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The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies

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This paper explores the role of the business model in capturing value from early stage technology. A successful business model creates a heuristic logic that connects technical potential with the realization of economic value. The business model unlocks latent value from a technology, but its logic constrains the subsequent search for new, alternative models for other technologies later on—an implicit cognitive dimension overlooked in most discourse on the topic. We explore the intellectual roots of the concept, offer a working definition and show how the Xerox Corporation arose by employing an effective business model to commercialize a technology rejected by other leading companies of the day. We then show the long shadow that this model cast upon Xerox's later management of selected spin-off companies from Xerox PARC. Xerox evaluated the technical potential of these spin-offs through its own business model, while those spin-offs that became successful did so through evolving business models that came to differ substantially from that of Xerox. The search and learning for an effective business model in failed ventures, by contrast, were quite limited.

1. Introduction

> Not everything we start ends up fitting with our businesses later on. Many of the ideas we work on here involve a paradigm shift in order to deliver value. So sometimes we must work particularly hard to find the 'architecture of the revenues.' . . . here at Xerox, there has been a growing appreciation for the struggle to create a value proposition for our research output, and for the fact that this struggle is as valuable as inventing the technology itself. (John Seely Brown, Chief Scientist of the Xerox Corporation and Director of the Xerox Palo Alto Research Center[1])

Established firms as well as startups take technology to market through a venture

[1]The quotation is taken from Chesbrough (1998: 1).

shaped by a specific business model, whether explicitly considered or implicitly embodied in the act of innovation. The inherent value of a technology remains latent until it is commercialized in some way. In some instances, an innovation can successfully employ a business model already familiar to the firm. In other cases, though, such a business model will not fit the circumstances of the technological or market opportunity. In the latter cases, technology managers must expand their perspectives, to find the right business model, or 'the architecture of the revenue', in order to capture value from that technology. Failure to do so will cause technologies to yield less value to the firm than they might otherwise. Consistent failure to do so may cause the corporation to reduce, or even withdraw from, its commitment to the creation of potential technologies in the first place (Rosenbloom and Spencer, 1996).

The next section develops the antecedents of the idea of the business model in business strategy, while the third section offers a working definition of the idea, and an illustration of it. In the fourth section, we describe the role of business models in several ventures designed to commercialize technologies originally developed at the Xerox Corporation's Palo Alto Research Center (PARC). While those technologies originated under the aegis of the Xerox Corporation, most of the commercial spin-offs ultimately employed models that differed in important ways from the traditional Xerox business model. The final section of the paper presents some observations on the implications of this evidence.

2. Antecedents to the business model concept

Alfred Chandler's seminal *Strategy and Structure* (1962) presented the first systematic and comparative account of growth and change in the modern industrial corporation. He showed how the challenges of diversity implicit in a strategy of growth called for imaginative responses in administration of the enterprise. In his subsequent work, Chandler (1990) showed how scale and scope economies provided new growth opportunities for the corporation during the second industrial revolution.[2]

Ansoff (1965) built upon ideas from *Strategy and Structure* and applied them to emerging concepts of corporate strategy. Strategy came to be seen as a conscious plan to align the firm with opportunities and threats posed by its environment. In 1971 Andrews was one of the first theorists to differentiate between a business strategy and a corporate strategy. He held the former to be 'the product-market choices made by division or product line management in a diversified company' (Andrews, 1987: xi). Corporate strategy was a superset of business strategy.

[2]Chandler (1990: 15) 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.' Later in the volume, he includes the introduction of new products, based on internal research and technology, as part of this definition.

> Like business strategy, [corporate strategy] defines products and markets—and determines the company's course into the almost indefinite future. . . . A company will have only one corporate strategy but may incorporate into its concept of itself several business strategies. (ibid.: xi)

Thus, a firm's current businesses influenced its choice of likely future businesses as well.

While the notion of strategy was subsequently developed in a myriad of directions, one branch of its development that prefigures the argument here was research in how managers could leverage the resources of the organization beyond that organization's current business. Early work started from a cognitive model of rational calculation and full information. Edith Penrose (1959) introduced the notion of sources of growth for the firm arising from management's ability to manage additional businesses. Teece (1982) relaxed the assumption of full information, building a framework where a firm's underutilized resources, combined with imperfections in the markets, conferred advantage for diversification moves. Empirical evidence has shown how a firm's technological position helped it enter nearby business areas, because experience in 'related' technologies reduced the costs of entering into adjacent areas (Teece *et al.*, 1993; Silverman, 1999). Mintzberg (1979, 1994) relaxed still further the information assumptions underlying the process of making strategy. He identified the 'emergent' character of many successful strategies, and emphasized the importance of adaptation over teleological planning. Burgelman (1983a,b) developed a process model for how a firm can enact strategic change based on managing limited information.

A later branch of the strategy literature incorporated cognitive bias into the idea of strategy. Prahalad and Bettis (1986) introduced the notion of a dominant logic: a set of heuristic rules, norms and beliefs that managers create to guide their actions. This logic usefully focuses managers' attention, as they seek new opportunities for the firm. It facilitates organizational coordination across different parts of the company. Importantly for the present paper, the dominant logic also implicitly filters out ideas and behaviors that do not comport with the dominant logic. This selection mechanism works to maintain focus and internal coherence among the firm's activities.[3] Empirical examples of this path-dependent behavior can be found in autos (Abernathy *et al.*, 1983), semiconductor equipment (Henderson and Clark, 1990), disk drives (Christensen, 1997) and typesetting (Tripsas, 1997).

The technological management literature shows that firms have great difficulty managing innovations that fall outside of their previous experience, where their earlier beliefs and practices do not apply. Authors do not agree, however, whether the roots of that difficulty lie in characteristics of the technology itself, the management processes employed to manage it, or the means used to access the surrounding resources. Some

[3]Prahalad and Bettis regard managers' cognition as bounded in its scope. Prahalad's later work with Hamel around utilizing 'core competence' in designing and developing new businesses (Prahalad and Hamel, 1990) effectively assumes greater rationality than his earlier work. The present paper builds upon Prahalad's earlier assumption with Bettis of more bounded rationality of managers.

scholars conclude that firms may indeed develop the ability to manage new technological opportunities effectively if they invest in integrative capabilities (Henderson, 1994), ambidextrous internal processes (Tushman and O'Reilly, 1997) or complementary assets (Tripsas, 1997). Other scholars believe that the firm must avoid internal resource allocation processes, and manage disruptive technologies outside the main business (e.g. Christensen, 1997).

The present paper seeks to contribute to this literature by offering the business model as a construct that can inform these earlier perspectives. The business model provides a coherent framework that takes technological characteristics and potentials as inputs, and converts them through customers and markets into economic outputs. The business model is thus conceived as a focusing device that mediates between technology development and economic value creation. The failure of incumbent firms to manage effectively in the face of technological change can be understood as the difficulty these firms have in perceiving and then enacting new business models, when technological change requires it.[4] We argue that firms need to understand the cognitive role of the business model, in order to commercialize technology in ways that will allow firms to capture value from their technology investments, when opportunities presented by its technologies do not fit well with the firm's current business model.

3. The business model as a mediating construct between technology and economic value

While the term 'business model' is often used these days, it is seldom defined explicitly.[5] The rise of e-commerce, with its myriad new firms eschewing conventional ways of doing business, has thrown a spotlight on the topic, which is widely discussed by practitioners and investors, but is not yet prominent in academic discourse. A search of the World Wide Web turned up 107 000 references to 'business model', including the one quoted above. In contrast, in the academic literature, which remains slow to reflect new terminology from practice, a search of a database of academic journals in economics found only three citations for the phrase, none using it in the sense implied here.[6]

[4]Chesbrough (2001) identifies three classes of problems that incumbents have in managing technical discontinuities: (i) managing internal complexity, (ii) managing external linkages and (iii) managing institutional environmental differences. Our framework of the business model addresses the first two of these, but is silent on the third.

[5]An exception is the following definition, offered by KMLab, Inc., a consulting firm: '. . . a Business model is a description of how your company intends to create value in the marketplace. It includes that unique combination of products, services, image, and distribution that your company carries forward. It also includes the underlying organization of people, and the operational infrastructure that they use to accomplish their work' (see http://www.kmlab.com/4Gwarfare.html, accessed 20 June 2000).

[6]The Web search was done using Google; the economics database used was Econolit. Searches were performed in May 2000.

One reason why academic scholarship has not focused on the concept may be that it draws from and integrates a variety of academic and functional disciplines, gaining prominence in none. The academic applications, accordingly, are emerging in management curricula, rather than in the scholarly disciplines.[7] For example, the syllabus for a course called 'Managing the Digital Enterprise', includes a section on business models that begins as follows.

> Business models are perhaps the most discussed and least understood aspect of the web. There is so much talk about how the web changes traditional business models. But there is little clear-cut evidence of exactly what this means.
>
> In the most basic sense, a business model is the method of doing business by which a company can sustain itself—that is, generate revenue. The business model spells out how a company makes money by specifying where it is positioned in the value chain.[8]

This is one of many depictions of the variety of business models that have proliferated on the Internet. The essence of the idea is 'how you get paid', or 'how you make money', with a taxonomy of alternative mechanisms. A recent academic book, *Internet Business Models and Strategies*, devotes a chapter to discussion of the components of a business model, which the authors define as describing 'how [the firm] plans to make money long-term using the Internet' (Afuah and Tucci, 2000: ch. 4, p. 2).[9]

In essence, these definitions are modern variations on Andrews's 1971 classic definition of the strategy of a business unit. They are also phrased at a high level of abstraction. We offer the following, more detailed and operational, definition:

The functions of a business model are to:

- articulate the *value proposition*, i.e. the value created for users by the offering based on the technology;
- identify a *market segment*, i.e. the users to whom the technology is useful and for what purpose, and specify the revenue generation mechanism(s) for the firm;
- define the structure of the *value chain* within the firm required to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain;
- estimate the *cost structure* and *profit potential* of producing the offering, given the value proposition and value chain structure chosen;

[7]In the mid-1990s, one of us designed and led a series of management workshops on 'The Business Model' to introduce the concept to a group of senior technology managers. The topics in that workshop included ideas and methods from strategy, finance, operations, logistics, marketing and entrepreneurship (see Buderi, 1998).

[8]This course was offered by Professor Michael Rappa at North Carolina State University at Raleigh. Quotation from http://ecommerce.ncsu.edu/topics/models/models.html, May 2000.

[9]For another view of the business model in a similar vein in the Internet context, see Applegate (1999).

- describe the position of the firm within the *value network* linking suppliers and customers, including identification of potential complementors and competitors;
- formulate the *competitive strategy* by which the innovating firm will gain and hold advantage over rivals.

These six attributes collectively serve additional functions, namely to justify the financial capital needed to realize the model and to define a path to scale up the business.

The process begins with articulating a value proposition latent in the new technology. This requires a preliminary definition of what the product offering will be and in what form a customer may use it. The business model must then specify a group of customers or a market segment to whom the proposition will be appealing and from whom resources will be received. A customer can value a technology according to its ability to reduce the cost of a solution to an existing problem, or its ability to create new possibilities and solutions. Importantly, different prospective customers may desire different latent attributes of the technology. Thus, there is no single inherent value for the technology: if it subsequently were to be developed in different ways, it would likely accrue different value to its developer. Value, of course, is an economic concept, not primarily measured in physical performance attributes, but rather what a buyer will pay for a product or service.

A market focus is needed to begin the process in order to know what technological attributes to target in development, how to define and configure the offering, and how to resolve the many trade-offs that arise in the course of development (e.g. cost versus performance, or weight versus power). Technical uncertainty is both a function of the technology itself (such as the maturity of the technology, and the level of scientific understanding of its characteristics and interactions), and also a function of its external market.

Identification of a market is also required to define the 'architecture of the revenues'—how a customer will pay, how much to charge and how the value created will be apportioned between customers, the firm itself and its suppliers. Options here cover a wide range including outright sale, renting, charging by the transaction, advertising and subscription models, licensing, or even giving away the product and selling after-sales support and services. The Internet is an arena in which a multiplicity of payment models has arisen.

Creating value is necessary, but not sufficient, for a firm to profit from its business model. Once the firm has identified the value chain needed to deliver its offering, it must then address how it will appropriate some portion of that value for itself. One mechanism for capturing some of this value is the use of complementary assets (Teece, 1986). Creating and appropriating value also involves third parties, both within the vertical value chain, and from the value network (Christensen and Rosenbloom, 1995). The value network created around a given business shapes the role that suppliers, customers and third parties play in influencing the value captured from commercialization of an innovation. The value network increases the supply of complementary goods on the supply side, and can increase the network effects among consumers on the

demand side. Positive alignment with the value network can leverage the value of a technology. Failure to align with a value network can dissipate potential value.

Having some sense of what the market will bear helps to inform what cost structure is indicated, indeed mandated, by the value proposition. The choice of a market and a value proposition also supplies the heuristic logic required to translate between the domains. In any market of reasonable size, there will probably be many technical alternatives, target markets and prospective competitors. Few development programs can afford the expense and time required to go beyond what is absolutely necessary to serve the intended market. Targeting a specific market with a clear value proposition informs choices of what must be done and what can be omitted in the technical domain. This gives scientists and engineers signals on where to focus their activities. This focus is crucial for on-time delivery and achieving competitive cost structures.

This preliminary sense of price and cost yields target margins. Target margins provide the justification for the real and financial assets required to realize the value proposition. The margins and assets together establish the threshold for financial scalability of the technology into a viable business: in order for the business to attract sufficient capital for growth, it must offer investors the credible prospect of an attractive return on the assets required to create and expand the model.

3.1 Differences between the business model and strategy

Our concept of the business model differs from the focus of strategy in at least three ways. Firstly, the business model starts by creating value for the customer, and constructs the model around delivering that value. There is some attention to capturing a portion of the value created, but the emphasis upon value capture and sustainability is much stronger in the realm of strategy. There, the competitive threats to returns posed by current and potential entrants take center stage, whereas these are less central in the business model.

A second difference lies in the creation of value for the business, versus creation of value for the shareholder. Oftentimes, the financial dimensions of a business are left out of the business model. The model is assumed to be financed out of internal corporate resources, so that financing issues do not figure prominently in the business model; or the model of a startup is to be financed through early stage venture capital. Clearly, though, the ability to translate value in the business into value for the shareholder requires the incorporation of the financial domain to the construct we offer here.

A final difference, which we will explain below, lies in the assumptions made about the state of knowledge held by the firm, its customers and third parties. The business model construct consciously assumes that this knowledge is cognitively limited, and biased by the earlier success of the firm. Strategy generally requires careful, analytic calculation and choice, which assumes that there is a great deal of reliable information available. It similarly assumes that any cognitive limitations on the part of the firm are of limited importance. While this may be appropriate generally, we think this assumption is not met in the commercialization of early stage technologies, particularly when

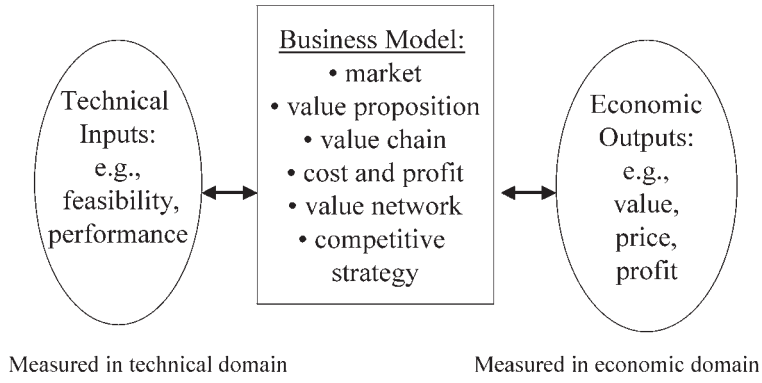

Figure 1 The business model mediates between the technical and economic domains.

commercialization occurs within an established company with a previously successful business model.

3.2 The cognitive implications of the business model

Cognitively, the business model maps from the technical domain of inputs to the economic domain of outputs, as depicted in Figure 1. The cognitively challenging aspect of defining the business model for technology managers is that it requires linking the physical domain to an economic domain in the face of great technical and market uncertainty. Because of the richness and complexity of each domain, companies usually specialize personnel to focus within each domain.[10]

Constructing business models in environments characterized by high complexity and ambiguity has much in common with Weick's (1993: 636) notion of sensemaking: 'Sensemaking is about contextual rationality. It is built out of vague questions, muddy answers, and negotiated agreements that attempt to reduce confusion.' We think that this process is closely related to Prahalad and Bettis's (1986) notion of a dominant logic, since that logic is intended to reduce ambiguity and make sense of complex choices faced by managers. While this logic is useful and beneficial, it comes at a cost. The choice of business model constrains other choices, filtering out certain possibilities, even as other prospects are logically reinforced. We will illustrate this below, in our discussion of Xerox and its spinoff companies.

3.3 The Xerox business model: commercializing the Model 914

That business models provide both a source of value realization, and a potential source of cognitive bias, will be true especially when they have proven successful over time.

[10]Despite the evident value of specialization, business model conception and execution clearly is aided when firms develop positions in which individuals can learn to span those domains.

Consider the original Xerox copier, the Model 914.[11] It was not obvious *a priori* to Haloid (the original name of what would become the Xerox Corporation) what would be the best economic use of the powerful capabilities inherent in the technology of electrophotography. Joe Wilson, Haloid's president, saw the potential for massive revenues in office copying, for which the desk-sized 914 copier was designed. At that time copies were made for business use either by 'wet' photographic methods or by low-quality, dry thermal processes. Prevailing business models for each process involved charging for the equipment at a modest markup over cost, and charging separately for supplies and consumables, usually at a much higher markup over cost—a 'razor and razor blade' business model. Both copier technologies required special paper and supplies, creating an aftermarket revenue stream for vendors. Typical office machines sold for $300; the average machine in use produced 15–20 copies per day and 90% were used for fewer than 100 copies per day. The 914 copier produced high-quality images on plain paper, but the manufacturing cost of the machine was estimated at $2000. Its variable costs per copy were roughly on a par with earlier methods.

This created a problem for commercialization of the technology. Its manufacturing costs were much higher, while the costs of its supplies were on a par with earlier technologies. How could this new technology penetrate the market, given these economics? Haloid sought to find a strong marketing partner for the 914, but was rebuffed by Kodak, General Electric and IBM. The latter rejected the 914 after a careful and highly professional market analysis by Arthur D. Little and Co. (ADL), a respected firm. As they evaluated the technology for IBM, ADL could not conceive a successful business model, in part because they could not identify a salient value proposition. As they reported:

> [Because] the Model 914 . . . has considerable versatility, it has been extremely difficult to identify particular applications for which it is unusually well suited in comparison with other available equipment . . . perhaps the very lack of a specific purpose or purposes is the model 914's greatest single weakness. (Arthur D. Little, Inc., 1959: 42)

ADL analysts essentially assumed the 914 would be offered within the business model then extant in the office copy machine industry—which charged customers the full price of the initial equipment and charged them again for supplies as needed. Skeptical that customers would invest thousands of dollars to acquire a copier (which was only used to make a few hundred copies a month in those days), they concluded: 'Although it may be admirably suited for a few specialized copying applications, the Model 914 has no future in the office-copying-equipment market.' While in hindsight one may dismiss the ADL study as perhaps myopic, recall that Kodak and GE had independently come to the same conclusion.

On 26 September 1959, Haloid brought the 914 to market by itself, surmounting the

[11]The following account of the Model 914 innovation is based on McColough (1984), Gundlach (1988), Kennedy (1989) and Pell (1998).

obstacles of its high equipment cost by using an innovative business model. Instead of selling the equipment, Haloid offered customers a lease. A customer needed only to pay $95 per month to lease the machine, promising to pay 4¢ per copy beyond the first 2000 copies each month. Haloid (soon to be renamed Xerox) would provide all required service and support, and the lease could be cancelled on only 15 days notice.

This was an attractive value proposition for customers. This business model imposed most of the risk on the tiny Haloid Corporation: customers were only committed to the monthly lease payment, and did not pay anything more unless the quality and convenience of the 914 led them to make more than 2000 copies per month (Kearns and Nadler, 1992: 34). Only if the 914 were to lead to greatly increased volumes of copying would this business model pay off for Haloid. Haloid's model essentially acknowledged that the ADL analysis was right, but was incomplete. Joe Wilson bet that there was greater potential value latent in electrophotography technology than ADL had judged, but that its realization required a different business model from the 'razor and razor blade' approach of the day.

It proved to be a smart bet. Once installed, the appeal of the machine was intense; users averaged 2000 copies per *day* (not per month), generating revenues far beyond even Joe Wilson's most optimistic expectations. The business model established for the 914 copier powered compound growth at an astonishing 41% rate for a dozen years, turning the $30 m. Haloid Corporation into a global enterprise with $2.5 bn in revenues by 1972. This was an early demonstration of a proposition now more widely recognized: that technologies that make little or no business sense in a traditional business model may yield great value when brought to market with a different model.

The huge success of the 914 business model—which generated more revenues when more copies were made—established the dominant logic for Xerox's copier business, imposing a certain cognitive bias in future years. This logic motivated Xerox to develop ever-faster machines that could handle very high copy volumes, with maximum machine uptime and availability, and, in turn, discouraged development of low-speed copiers. As a later Xerox CEO observed: '. . . our profits came from how many copies were made on those machines. If a copier was slow in generating copies, that was money plucked out of our pocket' (Kearns and Nadler, 1992: 88). Meanwhile, Xerox's monopoly of plain-paper copying technology ended, as an action brought by the Federal Trade Commission forced the company to accept a consent decree requiring it to license its patents and to offer machines for sale, as well as on lease. Kodak and IBM entered the high end of the market. At the same time, a host of Japanese manufacturers entered the low end—where Xerox was weak—employing different product configurations, pricing strategies and distribution channels, i.e. a different business model.

Xerox's business model as of the late 1970s is summarized in Table 1 according to the attributes described above. It targeted its products and sales efforts to major corporate customers and government organizations. Its value proposition was 'high quality copies in high volume, at a low monthly lease rate'. Xerox organized its value chain to deliver completely configured copier systems sold through its own direct sales

Table 1 Summary evaluation of Xerox and selected spin-offs on key business model attributes

	Xerox	3Com	Adobe	SynOptics	Metaphor	LiveWorks	Documentum
Identified market segment	Corporate and government market	Corporate PC market	PC, Mac and laserprinter market	IBM-installed token ring segment	Knowledge workers in corporations	Workgroups in corporations	Project teams in corporations
Clear value proposition	High-quality copies at a low monthly lease rate	establishes file and printer sharing between IBM PCs	enables output of richer document types	faster network speed on same lines	enables non-technical queries of corporate databases	facilitate remote group collaboration	organize document management via previously installed equipment
Elements of value chain	developed entire copier system, including supplies; sold through a direct sales force	focused on Ethernet protocol, and add-on boards	focused on supplying fonts to laserprinter mfgrs, and software firms	developed software and add-on boards for high-speed networking	developed and sold entire systems, from hardware to software to distribution	developed and sold entire systems, from hardware to software to distribution	developed software compatible with installed customer equipment
Defined cost and profit	modest profit on equipment, high profit on supplies, or per 'click'	high volume, low unit cost	very high fixed cost	very low variable cost	high fixed costs, low installation costs	high fixed costs, high margin, low unit volume	high costs, high margins low volume
Positioned in value network	First mover in 'dry' copy process; did not require or pursue partners	set the IEEE 802 standard; utilized PC distribution channel	defined the PostScript standard for scalable fonts	Prolonged life and value of IBM token ring copper wire; utilized VARS	no third parties or com-plementors utilized	no third parties or com-plementors utilized	leveraged Xerox sales, customer's installed equipment
Formulated competitive strategy	competed on technology, product quality, product capability	compete on standard, new channels	strong network externalities, high switching costs	compete on performance and time to market	compete on superior technology and usability	compete on superior technology	add value to customer documents, lock in customer

organization; and comprehensive maintenance services by its own technicians. It priced its products and services so that it made some money on its equipment, but made the bulk of its profits from sales of services and supplies (such as toner).

This business model did not require partnerships with third-party organizations, enabling Xerox to choose instead to provide the many elements of its business model itself. Xerox conducted its own research. It performed all of the required product development activities to launch and support new products. Xerox manufactured most of its products internally. It distributed all of its products through its own channels of distribution. It provided its own financing to customers, and its own service and support. Xerox even made its own paper, to ensure the proper handling characteristics

when feeding paper into a copier, though here it had to support other companies' paper as well.

In 1968, C. Peter McColough, who had led sales and marketing of the 914, was appointed Chief Executive of Xerox, with Wilson remaining as Chairman until his untimely death in 1971. As the growth of copier revenues began to flatten at the end of the 1960s, McColough set a new direction toward 'The Architecture of Information'. His first steps toward realizing this vision were to enter the computer business in 1969 through the billion-dollar acquisition of Scientific Data Systems (SDS) and to establish the PARC in 1970 to lead the way technologically. Although SDS soon collapsed—shut down in 1975—PARC outperformed all expectations, inventing many of the foundations for the future of desktop computing.[12]

3.4 The path-dependent commercialization of PARC technologies

The research community within Xerox flourished during the 1970s, with generous budgets and few restraints on freedom to explore new boundaries. The first commercial payoff from PARC technology emerged in 1977 as Xerox entered the electronic printing business with a high-speed laserprinter. Xerox's high-speed copier business model worked beautifully with the new printer technology, creating a new, large and profitable business (Weiser and Garman, 1995). The same year, Xerox took the first steps toward building a major line of business intended to serve the 'Office of the Future'. An Office Products Division, newly established in Dallas, marketed a stand-alone electronic word processor, but resistance from corporate executives delayed efforts to launch products based on the more advanced network and workstation technologies developed at PARC. In 1979, the first 'office system' offering used Ethernet technology to link word processors and printers; in 1981, the 'Star' workstation was introduced as the centerpiece of an integrated system for office automation.

The latter move set a pattern for the business model to be used to exploit PARC's innovations in computing. Customers were offered an integrated system, comprising a set of proprietary technologies, with no option to use third-party equipment or software. Xerox initially offered the Star workstation for purchase at $16 995; the requisite network facilities and shared printer raised the cost for a three-user system to over $100 000. These systems then were sold primarily to Fortune 1000 companies through a direct sales force and supported by a field service organization (Smith and Alexander, 1988: 238; Hiltzik, 1999: 366–367). This revolutionary technology was taken to market by Xerox replicating many elements of the business model that had worked so well for its copiers.

Some of the PARC scientists, though, sensed that more could be done. They questioned the pace at which Xerox was pursuing commercialization of their inventions, or

[12]These inventions included, among others, client–server computer architecture and 'personal' computers with a graphical user interface linked by Ethernet LANs, the laserprinter and precursors to Microsoft Word and PostScript. See Hiltzik (1999) and Chesbrough's (2002) discussion of 'Regime 1' technologies.

disagreed with the company's commitment to proprietary standards and 'systems only' marketing. In pursuit of what they regarded as underexploited latent value, they chose to leave Xerox to found new companies to exploit individual component technologies. This created a situation in which, during the 1980s and 1990s, a number of new PARC technologies were being exploited simultaneously by Xerox within its integrated systems, and by independent entrepreneurial spin-off companies as stand-alone innovations. This seemed to us to offer an unusual opportunity to compare commercialization practices in a setting where the technologies and market environments were similar, while the business models employed were sharply different.

4. Exploring the effects of the business model on technology commercialization: Xerox's experience with selected spin-off companies

The raw material for our exploration was provided by a recent comprehensive survey of 35 spin-off companies that commercialized technology emanating from Xerox's research laboratories over a 20 year period beginning in 1979 (Chesbrough, 2002).[13] This section of the paper presents brief descriptions of six of the 35 ventures, focusing on the business models selected initially and their evolution over time.

While Chesbrough's data are believed to be a nearly complete account of all relevant Xerox spin-offs, our sample from his data is not intended to be representative of the whole. We selected six cases from Chesbrough's sample above to illustrate a suitable variety of approaches to the creation of a spin-off's business model. This variety will allow us to flush out nuances in the concept and to illustrate its application in multiple settings. Two of the spin-offs borrowed extensively from Xerox's then-prevailing business model. Since our argument contends that the business model conditions subsequent performance, it is useful to select cases where the primary elements of the model were not changed appreciably. Four of the selected ventures went on to create significant economic value. We hoped that these would illuminate salient aspects of the role of the business model in economic value creation.

[13]Chesbrough (2002) defined a Xerox 'technology spin-off company' as an entity that satisfied all of the following three criteria: (i) The technology involved was initiated or pursued for at least one year's time at a Xerox research center. This criterion excluded technologies that were simply licensed into Xerox, though it includes some that originated outside of Xerox, and came in through acquisition, and then were developed further within Xerox. (ii) At least one Xerox researcher left along with the technology to become an employee of the new spinout company. This excluded technologies that were licensed or otherwise sold out of Xerox. (iii) The entity that received the technology and the researcher was separated from Xerox, and incorporated into a new legal company. This criterion facilitates measurement of the *ex post* development of the technology and the organization. It excludes technologies that satisfied the first two criteria, but went into established organizations, where the influence on the subsequent performance of the company was not easily separable from the company's overall performance. See also Block and Macmillan (1993: 30); unlike Block and Macmillan, Chesbrough did not require that Xerox approve the creation of the spin-off entity to qualify it as a 'spin-off'.

In short, we opted to select cases that would illustrate a range of different approaches to the definition of a business model as well as variation in the commercial outcomes that resulted. Table 1 lists the six selected companies, and provides a summary of the principal elements of the business model ultimately employed in each case. Table 1 also provides, for comparison, a summary of the main elements of the Xerox business model for copiers, as of the late 1970s.

4.1 3Com

3Com Corporation was the first of several highly successful spin-off companies based on technologies created at Xerox PARC. It was founded in 1979 to promote and to exploit the Ethernet local area network (LAN) technology invented by its founder, Robert Metcalfe.[14] 3Com stock was first sold to the public in 1984; in June 2000 its market capitalization was roughly 30% greater than that of Xerox.

Robert Metcalfe was a young computer scientist at Xerox PARC when he invented the Ethernet LAN technology. This was in use within PARC as early as 1975. Sensing the latent opportunity of Ethernet, and impatient with Xerox's indecision about commercializing PARC's pioneering technologies, Metcalfe left PARC in January 1979. He formed 3Com Corporation ('computers, communication, compatibility') in June 1979. He envisioned the company as a leading supplier of networking hardware and software to producers and users of desktop personal computers.

At that time, of course, no such market existed; the personal computer market, led by inexpensive Apple II machines, was just beginning to emerge beyond a hobbyist enterprise; the IBM PC did not appear until August 1981. Neither was there a market yet for workstations: Apollo Computer was founded in 1980, the Xerox Star marketed in 1981, and Sun Microsystems formed in 1982.

Metcalfe was soon engaged as a networking consultant to Digital Equipment Corporation (DEC) by Gordon Bell, then the leading technical figure at DEC. Encouraged by Bell, Metcalfe successfully persuaded Xerox to license the Ethernet technology, on which it held four strong patents. Metcalfe was granted a one-time non-exclusive license to these patents for $1000. Xerox's agreement to this proposal reflected a strategic choice, rather than inadvertence. Xerox was a large user of DEC computers and was eager to promote a technology to link Xerox printers and workstations to DEC minicomputers. DEC's help would be vital to accomplishing that.[15] Spurred by Metcalfe's efforts, Digital, Intel and Xerox formed an alliance (DIX)

[14]The following account is based primarily on a personal interview with Robert Metcalfe held on 1 July 1999, supplemented by Metcalfe (1994) and von Burg (1999).

[15]One can see the implicit effects of Xerox's dominant logic at work in this decision. In the context of Xerox's established business, it made strong business sense to form an alliance with DEC to pursue Ethernet. While the terms of the $1000 license thus made good sense with the context of the established businesses, it accorded little or no value to any additional commercial opportunities that might arise from the technology. One can infer that Xerox managers may have filtered out any consideration of alternative business uses for Ethernet.

to define a standard for Ethernet LAN communication and to promote its widespread adoption as an 'open standard' by the computer industry.[16]

Armed with the DIX alliance, 3Com began in October 1980 to seek venture capital in order to begin developing hardware products. In the absence of established markets for either PCs or workstations, the business plan for 3Com was necessarily vague. The search paid off in February 1981, with first round funding of a million dollars from investors who looked beyond the formal plan and were attracted by Metcalfe's vision and charisma, as well as his team's strong technical talents (von Burg, 1999: 215). 3Com's first products linked DEC minicomputers to Ethernet LANs.

By 1982 the minicomputer market for Ethernet had begun to take off. Among this market's suppliers was the first-mover and early market leader, Ungerman-Bass. This was a market in which one sold primarily to scientists and engineers who used the Unix operating system, and distribution was accomplished through direct sales or value added resellers. Interestingly, Ungermann-Bass's early success in the Unix market (where it was much larger in sales than 3Com) may have locked it into a business model that was ill-suited for the coming PC era. 3Com, although a minicomputer market participant, restrained its commitment to that market, as Metcalfe continued to focus on the desktop market that he was sure would emerge.

3Com realized much greater success in the IBM PC marketplace, selling Ethernet adapter cards to be installed in corporate networks running Novell's operating system. The core value proposition became the ability to share files and printers via an Ethernet compatible with the nascent IBM PC standard. Metcalfe had originally expected 3Com to follow the business model of an integrated manufacturer with its own direct salesforce, which was then the prevalent pattern in the industry. After leaving Xerox, however, he had collaborated with his wife to compile a directory of independent vendors of local area computer networks across the United States. When many hundreds of copies sold at $125 each, they published annual revisions for five years. Now aware of the existence of these complementary assets, 3Com elected to eschew the direct sales approach, and to reposition itself within the emerging value network by distributing its products through independent resellers.

Thus, the key ingredients in what emerged as the working definition of 3Com's business model stood in sharp contrast to the consistent Xerox preference for exploiting unique proprietary technologies through a direct sales system to a group of known customers. The latent value in the Ethernet technology did not materialize until the technology was targeted at a different market, offering a different value proposition, utilizing an open technology platform, and sold through a new set of distribution

[16]Although this sort of strategic alliance around an 'open' standard was commonplace in the 1990s, it was highly unusual in the computer industry in 1979. IBM, DEC, Apple, Xerox and others all built their computers around closely guarded proprietary technologies. Xerox would have been able to discern Ethernet's huge ultimate value only when and if it fully comprehended the implications of competing via open standards.

channels. It seems reasonable to infer that a business model similar to 3Com's would not have evolved had the technology remained within Xerox.

4.2 Adobe

The spin-off of Adobe from Xerox followed a path similar to that of 3Com. Adobe's founders, Charles Geshke and John Warnock, left PARC in 1983 in order to commercialize a page description language that became their first product, PostScript. PostScript allows printers to use digital fonts to reproduce a wide variety of characters generated from a PC. Adobe Systems, Inc. went on to become a public company in 1987, and continues to operate as an independent company with a valuation exceeding $15 bn as of this writing.[17]

The technology embodied in PostScript came from Interpress, a page description software developed at Xerox PARC. Interpress was an internal, proprietary protocol used to print fonts generated from Xerox workstations on Xerox printers. This was an effective usage of the technology, because it linked tightly with Xerox's own business model, but its latent value was limited to that of an important proprietary component in a larger Xerox system. Warnock and Geschke argued with Robert Adams, then the head of Xerox's printing division, over whether to make Interpress into an open standard, as Ethernet was then becoming. Adams strongly resisted, contending that he could not see how Xerox would make any money if they 'gave away' the font technology. After debating this inside Xerox for over a year, Warnock and Geschke left PARC. As Geschke remembered it, 'Certainly, within Xerox, none of this was going to happen. They wanted to have an industry standard, but they wanted to control everything at the same time.'

Arguably, Adams was at least partly right: it may well have been that Xerox's business model could never have benefited from the technology as an open standard. The business model that eventually realized significant economic value for Adobe differed substantially—both from that of Xerox and from Warnock and Geschke's original intentions. Indeed, Adobe's initial business model had contained many elements that were similar to the model then dominant at Xerox, but subsequent events forced the founders to change it. As Geschke recalled,

> Our original business plan was different. We were going to supply a turnkey systems solution including hardware, printers, software, etc. With this in hand, we were then going to build a turnkey publishing system. It turns out other people were trying to do this at the same time—there would have been a lot of competition if we had gone this route. . . .
>
> In many respects Steve Jobs and Gordon Bell (my teacher in graduate school) were key ingredients in getting things going the way they did. Gordon said, 'don't do the whole system', and Steve came to us and said, 'we don't want your hardware, just sell us the software'. We said, 'No!' Later

[17] 20 June 2000. In comparison, Xerox's valuation was roughly $13 bn, and 3Com's $17 bn at that date.

> Steve came back and said, 'OK, then just license it to me'. That's how the business plan formed. It wasn't there in the beginning.[18]

Selling and supporting a turnkey publishing system, complete with its own hardware, would have required a direct sales force and a field service network very much like the one Xerox managed in its copier business. In Geschke's view, it would have taken a long time, and would have encountered a lot of competition. The font technology on its own might not have been that valuable, in that configuration, since again it was merely a component in a larger system.

Instead, selling font libraries to computer and printer original equipment manufacturers like Apple and Hewlett-Packard required very different resources to execute. This configuration allowed the font technology to capture significant value by leveraging the efforts of computer makers like Apple and IBM, and printer makers like Canon and Hewlett-Packard into a new value network. Together, they effectively created a new value proposition that enabled the output of rich document types via desktop publishing and WYSIWYG graphics.[19] They focused on supplying just the digital font libraries to laser printer and software manufacturers, which were made increasingly valuable by the impressive improvements in PCs, printers and software. They competed through establishing PostScript as a *de facto* standard, and then leveraging the investments of complementors to create high switching costs for consumers. As with 3Com, the business model that eventually created significant economic value out of PostScript for Adobe differed greatly from the Xerox business model. Had Adobe persisted with its initial intentions, that latent value might never have materialized.

4.3 SynOptics

Andy Ludwick and Ron Schmidt left PARC in 1985 to form another company to commercialize PARC technology. SynOptics sought to enable Ethernet technology to run over fiber-optic cabling. This was a pioneering technology commercialization endeavor. The founders intended to develop the capability to deliver a complete network system: fiber-optic cabling and the software, other hardware, and networking services required to run Ethernet over that faster medium. Their original business model would have involved the creation of an extensive field installation and service organization, along with a direct sales force. They intended both to support third-part resellers to handle small accounts and to handle large customers directly.

What got the company off the ground, though, was its discovery of the ability to run Ethernet communications at high speeds over already-installed IBM token ring copper wires. Ron Schmidt had been experimenting with this capability just prior to leaving PARC, but it was not until after SynOptics was formed that its importance became

[18]Interview with Charles Geschke, 7 April 1999.

[19]The acronymn WYSIWYG stands for 'what you see is what you get', connoting the ability to display text on a computer monitor in substantially the same way that it will appear in printed output.

evident. SynOptics soon abandoned the fiber-optic approach implied in its name, and focused instead on running networks using its protocols and software on copper wiring already installed for IBM networks. .

This approach allowed SynOptics to avoid providing installation, field service and support in its own part of the value chain. Instead, they were able to leverage the value network around them: relying on a network of resellers to distribute, service and support the product, and selling into IBM's substantial and growing installed base. SynOptics made customers' already installed copper wire more valuable, and enabled faster network transmissions—a powerful value proposition. They saved a great deal on installation costs, and customers saved a great deal on integration costs. Thus, SynOptics' eventual business model differed completely from Ludwick and Schmidt's initial business model—and even from its name. Had the SynOptics technology been commercialized within Xerox, Xerox managers would have had little incentive to promote a technology that could do relatively little to increase the sales of Xerox's own equipment. It seems unlikely that they would have been motivated to sell products whose primary application was to accelerate the performance of IBM networks.

4.4 Metaphor: a Xerox spin-off that maintained a Xerox business model

3Com, Adobe and SynOptics created value from Xerox technologies only after they transformed their business models substantially from the one that Xerox usually employed. In contrast, the founders of Metaphor commercialized some promising user interface and database query concepts through a business model that was quite similar to the one at Xerox. This makes Metaphor an important contrasting case.

Metaphor was created by David Liddle and Donald Massaro in 1982. It developed a series of technologies that allowed non-technical users (knowledge workers) to create sophisticated queries of large databases. This enabled a new group of users to mine corporate data for a variety of new purposes, such as market research, pricing analyses or analyzing possible new product features. Instead of relying on corporate programmers to write report generators to extract data from a mainframe, Metaphor would let knowledge workers construct their own database queries to access corporate data directly. The ability to extract useful corporate data directly was a potentially powerful value proposition. It was one of the first true client–server applications, employing the graphical user interface technology out of PARC to construct database queries in an intuitive fashion.

Metaphor's ambitious technical approach was accompanied by a business model that would have been familiar to Xerox. This included developing a proprietary software product, and selling that software bundled in with proprietary hardware as a turnkey solution for its customers through Metaphor's own direct sales force. As with Xerox's business model, Metaphor had a strong systems approach to commercializing its technology, and also had a similar approach towards proprietary technology. Essentially, it built an internal value chain, and eschewed an external value network.

Liddle defended this approach as the only viable means at the time to implement their product strategy:

> The problem wasn't one of a business model. When we started Metaphor, standards weren't available and the only choice was to do the entire system—that's the way every body did it then. It's not like today. What's more, this kind of product couldn't be sold at a retail level. The only way to sell it was with a knowledgeable sales force. . . . There was no packaged software at the time, we had to make our own equipment.[20]

While Liddle's defense seems plausible, many aspects of Metaphor's circumstances appear to be similar to Adobe. At the time Warnock and Geschke left PARC (not long after Liddle and Massaro left), there were no standards for fonts or generating computer characters mathematically on laserprinters either. Nor was there an obvious way to distribute such a product. And as we have seen, Adobe's initial plans were to develop the entire system as well. Their value network also had to be constructed *de novo*. Warnock and Geschke believe that, in hindsight, they would not have succeeded had they continued with their initial business plan. They also felt Metaphor imported this approach as a direct result of their experience in Xerox. John Warnock remarked to us that, 'Metaphor took the Xerox business model with them.'

This may have been a mistake. Metaphor was not one of the great commercial successes spun out of PARC. The company did manage to survive from 1982 until its sale in 1991 to IBM, but its financial performance was meager, and it burned through a great deal of venture capital. Although the amount that IBM paid in 1991 was not disclosed to us, we did learn that it did not reach the amount of capital cumulatively invested in the company. While there are undoubtedly many explanations for Metaphor's performance, its failure to explore alternatives to the Xerox business model stands as one plausible explanation—particularly in comparison with the value network Adobe erected for its font technology. As we have seen, Adobe initially intended to develop the entire system as well. We do not regard Metaphor's lack of success as a reflection of limitations in its technology; rather, we attribute its fate to its inability to find the model that would unlock the latent value embedded in that technology.

4.5 LiveWorks—another promising PARC technology without a viable business model

LiveWorks is a more recent PARC spin-off, formed in 1992. The company was set up to commercialize an innovative electronic whiteboard. This whiteboard could capture comments on one board, and then transmit and display those comments on a separate whiteboard. This was useful for coordinating group work activities between remote sites—an exciting value proposition for any company with multiple work locations that had to coordinate the work of remote groups. The idea emerged from within PARC,

[20]Interview with David Liddle at his office at Interval Research, 16 April 1999.

which used the technology itself to link its West Coast developers with other Xerox personnel in other locations.

LiveWorks never developed a viable business model. Early sales were made to customers within Xerox; when the decision was taken to expand the business, a Xerox technologist was recruited to manage the spin-off. While the initial management identified a number of technical challenges to be fixed, the company was merely opportunistic in its sales. The company had a high-cost manufacturing strategy, so that the revenues it did generate did not yield a profit.[21] It tried to use Xerox's own sales force to sell its products, but this was not effective. It never did connect with third parties to establish a larger value network. As Mark Myers, then the chief technical officer of Xerox, recalled, '. . . we thought we would work out the business concept someplace after we got to market. . . . We knew there had to be [a market] out there . . . [but we] couldn't figure out how to make money.'[22]

By the time that company executives realized that the initial approach would not succeed, a lot of money had been spent. Alternative business models, such as licensing the technology to other manufacturers, were not explored until the end of the company's life. The company was shut down in 1997, after losing tens of millions of dollars. People who saw the whiteboards in action found them to be an exciting technology. Arguably, the failure of LiveWorks was not due to technology with little inherent value. In our judgment, the failure was in the inability to unlock the potential value of that technology through the development and execution of a viable business model.

4.6 Documentum—a recent Xerox spin-off success

Documentum, by contrast, illustrates what can happen when promising Xerox PARC technologies are commercialized through an effective business model. The company was formed in January of 1990, by Howard Shao and John Newton, under the aegis of Xerox's Technology Ventures (XTV) group. Hence, Documentum, like Liveworks, was formed under the sheltering presence of the Xerox Corporation, in contrast to 3Com and Adobe. Shao and Newton were invited by XTV to visit PARC for six months in order to identify a set of promising technologies to commercialize.

They soon discovered an opportunity to help customers' teams manage documents more effectively. Xerox had earlier conducted an extensive analysis of its customer needs through a study called Express. Express demonstrated the problems faced by many large Xerox customers that had enormous document flows to coordinate, for activities such as reporting progress on clinical drug trials to the Food and Drug Administration (FDA). There was a strong potential value proposition for any company that could help companies manage this, since it would reduce costs and speed up the processes in the companies that were creating these document flows. As Shao saw it,

[21]LiveWorks' revenues peaked at over $14 m., according to Chesbrough (2002).

[22]Myers is quoted in Chesbrough and Rosenbloom (2000: 62).

Xerox already had the component technologies for document management solutions in hand at PARC. What was lacking was a process to get these technologies out of the lab and into the market through an appropriate business model.

Shao and Newton spent six months examining document workflow software products. They also spent significant time at customer locations, to understand what document management problems customers were having. They also learned about the already installed hardware and software platforms that a document management solution would have to work with, in order to be incorporated into the customer's premises. This was a key insight missing at PARC, where the technologists were trying to implement solutions on top of proprietary hardware architectures that were incompatible with customers' installed equipment. Shao and Newton eventually identified a product architecture that could provide real solutions to these customer needs, but do so in a way that was compatible with customers' installed equipment, so that every sale would not require an entirely new system to be installed.[23]

This led to the creation of a business model that would create value for the customer and revenue for the document technology contained in the venture. Once customers adopted the Documentum approach, their subsequent use tended to lock them into the company's products. Documentum initially made extensive use of Xerox's sales channels, which worked well for selling this type of product. Documentum has also moved beyond Xerox's sales force to develop its own channels as well. The company went public in 1996, and realized a market capitalization of $323 m. at the end of its first day of trading. For its part, Xerox owned more than 30% of the company at the time of the initial public offering, and so realized a handsome return on this technology commercialization effort.

5. Conclusions and implications

The ultimate role of the business model for an innovation is to ensure that the technological core of the innovation delivers value to the customer. Because discovery-oriented research often produces spillover technologies that lack a clear path to market, discovering a viable business model for these spillovers is a critical and neglected dimension of creating value from technology. By design, in all the cases that we have examined, the technologies resulted from path-breaking inventions in a research laboratory that had no obvious path to market within the company that funded the research. The situations generally exemplified what is often termed 'technology push'.

All six of our selected ventures were developing promising technology, yet the success of each technology varied. Our brief examination of these half-dozen selected ventures gives rise to a few working conclusions, which can be treated as hypotheses deserving of further refinement and empirical testing.

[23]The difficulty of achieving compatibility with the installed base should not be underestimated. In Documentum's case, they had to jettison all of the existing document management software code at PARC, and write the entire program from scratch.

We offer an interpretation of the business model as a construct that mediates the value creation process. It translates between the technical and the economic domains, selecting and filtering technologies, and packaging them into particular configurations to be offered to a chosen target market. Because both technical and market uncertainty are involved in this translation, the set of all feasible business models is not foreseeable in advance. Heuristic logic is required to discover an appropriate business model, and an established corporation's 'sense-making' task will be constrained by its dominant logic, which is derived from its extant business model. Hence, that filtering process within a successful established firm is likely to preclude identification of models that differ substantially from the firm's current business model.

In contrast, a start-up seems likely to be less constrained in the evaluation of alternative models. It seems notable that among the separate spin-off examples we have reviewed here, while some business model was implicit from the start in each, a different model was in place by the time the successful ventures had demonstrated their viability.

The need to span the technical and economic domains, with the attendant complexity and uncertainty, combined with the need to employ heuristic cognitive approaches, cause the business model concept to differ from conventional notions of 'strategy' (Porter, 1980; Andrews, 1987). The initial business model is more of a proto-strategy, an initial hypothesis for how to deliver value to the customer, than it is a fully elaborated and defined plan of action. It results less from a carefully calculated choice from a diverse menu of well-understood alternatives, and more from a process of sequential adaptation to new information and possibilities. In established companies, this adaptation is also more cognitively bounded, as new information is filtered through a heuristic logic that was established from previous success.

If companies that fund research that generates spillovers are to develop a better business model to commercialize their spillover technologies, our traditional notions of technology management must be expanded. Creating value from technology is not simply a matter of managing technical uncertainty; there is significant uncertainty in the economic domain as well, and in the many possible ways of mapping between the domains. Identifying and executing a new or different business model is an entrepreneurial act, requiring insight into both the technology and the market. The discipline enforced by the imperative of reaching a coherent statement of the business model creates a framework for learning about both the technology and its economic environment.

Learning about the customer was especially challenging in cases like 3Com and Adobe, where the novel technology was ahead of its time, and the value network had yet to emerge. Metcalfe, Warnock and Geschke benefited from strong connections in the communities of users and inventors in which their firms would eventually flourish. In each case, the ultimate business model emerged from an interactive process involving the entrepreneurs' robust vision of latent opportunity—e.g. Metcalfe's persistent pursuit of a mass market for personal computers in corporations well before the

introduction of the IBM PC transformed the marketplace—tempered by adaptation in response to substantive interactions with potential customers and sources of funding—e.g. Adobe's redirection to a licensing strategy.

Two of the cases, Metaphor and LiveWorks, are illustrative failures in this context. Both ventures were built on technologies that seemed to embody attractive potential value propositions. But their failure should not be ascribed to shortcomings in the technologies themselves. In our judgement, the technologies held as much promise as the other PARC technologies that went on to create value. The leaders of these ventures, however, failed to discover appropriate business models that were capable of realizing the value latent in the technologies. In fact, the search process seems to have been very limited in these two cases, in that the business model each venture initially adopted was little modified thereafter.

The Documentum case shows how important, and how subtle, this process of discovery can be. Before the venture was launched, PARC had already developed many of the building blocks of document management software. Documentum was able to utilize Xerox's own sales force for much of its revenue, so even that element of its successful business model was already in place. The missing piece seems to have been the effective pursuit of a powerful value proposition for customers—delivering document management technologies that added value to customers' *existing* equipment—and reshaping the technical architecture to realize that value proposition. That process also applied to SynOptics' learning process. Their technological adaptation enabled their product to run on top of already installed IBM token ring hardware, and thereby leverage the customer's installed equipment, as well as the IBM PC value network.

It is important here to be careful to avoid circular reasoning. The best measure of the worth of a given business model is the success of the enterprise. But one cannot then infer simply that good business models are what lead to success. Not every Xerox spin-off venture that attempted a new business model went on to success. What emerges from our examples is a conjecture: the process of reshaping an initial business model (which seems to occur in a significant number of cases) creates opportunities to discover new mappings between technical potential and economic value, and these novel mappings may contribute importantly to success. In environments characterized by high technical and market uncertainty where many such mappings are possible, this learning process may be a critical determinant of creating economic value from a new technology.

This perspective suggests that, as John Seely Brown noted in the introduction to this paper, technology managers must regard 'the architecture of the revenues' as a vital and necessary element of capturing value from technology. Technology managers cannot disregard these matters or simply rely on others in the organization to address these questions on their behalf. Instead, technology managers must themselves become conversant in these issues. They need to extend their experiments to include experiments in alternative business models. This is as important as the experiments they conduct to evaluate technical risks inside their labs. This will also require

technology managers to create processes to explore the economic domain far more thoroughly, from customers and suppliers in a value chain, to third parties and the surrounding elements of the value network. The development of the business model needs to become part of the new dominant logic for managing technology commercialization.

One source of greater insight into these issues for technology managers comes from the technology commercialization process employed by venture capitalists (VCs). VCs necessarily commercialize technology in environments of significant technical and market uncertainty. Their portfolio companies deploy business models that implicitly map between the technical and social domains. Indeed, the very term 'business model' is a commonplace in that community.[24] Many VCs conceive of their decisions as investments in business models. Then, once they have invested in a venture, VCs force change in the venture's business model when it becomes obvious that the existing model is not working. They provide strong incentives to motivate entrepreneurs to run the risks involved in developing a new business model. And VCs must provide careful governance and oversight to select the most promising models, and reject those that do not appear to be effective.

We need to learn more about the forces that facilitate and impede the search for constructive adaptation in the elements of an extant business model. The process of adaptation appears to be either more highly motivated or more easily implemented in independent ventures than in established firms. Several of our cases suggest that the process of adaptation is triggered by the realities in the context of an independent business enterprise, which enable search processes for models far from the familiar business model of the parent company. Entrepreneurs securely employed in a large enterprise, itself with a strong culture—including its beliefs and dominant logic derived from a successful and well-established business model—may feel little incentive to search for alternatives outside that successful model. On the other hand, it may well be that the forces that apply in a *de novo* venture are similar in character, even if different in degree, to those found in the successful established firm. Many corporate venturing structures, for example, seek to harness these forces (Chesbrough, 2000). These issues are well worth further exploration.

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[24]A recent entertaining example of 'business model' in colloquial use comes from Michael Lewis (2000: 256–257): '"Business model" is one of those terms of art that were central to the Internet boom: it glorified all manner of half-baked plans. All it really meant was how you planned to make money.'

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