

Adoptions of Disruptive Technologies That Worked and Others That Did Not

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The fear that a new technology will emerge from some unpredictable corner of the economy or out of some university laboratory, constantly worries those executives long experienced with technologies. On occasion their worst fears are confirmed, as we are seeing at the moment playing out in the music industry in its dealings with file swapping. Historically, when an effective alternative technology does come along, it will cause massive changes. The telegraph made national railroad networks possible, hence large national markets for many industries; merger of telecommunications with computing permitted organizations to do online processing and tighten control over larger organizations. In many fields today, the potential for the arrival of disruptive technologies has actually increased because so much science and engineering is underway. The poster child for this trend is the historic transformation occurring in the science of medicine and in the creation of new treatments for disease that move away from the traditional chemical and surgical bodies of knowledge and toward biologics and programming of living cells.

Disruptive technologies have essentially three effects on any organization: positive, negative, or none at all. In the world of information technology (IT) they tend either to profoundly enhance or threaten an organization's capabilities. The same technology can work either way at the same time, as for example the Internet, which enhanced book sales but threatens the fundamental business model of the music industry. New IT technologies tend to come slowly enough that firms have enough time to see them coming and to formulate their response to them; some do and some do not. What we do know, however, is that such trends cannot be ignored as will significantly effect firms, industries, and national economies.

Taking An Industry Perspective on the Role of Disruptive Technologies

By looking at disruptive technologies through the lens of industries, rather than from the perspectives of firms or national economies, we gain new insights on their arrival and effects. Firms identify with an industry and form their opinions and reactions to technologies in a collective fashion within their industry. Industries influence and pressure firms to react collectively. Cases of these patterns of behavior jump out at us quite clearly, backed with large bodies of empirical data to document their occurrence. The reason for discussing the industry view at this time is because economists, technologists, and executives have barely started to do so, which comes at a time when we might actually see an increase in the number of disruptive technologies arriving at our doorsteps. Treating them as unwanted "gifts" has never been a positive option for any economy.

I propose that the way to describe disruptive technologies within the context of the industry prism is to think of them as having one or more of the following features:

- A technology that displaces a prior existing one, such as electricity for steam, computers for mechanical calculators. They may arrive slowly or quickly.
- A technology that upsets or changes relative economic advantages of firms or allows new ones to enter markets, such as television disturbing the movie industry and today the Internet the music industry.
- A technology that upsets or changes the corporate or institutional cultures of an individual, firm, or industry, such as PCs did when displacing “glass house” mainframe computing, thereby minimizing the political and economic influence of MIS directors. The changes are also cultural, as is happening with the Internet challenging teachers and professors to alter their traditional lecture methods.

Some disruptive technologies displace earlier ones, while others do not; they co-exist.

They can also be positive catalysts for change. For example, in the 1970s the U.S. grocery industry collectively led IT vendors in developing the bar code to meet their needs for more effective inventory control, using existing point-of-sale terminals as data collection devices. That technology then spread across almost all industries. Mainframes in the petroleum industry displaced over a half century’s worth of analog monitors with new applications that required fewer employees. The same technology changed seismic studies of potential drilling sites. So, while most people think of disruptive technologies as a negative phenomenon, they can also be positive forces.

But because they can also be negative, threatening forces, or failed developments they pose a danger as well. Picturephones in the 1960s failed to take off in the telephone industry. Cameras attached to phones to allow one to see who they are talking to have yet to deploy; only in the past couple of years did it become possible to take still photography (in 2003 limited video) using a cell phone exactly like a camera. Packet switching as the means for transporting conversations took over 30 years to be embraced by the telephone industry as a more attractive replacement for circuit switching technologies; as of this writing the adoption process remains labored.

General Observations about Disruptive Technologies

They are potentially all over the place; some already have arrived in some industries earlier than in others, such as the Internet for book dealers but less so for grocers. They are not necessarily bad, just uncomfortable until understood and tried. Every industry experiences these and has them lurking in the shadows, potentially helping and hurting existing business models and practices. They eventually make it into one’s own industry and have to be dealt with in one fashion or another. In short, they can never be ignored. The most disruptive feature is not so much the technology but how it is used. For example, when AT&T developed the transistor was developed in the 1940s, engineers at Bell Labs expected that it would be used to enhance long distance telephone call signals and to improve hearing aids. Within a decade the proverbial “everyone” had, instead, a transistor radio, and in the following decade a whole generation of computers relied on this technology.

We do not have good metrics and definitions for identifying potentially disruptive technologies nor managerial practices for dealing with them. In large part the problem

has been that disruptive technologies are new, hence unknown, unfamiliar, untried, and with no best practices to guide organizations they affect. But we know a few things:

- They usually emerge over time so one can scan the horizon for potentially useful ones. Organizations that do this have acceptable processes for getting the job done.
- They normally appear first in someone else's industry, so we should monitor activities in other industries, not just in our own.
- They are often funded by venture capitalists eager to convert them from science and engineering into products. They do this before firms and industries have identified the potential benefits and dangers of the new knowledge.
- They can be invented by industries, as did grocers with bar coding. The technologies can be embraced and standardized by industries as the banking industry did in the 1950s when it applied MICR coding to standardize all checks in the United States.

But many practices and consequences to management have yet to be developed to make these four possibilities a routine reality for organizations, industries, and management.

There is an urgency to deal with these human/institutional issues because a large body of potentially disruptive technologies is in front of us that will have large effects on the economies of the United States and the world at large within a decade. These include nanotechnology, quantum computing, massive storage, and biology for targeted treatments of diseases. A bit further out we will have to deal with cognitive technologies and the potential of portable electricity. The latter, if actualized, for example, could eliminate utility industries around the world, along with perhaps existing battery manufacturers. Any of the emerging IT developments could destroy a company's core knowledge and portions of an economy's infrastructure, or give them new competitive advantages and revenue growth opportunities. In time, however, any one of these developments could also obsolete some managerial and business practices, such as the behavior of IT firms and their customers in exploiting Moore's Law.

Some Future Possibilities

I believe that existing technologies will continue to drop in cost and remain far over engineered for the needs of most organizations for the next five years, making much of what a high tech firm does both mundane and commodity-like. In short, we are living in a period in which build out is occurring in underdeveloped economies, such as in Southeast Asia and China, but less so across Africa. IT application ubiquity will extend, therefore, almost globally, masking the fact that existing technologies do not represent the future predictable world of IT. Computing and telecommunications technologies are cheap, relatively easy to deploy, and ubiquitous applications and their packages (e.g., SAP) are widely available, used, and understood, however. Meanwhile, we can expect some disruptive technologies will, in short, order disrupt the normal buildout process.

We are at a point now where IT equilibrium is being achieved across many industries, thus buildout will be on an industry by industry basis around the world, leading to a more common "look-and-feel" on an industry-by-industry basis around the world. For example, retailing will increasingly be done the same way around the world.

A third possible trend is that over the next decade we may begin to see the start of IT prototypes and business models that are based on biology, and on the patterns of behavior of biological systems, although at the moment they do not exist. The closest we seem to be is in expanding our knowledge of human and organizational cognitive behavior.

On How We Respond to Disruptive Technologies

The problem with disruptive technologies is less about what new ones are arriving, or when they arrive, rather how we react to their arrival. In general, people react rather badly. That is to say, they are hostile toward them, or they embrace them without understanding potential risks and hidden problems, or they do not have good methods for doing so. However, resistance and denial are the two most widely visible patterns of behavior. The costs to individuals, firms, and industries have been partially documented in the historical literature and form the basis for much of today's concern about the dangers of such technologies. Yet these technologies keep coming and thus we need to find ways to do more than be negative about them. The problem has been with us for a long time. The inability of the music industry to deal effectively with the Internet and file swapping is only the latest example of both ineffective behavior and just bad business judgment. Bankers resisted ATMs when they first appeared and stock brokers with early automated sales systems. We also have the infamous Luddite experience of the early 1800s in England when workers burned machined intended to automate their work and thus eliminate jobs.

We could do greater service to national economies and to our own industries if we could develop effective ways to ease the transitions to new technologies, ways that are quick, that reduce risk of failure, and that hold out the potential of economic advantage to firms and nations. The required tools are not more technologies, but rather economic, social, and cultural incentives and processes. Firms need economic incentives to embrace these technologies. Governments have to leverage regulatory bodies to motivate and permit new behaviors. Executives need to introduce incentives and measures into their organizations to promote understanding and adoption of disruptive technologies at times most advantageous to their firms. Institutional cultures have to be modified—perhaps the biggest challenge of all. Imagine, for example, asking tenured professors to spend a great deal of their time at a research oriented university in developing distance learning classes instead of conducting research on topics for which they are rewarded.

Perhaps because high tech companies are more often than not both the creators and victims of disruptive technologies, they should be the ones to define new managerial practices with which to develop, embrace, and manage disruptive technologies. The industries and nations that learn to do this the best the soonest, will probably be those that will enjoy the greatest prosperity in this new century. We can say that with confidence, because we have over two thousand years of the history of technology that has documented the long term effective behavior.

In more modern times we have the experience of U.S. and European government agencies funding research on new technologies which often became disruptive—such as the Internet by the U.S. Department of Defense—and that of many firms in bringing new products and practices to market. In the case of the U.S. economy, for instance,

disruptive technologies have normally been powerful engines for economic growth. They promise to continue to be so in the future. For companies operating in a global setting, identifying these national pockets of innovation has to be one of their great core competencies.