and what conditions must converge to create a disruption. Then, executives must have the resolve to act in a timely manner to enact strategies that will eviscerate or destroy their own profitable assets.

INTRODUCTION

Disruptive technology is a loosely defined term and so is subject to interpretation. Generally, the nomenclature refers to a new technology that is commercialized and gradually takes all, or a significant chunk, of the business of an existing technology. For example, while hand-held calculators spelled the death knell for slide rules, jet engines did not completely eliminate the market for propeller planes.

Actually, "disruptive technology" is something of a misnomer. As Papp and Katz (2004) observed, it is not the technology itself that is inherently disruptive. Rather, there is a convergence of circumstances that cause a disruption. The five components and requisite conditions that must come together to facilitate a technological displacement are shown in Figure 1.

In most cases, of course, a nascent technology will not end up displacing a prevailing technology. Yet if the right conditions happen to converge, the likelihood increases dramatically.

CUSTOMER BASE

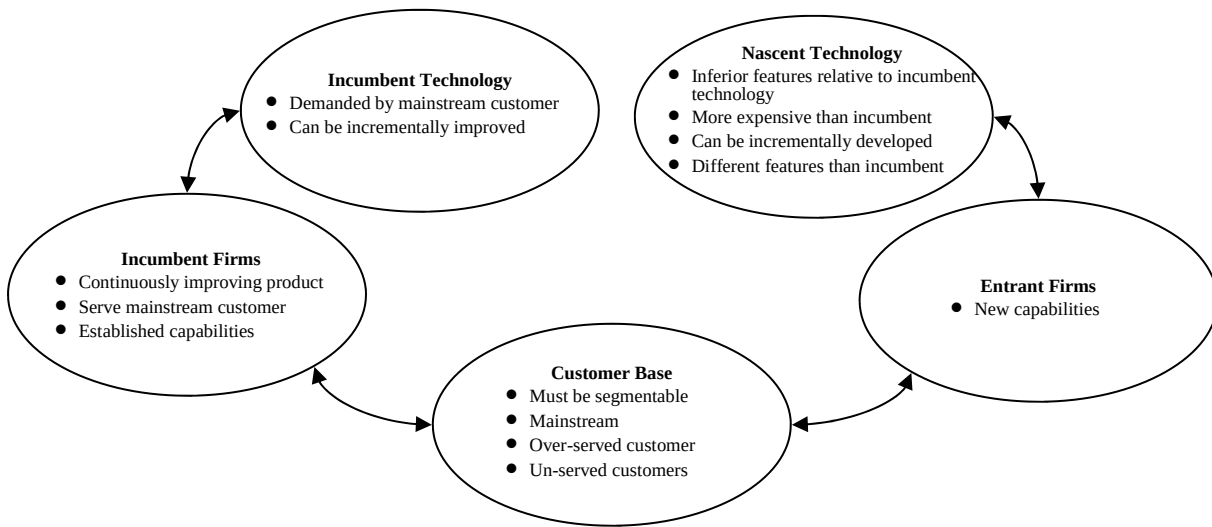
For a technology to be potentially disruptive, the generic market served by the incumbent

firm must be heterogeneous in order to be susceptible to segmentation. Otherwise, the standard and dominant incumbent technology will adequately meet the needs of the preponderance of customers and it will be very difficult for an incipient technology to secure a foothold. In practice, a homogeneous market rarely occurs. On the contrary, markets are usually comprised of segments with differing needs.

In industries that have been disrupted, one can usually go back to the genesis and find one or more over-served customer segments. In other words, customers who could be satisfied with the barebones version of the incumbent product and do not need or want additional features and benefits and the higher prices that generally go with them (Bower and Christensen 1995). For instance, the Arab oil embargo of the early 1970s provided the Japanese automobile manufacturers with an opening to cater to Americans who suddenly valued no-frills, economy cars over the gas-guzzling behemoths offered by Detroit.

Also characteristic of disrupted industries is the introduction of the nascent technology to customer segments that did not previously buy products in the incumbent-technology category. Personal computers found a ready market among un-served small business owners, who neither needed nor could afford all of the vast power and memory of the mainframe computer. Reigning technological leaders are predisposed to miss opportunities presented by over-served

FIGURE 1
Elements of and Necessary Conditions for Disruptive Technology



and un-served market niches because they devote the bulk of their attention and resources to the currently (as opposed to potentially) most lucrative part of the market. Meanwhile, as leaders cater to their best customers, new companies begin to woo neglected or ignored market segments. For example, deep-discount stockbrokers like E*Trade capitalized on the Internet to entice investors who did not want the full range of comparatively expensive services offered by Merrill Lynch.

INCUMBENT FIRM AND INCUMBENT TECHNOLOGY

The incumbent firm has competencies and ways of doing business that are steadfastly anchored in its current technology. The growth imperative for such a company promotes executive behaviors that markedly favor the incremental improvement of the incumbent technology, so as to meet and sometimes exceed the needs of the mainstream customer base. Moreover, the perpetual quest for profits requires process improvements to reduce costs (Anderson and Tushman 1995). In short, the company with the incumbent technology places increasing importance on specialized competencies and devotes ever-increasing resources to them.

Product-line extensions of the incumbent technology suit subsets of the mainstream customer base, but not the requirements of over-served and un-served customers. A single-minded dedication to the enhancement of the existing technology tends to blind the incumbent to the threat of the nascent technology and, concomitantly, to prospects for new competencies and strategies. IBM ceded the DOS operating system to Microsoft's Bill Gates because the greater value was thought to be in hardware rather than software.

ENTRANT FIRM AND NASCENT TECHNOLOGY

Incumbent firms and their mainstream customers are apt to look upon an emerging technology as being inferior to the existing technology, which early on is a correct assessment; consequently, they underestimate its threat. Executives in mimeograph companies in all probability would not have been alarmed about xerography had they viewed the first copies in 1936. Christensen (1997), author of *The Innovator's Dilemma*, recounts how Andrew Grove, Chairman of Intel, refers to unrefined but potentially disruptive embryonic technology as "trivial." However, the new technology may turn out to be inferior only when compared to the features

of the incumbent technology and the mainstream customers' needs.

In retrospect, when historical disruptions are revisited, it is apparent that the nascent technologies, while substandard on features possessed by the incumbent products and services, offered salient benefits not otherwise available. As a result, these fledgling technologies made inroads with over-served and un-served customers. As manufacturing volumes ramped up, entrant firms realized economies of scale and accrued the salutary effects of experience, and thus began to enjoy the flexibility to decrease prices. Additionally, products based on the nascent technologies were improved to broaden their appeal to more upscale segments of customers, à la Toyota's Lexus and Honda's Acura.

Executives in the mainframe computer companies in the early 1980s generally dismissed the personal computer as being second-rate. They would have been right if their evaluation had been based solely on the features of power and memory capacity sought by large companies that comprised the mainstream customer base. But the small business owner of the era used different standards. He or she thought of the personal computer as being more utilitarian than a mainframe, because it had enough power and sufficient memory for their purposes, and did not require a climate-controlled room of its own with a resident technician. For small businesses, compactness, affordability, and user-friendliness was a compelling value proposition.

Hence, the supposed inferiority of the "trivial" personal computer's power and memory was not a problem at all and the overall features were such a benefit that the over-served and un-served market segments were fertile targets for the entrant firms. The seemingly insignificant personal computer companies were able to make inroads with small businesses, as well as with educators and technologically sophisticated consumers. PC firms honed their products and competencies to the point where the

desktop computer began to encroach on the mainstream customer base, large corporations, for computing. Soon thereafter, personal computer makers, including IBM itself, turned the mainframe computer industry upside down and its halcyon days were over for good.

DISRUPTIVE VS. SUSTAINING

Michael Dell entered the market for personal computers by adapting a then-radical business model to create a competitive advantage. Instead of using the conventional bricks-and-mortar, manufacturer-to-distributor-to-retailer channel employed by extant personal computer manufacturers, Dell harnessed telemarketing, mail order, and later the Internet, to link directly to customers. An assemble-to-order manufacturing process and a just-in-time inventory modus operandi enabled Dell to gain a huge cost advantage vis-à-vis his competitors.

Albeit Michael Dell did not invent the business model that catapulted his company, he was first to apply it to the personal computer business. Even though Dell's action assuredly challenged incumbent firms, his process innovations in customer ordering and distribution did not simultaneously render obsolete the personal computer industry's product technology. Companies like Compaq and IBM had a new and formidable competitor, offering efficient ordering and distribution processes, but Dell's technology for making personal computers was very similar to the industry standard. The processes that Dell brought to the industry were sustaining and additive, rather than disruptive and obsolescing. As proof, Compaq and other mainstays eventually incorporated Dell's ideas into their traditional business models.

Why did not Compaq move immediately to follow suit when Dell's direct-to-consumer approach began to take away its business? Because, as with all market leaders, Compaq was entangled in conventional business arrangements that rendered a competitive advantage until Dell came along. Compaq was a victim, so to speak, of its own past success. A business

model that works superbly at one point in time turns out to be an albatross under far different conditions. In this instance, Compaq's retail affiliates accurately complained vociferously that if Compaq were to mimic Dell and sell directly to customers, the practice would cannibalize the affiliates' business. While Compaq was working to mitigate this tricky issue, the upstart Dell, which was unencumbered by historical business relationships, was gaining market share by leaps and bounds.

Dell cannily applied process technologies (mail, telephones, and eventually the Internet) to gain a competitive advantage, rather than instigate a new product technology that would render obsolete the offerings of incumbent firms. For a case in point of genuine technological disruption, consider once again the advent of the personal computer and its devastating impact on the mainframe computer industry.

Figure 2 depicts the performances of seven prominent firms in the computer industry from 1985 through 1995—an era of technological upheaval when personal computers became sophisticated enough to seriously erode demand for mid-range and mainframe computers. The graph shows the EBIT Margin (earnings before interest and taxes, divided by sales, and multiplied by 100) for each company over the eleven-year period. The rise to eminence of companies like Apple, Compaq and Dell, and the ensuing hard times for reigning market leaders—Honeywell, NCR, DEC, and IBM—demonstrate how one technology to a substantial degree displaced another.

“Big Blue” paid a heavy price because its business system for selling mainframes was inappropriate for selling personal computers: the painstakingly cultivated one-on-one relationships with influential people in the buying process and the long lead times required to sell mainframes generated too much overhead for low-margin personal computers to handle. The IBM Goliath, with its erstwhile policy of no layoffs of employees forever abandoned, suffered a near collapse in the early 1990s. The

company achieved the dubious distinction of first earning the most profits of any company in recorded history and then suffering the biggest dollar losses, all within just a few years' time (Thurow 1999). After realizing an incredible \$6 billion net income in 1990, IBM racked up staggering losses of \$2.8 billion, \$5.0 billion and \$8.0 billion in 1991, 1992 and 1993, respectively. IBM's decline would have been worse, and perhaps fatal, had its own entry into personal computers in the 1980s not helped to offset its losses in mainframes. All the while, personal-computer manufacturer Compaq was recording net income figures of \$130 million, \$213 million and \$462 million, respectively.

Not until Louis V. Gerstner Jr. took over, in 1993, as IBM's first-ever chairman and CEO from outside the firm, and changed strategy away from the “Big Iron” of mainframes to computer services and software, did IBM experience a reversal of fortunes. By contrast, Dell Computer was founded in 1984 and rode the surging wave of personal computers. In 1985, five companies—IBM, Apple, Compaq, Kaypro, and Tandy—accounted for 90 percent of the retail business for personal computers (Forbes 2004). By 1992, Dell was challenging for a leadership position and had made the *Fortune* 500 roster of largest U. S. companies, which is the fastest-ever ascension to this prestigious list.

Hindsight begs the question, “How did mainframe companies miss the developing personal-computer tsunami?” Certainly not because of a deficiency of technological competence: IBM and NCR easily could and did engineer state-of-the-art personal computers. The culprit was an unrealistic assessment among mainframe executives of the latent power and popularity of personal computing, along with a strong dose of hubris. Executives at NCR, Honeywell, and IBM in the 1980s were successfully producing and selling mainframe computers with all the confidence of leaders riding the wave of the dominant technology. The then-familiar condescending and dead wrong remark, “Who would want a computer in their home?” was reminis-

FIGURE 2
Selected Computer Companies EBIT Margin

cent of an equally contemptuous misguided aside by Harry M. Warner in 1927: "Who the hell wants to hear actors talk?"

EXECUTIVE GUIDELINES

Indeed, a recurring error by executives in firms threatened by nascent technologies is to underestimate the menace because, oftentimes, new technologies are introduced by extremely low profile companies in budding industries--Apple Computer began in a garage and Dell Computer was launched from a college dormitory room. For this reason, an incumbent's environmental scanning must encompass not only contemporaneous rivals, but also plausible challengers. An organization needs someone whose main responsibility is to look far and wide for would-be competitors. Kodak, for example, could and should have known that customers of photography-based products stood to benefit from digital imaging obtainable from Sony, Hewlett-Packard, and other non-film companies.

Simply asking executives to identify "unknown rivals" is nebulous. How does one analyze the "unknown"? By using the model proposed here, strategists can employ a "disciplined early-stage exploration" (Holmes and Glass 2004) of possible disruption. Those conducting the scanning should broaden the scope of their

inquiries beyond the mainstream customer. To be thorough, all companies seeking any of the segments in the generic market must be scrutinized. If nascent technologies are being used to fulfill needs not met by the incumbent technology, they should be warily investigated.

Once the early-stage exploration has produced data on newer technologies, including those that seem to be trifling, appraisal of their viability is next. If a fresh product or process seems to be inferior and a poor value, before dismissing it as non-threatening, contemplate the customer base. Is there a segment that is overserved by the incumbent product that might derive benefits from some aspect of the nascent technology? What about a segment that is not served at all by the incumbent's offering? Is it possible that a nascent technology could be creating a new market segment by aiming at some need or preference ignored by the incumbent? Are there signs that the entrant firm is incrementally developing the new technology and perhaps gaining momentum by employing a capability that is foreign to incumbent firms?

If the answers to these kinds of probing strategic questions are affirmative, pressing decisions must be made. How will the incumbent firm continue to satisfy its current, loyal mainstream customers and at the same time prepare to blunt

the potentially negative impact of the disruptive technology? Reaction and timing are critical. According to Schnaars (1994) and Neff and Shanklin (1997) being the first mover is not always the preferred strategy. A delayed entry affords the time to assess market potential, learn from others' mistakes, forego some of the development expenses, and still offer or acquire a valued new technology. Historically, the most prevalent pattern has been for a large company to wait and watch as smaller enterprises explore new technologies and markets. Then the larger firm enters with products and services it has developed or acquired and dominates the market (Schnaars 1994). The giant pharmaceutical companies have long pursued this strategy.

More often than not, top executives in a company imperiled by an incipient technology know full well that the situation will only deteriorate if they fail to act. Even so, for various reasons having to do with not wanting to kill the goose that laid the golden egg, they may not elect to put the company through a wrenching change, or at least not with alacrity. For example, Polaroid had a prototype for a digital camera in 1992, but by the time it introduced its PDC-2000 mega-pixel camera in 1996 there were 40 competitors selling digital cameras (Tripsas and Gavetti 2000). Likewise, DEC's leaders dawdled long after it was obvious that personal computers would obliterate their business. Realistically, however, would not most executives be tentative about giving up the huge gross margins that accompanied mid-range computers to reorient their company to the personal computer market where margins were relatively meager?

Finally, to overcome corporate-culture bias favoring incumbent technologies, it may be best to form a separate company to house a radically new and threatening disruptive technology in order to free the new from the legacy of the old. Arguably, Kodak might today have the dominant position in digital cameras had ten-to-fifteen years ago a digital version of the com-

pany been spun off to shareholders or as a tracking stock, or sold outright in an IPO, rather than nurtured in a company so steeped in George Eastman's venerated film technology. Similarly, is it likely that the vast majority of today's traditional colleges and universities are too immersed in the centuries-old bricks-and-mortar and eyeball-to-eyeball culture to transform fast enough to compete in distance learning with nimble for-profits like the University of Phoenix?

It is one thing to know a perfect storm is brewing that may capsize the corporate ship; it is another thing to have the will to act accordingly. The utmost fiduciary responsibility of a corporate board of directors is to make sure that their CEO not only has the knowledge and vision to take corrective action in the face of change, but also has the courage to do so.

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