Henry Chesbrough

Graceful Exits and Missed Opportunities: Xerox's Management of its Technology Spin-off Organizations

The Xerox Corporation has devised several strategies for managing the numerous spin-off firms that independently commercialized many of its technologies. From 1979 to 1998, thirty-five technology-based organizations emerged from Xerox's research centers. Contradicting the common perception that Xerox "fumbled the future" by letting its technology walk out the door, in fact the company set in motion a series of deliberate initiatives to manage its spin-off organizations. After initially adopting a laissez-faire approach, the company soon turned to ad hoc methods, which evolved into a formal internal venture capital structure and culminated in a triage process, with the result that only companies perceived by Xerox as fitting into its overall corporate strategy were retained. By using spin-offs to withdraw gracefully from areas it considered to be marginal, Xerox forfeited the potential to realize value from their research. Some, but not all, of the spin-offs obtained venture capital financing from outside sources and thus prospered independently. Their success demonstrated the opportunity that Xerox missed in managing its spin-offs.

The fruits of industrial research fueled the rise of many major U.S. corporations during the twentieth century. A virtuous circle developed, whereby the benefits of research conferred competitive

HENRY CHESBROUGH is assistant professor and Class of 1961 Fellow at Harvard Business School.

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advantage to the firms that funded it. The firms, in turn, were able to garner sufficient profits from their businesses to reinvest in new research and thus to gain further advantages as they increased both the scale of their current business and the scope of their new ventures. The growth trajectories of companies as diverse as General Electric, DuPont, U.S. Steel, IBM, and Merck can all be attributed in part to their management of internal research.¹

At the end of the twentieth century, industrial research, particularly that conducted under the aegis of a central laboratory, had come under increasing pressure to justify its continued funding.² While central research labs discovered numerous important technologies, their owners found it increasingly difficult to create new businesses from these discoveries. Other companies, with seemingly less investment in basic research activities, frequently appropriated much of the gain from new innovations that originated in these central labs. Often, even startup companies were able to commercialize new discoveries ahead of the companies that invested in the early stages of the research that led to those inventions. Some insightful observers have thus concluded that “industrial research is at the end of an era.”³

These developments shed new light on certain aspects of business history. While many scholars have followed Alfred D. Chandler’s inquiry into the growth of managerial capitalism through economies of scope, less is understood about the hurdles to realizing those economies. The history of the Xerox Corporation reveals numerous opportunities the company had for creating new businesses from its research discoveries. While Xerox channeled the benefits it had derived from

¹This is one theme in Chandler’s seminal book, Scale and Scope (Alfred D. Chandler Jr., Scale and Scope [Cambridge, Mass., 1990]). Chandler defines his research question in part as follows: “It then becomes critical to explain how and why the institution [of the modern industrial firm] grew by adding new units—units that carried out different economic functions, operated in different geographical regions, and handled different lines of products” (p. 15). He then defines “economies of scope” as follows: “Economies of joint production or distribution are those resulting from the use of processes within a single operating unit to produce or distribute more than one product” (p. 17). Later in the volume, he includes the introduction of new products, based on internal research and technology, as one important aspect of this definition.

²Qualitative indications of this pressure abound (see Robert Buderi, Engines of Tomorrow [New York, 2000] for anecdotes from many leading industrial research laboratories). Quantitative evidence of this pressure has yet to emerge in the government statistics on R&D. The National Science Foundation Division of Science Resources, Survey of Industrial Research and Development (1998), Table E-1, reports that federal funding for R&D has fallen by over one-third in the past ten years in constant dollars. While company funding of research has offset this decline, most of that offset has come in applied research and development, not in basic research.

research into its current businesses, the company was less successful in exploiting this research to create new enterprises.

The Xerox Corporation owes its own success to the establishment of a new business based on discovery-oriented research. The company's successful commercialization of xerographic technology created the high-volume copier industry, and it became a Fortune 500 company within a decade of this effort in 1970. Xerox also wrestled with the problem of how to manage technologies that did not fit within its mainstream business. In the last two decades of the twentieth century, the Xerox Corporation conducted a series of organizational experiments to commercialize technology outside its copier and printer businesses. While the companies that were offshoots of Xerox differed in important ways, they can all be characterized as attempts to capture value from technology that could not be applied to Xerox's current business interests.

The outcome of a few of these experiments is well known. Companies such as 3Com and Adobe Systems achieved great commercial success by developing technology that originated within Xerox's research laboratories. However, this known subset of firms provides a selective and misleading view of the entirety of Xerox's experiences with technology-based spin-off companies. Most of the spin-offs that have been overlooked to date were not successful, and their lack of success qualifies much of our earlier understanding of Xerox's history. In addition, Xerox did not stand idly by while its progeny walked out the door. Instead, the company steadily refined its processes for screening and evaluating spin-off candidates. The formation of these companies, and the processes that Xerox used to manage them, will be examined here.

This article chronicles the history of an institution rather than tracing personalities or politics. Xerox managers are shown to have acted reasonably and, in some cases, to have demonstrated real vision in dealing with technologies that did not fit within the company's established businesses. On occasion, Xerox sought to profit from its technology by embedding it in a supplier (e.g., Spectra Diode Labs) or in a third

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4 The first work to attract significant attention to Xerox's activities in this area was a book, *Fumbling the Future*, by two McKinsey consultants, Douglas Smith and Robert Alexander (New York, 1988). It showed that many technologies that went on to become fundamental elements of the personal computer revolution originated in Xerox's labs at PARC. A recent book has reinvestigated these events (Michael Hiltzik, *Dealers of Lightning* [New York, 1999]). However, there are limits and omissions in both accounts of Xerox's spinout company activity. First, the events recounted in both volumes terminate in 1983. Second, both accounts omit any consideration of spin-offs from other Xerox research facilities. Third, theventure capital industry was in its infancy back in the late 1970s. The enormous expansion of that industry has also expanded the hazards faced by technology companies, even as it increases the opportunities available to technically adept researchers.
party alliance (e.g., 3Com). More often, Xerox looked for ways to exit gracefully from businesses that had become strategically unimportant to its core businesses. With the passage of time and the benefit of hindsight, though, such a reasonable strategy appears to have overlooked the potential value of Xerox's technology for uses in new businesses. These other possible applications, however, were difficult to foresee, because they often diverged sharply from the company's current pursuits. Moreover, they required years of work and significant changes to their business plans before yielding any tangible rewards.

Xerox's difficulties in realizing the potential value of its technologies from these spin-off companies also indicate the role of internal mechanisms for connecting discovery-oriented research with profit-seeking development. Xerox defined its research process as a very early-stage activity, geared to initial discovery and exploration of new phenomena. Researchers were not chartered to translate their findings into practical applications. Thus, research projects "finished" while technologies were still nascent. At the same time, Xerox defined its development process as an applied activity, allowing only a short interval before a product reached the market. This approach discouraged Xerox from funding activities that required the company to create new businesses. While this procedure allowed technologies to be created in research and transferred by development effectively within the copier and printer businesses, other technologies were created in research that had no apparent marketable value. Xerox lacked procedures to identify and transform these technologies into salable products in new business areas.

Xerox Research and "the Architecture of Information"

In 1969, Xerox chief executive Peter McColough commissioned Jacob Goldman, who was then the head of research at Xerox, to build a new laboratory within the corporate research organization to provide the company with the technology necessary to realize McColough's vision of "the architecture of information." McColough's idea was that Xerox would transcend its current business of being the leading office copier company to become the leading office equipment supplier of information-intensive products. Goldman, in turn, assigned Xerox scientist George Pake the task of creating this research organization. Pake received his assignment at a fortuitous time, when government research spending on computer technology was declining. As a result, Pake and his staff were able to recruit many of world's best researchers
PARC was but one piece of McColough's strategy to transform the company from a copier producer to an information systems creator. He acquired Scientific Data Systems (SDS) in 1969 to serve as the receptacle for computer-systems technology. Xerox made other acquisitions in key computer peripherals to bolster its position: the inventor of the daisy wheel printer, Diablo Systems; Versatec, which made large-format plotter printers; Shugart Associates, at the time the world's leading floppy-disk-drive manufacturer; and Century Data Systems, a manufacturer of hard disk drives for minicomputers and workstations.

Goldman reminded his colleagues of the story of how RCA continued to invest in perfecting the vacuum tube and failed to invest in the transistor, which quickly rendered the vacuum tube obsolete. Goldman argued that RCA's failure to pursue new science caused it to be incapable of shifting to the transistor. By implication, Xerox needed to engage in fundamental research extending beyond its own current technology, lest it too be overtaken by new inventions. Pake and his staff hired outstanding researchers in many core disciplines to form this new technical base, including physicists, mathematicians, materials scientists, computer system architects, and software engineers. Their charter was to pursue fundamental discoveries in these various fields that would "both support and extend the company's business strategies."

PARC was established to feed the larger Xerox organization with the technologies necessary to embrace the architecture of information. With these technologies, Xerox could remain enormously profitable in the coming decades. This meant transforming the company's technical base from the analog light-lens xerographic copier technology into a fully digital base that would enable digitized images, networking, and electronic-document information transfer.

This charter was likely to generate unintentional results that would spill outside the mainstream Xerox business. However, Xerox would need new insights to create the technical base for its digital future, and it was not possible to specify these in advance. Some research spillovers

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5 Smith and Alexander, Fumbling the Future; and Hiltzik, Dealers of Lightning; also personal interviews with Mark Myers on 1 June 1998 at Xerox Corporate Headquarters in Stamford, Connecticut; with William Spencer on 26 Aug. 1998 at his office at the Haas School of Business in Berkeley, California; and with John Seely Brown on 10 Apr. 1998 at his office at Xerox PARC.

6 David Kearns and David Nadler, Prophets in the Dark: How Xerox Reinvented Itself and Beat Back the Japanese (New York, 1992), 86.

would not be captured, but this outcome was viewed as a necessary cost of fundamental research. \(^8\) The underlying premise was that Xerox would find a way to harness a sufficiently large portion of the results of these investigations, so that the return to the corporation would greatly exceed the costs of doing the research.

To manage the risk of incurring enormous expenditures in the pursuit of this ambitious mission, Xerox carefully circumscribed the scope of the research effort. Development work was considered to be far more expensive than basic research, so any efforts to develop discoveries made in the lab for commercial purposes were restricted. \(^9\) Research managers accepted this mandate, as they considered development work to be less technically inventive. \(^10\) Goldman later wrote that in a large company, where “responsibilities are compartmentalized,” the technical side of the house, which is “often the research and development laboratory,” works in an insulated environment. He went on to comment that the barrier works both ways: “it impedes the transfer of new technology to the operating groups, and impedes the flow of market information to the technical people.” \(^11\)

In the early years of PARC’s operation, this limitation did not figure prominently in its day-to-day operations. \(^12\) Pake managed McColough’s expectations effectively, telling him that it would require ten years for the investment in PARC to show material benefits to the corporation. \(^13\) As Xerox attempted to digest the SDS acquisition, it began to plan to introduce products that would incorporate PARC technologies. PARC researchers perceived that Xerox corporate managers were largely satisfied with PARC’s contributions. \(^14\)

However, the 1970s proved to be a turbulent period for Xerox’s primary business in copiers. At the beginning of the decade, Xerox was quite


\(^10\) Interview with Ron Kaplan, Xerox PARC, 31 Mar. 1999.


\(^12\) Selections of the research output of PARC during its first decade are contained in an edited volume by Giuliana Lavendel, A Decade of Research: Xerox Palo Alto Research Center, 1970–1980 (New York, 1980).

\(^13\) Hiltzik, Dealers of Lightning; Smith and Alexander, Fumbling the Future. This perception was confirmed in personal interviews with John Seely Brown, William Spencer, and Robert Adams.

\(^14\) Interview with John Ellenby, at his GeoVector office on 14 Apr. 1999; interview with Robert Metcalfe at his Boston residence, 1 July 1999.
profitable. The company had done so well that it was the target of an anti-trust action, filed by the Federal Trade Commission in 1972 and settled in 1975. That settlement had the effect of forcing Xerox to license its critical patents in xerographic reproduction. Up to that time, Xerox’s market position had been strong; its market share in 1976 was 82 percent.15

The antitrust investigation and its subsequent resolution distracted Xerox management from the research activities underway at PARC. Some PARC researchers, in turn, began to see greater opportunities for their ideas outside Xerox. In 1979, employees began to leave Xerox in order to commercialize the technology in their own companies. By 1998, thirty-five new companies had been created.

Given the many research activities underway throughout Xerox’s five research centers, it is necessary to define a “technology spin-off organization” and to outline the research methodology I used to recover information on these firms. I defined a technology spin-off firm as one that satisfies three conditions: The technology was initiated or pursued for at least one year’s time within a Xerox research center. At least one Xerox researcher left, along with the technology, to become an employee of the new company. The entity that received the technology and the researcher was separated from Xerox and incorporated into a new legal entity and did not necessarily receive Xerox’s assent to create a new company.

To organize this account, I have grouped spin-off company activities into four distinct policy phases between 1979 and 1998, based on the parallel evolution of Xerox’s corporate strategic direction and the activities of the spin-offs themselves. This account will discuss a couple of illustrative companies that exemplify procedural aspects of each period, report summarily on the remaining spin-offs, and conclude with some general observations. Characteristics of the thirty-five companies are briefly noted in Table 1.

The First Spin-off Company Phase:
Laissez Faire, 1979–1982

The first of these periods, from 1979 to 1982, was characterized by Xerox’s inexperience with creating spin-off ventures and its limited appreciation for their resulting implications. During this period, Xerox

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17 To understand the processes that led to the formation of these firms, I sought to interview participants within both Xerox and the spin-off firms. To manage the inherent problems with retrospective recall and self-serving representations of events, I tried to uncover contemporaneous evidence of the ventures from public sources. Armed with these aids to memory, I interviewed respondents. I attempted to cross-check accounts of events with multiple respondents and omitted information that could not be verified with a second respondent. However, some selective memory and bias nonetheless remain in this account.
Table 1
List of Spin-off Companies and Summary Characteristics

<table>
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<tr>
<th>Phase</th>
<th>Company Name</th>
<th>Spin-off Date</th>
<th>Disposition</th>
<th>Disposition Date</th>
<th>Technology Description</th>
<th>Initial X. Equity (%)</th>
<th>Research Center</th>
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held a laissez-faire attitude toward spin-offs, choosing not to encourage them. Their employees always instigated the spin-offs themselves. However, Xerox did not specifically discourage the formation of these new companies either.

Many of the early companies were created when Xerox felt it had little to gain from further investigation in a particular area. This strategy was first illustrated by 3Com, which was formed when Xerox decided to exploit a component technology, Ethernet, by spinning it out of the company. Ethernet was the networking protocol created at PARC to connect the Star workstations with Xerox laser printers. The Star workstation was a Xerox product family that consisted of networked workstations with a graphical user interface that shared a laser printer, all connected by Ethernet. Ethernet allowed different computing elements to be added to a network without having to change any hardware. While this feature proved to be quite valuable for computers later on, it offered real and immediate benefits to copiers as well. It enabled Xerox to offer a variety of equipment configurations in its copiers and printers with a single wiring harness. Xerox first included this capability in its Xerox 1075 copier in 1982, after announcing in 1979 that all future copiers would incorporate this technology. This configuration flexibility provided a valuable savings to Xerox.

Because Ethernet technology was used to connect Xerox proprietary devices and options, Xerox attempted to reduce its cost by leasing the Ethernet technology, for a one-time payment of $1,000, to a former PARC employee, Robert Metcalfe, who had invented it while on staff. Metcalfe, in turn, worked with DEC (Digital Equipment Corporation) and Intel to create a standard around the Ethernet protocol. Intel's participation ensured that circuits would be embedded in the technology at an affordable cost, while DEC's involvement offered high-level systems integration with its VAX minicomputers.

Although this approach provided significant benefit to Xerox, the 3Com spin-off denied it the opportunity to participate in an even greater benefit: the value of developing and controlling an important industry standard for networking computers, printers, and file servers. This opportunity was not lost on Metcalfe. Armed with his license from Xerox, and with the Ethernet networking standard that was supported by DEC and Intel, he raised venture capital and started the company that became known as 3Com.

Ethernet turned out to be far more valuable as an independent product and standard than as an internal Xerox component. 3Com

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18 Interview with Robert Metcalfe, 1 July 1999.
20 Interview with Robert Metcalfe, 1 July 1999.
went public in 1984, and its market value eventually exceeded that of Xerox itself. Yet Xerox did not participate in this additional value.

VLSI Technology, Inc., was incorporated in June 1979, only two months after 3Com Corporation.²¹ Like 3Com, the basis of its technology concepts had emerged from the Star workstation initiative. PARC researchers Douglas Fairbairn and Lynn Conway, working with Carver Mead of the California Institute of Technology, had developed a set of design methodologies and supporting design tools that allowed integrated-circuit engineers to create circuit designs out of high-level logic diagrams. This ability to translate block diagrams into actual circuit layouts radically reduced the complexity required for chip design.

Like Metcalfe, Fairbairn saw that the design tools he had helped create did not have direct business potential for Xerox; Xerox’s interest in the technology was mainly as a vehicle to encourage the application of PARC Star workstation technology. Fairbairn left PARC in 1979 to start a company based on the collective work of the group. It became the first spin-off to go public, in 1983, and operated for many years as an independent company. Again, Xerox did not participate in the value created by VLSI as a stand-alone company.

Other successful companies that emerged from Xerox research during this first phase included FileNet, Komag, and Adobe. All went public and all continued to operate autonomously for many years. However, other spin-off companies that emerged from Xerox, including GRiD, Aurora, Optimem, Sunrise, and Metaphor, were not successful. With the exception of Adobe, whose researchers simply left Xerox and started operations on their own, all the departing Xerox research staff in these spin-offs chose to pursue their ideas independently but with the consent of Xerox research management.

During their first ten years of operations, the revenues of these companies differed considerably. Some firms became highly profitable, but only after a period of many years. 3Com, VLSI, Adobe, and Komag reported sales figures that exceeded $100 million within seven years of start-up, though none reached this goal within less than five years. In each case, the value of the technology commercialized by these companies came from use of the technology as an industry standard rather than as a proprietary component in a Xerox system. Firms like Aurora, Optimem, and Sunrise, which tried to create components for other companies to use in their products, died soon after separating from Xerox.

²¹ VLSI stands for Very Large Scale Integration.
By 1982, Xerox’s market position had noticeably deteriorated. Its market share had been cut in half, from 82 percent to 41 percent. The company was clearly under attack in its copier business, by IBM and Kodak at the high end and Canon and Ricoh from below. Moreover, its strategic entry into office automation would encounter difficulty during this phase. Senior executives at Xerox eventually concluded that they had to retrench and scale back their ambitions in the nascent personal computer industry in order to defend their copier business effectively.

In parallel, Xerox embarked on a company-wide restructuring, called “Leadership Through Quality,” to transform the company’s products and processes in order to increase its customers’ satisfaction. Finally, in 1983, Xerox also initiated a diversification scheme through the acquisition of financial services and insurance businesses.

This shifting context increased the divide between research and development at Xerox. PARC technologists and their managers saw enormous commercial potential for their discoveries, albeit in a new and ill-defined marketplace. The initial public offerings of VLSI, 3Com, and, later, of Adobe, Komag, and FileNet during this phase seemed to validate this perception. The financial success of some of the offshoots prompted Jacob Goldman to reflect on the unpredictability of R&D results, which do not always fit into a company’s development plans. Often “the product (or process) . . . will die on the vine.” He noted that with “the emergence of a powerful venture capital force . . . frustrated innovators [were able] to leave the secure shelter of the big company and create an environment more conducive to the promotion of innovations.”

Meanwhile, Xerox corporate managers in Rochester, New York, and Stamford, Connecticut, had just experienced years of litigation, culminating in the licensing of their core patents, with the result that they were being pummeled by their competitors in the copier market. The company believed itself to be in a fight for its corporate life.

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22 This statistic, which measures revenue market share, comes from Jacobson and Hill-kirk, Xerox, American Samurai, 71. Kearns and Nadler, Prophets in the Dark (pp. 134–5), report a share decline from 80 percent to 13 percent in copier installations, a measure of unit market share.

23 Interview with Brian Stern, president of Xerox New Enterprise, via telephone, 21 May 1999.

24 Kearns and Nadler, Prophets in the Dark, 237–56.


26 As Kearns and Nadler recount in Prophets in the Dark: “How bad off were we? If nothing was done to correct things, we would be destined to have a fire sale and close down by 1990,” p. xiv.
Coast managers were looking to their researchers for technological ammunition to fight a war. Even the diversification initiatives into financial services were intended to provide cash to give the copier business time to recover.27 The possibilities of new business products for fledgling markets offered by the PARC researchers seemed of little immediate help.28 Moreover, the startup, rush-to-market attitude characterizing

27Ibid., 259.
28As it husbanded its resources to fight back in the copier market, Xerox also began to evince greater interest in strategic partners in the nascent computer industry. For example, Xerox had made a minority equity investment in Apple and was eager to broaden its relationship with Steve Jobs and Apple. Hence, corporate executives at Xerox pushed PARC managers to “open the kimono” with Jobs—a presentation that would motivate Jobs to commercialize much of the Star workstation’s concepts in a personal computer. This led to Apple’s introduction of the Lisa, and later, the Macintosh. As Josh Lerner describes (“Xerox Technology Ventures,” Harvard Business School case no. 295-127, p. 2), Xerox had made a $1 million investment in Apple that would ultimately prove to be worth $50 million. The impetus for the detailed demonstration of PARC technology to Jobs came from the Xerox executive who was in charge of this strategic investment (Hiltzik, Dealers of Lightning, 331–3). A second example, noted above, was Metcalfe’s license from Xerox to commercialize the Ethernet technology that became 3Com, where Xerox was trying to partner with Digital Equipment Corporation and Intel.
these new ventures seemed antithetical to the Leadership Through Quality doctrine of controlled, capable processes needed to increase customers' satisfaction with Xerox's products.

While corporate management girded for war in the copier sector, some West Coast researchers became uneasy about Xerox's continued commitment to capitalize on their work. Sensing the latent potential in their own discoveries and realizing how distracted their corporate management had become by problems in the copier business, more researchers departed from PARC. As research management, in turn, began to support projects of direct, immediate value to the company, it used spin-offs to create graceful exits for research that no longer seemed useful to Xerox.

An important defining event of this new period was Bill Spencer's promotion to run Xerox PARC in 1983. Spencer had joined Xerox in 1981 to set up and manage one of their integrated-circuit fabrication facilities and then went on to become manager of one of the laboratories within PARC. Spencer was convinced that part of the job of research was the transfer of its technological discoveries to its "customers," the product development groups.29 He also had to weigh the shifting Xerox corporate direction against the needs of his research staff. This balancing had to be done delicately. He was aware of the importance of treating researchers well. He felt that firing certain researchers would send a powerfully negative message through the division and diminish the ability of PARC to recruit excellent researchers in the future.

However, some research projects were no longer critical to Xerox as it conducted its retreat from the computer marketplace. Spencer viewed spin-off organizations as one graceful way to end research support for these projects. He helped individual researchers transfer their projects outside the company, often allowing them to take equipment they had used at Xerox with them.30 In this way, he attempted to redirect PARC's staff toward work that was more closely aligned with Xerox's copier and printer businesses without alienating the researchers.31

The laissez-faire attitude toward spin-off organizations had changed at Xerox. Instead, spin-offs were now viewed as useful, provided that they served a strategic purpose for the company. The case for each

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29 Hiltzik, Dealers of Lightning, 377.
30 In particular, both Komag and SynOptics were able to take much of their lab equipment with them. In each case, some money was paid back to Xerox later for the equipment, but the ability to have immediate use of the equipment was beneficial to both companies.
31 Despite Spencer's efforts, some research staff were alienated, particularly after Spencer forced the departure of Robert Taylor from PARC. Taylor, who had been at PARC as an assistant director since its early days, had been a strong and effective proponent of a research-driven approach within PARC. Spencer's agenda to bridge the divide between research and development conflicted in many ways with Taylor's. (See Hiltzik, Dealers of Lightning, 1999.)
spin-off had to be justified at the highest organizational levels within Xerox before the process of separation was allowed to proceed. Xerox also began to take an equity interest in its spin-offs, in return for licensing its intellectual property to the new companies. Strong resistance was developing to letting researchers depart on their own initiative, as they had done in the first phase. One manifestation of this shift in attitude was Spencer’s rule of “no additional invested capital.” Spencer did not want to encourage researchers to leave, so he mandated that Xerox would not put additional money into a spin-off company. The fledgling enterprise would have to raise funds on its own, if it could.32

This rule was designed to reduce the moral hazard facing Xerox researchers with promising technology. If researchers felt that Xerox might be willing to provide financial support to a company that had been generated by their technology research, they might be encouraged to intensify their efforts in order to increase the chances of creating a spin-off. This could compromise their efforts to perform their primary task, which was to develop technologies for use within Xerox’s current businesses. Under Spencer’s rule, researchers who were tempted to leave could expect no financial help from Xerox. This reduced the temptation to create technologies expressly for spin-off commercialization. While this rule may have diminished the number of researchers working on technologies designed primarily to form the basis of new ventures, it came at a cost. The “no new funds” rule also precluded Xerox from participating in the financial success of its offshoots, beyond whatever interest it could secure for its intellectual property.

Although Spectra Diode Labs (SDL) formally evolved from PARC prior to Spencer’s promotion to the head of PARC, its separation exemplified the new approach Xerox adopted toward managing its progeny in this second phase. Moreover, Spencer had been deeply involved in orchestrating the spin-off before taking over PARC, and his positive experience with SDL influenced his later policies toward these newly created companies in the second phase.

The origins of SDL’s laser diode technology began in 1972 at PARC with the arrival of physicist Donald Scifres. A team of researchers working in Stig Hagstrom’s Physics Research Lab within PARC, including Scifres, Robert Burnham, and William Striefer, soon created powerful and efficient solid-state lasers. Laser diode research was not initially motivated by the Star workstation effort, though it quickly became apparent that innovations emerging from this group had implications in two related areas: optical recording and laser printing.33

33 Most of the techniques had been developed by Scifres, who holds a total of sixty-six patents, thirty of which are related to laser diode technology.
The impetus for spinning off SDL came directly from Xerox research management, who saw an opportunity to commercialize a PARC project without expending large amounts of additional cash. Spencer realized that Xerox's needs for laser diode technology could be met as a customer, rather than as the developer of the technology. Spencer further realized that Xerox's own production volumes would not be sufficient to support large-scale manufacturing of laser diodes. Producing laser diodes was a capital-intensive business, so a Xerox facility with low volumes would have high costs. He later described the SDL structure as using "Xerox technology, Xerox employees, Spectra Physics cash and [the administrative support of] Spectra physics. Xerox would continue to do research in high power solid state lasers, at a reduced level, and the intellectual property would be transferred to SDL. Xerox was to supply no dollars and no one remaining at Xerox would have equity in the new company. Xerox and Spectra Physics each had about 40% ownership, with 20% for the employees."34

SDL proved to be a modest success for Xerox, becoming a capable source of diode lasers for its printers and high-end copiers. Later on, SDL became a major success for its managers and shareholders, but without Xerox's participation. In 1992, Xerox realized a return of $15 million when the SDL management, led by Scifres, performed a cash buyout of the shares of both Spectra-Physics (itself now owned by Ciba-Geigy) and Xerox for $30.3 million. Three years later, in 1995, SDL went public at a market capitalization of $50 million.

Another outgrowth of PARC was SynOptics, which was incorporated by two Xerox managers, Andy Ludwick and Ron Schmidt, in October 1985. Ludwick had come to Xerox from SDS in 1969 and had served in a variety of midlevel management and sales positions. At PARC, Schmidt had developed an Ethernet-compatible system, then called AstraNet, that could operate Ethernet on an optical cabling system. This would allow much faster transmission of network data than that offered by the coaxial cabling, which was the standard cabling at the time. For nearly two years the pair tried to sell the technology for adoption within an existing Xerox division. They encountered three key impediments, as Ludwick explained:

[First] none of Xerox's operating divisions was interested in AstraNet because they did not have the right sales force to sell this

34 Personal written communication from William Spencer to the author, 15 Aug. 2000. Spencer's recollection of SDL's initial structure is broadly similar to that of Scifres, but they do differ on details. Scifres recalls that Xerox did have to invest an additional $1 million, and that Spectra Physics invested an additional $3 million into SDL. Scifres further remembers that Spectra Physics held more equity than Xerox as a result of this larger cash infusion.
system. . . . [Second], the divisions did not believe that it was possible to commercialize AstraNet within the limited window of opportunity that existed. They viewed everything in terms of copier machines, and it usually took four years to roll-out a new copier. Finally, since I thought that the market for AstraNet was at most $100 million, no one at Xerox wanted to invest any time in the technology.\textsuperscript{35}

The successful spin-off of Spectra Diode Labs had stimulated Xerox to create an Innovation Board at its corporate headquarters for considering future spin-off companies. Xerox established the Innovation Board to screen research projects in order to determine whether to allow interested individuals to form companies that would seek outside financing. Companies that received permission, in turn, agreed to give Xerox an equity position in return for a license to use its technology. Xerox would not contribute additional funds.

Ludwick and Schmidt took their AstraNet proposal to the Innovation Board, which was chaired by Frank Pipp, head of the Diversified Business Group. With Pipp's support, the pair secured an agreement that gave Xerox a 15 percent equity stake in their venture, in consideration for access to Xerox's technology and a note against Schmidt's lab equipment. Notwithstanding the Innovation Board's decision and Xerox's equity interest, there was active resistance to the spin-off within Xerox. Ludwick, who had spent years in the Xerox sales organization, vividly remembered a moment that revealed this internal resistance:

I was well connected with Stamford at the time and this helped us with our spin-off. You have to understand what was going on at the time— the relationship we had with Xerox. When we were about to spinout Astra, I spoke with the Xerox attorney over the telephone. He proceeded to ask "how do you want to go about screwing these guys?" clearly not aware that I was on the team. They wanted to make sure that we failed.\textsuperscript{36}

Despite this resistance, Astra was established with the Innovation Board's permission and became SynOptics. As its new name implied, SynOptics's initial intent was to provide the technology to run local-area computer networks faster over optical fibers. This would require SynOptics to be able to install and support new optical cabling at its customers' premises. This meant that the sales cycle for SynOptics's products would be long, and revenues would likely grow slowly. Once outside of Xerox, though, the company soon discovered a different


\textsuperscript{36} Interview with Andrew Ludwick at his residence, 22 Apr. 1999.
path. IBM had launched its token ring-cabling system in 1985 but lacked the necessary software protocols to make it run fast. Technologist Ronald Schmidt realized that the same software SynOptics was developing to run fast optical networks could be adapted to send network data much faster on IBM copper-wire networks. This allowed SynOptics to accelerate the speed of cabling that had already been installed at its customers' premises, enabling the company to serve a much larger market with a far more attractive value proposition. Revenues could now grow much faster. Within five years, SynOptics's revenues leaped to over $100 million, and the company made its initial public offering in 1988. SynOptics later merged with Wellfleet to become Bay Networks, which was subsequently acquired by Nortel.

Other spin-offs emerged as the Innovation Board reviewed technologies for possible exit from Xerox. ParcPlace and StepperVision were formed when Xerox managers determined that their respective technologies no longer fit with the company's business needs. Nor was this process confined to Xerox PARC. AMTX, Entire, Envos, and Microlytics all resulted from similar screening of Xerox technologies developed in Rochester. In this second phase, Xerox utilized spin-offs to manage strategic exits from internal technology efforts. In all these cases, Xerox received an equity stake in return for licensing its technology to the venture. Xerox invested little or no additional money in these companies, however, so its resulting equity stake in each new enterprise tended to be small. Despite Xerox's partial ownership, there was evidence of internal resistance to these spin-offs, particularly to SynOptics and ParcPlace. With the notable exception of SynOptics, which had the largest early revenues of any company in this sample, the revenues of these spin-off companies did not grow to the level achieved by the companies formed during the first phase. SynOptics grew most rapidly, reaching $700 million in its ninth year. Spectra-Diode Laboratories, by contrast, did not achieve revenues of $50 million, even in its tenth year, nor did ParcPlace or most of the other spin-offs from this phase.


By the end of the second spin-off regime, Xerox's position in the copier market had begun to improve. While its share of the market would never return to 80 percent levels, Xerox was able to regain more than ten market share points, beating back the Japanese and fighting off Kodak and IBM. During this period, PARC delivered some important technologies for the corporation. One of the most critical inventions was laser printing for Xerox's printers and copiers, an effort that
led to new Xerox products accounting for over $2.5 billion annually in revenue. This confirmed the rationale back in 1970 for PARC’s charter as a separate research center. As Robert Adams, then a Xerox senior vice president, recalled, “The laser printer alone paid for all of the other PARC research projects many times over. If some of the innovation results fall off the wagon, so what?”

_Fumbling the Future_ was published in 1988, and the impact of this book reverberated throughout Xerox, stimulating many responses. As the story was recounted in the business and financial press, PARC’s technological contributions to Xerox’s imaging business, which were acknowledged in the book, were overwhelmed by Xerox’s mismanagement of the computer applications for its technology. In response to the criticism set forth by the two authors, who were consultants for McKinsey, Xerox decided to improve its ability to profit from technology that was not utilized in its core businesses.

In reorganizing to capitalize on its technology, Xerox created a new entity in 1989, headed by Robert Adams, that effectively established a third phase for managing spin-offs. Adams had created a new business for Xerox out of PARC’s laser technology, which had fostered a multi-billion-dollar product line within Xerox. He had the support of Xerox’s chief executive officer, David Kearns, for establishing the new internal structure. This structure would work much like an internal venture capital firm. Xerox would exploit Adams’s skills in obtaining value from new PARC technologies by allowing him and his team to scan Xerox’s technology base and identify investment opportunities that might otherwise have been missed. This structure was called Xerox Technology Ventures (XTV).

XTV was given $30 million to manage. It was set up formally as a corporate division within Xerox, but Adams negotiated special terms that mimicked many aspects of independent venture capital firms. Eighty percent of the gains of the fund would go to Xerox, while the XTV principals would share the remaining 20 percent among themselves. For investments below $2 million, the XTV principals had sole discretion in whether and when to invest. For investments over $2 million, an oversight group called the Management Board (consisting of the XTV principals, the Xerox chief executive officer, chief financial officer, and a senior staff executive) had final authority. This promised

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38 It also acted as something of a consolation prize for Adams, who was passed over for a promotion within Xerox’s management, according to William Spencer. Interview at his residence in San Francisco, 17 Aug. 2000.
a far shorter deliberation process than was typical of the Innovation Board in the second period.\textsuperscript{39}

The intention of XTV was to align Xerox's incentives with those of the spin-offs and to employ venture capital processes to create value for its peripheral technologies. If there were promising technologies within Xerox that were not being utilized in Xerox's businesses, XTV provided a new path for them to enter the market. If that technology subsequently created significant economic value, XTV's investment enabled Xerox to participate substantially in the resultant value. As Kearns stated in 1993, "XTV is a hedge against the repeated missteps of the past."\textsuperscript{40}

Armed with this new structure and the charter to hunt for commercial possibilities within Xerox's technology portfolio, Adams and his partners began reviewing the company's inventions. The first opportunity they uncovered was Advanced Workstation Products (AWP). Xerox's high-end printers actually were complex computer systems that contained extensive networking connections. However, these internal computers were expensive because they were built with proprietary components, a manifestation of Xerox's approach to systems design. The development costs of these proprietary components had to be borne by the low unit volumes of its printers, in contrast to industry-standard parts costs that could be spread over large volumes. Tony Domit, vice president of a network business unit, began developing a method that used off-the-shelf components to perform the Xerox networked printer-controller functions. Domit's solution used an IBM personal computer, some special chips, and a controller board to emulate the functions of the Xerox system. As Domit recalled, "The [Xerox proprietary] approach was costing around $15K and our approach was less than $1500, not including the IBM PC."\textsuperscript{41} Domit's low-cost, "not invented here" system generated friction with internal Xerox units that were developing new extensions to their proprietary solutions. The internal development organization felt that an off-the-shelf solution would never perform well enough to substitute for its proprietary technology. This belief had frustrated Domit's ability to advance his inexpensive, informal approach within Xerox.

Under the sponsorship of Adams, and armed with funding from XTV, Domit got the opportunity to develop his strategy outside Xerox's internal development units. Domit became the CEO of AWP, which

\textsuperscript{39} Lerner provides the general terms of the XTV structure. See his "Xerox Technology Ventures," Exhibit 5.

\textsuperscript{40} Kearns's quote is taken from Larry Armstrong, "Nurturing an Employee's Brainchild," \textit{Business Week}, 23 Oct. 1993, 196.

\textsuperscript{41} Interview with Tony Domit at his office, 19 Apr. 1999.
gave him the resources to turn the print-controller system that he had designed into a final product. XTV invested $3.5 million and received 80 percent of the equity in the company. Becoming independent also gave the start-up organization the freedom to compete head-on with the internal Xerox development units in Rochester. To their surprise, Domit's group was able to raise the controller's performance to the level of the proprietary Xerox system—at one-fifth the cost.42

This price performance breakthrough gave Xerox a strategic benefit, reducing the costs of its high-end printers. Subsequently, in January 1991, one and a half years after AWP was incorporated, Xerox bought the company back for $15 million. Domit and other AWP employees, who had received a 20 percent equity stake in the new company, now profited handsomely from their work. Furthermore, the XTV partners received roughly $2.5 million from the transaction. Certain Xerox managers, who did not wish to be identified, regarded XTV's compensation as grossly excessive relative to the time and effort the partners had invested in AWP.43

XTV's third investment, Documentum, proved to be its primary money-maker. Documentum was a company formed as a direct result of the strategic intent of XTV. Xerox had done extensive research on document management, but none of the projects had resulted in new products or services. To be sure, some project results had filtered into Xerox's printers and copiers, but only as individual components of a larger system.

Robert Adams considered that the PARC document-management solutions offered pivotal know-how that could open doors for Xerox's high-end networked laser printers, while producing an outstanding business opportunity. Adams invited Howard Shao and John Newton to come to PARC and canvass its current research on document management, with a view to identifying a potential spin-off. Shao and Newton had both worked together at Ingres, a database software company. Shao had been a member of one other startup company and had spent some time at CitiCorp. The two men spent about six months talking with researchers at PARC. Much of that time was occupied with interviewing prospective customers who had significant problems with document management. For example, a pharmaceutical company that was applying for FDA approval had to manage hundreds of documents that

42 "A Walk in the PARC," Economist, 10 July 1993, 68.
43 I heard many charges and accusations made "off the record," and generally, exclude such criticisms from this account. I include this one for two reasons: first, that it was made by three separate individuals at different stages of the research; and two, it foreshadowed the later decision to terminate the XTV structure, despite its financial success. This last decision is difficult to understand, absent these sentiments.
ran into tens of thousands of pages. As Shao said later, “Xerox PARC had all of the pieces to implement a document management solution. They just didn’t know what to do with the pieces, and how to put them together.”

Documentum was formed in January 1990, and XTV took an initial 80 percent stake in the company. Beyond the founders’ systematic and thorough approach to marketing, the Xerox association was critical to the startup’s success for two reasons: it gave them direct access to customers who were interested in their intended products, and it gave them credibility with those customers. However, Documentum’s products were designed to work with IBM systems and with those of other high-end systems suppliers, as well as those of Xerox. This compatibility with such systems was inconsistent with Xerox’s preferred strategy to develop and sell complete Xerox solutions. It also required Documentum to rewrite all the software code, in order to create products that were compatible with IBM and other third-party hardware.

With subsequent rounds of financing, XTV’s ownership percentage declined. This was the only XTV spin-off that was syndicated to outside venture investors. By January 1996, Documentum had its initial public offering, creating a market value of $323 million at the end of the first day of trading. It would prove to be the most successful investment of all the XTV companies. Even though Xerox’s share had declined to 38 percent by the time of the IPO, its stake at the end of the first day of trading amounted to $106 million, the largest financial return to Xerox made by any of the spin-offs described in this study. Xerox then progressively sold off its holdings in Documentum once it became public.

Despite XTV’s tremendous financial success with Documentum, the venture nonetheless had its critics within Xerox. One senior research manager felt that Documentum had “stolen” some of PARC’s best work. He believed that much of Documentum’s success had been achieved through sales to Xerox’s top corporate accounts by Xerox’s own sales force at the expense of other Xerox products.

44 Interview with Howard Shao, 17 Aug. 1999, at his offices at Documentum.
45 Interview with Larry Mansinter, 29 Feb. 2000, at his offices at Documentum. Mansinter had worked on software projects at PARC since 1973 and had been involved in the Documentum spin-off process from the technical side of Xerox.
46 This perception is not shared by respondents from Documentum. While such a dispute cannot be adjudicated ex post, there was an organizational attempt by Xerox to utilize its document management technology more directly. About one year after Documentum was spun off, Xerox created an internal business division called Xsoft. Xsoft’s products would compete in the same space as Documentum in document management software. In the words of Xerox president Allaire, “[B]y consolidating document software development and marketing [into XSoft], we can respond more quickly to the ever-changing needs of our customers” (Business Wire, 22 Aug. 1991). In the event, Xsoft’s financial results were quite minimal, compared with those of Documentum. By 1995, Xsoft sold off many of its businesses, and others were broken off into separate Xerox New Enterprise companies in the fourth stage.
The other significant financial success in XTV's portfolio, Document Sciences (DSC), was started in the fall of 1991. Other XTV investments in Xerox spin-offs were less successful. All of XTV's portfolio companies were created and funded by the end of 1992, with the result that its focus shifted to providing them with additional funding when and if additional funds were justified. During the XTV period, though, three PARC technologies emerged from Xerox without XTV's involvement: LiveWorks, Customers and Technologies, and Xerox ColorGraphX. Each of these companies was formed after XTV had committed its available funds. XTV's participation was not sought in any of the three ventures, either by Xerox or by the Xerox researchers who were involved.

LiveWorks arose out of an ambitious project to commercialize group collaborative technology concepts that had been incubating within PARC since the mid-1980s. This project was sponsored by the new Technology and Market Development (TMD) organization, formed under Roger Levien at Xerox headquarters. Rather than being culled from research efforts that were viewed as marginal by Xerox, LiveWorks commercialized research in an area deemed central to Xerox's strategy: ubiquitous computing. Ubiquitous computing was built on multimedia, networked, and portable electronic-document access technologies, and on previous PARC research in fields like cognition and anthropology. The culmination of these efforts in 1991 produced two innovative systems devices: the E-Case, a portable electronic-document reader, which would later become the technological basis for a spin-off called Uppercase; and the LiveBoard, a sophisticated workgroup interaction tool that was the basis for LiveWorks. The LiveBoard was a large electronic whiteboard with a sixty-seven-inch diagonal display that users could access or write on from across a room with special electronic pens. Users could simultaneously view people writing on LiveBoards at two separate sites. This allowed work groups in separate cities to collaborate in real time. The devices, which were produced starting in 1994, cost between $40,000 and $50,000 dollars each.

PARC researcher Richard Bruce, who had been leading the project since 1989, became president of the group, which started with about thirty full-time "consultants." The group had already completed twelve preproduction LiveBoard units by the time it officially became LiveWorks in August 1992. However, it faced significant challenges, including the lack of a viable manufacturing plan and significant cost overruns.

An outside CEO was brought in to replace Bruce once the venture was formally launched as an independent entity. The company continued to struggle to meet its costs and to supply LiveBoards of acceptable quality. Despite reaching revenues of $14 million, the company continued to incur significant financial losses. By 1996, the outside CEO had
left and was replaced by Timothy da Silva. After investing over $35 million in LiveWorks, Xerox officially shut it down in July 1997.

Customers and Technologies was formed by two Xerox researchers who left without formal permission from Xerox in 1994. They attempted to use the findings of Xerox's research on document management by offering a consulting service to commercial clients. The company operated for a number of years but never achieved significant revenues. ColorGraphX was spun off from Xerox under Barry Lathan in 1996 but was then incorporated back into Xerox's large-format printing business, Xerox Engineering Services, three years later. It similarly did not make much money.

XTV's Performance and Its Termination

By 1996, the XTV pool of $30 million committed in 1989 had returned a total of $219 million to Xerox, after fees and profit sharing with the general partners at XTV, according to one calculation. This represented an internal rate of return exceeding 56 percent, which compared very favorably with the 13.7 percent average rate of return from other independent venture capital funds that started in 1989. By any reasonable standard, XTV had been a tremendous financial success for Xerox. The XTV portfolio derived its returns primarily from two successful ventures: Documentum's revenues exceeded $120 million in its seventh year of operation, while Document Sciences earned close to $20 million during the same period. These gains more than covered the losses from other XTV investments. XTV succeeded because it relied on methods adopted by successful ventures and bypassed Xerox's internal processes. By contrast, LiveWorks, CTI, and Xerox ColorgrafX, which did not utilize XTV's approach, went nowhere. XTV also enabled Xerox to own a larger share of the ventures and thus to reap more of the profits when they succeeded.

Yet, despite this performance, Xerox elected to terminate the fund in 1996. This decision was a puzzling one, and the reasons for it have been difficult to unravel. One issue was the autonomy accorded Adams and the XTV principals. Some senior Xerox managers felt that this independence compromised the ability to develop strategic ties between

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47 Some of the facts surrounding the failure of LiveWorks were unavailable to me because of the terms of a settlement of a lawsuit between Xerox and three of the outside professional managers (which did not include Bruce) of the failed venture.

48 The assumptions behind these calculations are detailed in Josh Lerner, "Xerox Technology Ventures: January 1997 Teaching Note," Harvard Business School case no. 5-298-152, 1998. They assume that XTV liquidated its position at the end of the first day of public trading for Documentum and Document Sciences.
the spin-off technologies and Xerox's internal businesses. Once the technologies were diverted into startup companies funded by XTV, the spin-offs treated the Xerox businesses just as they would any other potential customer. There were allegations that some of the success of the most profitable XTV companies, Documentum and Document Sciences, came partially at the expense of Xerox products. The rate of return earned by XTV took no account of this potential lost business to Xerox. Indeed, the XTV structure and its incentive systems assigned no value to fostering synergy with Xerox's own businesses.

While these are plausible critiques of the XTV structure, one suspects that there were additional reasons for the decision to terminate the fund. These incentive issues were obvious from the outset, yet Xerox nonetheless chose to proceed with XTV. Xerox managers' envy of the wealth accrued by Adams and his two partners may have been another reason. XTV capitalized on technologies that were available to internal Xerox businesses, and XTV's success might have made the internal units look bad by comparison. The penchant for autonomy by XTV and the prior history of resistance to spin-offs in the Xerox culture in general probably added fuel to the fire and continued to be an issue well after the events of the third phase.

A final contributory factor in the demise of XTV was that its financial success may not have directly translated into gains for Xerox's shareholders. The earnings through Documentum and Document Sciences, for example, might have been discounted by financial analysts as "one-time gains" or nonrecurring items. Such one-time gains may not have yielded much to Xerox's shareholders. Possibly Xerox needed an additional financial mechanism to convert revenue from its spin-offs into equity gains for its shareholders.

The Aftermath of XTV's Dissolution: Xerox New Enterprise

Although Xerox terminated its XTV structure, it remained interested in managing spin-offs in order to profit from its technology. It soon began to set up a new and different process to evaluate technologies for commercialization, including the creation of new businesses. This time, the creation of synergy with Xerox's own businesses was of paramount concern. Rafik Loufty, then vice president of corporate

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49 Under two scenarios of returns to Xerox after partners' fees, one from Lerner (see above) of $219 million, and the second from Adams's claim of $300 million, the three XTV partners would have received between $55 and $75 million as their portion of the returns from for the six years they spent with the fund. In addition, they would have collectively received 2 percent of the fund each year for salary and administration.
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research and development, recounts how in 1996 he began to look for ways that the corporation could commercialize its software and solutions technology. After asking the question, “How should we parse the $1 billion we have in R&D?” he elaborated: “At that time, there was no path for our technology to get to market. We felt that our business groups did not have the capability, nor the complementarity with their current businesses to adequately assess these technologies on their own.”

The new process that the company came up with examined promising technologies and offered them first to the business units. One impetus was to speed up the time it took for a product to leave the lab and reach the marketplace. A new aspect of this review was that the business units had nine months either to commit themselves to or decide against adoption of these technologies. “Adoption” meant that the business units would take over their subsequent funding and development. Prior to this mechanism, business units could only express interest in a technology. This meant that the research unit had to continue to develop the technology without a firm commitment to its subsequent deployment. Research managers at Xerox felt that a procedure was necessary to avoid this delay, to move technologies out to the market.

The new process started by identifying and selecting technologies that had matured to the point where their eventual commercial path could be evaluated. These projects were aggregated and screened. The final selections were evaluated, and of these, only some were commercialized outside the company.

The Corporate Innovation Council (CIC) was formed within Xerox to manage this process. Mark Myers, senior vice president of Corporate Research and Technology at Xerox and the cochair of CIC, explained the four options for commercializing technologies:

When we evaluate technologies for spinout, we filter candidate technologies into four categories. (1) The ones that our business groups [BGs] are willing to fund get top priority and are effectively sponsored by the business units. (2) Technologies that the business units are not willing to acquire, but the Xerox New Enterprise Board [XNE] is willing to support, get second priority. (3) Spinning the technology out to the venture community. If we’re not interested in the technology for ourselves, it may be best for the employees and for Xerox to spin the thing out. There may even be an opportunity

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50 Interview with Rafik Loutfy, then vice president, Corporate Research and Development, at Xerox PARC, 9 Apr. 1998.
for the spinout to be a supplier to Xerox later on. And of course, (4) we don't commercialize it, and instead keep it in the labs.52

Promising candidates were given seed funding for assessment of their technical feasibility and potential market value. This phase might last an additional three to six months. At the end of that period, the technology was reviewed, with the goal of placing it in one of the four different paths to market.

Xerox established the Xerox New Enterprise (XNE) Board as a holding company of internally funded ventures and a place for incubating technology and business projects that did not fit comfortably inside the Xerox corporate structure but held promise for the company's long-term strategy. The president of XNE reported to the CFO of Xerox. XNE was designed to combine the power of the Xerox Corporation with the entrepreneurial environment of a startup. Mark Myers explained that Xerox would maintain "at least 50% ownership of these quasi-independent entities." He pointed at that "the employees of these companies are thinking as entrepreneurs, not as Xerox employees," and thus are not particularly interested in being reacquired by Xerox at some later date. Nor did Xerox want to buy back all the businesses. "We would only want to buy back the good ones, and valuations are high these days."53

XNE was structured to provide access to corporate resources without imposing corporate structure. Following the model constructed by Thermo Electron, XNE provided legal, financial, and strategic services to the businesses in its portfolio and charged a low percentage of revenue for these services.54 While Xerox owned, funded, and managed the XNE companies, each was legally distinct from the parent corporation. XNE employees were not Xerox employees, and any Xerox personnel that joined an XNE company had to resign from the parent company. While salaries of XNE companies were comparable to those in Xerox, the benefits packages varied. Perhaps most important, up to 20 percent of the stock in each XNE company was reserved for managers and employees.

52 Mark Myers, Xerox Chief Technology Officer, quoted in Christina Darwall and Henry Chesbrough, "PlaceWare: Issues in Structuring a Xerox Technology Spin-off," Harvard Business School case no. 699-001, 1999, 3.

53 Myers's quote is from Darwall and Chesbrough, "Inxight," 2.

Each XNE venture had a president who reported to the head of Xerox New Enterprise. Each new company had a board of directors, chaired by the head of XNE. The other members of each board were two other XNE company presidents and representatives from Xerox corporate management. The head of XNE reported to the CFO of Xerox, who in turn reported to the CEO.

In June 1996, Chrystal Software, which had created the document management software application called Astoria, became the first business to be moved out of Xerox’s XSoft unit into XNE. The Astoria application broke down documents as objects and could distinguish between “boiler plate” and custom components. This functionality was marketed to large corporations, such as insurance and manufacturing companies, as well as to other traditional Xerox customers. Though Astoria had modest sales while it was still an XSoft product, no Xerox divisions were interested in supporting the Astoria software product line.

Xerox retained 80 percent of the company’s equity. The first CEO of Chrystal was Steven Kiser, who had most recently served as XSoft’s president and had previously performed various strategic and general management roles inside Xerox. By the time Chrystal was spun off in June 1996, it already had an installed base of about thirty systems. Chrystal found some aspects of XNE management beneficial, as it was not forced to face the fiscal challenges that “normal startups” typically confront. In Kiser’s words, “We didn’t have to look for cash, and could essentially ignore issues like making payroll,” which often preoccupied management of more traditional startup ventures. Furthermore, they would be able to utilize Xerox’s marketing and sales organizations to sell their product, and they also inherited additional promising software products from Xerox.

As operations under XNE oversight evolved, however, Kiser and his team saw that there were also tradeoffs in the arrangement: First, by having to negotiate their annual budgets many months in advance, they lost some operational flexibility, reducing their ability to respond to unforeseen issues and opportunities. Second, Kiser felt that the small organization had no leverage over the Xerox marketing and sales forces and could not motivate it to sell the Astoria software with Xerox’s mainline products. Finally, Kiser felt the processes XNE followed to foster synergy with Xerox’s businesses were not appropriate for Chrystal: “There’s a huge gap between Xerox corporate strategy and our needs. Software companies have to work at the speed of light because things are changing so fast. This isn’t possible under strict Xerox oversight.”

55 Interview with Steve Kiser, former CEO of Chrystal Software, at his office at Chrystal, 20 Apr. 1999.
While Xerox's Corporate Innovation Council was redirecting technologies back into the business units or into the XNE incubation structure, one of its technologies was transferred to the external capital markets (i.e., not into XNE) for further funding and commercialization. This new entity was PlaceWare, which commercialized Internet software technology to enable group interactions over the Web.\(^56\) The PlaceWare technology had originated with researcher Pavel Curtis in 1990. Curtis wanted to understand how a community of users responded to tools that enabled them to construct virtual meeting places and define their own cyber interactions. In 1994, Richard Bruce, who had recently stepped down as general manager of LiveWorks, was appointed administrator of the project.

Under Bruce, the company recruited an outside marketing consultant and interacted with potential customers such as Hewlett-Packard and third parties like Sun and its JavaSoft group to identify applications for their technology. This proved to be challenging, both inside and outside of Xerox, because the technology was ahead of its time. Outside parties, though impressed with the technology, were unable to envision specific applications. In the words of Xerox researcher Bob Kravacic, it was “a platform in search of an application.”\(^57\) Within Xerox, management did not consider it to be a strategic technology.

In June 1996, Bruce pitched a plan to CIC that featured a Xerox minority share and the inclusion of outside capital and know-how. CIC approved the plan and assigned Andrew Garman to negotiate with outside investors. Garman succeeded in bringing in two private individual investors, Rick Magnuson and Kanwal Rekhi, for a seed round, and PlaceWare was spun off in November 1996. PlaceWare was unique among the Xerox offshoots of this period in that Xerox did not have oversight and held only a minority equity position. One year after it was established, Richard Bruce, PlaceWare’s initial CEO, returned to PARC. In 1997, the company brought in an outside CEO, Barry Folsom, to run the company. In that same year, the company had its first venture round at a $15 million valuation.

The other XNE spin-offs are shown in Table 1. One of them, Xerox Engineering Systems, has aggregated Xerox’s large-format printing businesses for engineering and architectural applications. These businesses, initially acquired from Versatec, have developed within Xerox over the course of many years. The company is rumored to be planning an IPO for the near future. Another firm, Inxight, has raised some outside equity funding and may eventually go public as well. The other

\(^56\) See Darwall and Chesbrough, “PlaceWare: Issues in Structuring a Xerox Technology Spinout.” This case provides an excellent overview of the PlaceWare spin-off process and issues.

\(^57\) Interview with Robert Kravacic at Xerox PARC, 12 Aug. 1998.
XNE companies started between 1996 and 1998, however, have either been shut down or sold off at a loss.

Although XNE is still relatively new, its spin-offs have not matched the revenue records of the best of the earlier spin-offs. The most visible spin-off from XNE, dPix, received $40 million in its fourth year of operation. This venture attempted to commercialize the amorphous silicon flat-panel display technology that had been developed at PARC. However, it required a great deal of capital and was highly unprofitable. Xerox sold the company to Planar Systems, a collaboration of Siemens, Thomson CSF, and Philips Medical Systems, but retained a 20 percent interest in the company, which resulted in its having to write off tens of millions of dollars in losses. Two other software companies, PlaceWare and Inxight, brought in close to $10 million in revenues in their fourth year of operation, almost breaking even.

XNE's structure was designed to coordinate strategic links between the XNE spin-offs and Xerox's own businesses, while providing a more entrepreneurial environment for the new companies. The performance of its spin-offs to date, though, lagged behind that of the XTV regime. With the exception of XES, which really consolidated a number of established niche technologies into a single company, there were not yet any early examples of XNE successfully nurturing a spin-off entity.

There are also suggestions that XNE's processes have not enabled its ventures to adapt to new opportunities and issues as rapidly as needed. Capital infusions are tied to the annual budget cycle and are inflexible between cycles. XNE's reporting and governance relations are more typical of corporate hierarchies than of venture companies. While it has mimicked particular corporate processes found in the Thermo-Electron model, the XNE structure has neglected the attribute that infused external market discipline and oversight into the Thermo-Electron companies: the public listing of stock in each venture. The procedures that XNE utilizes must continue to evolve if they are to foster the development of new businesses for Xerox.

Conclusion

One implication to be derived from this history is that research-driven companies cannot continue to rely on the processes they have in

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58 The commitment to publicly list the spin-off requires that the spin-off have sufficient size and momentum to qualify for listing, and be able to survive as a public entity. By contrast, XNE is spinning off early stage technologies into companies that, with the single exception of XES, are years away from qualifying for an IPO. For more on Thermo Electron's approach, see Allen, "Capital Markets and Corporate Structure."
place for connecting research products with current businesses, in or-

der order to nurture new business ventures. Xerox's research investments in

the Architecture of Information led to potentially promising technolo-
gies that lacked a direct connection to its core businesses. This caused
Xerox to form a number of spin-off companies. Xerox's current busi-
ness was able to benefit from some of its offshoots. In three instances—
Advanced Workstation Products, Xerox ColorGraphX, and Xerox
Engineering Systems—Xerox acted to retain the technologies created
by the new companies and incorporate them into its main products.

Xerox was able to lower the production costs of its laser diode compo-

nents through its formation of Spectra Diode Labs, and its standardiza-
tion of Ethernet via 3Com led to lower costs and greater configuration
flexibility in its own copiers and printers. The many other technologies
that were spun off, though, did not materially enhance Xerox's existing
businesses or lead to the creation of new Xerox enterprises.

Another aspect of this history is the challenge that companies with

proprietary technologies face in adjusting to the advent of open stan-
dards. Xerox enjoyed a strong proprietary technology position in the
office copier market. It sought to create technologies that would further
that advantage, and indeed the company fostered a number of such ad-

vances. However, it did not foresee the business opportunities that
could arise from a different strategy entailing open hardware and soft-
ware standards. Exploiting such a strategy could have enabled the for-

mation of new Xerox businesses. These businesses, however, would
have added value to systems manufactured by companies other than
Xerox. As evidenced by Xerox's management of the technologies be-

hind VLSI, 3Com, and later, Adobe, Xerox managers did not under-
stand how they could create new and profitable businesses based upon
competition within open standards. Even after open hardware and soft-
ware standards were well established in the computer industry, Xerox
still was unable to use them to form new businesses, as evidenced by
the AWP and Documentum spin-offs. Indeed, although Xerox has cre-
ated a number of important software technologies, the company has yet
to capitalize effectively on any of these technologies, as shown in the
Chryystal spin-off and the problems of the Xsoft division.

Many of the spin-off ventures originated as vehicles to exit grace-
fully from technological areas no longer deemed relevant to Xerox.
When Xerox determined that its current businesses no longer needed

technologies in networked workstations or mass storage, it jettisoned
potentially valuable technologies (along with their researchers and
equipment), as in the cases of Komag and SynOptics. Xerox apparently
lacked internal procedures at the time that could have incorporated
these technologies into new businesses within the company.
Later on, when Xerox created XTV, it appeared to have found some of these processes. The XTV system did create two profitable new business opportunities and allowed Xerox to participate significantly in their financial success. A third venture significantly reduced Xerox’s own costs with off-the-shelf parts that likely would not have been developed without XTV’s involvement. Despite this success, Xerox chose to abandon XTV and its business creation processes.

Xerox’s focus on its current businesses seems to have caused Xerox management to discount revenues and financial gains in new areas. Even in situations where a spin-off company achieved a significant financial return for Xerox, Xerox managers still were often critical if that return was realized without any perceived benefit to the main businesses of the company. This disapproval manifested itself during the formation of SynOptics and intensified during the period when the XTV companies, such as AWP, Documentum, Document Sciences, and even the XTV fund itself, were being established. Instead of building on the success of these ventures and on their ability to expand into new business areas, Xerox disbanded these efforts and sold off their equity interests.

Generally, both spin-off participants and Xerox executives felt that the corporate strategic imperatives of Xerox’s current businesses outweighed Xerox’s goal of generating new businesses. As one manager who participated in two of the spin-offs put it:

And at the end of the day, even if things do go well for the spin-off, with the right incentives and the company survives and makes it, you get a $20 million company. This is a rounding error for Xerox. Moreover, Xerox doesn’t benefit directly by the market cap of the company, they really only benefit from revenues and earnings, so they even play by a different set of financial rules from the VCs [venture capitalists]. So for Xerox, the key has to be how to leverage the Big House, the printing engine, vs. seeding the next 3Com.\(^59\)

Xerox chief technology officer Mark Myers agreed, noting that, as a $20 billion company Xerox needs “to add $2–3 billion in new revenues every year.” He commented that the typical payout of $10–$50 million from a successful spinout wouldn’t “make a dent,” and he concluded: “We just can’t meet our growth goals using these spinout mechanisms.”\(^60\)

Figure 1 provides a poignant commentary on these observations. It displays the market capitalization of Xerox alongside that of the top ten spin-off companies. It also aggregates the top ten spin-offs and compares that combined figure with Xerox’s market capitalization. In 1994

\(^{59}\) Interview with Richard Bruce, 31 Mar. 1999, at Xerox PARC.

\(^{60}\) Interview with Mark Myers, 1 June 1998, at Xerox Corporate Headquarters in Stamford.
the combined value of these emergent companies exceeded that of Xerox itself, and it continued to do so from 1999 onward. Myers’s perspective was correct in the short term: it took many years for spin-off companies to generate significant revenues and “make a dent” in Xerox’s growth goals. However, with the passage of additional time, these new ventures generated significant revenues and earnings, yielding a market value greater than that of Xerox itself. Over time, these ventures could indeed “make a dent” in Xerox’s growth.

While Xerox did participate financially in a few of these companies, such as SynOptics, Documentum, and Document Sciences, its financial return overall is very small in relation to the market value, as shown in Figure 1. The market value reflects not only the potential that resided in Xerox’s technology, but also the importance of developing processes to create new markets for that technology. Indeed, Xerox could have managed its spin-offs as a portfolio and relied on external venture capital to administer these companies. While any individual spin-off would likely fail, a few might perform well and become significant companies. Xerox’s risk would be limited to its initial investment, while its rewards would be unbounded. Thus, such a portfolio of spin-offs could be regarded as a series of “real options.”61 Instead of looking to them primarily for near term revenue that would be incremental to the current

61 For an introduction to real options, and their application to research projects, see Lenos Trigeorgis, Real Options: Managerial Flexibility and Strategy in Resource Allocation (Cambridge, Mass., 1996).
business, the spin-offs could be managed as long-term options on new future markets. This would free the spin-offs from the tyranny of supporting only the existing businesses and could provide Xerox with a platform for building future businesses.

Xerox’s graceful exits thus may have led to lost opportunities. This history suggests that Xerox’s managers may have erred by expecting to derive profit from the company’s research that would apply only to its current businesses. This has caused Xerox to forfeit chances to participate in the creation of new businesses that utilized this research. The data in Figure 1 suggest that Xerox therefore missed out on important sources of new value creation.

In some respects, the challenges of the business environment have significantly intensified since Xerox’s first spin-off companies were created in 1979. Venture capital has swelled to enormous proportions relative to its size at that time. The labor mobility of skilled technical personnel has increased, so keeping talented researchers has become more difficult. Even highly specialized Ph.D. graduates are eschewing careers at research laboratories, choosing instead to commercialize technology through startup companies. What proved challenging for Xerox through most of the period from 1979 through 1998 was also troubling afterward.

Thus, Xerox’s experience managing its spin-offs may serve as a cautionary tale to other firms that conduct discovery-oriented internal research. It is likely that all research-driven companies will find themselves—at least occasionally—with technologies that lack a clear path to the market within the companies’ current businesses. Such technologies cannot simply be kept “on the shelf” until the day when the company is ready to make use of them. Today, all research-oriented companies operate in the shadow of venture capital, with the resulting external options for people and technology that this implies. These outside opportunities increase the pressure upon the research-driven firm to deploy the technology itself or risk seeing it developed elsewhere without any benefit for the firm that funded the research.

The history of Xerox has important implications for the organization of basic, discovery-oriented research. If a company restricts itself to utilizing only the results that support its current business, the day will inevitably come when that business matures and declines. In order to sustain a strong, long-term commitment to basic research, companies must learn to develop new businesses from the seeds of their research efforts. If they cannot do so, they will be unable to sustain their research efforts beyond the life of their current businesses.

This history also suggests that the processes that companies will need to nurture such enterprises will differ greatly from the methods
they employ to manage their current businesses. Instead of trying to align resources with current customers and markets, companies will have to establish procedures for promoting experimentation in new areas. This account further suggests that some of the venture capital methods that are employed for commercializing startups may be relevant to such a task. Companies will have to devise strategies for halting investment in failing experiments and for channeling additional resources in a timely way to experiments that are succeeding. These issues are sure to figure prominently in the pursuit of economies of scope during the next era in industrial research.