Why Companies Kill Their Technologies

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Several forces at work in most organizations can kill promising technologies before they ever become transformed into marketable products. Here's how to recognize the syndromes and combat them if they have already taken hold in your company.

Every executive today doubles as a technology manager. Very few industries—large or small, goods or services, consumer or industrial—could not be described as high-technology industries. The technology may lie in the products, in their accompanying elements, in the processes used to manufacture and deliver them, or even in the decision-making structure and tools used to manage and market them.

Unfortunately, as global competition has intensified, many US corporations have not adequately adapted themselves to these new realities. Consider the following:

☐ The last remaining US manufacturer of heavy robots, a unit within Westinghouse, was acquired by a division of the pan-European corporation, Asea Brown Boveri. The Westinghouse division's robots chronically leaked hydraulic oil because of a major design flaw. Management seemed extraordinarily myopic: it chose to continue producing the leaky robots rather than redesign them, because the company was making large profit margins on the sale of drip pans and replacement hydraulic fluid to these "hostage" customers. The company failed to recognize and adapt to emerging technological standards and continued to produce messy hydraulic robots when the industry had settled on far more reliable and less complex electrical robots. US firms continue to excel in robot science; unfortunately, most of their research now appears destined to be harnessed by overseas competitors.

☐ Japanese manufacturers have enthusiastically adopted fuzzy-logic technology to create numerous smart products. These include washing machines that, at the push of a button, automatically choose from one of 600 cycles based on the weight, type, and dirtiness of clothes; air conditioners that consume an average of 24% less electricity; vacuum cleaners that sense the amount of dirt in a carpet and apply the appropriate degree of suction; camcorders that eliminate picture shakiness from unsteady hands; and commuter trains that stop and start more smoothly. It should come as no surprise that the concepts underlying fuzzy logic were developed in the US in the mid-1960s, only to be dismissed by senior management as being too imprecise to have practical applications.

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☐ Gallanium arsenide (GaAs) chips are expected to replace silicon chips in the future, because of two major advantages. First, they enjoy a nearly tenfold advantage over silicon in the speed with which signals can flow between circuits. Second, their much lower level of power consumption results in negligible heat generation. Both advantages are particularly crucial to high-end applications (e.g., workstations and supercomputers). The technology has been developed entirely in the US, by corporations and universities.

The next chapter of this story is, by now, depressingly familiar. The company that finally overcame significant technological barriers to manufacturing GaAs chips (primarily, their extreme brittleness), Vitesse Semiconductor Corp., was unable to find a US partner willing to license its designs and invest the $30 million to $40 million necessary to establish a factory. Eventually, Fujitsu, Ltd., licensed the designs and is now building a $200-million plant to implement them. In addition, France's Thompson-CSF has signed a licensing and marketing arrangement with Vitesse in exchange for a small stake in the company.

These examples illustrate that the United States is falling farther behind each year in the global race to harness and profit from new technologies. There can be no argument that a clear conceptualization and enactment of technological vision, strategy, and (most important) implementation is the foremost competitive imperative facing United States industry today. If the United States is to thrive in the future, US industry must revamp the ways it develops and deploys technology.

It is quite evident that the ability of the United States to develop new technologies and generate scientific breakthroughs remains unparalleled. Recent breakthroughs in superconductivity, biotechnology, genetic engineering, gene therapy, and materials science testify to the undiminished vitality of US laboratories.

Given that there is apparently no shortage of newly developed technologies, the problem must lie in the process of converting these technologies into marketable goods and services. It also appears that most US companies have been unwilling to invest adequately in commercializing new generations of technologies that, if successful, have the potential to render obsolete the current way of doing business for these companies. This is especially true of large companies, which have the most to gain (as well as the most to lose) from the new technology. In contrast, Japanese companies, though very adept at incremental innovation, have not been hesitant to come out with radically different technologies.

In creating products with new technology, many companies have paid inadequate attention to aspects of design—not only functional ability and aesthetics but such considerations as manufacturability, ease of assembly, maintainability, repairability, expandability, upgradability, and recyclability. In the absence of these considerations, products based on new technologies are often rejected by the market and are more vulnerable to competition.

Why Technology Perishes

Why do new technologies fail to survive outside the laboratory? Some of the reasons have to do with the technology itself; it simply may not solve an existing problem in a way that offers compelling advantages over existing solutions. In many instances, however, the demise of promising technologies can be attributed to management failure. This failure may signal the existence of several syndromes that pervade organizations that fail to successfully commer-

cialize marketable new technologies. A few of these syndromes are well known; several others are not so apparent.

Lab in the Woods

This phrase refers to the tendency of companies to place research facilities in a location removed from operating divisions. Such laboratories are often extremely successful in generating technological breakthroughs; however, the likelihood that the organization will actually deploy the technology developed there is usually low.

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This was certainly the case with the Xerox Palo Alto Research Center (PARC) during the 1970s. Like PARC, which excelled in applied research, Bell Labs has long been a pioneer in basic research, averaging a patent a day since 1925 and winning seven Nobel prizes. However, it has proved to be much more of an asset to the scientific community than to its parent company, AT&T.

Transferring technology between the lab and a company's operating divisions requires conscious and concerted effort along several dimensions. For example, 3M designs its R&D facilities to be near its operational facilities; it even arranges office layouts to maximize the likelihood of incidental contact between R&D and marketing personnel.

The lab-in-the-woods syndrome may also be overcome through the systematic transfer of personnel between the R&D and engineering functions and by giving technology developers the responsibility, facilities, and funds they need for product development.

Not Invented Here

This syndrome refers to the frequent lack of internal intellectual commitment to new technologies imposed from outside the organization. Consider the example of GTE Labs, located in Waltham MA.

In the early 1970s, GTE Labs was a pioneer in fiber optics and transmission technology. In 1979, GTE decided it was ready to commercialize the technology; it asked GTE LENKURT, a division located on the West Coast, to develop applications for the new technology. The sheer physical separation between the two facilities, coupled with strong resistance from managers at LENKURT, who had no ownership stake in the new technology, hindered the technology transfer.

After two years passed and nothing happened, the company decided a technology push was in order. GTE LENKURT was ordered to drop its existing product line and instead build products based on the new technology. Two years later, GTE was forced to shut down the entire facility, because it had no existing products (which had all been dropped) and no new products. All 3,000 workers were laid off. Subsequently, the fiber-optic network installed by GTE-owned US Sprint did not use any GTE technology; it was all acquired from outside vendors.

The not-invented-here syndrome has to be replaced by an attitude that companies just can't do it all by themselves. They must adopt procedures designed to facilitate an attitude of ownership on the part of individuals involved in carrying a technology from concept to market. This can be accomplished through the exchange of personnel, the use of technology champions, and the early and continuous involvement of engineer-

ing and marketing in the R&D effort. Such multilayered teams ensure that the new technology has many parents and will receive corresponding attention.

Managers must be given incentives to cross-deploy technologies being used elsewhere in the company; American Express has achieved significant success over the years with its One Enterprise program, aimed at extracting synergies from the firm's internal resources. The syndrome may also be combated through the use of creative funding arrangements—for example, requiring R&D to obtain a large portion of its funding from various line units.

Finally, firms could enter into technology-based strategic alliances. IBM and Sony have been very successful in setting up such alliances with a number of small companies, with the explicit intent of leveraging the small companies' technologies into larger markets.

If It Ain't Broke . . .

This syndrome reflects an implicit attitude that because the company's current technology works just fine, why would customers want new technology? In fact, as technology expands beyond the point of necessity (as interpreted by the standards of the moment), consumers rapidly find uses for the new capabilities by relaxing various restrictions and incorporating functional enhancements. Soon, technology is forced to provide another quantum upgrade in capability. This has happened in the personal computer industry, in which requirements for mass storage have expanded far beyond any reasonable projections from the early years of the industry.

As has been the case with almost all technological innovations, hardware leads applications; once hardware exists, the applications will come—provided the hardware offers significant advantages. If a high-capacity information pipeline is built to the consumer's home, applications will rapidly emerge. Critical services (e.g., medical, educational, and government services) can be delivered with greatly increased levels of efficiency and customization. The French videotext system Minitel, using technology that is primitive by the aforementioned standards, has nonetheless transformed many aspects of life for millions of French citizens.

This is clearly a difficult syndrome to overcome. Managers must allow radically new technologies to be nurtured and tested. They must constantly seek to distance the company from its present set of technologies by separating the current technological means from the more persistent, market-based ends it seeks to achieve. A sense of technological excitement should be fostered, a sense that places a premium on developing approaches that will cause the company to try to make its own deployed technologies obsolete.

Bootstrapping, practiced by 3M and others, is a corporate philosophy that encourages employees to think of ways to improve or alter a company's products. At 3M, employees are told to spend 15% of their time engaged in such activities. This fosters an attitude of constantly questioning the company's technological solutions to its customers' needs.

Technology Life Cycle

The attitude that an old technology must mature and decline before a new one becomes feasible has led many companies to fatally delay the introduction of new technologies. New technologies exert powerful pressures on the market; companies can let this pressure work for them or against them. Many companies and industries have adopted an overly cautious, wait-and-see approach, only to be driven out of business by competitors.

To deal with this syndrome, managers must toss out the self-fulfilling and self-defeating notion of technology life cycles. There is no reliable way to

predict how long a technology will continue to be current. Instead, managers should create flexible processes that can rapidly exploit each technology's advantages.

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Intel Corp. has proved itself adept at this process. The company periodically renders its own microprocessors obsolete through relentless innovation. Although the company's 486 chip is still at an early stage of market penetration, Intel is already working on a 586 and a 686 chip. It deals with competition from reverse-engineered clone chips through innovative marketing practices and learning curve advantages.

Intel's strategy is also interesting for its extensive telescoping of future technological developments. The company has always publicized its next-generation chips before they become available, which allows customers a reassuringly predictable view of the future. Although software companies have often been accused of dealing in announced products that are greatly delayed or never arrive, Intel has consistently delivered on schedule. This strategy has locked in a large number of customers who might otherwise have migrated to other platforms.

Head in the Sand

When US companies were the only real players in the aftermath of World War II, they could survive and even prosper by not investing in expensive, new-generation technologies. Today, large domestic companies continue to compete in mature markets by essentially halting all technological development efforts. This process invites eventual devastation by aggressive domestic or foreign competitors.

Sears, for example, has long enjoyed a comfortable position in the mature lawnmower market; it has made few changes in the design of its products. In recent years, Honda has posed a strong technological challenge in the industry, effectively achieving what has been referred to as dematuring. Honda's lawnmowers embody several innovations borrowed from its expertise in automotive engineering and not found in any other lawnmowers. The company also excels in aesthetic and ergonomic product design. Sears will have to respond to this challenge if it is to protect its market.

Likewise, Kodak has long dominated the market for slide projectors, with a rather stodgy design that has basically been unchanged for two decades. Such a lack of proactive, self-initiated innovation is bound to invite a technology-minded competitor to make a serious attempt to break Kodak's stranglehold on this market. One can imagine what a new Sony or Yamaha slide projector might do to Kodak's slide projector business, just as Japanese camera companies have all but destroyed Kodak's snapshot business by creating products that combine simplicity with technological sophistication.

Technology can drastically change the operating characteristics and economics of an industry. Firms that ignore technological developments on the periphery of their industry are likely to be relegated to long-run secondary positions once such developments penetrate the mainstream of the industry.

The solution to this problem is easy to propose but difficult to put into practice. Companies must constantly and violently rock their own boat. Product improvements and refinements should be internally driven, rather than occurring as a response to competition. For example, after Sony invented the Walkman personal stereo, it has held its own against competition by constantly innovating. At last count, the company had almost 80 models of Walkmans on the market, including waterproof and sandproof models.

That's Not the Business We Are In

This syndrome, especially prevalent in companies that have dominated an in-

dustry in the past, is illustrated by Xerox's experience with PARC. Despite all their protestations to the contrary, the fact remained that Xerox rank-and-filers still regarded themselves as being in the copier business.

To counter this syndrome, senior management must undertake substantial internal marketing efforts aimed at getting the company united behind a broader definition of its mission. This would lead to a greater willingness, even an eagerness, to embrace new technologies.

Kodak has taken some bold steps to position itself for what may be a filmless future. After missing major market opportunities in 35-mm cameras and videocameras, the company has now announced an innovative new photo CD system, to be launched in early 1992. The product combines film and digital CD technologies; customers will have the option of receiving film output on paper or compact disk.

The company's earlier response to the encroachment of electronic technologies on its traditional business had been a defensive one: let's circle the wagons. The attitude the company is now trying to foster has been stated as follows: "We cannot stem the flow of technology. If the lunch is on the table and it's going to be eaten, your choice is do you eat it or does somebody else eat it?"[1]

Let's Just Research This Thing to Death

There was a time when companies could take years, even decades, to research and develop a new product. They no longer enjoy that luxury. Even competitors in mature industries (e.g., Procter & Gamble) are radically revamping and collapsing their development processes. At some point, companies have to balance the conflicting requirements of perfecting a technology and losing valuable time in the marketplace.

Two opposite examples illustrate the difficulty of this decision. Ashton-Tate Corp. rushed dBASE IV to the market before it was adequately bug-free; the firm soon had to withdraw the product after it caused many customers enormous damage. The product was relaunched almost two years later, but by that time, the company's stock price, market share, and image had been devastated (Ashton-Tate has since been acquired by a competitor, Borland International, Inc.).

On the other hand, Motorola kept important workstation makers (e.g., Hewlett-Packard) waiting for more than six months while it removed every last bug from the 68040 microprocessor. Meanwhile, many of its potential customers switched to other chip makers. In contrast, Intel shipped the 80386 and 80486 chips with some bugs remaining; it later replaced the chips with bug-free versions. Other examples of rapid product development include IBM's laptop (14 months in development) and Matsushita's fuzzy-logic washing machine, which was launched just one year after the project was initiated.

Addressing this syndrome requires a careful balancing of early-mover advantages with the disadvantage of presenting imperfect technologies to users. The latter can be mitigated in two ways. First, users must be provided with an easy and inexpensive upgrade path to the more refined technology as soon as it becomes available. Microsoft mails bug-free updated versions of its software packages to all registered users without waiting for them to call in with problems (as is the practice at most other software companies).

The second way to reduce the disadvantage is with effective communication and marketing programs. Consumers must not be caught by surprise, and they should know in advance that the company will move quickly to improve the product. They should be alerted to any major risks inherent in using a product—something Ashton-Tate failed

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[1] "Kodak Tries to Prepare for Filmless Era Without Inviting Demise of Core Business," *The Wall Street Journal* (April 18, 1991), pp. B1 and B7.

to do with early dBASE IV users, many of whom lost large amounts of valuable data.

Too Good to Be True

When technology promises benefits far greater than consumers can conceive, it naturally invites a great deal of skepticism. Ironically, the greater the promised payoff, the more resistant some companies become to investing in the technology. This almost requires that such technologies be undersold—that some of their benefits (sometimes their major benefits) be held back from the customer. Once the customer absorbs the base technology, refinements and extensions can be gradually introduced.

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Just Too Complicated

This syndrome has three aspects. The first—"Our customers will never understand this"—translates as, "We don't understand this technology well enough to explain it or package it in a form that consumers will respond to." The original IBM PC was a formidable machine, made approachable because of the use of a Charlie Chaplin character in its advertising. That friendly image helped the product achieve rapid success. Most technologies are inherently complex; products developed from these technologies need not be.

The second aspect—"Our workers aren't skilled enough to make this"—reflects one of the enduring beliefs of US management.[2] Clearly, workers with adequate training and well-designed manufacturing systems can handle almost any level of complexity. The notions of design for assembly and design for manufacturability are central to combating this syndrome.

The third aspect—"Wall Street doesn't like it"—translates as, "We haven't done an adequate job of communicating with the analyst community regarding the company's technological thrust." Wall Street's quarterly fixation on the bottom line can be somewhat mitigated with frequent communications from the company.

Design Is a Frill

Design is probably the crucial element in determining whether a new technology succeeds. Products created according to old design ideas are unlikely to win customer acceptance; they are also costly and difficult to manufacture, assemble, and repair. Many companies stress frills over functional economical design. Others go to the opposite extreme, producing completely unaesthetic products.

Eighty percent of quality and almost 100% of functional ability are locked in at the design stage, yet design occupies only a small part of the product development budget and a relatively small proportion of total development time.

Studies have shown that more than 90% of production costs are determined by design issues that themselves may take less than 5% of the development budget.[3] An example of the tremendous leverage inherent in design-related expenditures is provided by General Electric. By redesigning its gas turbines, GE reduced manufacturing costs by 25% and installation time by 70%; it doubled production with 20% less floor space.

Although US industry has gradually moved toward a greater appreciation for the role and importance of technology, the overall outlook continues to be clouded. In a relative sense, US companies have not been gaining any real ground, because their improvements have been more than offset by further gains made by competitors. Companies in every industry must come to grips with their own explicit and implicit barriers to innovation; identifying them is the first step toward their elimination. ■

[2] A survey by Continental Bank revealed that a majority of US CEOs believe their workers are inferior to those in foreign countries; however, about 80% believe that US management is better.

[3] "A Smarter Way to Manufacture," *Business Week* (April 30, 1990), pp. 110–117.