

Exploratory Capacity and the Adaptive Organization

Dorothy Leonard - Harvard Business School

Walter Swap - Tufts University

Georg von Krogh - University of St. Gallen

Exploratory Capacity and the Adaptive Organization

Dorothy Leonard

Harvard Business School

Walter Swap

Tufts University

Georg von Krogh

University of St. Gallen

Abstract

The concept of *Exploratory Capacity* (EC)—the amount of slack resources an organization has (in the form of people, time and/or money), that can be devoted to simultaneous technical and market discovery—is introduced to describe how innovators can proceed under conditions of great uncertainty, specifically when technologies and markets are co-evolving. Drawing on a sample of 31 companies whose business models were tied to the Internet, the authors discuss how startup companies deal with uncertainty through *experimentation* in the market and *morphing* of the business model. Tradeoffs among people, time and money are often necessary to create EC, although the three are not fully interchangeable. It is posited that an optimal amount of EC is ideal for successful innovation, as there are risks inherent in both a scarcity and an excess.

Exploratory Capacity and the Adaptive Organization

Dorothy Leonard

Harvard Business School

Walter Swap

Tufts University

Georg von Krogh

University of St. Gallen

Introduction

By its very nature, all innovation requires dealing with uncertainty. Technological innovation involves uncertainty about the feasibility and functionality of the new technology and also its reception in the marketplace. When both the technology and the market for that technology are rapidly *co-evolving*, the innovator will be particularly challenged. The technology capability and its potential drive exploration of possible markets or even creation of new markets, while evolving markets and patterns of use influence the form of the technology. This iterative process of mutual adaptation was most notably illustrated in the recent large-scale, widespread experimentation with the Internet. Founders of companies that were started to exploit the potential of the Internet struggled with the uncertainty inherent in technology/market co-evolution. Because no precedents for successful business models existed, innovators in the Internet space had to conduct a process of search and discovery with both the technology and the marketplace, and to make adjustments in their business models based on the feedback they received.

In the following pages, we develop the concept of *exploratory capacity* (EC) to describe how innovators can proceed under conditions of great uncertainty. We first define EC and describe the research used for illustration. We then discuss why EC is so important to innovation—particularly for startups—and describe two forms of discovery that require EC: experimentation and morphing. We propose a curvilinear relationship between EC and performance, with extremes of too little or too much capacity both threatening innovative activity. We conclude with a discussion of challenges EC poses for managers of startups (and, by extension, other innovative activities) and suggest some possible strategies for coping.

Exploratory Capacity: What is it?

Exploratory Capacity (EC) is *the amount of slack resources an organization has (in the form of people, time and/or money), that can be devoted to simultaneous technical and market discovery*. The three elements of EC (people, time and money) are partially interchangeable in terms of creating this capacity; that is, deficits in one can be somewhat compensated for by an abundance in another. However, they are less interchangeable than inexperienced managers often assume. Moreover, external constraints on an innovation process come in various forms: short pay-back time on investments, limited supply of technology, a competitive market for talent, time needed to put in place

effective intellectual property protection, and so on. These external constraints force managers to make relatively fixed commitments to one or another of the three elements—and those commitments hinder further exploration. The hardest of the three to manage is people, who often constitute the most fixed asset in an exploratory capacity.

EC is Most Important for Discovery

Research in a number of different fields suggests that the ability to morph is essential to the success of innovations.¹ Studies of product development indicate that the ability to alter design features—initial conditions—is important. “Freezing” the design early results in poorer market reception, as feedback from testing prototypes cannot be incorporated into the product.² Similarly, one of the benefits touted for modular designs is the way that products can evolve to meet changing market needs, even without overall architectural dictates.³ Research on diffusion has reported on the need to adapt innovations to conditions differing from the ones in which the initial design originated, if the innovation is to be successfully adopted.⁴

Exploratory capacity is essential for any innovation, but it is especially critical in circumstances of extreme uncertainty about the market for a new technology or a new technology for a market, i.e., when technology and market are co-evolving.⁵ In such uncertain environments, market research cannot reveal the value proposition with the greatest appeal⁶ and no dominant design has emerged for the technology.⁷ Therefore, the only viable response to the uncertainty is a process of active search and discovery—iterative cycles of experimentation during which patterns of use and technical improvements advance in parallel. History is replete with examples of new publicly available technology for which the initial market was unclear—or was proven to be less profitable than later applications. Lasers, biotechnology, digital and analog computing,

¹ See also Rindova and Kotha (2001)

² See MacCormack, Verganti and Iansiti, 2001; .

³ “With value as the force propelling change, and the modular operators as the means of effecting it, the design of a complex artifact could evolve in unplanned but nonetheless coordinated ways. The result was a ‘complex adaptive system,’ whose elements were constantly being modified, giving rise in turn to modifications of other elements. No architect had to give permission for these changes to take place; the possibilities were inherent in the modularity of the design itself.” Baldwin and Clark, p. 14.

⁴ Everett Rogers writes about the need for “re-invention” of many innovations, if they are to be accepted. See pp. 174-180 in Rogers, 1995.

⁵ See Alan MacCormack, Roberto Verganti and Marco Iansiti, “Developing Products on ‘Internet Time’: The Anatomy of a Flexible Development Process,” *Management Science*, Vol. 47, no. 1, January 2001, pp. 133-150.

⁶ The ability of potential users to guide development through traditional market research is limited when the product or service being investigated is without precedent. See Leonard and Rayport, 1997.

⁷ James Utterback writes that a dominant design is “the one that wins the allegiance of the marketplace, the one that competitors and innovators must adhere to if they hope to command significant market following. ... [It] usually takes the form of a new product (or set of features) synthesized from individual technological innovations introduced independently in prior product variants” ((1994, p. 24). Utterback gives many examples: the all-steel enclosed body for automobiles, the Underwood Model 5 typewriter with its visible print, QWERTY keyboard and the first tabulator; electronic calculators. In all these and many other cases, the emergence of a dominant design was followed by industry consolidation and a switch from product innovation to more process innovation.

microwaves, various composites, and videocassette recorders come to mind. Usage in various markets drove adaptations in the technology and the adaptations stimulated different uses.

In such cases, knowledge to guide entrepreneurs who would like to build businesses around the potential of the technology is in short supply. Who has the accurate crystal ball? Potential customers cannot guide development because they have no experience with this technology and analogies to existing ones may be flawed. (Microwave ovens were originally thought of as a substitute for conventional ones—but people didn't cook meals in them until the in-home fast food industry changed its processes and packaging—and even today, cooking “from scratch” is almost exclusively done in conventional ovens.) Technology experts can't foresee all possible applications—and are often misguided by their own expertise into expecting that the technology offers enough value to stimulate significant changes in human behavior.⁸ The inability of innovators to pry typists' fingers off the QWERTY keyboard in favor of a more efficient one is a famous example. The greater the uncertainty, the more that entrepreneurs have to rely upon a process of deliberate exploration as both market and technology evolve.

It is not surprising, therefore, that we see a need for EC in technology-based startups, which are themselves innovations—sometimes quite radical ones. Nor is it surprising that the morphing often takes the form of accommodating existing infrastructure, organizational forms and human behavior. When fundamental, novel, and publicly available technologies emerge (such as lasers, digital computing, biotechnology), managers rarely know what will be the best way of exploiting these in a commercially viable business. This uncertainty creates an evolutionary game where firms try to carve out their own niches in their struggle for survival. They may rapidly and frequently change the very reason for their existence in the process.⁹ When the business model of a startup provides no room for such adaptation, it has a binary future in the near term: success or failure.¹⁰ That is, startups in a time of great uncertainty about successful business models must either hit the right model to begin with, morph or die. For most, the choice is between the latter two options.

⁸ Many companies started to exploit the Internet, e.g. Pets.com., founded on precisely this reef: there were many products and services that customers would not buy over the Internet.

⁹ Granstrand (1998) makes a very compelling argument for why the evolution of technology will strongly influence the evolution of the firm. When technology emerges, the firm is likely to engage in technological diversification that might change the very nature of its business model and operations. An example is Nokia's early entry into semi-conductors and telecommunications that provided the foundation for a successful consumer electronics business.

¹⁰ Some venture capitalists would argue that the determination of the ultimate success of a startup should be made very swiftly. According to this viewpoint, the exploratory capacity resides in the VC firm, which will give initial aid to a large number of startups and within a few months, close down those that have not provided enough evidence of future success. Other VCs maintain that this extreme Darwinian approach to the discovery process would eliminate the kinds of technology-based opportunity that require co-evolution—including some of the most profitable companies of the past few decades.

Study Background and Data Sources

At the end of the 20th Century, the Internet suddenly became the focus of much entrepreneurial activity. Managers inside large companies, venture capitalists and a huge proportion of business school students or graduates saw enormous potential for businesses that would introduce to the world new business models based on the power of the Internet to reach people both individually and collectively through a new medium. Yet no one knew how institutions and individuals would respond to new channels for buying, selling, trading, communicating, entertaining, educating or seeking information.

The study that informs this paper was conducted in 2000-2001 (with some follow up in 2002 as well.) The study thus encompasses a natural experiment in the business environment, when numerous companies sprouted to take advantage of the Internet potential during the opulent funding days of 1999 and early 2000—only to be hit by the monetary drought of 2001 and 2002. Managers in the 31 companies in our sample of startups with Internet-based products,¹¹ most of which were at an early evolving stage, could not halt exploration if the startups were to survive—but the exploratory capacity had to be quite differently constructed in the two time periods, during and after the “Internet bubble.”

Data are drawn from multiple sources, principally from in-person interviews of pairs consisting of a startup “coach,” i.e., a venture capitalist, mentor capitalist¹² or founding partner of an incubator, matched with an entrepreneur who was being coached, at two points in time roughly a year apart. In addition, we wrote in-depth descriptive cases of three of these companies at a single point in time: one case for each type of coach mentioned above.¹³ These “snap-shot” data-gathering efforts were complemented by longitudinal studies of two of the companies, including observation of board meetings during the first six months of their existence and periodic interviews for 18 months thereafter. We also interviewed 32 informants—observers of the environment in which the startups operated. Of the 31 startup companies, 13 were in California, six in the Boston area, four in East Asia (Hong Kong and China) and eight in India (Bangalore and

¹¹ There were 36 companies in the sample, but the initial business model of five of them included no Internet capabilities and so those companies and their coaches were eliminated from this analysis and report.

¹² Mentor capitalist is a term constructed in Silicon Valley in the late 1990’s to describe a particular kind of “angel” investor: one who worked as an individual advisor to startups and invested his/her own money. Most of the mentor capitalists had been entrepreneurs themselves. This class of investor is different from venture capitalists in the following ways: venture capitalists are part of a firm that has raised a fund of money and invests it for the people who have contributed to the fund. Many VCs have been entrepreneurs also—but many have not, and come from backgrounds in investment banking, law, business school, or positions of authority in large corporations. Mentor capitalists tend to invest smaller amounts of money and to invest very early in the startups—at the seed money stage. Especially during the hey-days of the Internet boom, some VC firms invested at that stage as well, but historically and in recent years since the Internet bubble burst, VCs tend to invest a bit later, with other VC firms, and with much larger amounts of money.

¹³ The three Harvard Business School cases are: Verge Software (A), 9-601-065, Verge Software (B): XMarktheSpot 9-601-066; Zaplet, Inc. 9-601-165. A fourth was written in 2002 about one of the companies followed longitudinally: Collabrys, Inc. – The Evolution of a Startup 9-603-064.

Delhi). Seven of the companies were being “incubated”; six of the incubators were in Boston and one was in Hong Kong.

Because of the fruit-fly nature of companies based on the Internet as a market, five companies (four of them incubator-spawned) shut their doors during our study, four were acquired, some completely changed their business model and the rest vary greatly in performance. Moreover, six coach/investors left the companies during our study (four of them were Incubator coaches) and nine entrepreneurs were either completely removed from operations or had their role changed significantly by the coaches. The story is not yet over for those infant companies. In 2001, when we asked coaches to evaluate how well the companies were performing, both relative to other companies they had coached and to other startups of the period, many of the evaluators reminded us that they could say only how the companies were doing, considering where they were in their development. “The jury is still out,” we would be told. The coaches, while more optimistic about the future of some than others, were cautious about predictions. We did ask both entrepreneurs and coaches for assessments of startup success at the time of our second wave of interviews along several seven-point scales where one represented very low ratings and seven was high and those ratings are used for illustrative purposes in the figures referenced later in this paper. However, co-evolution is a messy process.¹⁴ Despite the number of cases in our study, therefore, statistical analysis could be misleading. Rather, we have focused on the deep, rich clinical data that we have about entrepreneurs learning their trade in a turbulent time to illustrate the nature of EC.

EC and the Discovery Process

All 31 companies that we studied undertook some discovery, and most did so very extensively. Discovery took two forms: 1) simultaneous *experimentation*, i.e., forays into several different markets or various potential applications for a technological solution; 2) *morphing*, i.e., sequential re-definition of the value proposition and business model built upon it, in response to the growing understanding of both what could be done with the Internet—and what people would pay for. Experimentation is a local search for technologies, products, services, and unmet customer needs, and provides data for choice among alternatives. Morphing implies a more fundamental process of change in response to market feedback. Both experimentation and morphing require EC. Although the two forms of discovery are highly interrelated, in that the process of morphing over time usually encompasses sporadic episodes of experimentation, the two are conceptually different, and can occur independently. We have seen instances of experimentation that did not change the overall business model and instances of sudden morphing in the absence of any informing experimentation.

Neither experimentation nor morphing is peculiar to startups. Many mature companies have morphed over time and continue to do so,¹⁵ but true to our analogy of the fruit flies, the startups in our sample changed at great speed their very reasons for being. While *all* of the companies studied conducted some experiments, the degree to which the

¹⁴ Helfat and Raubitscheck (2000)

¹⁵ See, for example Bartlett and Wozny, 2002.

companies morphed during the first few years of their existence depended upon how closely their original business model was tied to the Internet—either as a tool or as a market.

Experimentation

If the original value proposition showed early signs of acceptance by some markets, the EC tended to be focused on answering the question of which markets would be the most hospitable and profitable. One of the two companies that we followed intensively, ActivePhoto, was based on technology that could deliver photographs, without wires, from camera to website, where it could be viewed. Initially, the young entrepreneurial team thought that the best application would be consumers who could exchange family photos. They abandoned that idea at the behest of their coaches and focused instead on commercial markets: public safety such as firefighters, who would be able to bring expertise in from headquarters while still at a blaze; property insurance damage assessors, who already used hard copy photographs in their jobs; and auctioneers, who would like to display their wares on line. The team developed ways of labeling photos and tracking them right from the camera. After a few months of experimentation in the three markets, ActivePhoto management concluded that the public safety market was too fraught with regulatory and financial barriers, and proceeded to concentrate on winning customers in the other two.

Morphing

Companies trying to sell services on the Internet were buffeted not only by changes in customer desires, as those customers began to understand the potential and the hazards of dealing over the Internet, but also by the shifts in investor perceptions of fund-worthy business models. As hundreds of experiments were conducted simultaneously and the media kept everyone aware of what was delivering value and what was not, successive waves of fads in business models washed over the infant companies. Many of the first business models assumed that the Internet was going to deliver goods, services and advertising to individual users (the Business-to-Consumer model). Then as that model appeared weak in many regards, the Internet was conceived to be a good way for businesses to interact (the Business-to-Business model). Finally, many software-based businesses began to see the value of delivering their products *within* businesses (the Business-to-Enterprise model).

Companies with adequate EC responded to feedback from the market (and investors) by changing direction, deploying their people or money to altered business models. Adequate EC enabled a number of them to build intellectual property as they went, and some came back to paths that had been explored and abandoned, when either changes in the environment or the maturation of their products rendered those markets appealing once more. The more that the entrepreneurs and their coaches tied the fate of their companies to the new, highly uncertain technological opportunity of the Internet, the more they re-invented themselves. The second company that we followed intensively from its inception, Collabrys, started with a business model that was quickly determined

to be inadequate and it morphed extensively over the next two years. The venture capital fund that backed them, Versant Ventures, specialized in the health care industry but had few investments in Internet-based startups and proposed to learn through funding and coaching the two original entrepreneurs—both of whom already had some startup experience. Over a period of two years, the business model changed from: 1) providing timely emailed advice to consumers who had specific health-related aspirations, e.g., losing weight; to 2) partnering with companies in the healthcare business to target content and broader lifestyle messages to their customers through eMagazines; to 3) selling similar services through advertising agencies; to 4) providing brand managers at Fortune 1000 companies with aggregate data on their customer segments, based on choices these customer segments had made from the e-publications sent out to them; to 5) considering offering a sophisticated software application for psychographic profiling and lifestyle segmentation to clients in a variety of industries; to 6) providing very rapid feedback from their customers to managers in the process of launching new products—a process that is traditionally very expensive, highly uncertain, and for which normally feedback is unavailable the first six to eight weeks after launch. Over the two years, the company had also built intellectual property in the form of patented, artificial intelligence-based software. By 2002, the original entrepreneurs had left; some of the highly paid individuals recruited to work on content were no longer needed as the company morphed. Nevertheless, the company could not have survived had it not morphed, using the money and access to people provided by the venture firm—as well as the time represented by their VC coaches' tolerance for discovery.¹⁶

For the purposes of this paper, we have excluded from our overall sample of 36 startups, the five companies that had business models completely independent of the Internet technology. However, even within the 31 remaining startups, the degree to which the business model and value proposition were tied to the Internet varied. At one extreme, the Internet was merely an additional distribution channel for goods or services already being marketed through physical channels. At the other extreme, the market was other Internet companies or users; these entrepreneurs tended to “bet the farm” on an initial business model, and when other Internet companies went under, they were forced out of business. In 1999 entrepreneur Ed Hunter pitched an idea to Reach Incubator in Cambridge, Massachusetts: a credit management system for businesses who interacted with each other online, providing guaranteed credit lines to buyers and communicating credit thresholds to sellers—a sort of “credit card approval” or credit-validation system for large purchases between businesses. Ziptran’s software could track and invoice for purchases, paying suppliers and reporting on delivery while informing buyers about cash availability and aiding in accounting reconciliation. The company built software and won customers, but when the small Internet companies that favored this kind of exchange went out of business, Ziptran was left without a market. Although they still had enough money to continue exploration, their initial attempts to peddle their software to large enterprises failed, and they never took possession of a second round of funding offered

¹⁶ See Leonard and DeLacey, 2002.

them. “Market choice is destiny,” Reach incubator founder Mike Kinkead observed when Ziptran closed its doors.¹⁷

The startups in our sample had a very limited amount of time to identify the value proposition that would ensure their continued existence. The 31 companies proceeded from one of three starting points: 1) *Market-need based*, with a proven product category—albeit not necessarily with an assurance that the company could successfully compete in that space (e.g., NapaStyle, a media and restaurant business based on the proven talents of chef Michael Chiarello, who had started successful restaurants and also had book-writing and television experience); 2) *Technology-based, Market-enhancing*. These companies were formed on an assumption of possible application of their technology in a number of alternative markets (e.g., Active Photo as described above.) 3) *Technology-based, Market-creating*. These targeted a new market, on the largely unproven assumption of need (e.g. Ziptran, as just described above). The first and third categories had little room to morph; in both situations, the companies’ performance was largely path dependent, i.e., determined by their initial business propositions. The founders had identified a particular market and customer base. Companies starting from the first category, however, faced less uncertainty. They knew who the customers were and they knew that those customers valued the *kind* of product or service they offered, because the product category already existed. Market creation (the third category) is much more difficult since companies starting from this position either had to educate customers to want their product—or change their target market after having made a sizeable investment in the original target. Several of the survivors starting in this category morphed extensively as they found their initial target market did not value their offerings. The second category, those companies that selected from several existing markets those that appeared to value the technology and then used that technology to enhance operations in one or more of the trial markets, also did much morphing—but they started with the assumption that they were technologies in search of an established need rather than that they had to create the need. **Figure 1** illustrates the three starting points of the business models in our 31 cases.¹⁸ In 2001, when the respondents in the study (both entrepreneurs and coaches) assessed the success of the startups at that point in their development, overall summary ratings on the questions reported in Figure 1 ranged from a low of 6 points to a high of 29.5 from a possible range of five (very unsuccessful) to 35 (very successful).

¹⁷ Markets and technologies do not cease to morph, of course, because a company closes its door. The employees go on to other firms, carrying their knowledge with them. Many times in the history of technology there are a series of failed instantiations of technology before market and technology coalesce to provide real value. (See Bahrami and Evans, 1995; Gomes-Cassares and Leonard, 1997.) The hugely successful Palm Pilot was preceded by many prior attempts to create a valuable “Personal Digital Assistant” including the infamous Newton at Apple, and companies such as GO. However, in this paper we confine our discussion to the morphing that occurs within the bounds of an organization rather than within an industry or product category.

¹⁸ As noted before, we do not discuss in this paper the five companies that were based on technologies totally unrelated to the Internet. And even those three companies that relied little on the Internet all fell into the category of knowing their initial markets. Therefore the two empty cells in Figure 1 are an artifact of sample selection.

Creating EC: Managerial Trade-offs

Entrepreneurs talk of having enough “runway” to get their companies off the ground, by which they usually mean EC: the slack resources to accommodate their search and discovery process--homing in on the best value proposition and honing the business plan. Managers have to construct this capacity by putting together enough money and skilled people within the available time limits and the way that they do this heavily influences the company trajectory. Entrepreneurial teams make tradeoffs among the three elements of EC, and an important managerial skill is identifying and managing the resource that constitutes the bottleneck at the time.

People versus Money versus Time

The three elements of EC are not perfectly substitutable. However, if time is not pressing, that is, if investors accept a more extensive pay-back time and the market window is perceived to be reasonably lengthy, the discovery process can proceed more slowly, with fewer people and less money. A few highly skilled individuals, perhaps working long hours, can conduct experiments even without a lot of money. On the other hand, entrepreneurs with abundant funding can afford numerous parallel experiments—especially if they hire contractors and consultants, so that they can explore ideas without investing in a large number of permanent employees. The element upon which the entrepreneur must focus the most attention depends upon the competitive situation. What is the bottleneck in the discovery process? The scarce resource can be money, people and/or time—and the development of the EC depends upon exogenous factors as much as on factors within the control of the manager.

In the years 1999 and the first half of 2000, money to fund discovery was unusually abundant in the U.S. (One wag in our study commented that anyone “who could boot up PowerPoint could get funded.”) The labor market was fluid and characterized by high employee mobility; new ventures benefited from the expertise and information that new employees brought from their former employers.¹⁹ However, skilled knowledge workers were also in short supply, and time to market was perceived to be critical. Responding reasonably to the circumstances, therefore, experienced entrepreneurs and their coaches concentrated on using their cash to hire the best people possible—enough of them to experiment widely with the Internet-enabled technology and market—and hopefully, to accelerate the startup process.

The Case of Zaplet²⁰

One of the best known and most experienced coaches in our sample, Vinod Khosla, partner at the powerful California-based venture capital firm of Kleiner, Perkins, Caufield and Byers,²¹ built a large amount of exploratory capacity into the startup that

¹⁹ Some experts linked this high mobility to technological progress. See for example Cooper (2001)

²⁰ See Harvard Business School teaching case, Zaplet, Inc. (A), 9-601-165.

²¹ Khosla, one of the founders of SUN Microsystems, had not backed a failure in 15 years. His knowledge of technology was legendary; therefore his name alone lent tremendous credibility to any undertaking.

he coached. Khosla knew from the outset that the idea pitched to him by two inexperienced would-be entrepreneurs--a software application that combined the ease of email with the power of a website--could be big, but it would need a great deal of development. Khosla: "When you have a novel idea, it's very hard to imagine everything you can do with it."²² Being backed by KPCB meant that the startup had lots of money—just over \$100 million in total. After bringing in other experts to evaluate the potential, Khosla directed founders David Roberts and Brian Axe to explore enough possible uses for the Zaplet technology to discover the best market: consumer, commercial or enterprise. Roberts and Axe knew from the first conversation with Khosla that they would need to bring in an experienced CEO to run the company; their job in the meantime was to get the company ready for a decision among the myriad possible market applications for the technology by exploring a lot of possible avenues. For 9 months, the company operated in "stealth mode" under the name of FireDrop.

Khosla and the founders, knowing that others might be able to imitate their idea, and/or that other companies could offer similar solutions, were racing against time. Given that they had plenty of money, the scarce resource for Zaplet, as the firm was eventually named, was skilled people. Whereas neophytes Roberts and Axe might have had difficulty recruiting top talent, Khosla needed only to make a few phone calls. Highly respected Senior Director of Enterprise Java at Sun Microsystems, Mala Chandra, left her secure position to take a chance on this new venture, and one of her similarly talented colleagues was immediately intrigued enough to join. With two members of an "A Team" on board, the company could attract other skilled people. Khosla observes:

The first three months [of a technology-based startup] are always about what I call the "engineering the gene pool" phase. Before you can develop any technology, you need to build the gene pool within the company. If you don't have the gene pool to express certain traits, [they] won't [appear] in the company, and I mean it in a very biological sense. So if you want scalability in your software, you better have a scalability expert. Evolution is very important, and evolution doesn't happen without experimentation, right? Evolution is key to adaptation. The species that have survived periods of change have been the most adaptable ones. The dinosaurs did not survive because they were unable to adapt quickly. That's very, very true of companies.

"Vinod argued persuasively, 'You need to get to 100 people as fast as possible'," recalls founder Brian Axe. "And then when we hired 100 employees, he said 'You need to get engineers in India.' So we'd get four or five engineers in India. He would then say, 'No, you need 20 engineers in India.' Even after we had hired 100 employees, he said, 'No, you need 100 engineers, not employees.'"

²² Zaplet Inc. (A) Harvard Business School Case 9-601-165. Unless otherwise indicated all quotes in the following description are from this case.

Meanwhile, four summer interns from Stanford Business School were recruited to conceive as many product ideas (“Zaplets”) as possible. Their notions of potential market evolution were important to the software architects. Mala Chandra’s team spent a month implementing prototypes based on some of these Zaplet ideas. According to Chandra:

We looked for patterns in the prototypes. Lo and behold two distinct patterns emerged. First, there were a number of services. Second, the engineering team identified a group of building blocks of functionality for building Zaplets in conjunction with the services.²³ With these, you could create a lot of different Zaplet applications by simply combining these building blocks and turning on whatever services and features you wanted. That was a fabulous discovery because we found that with about 30 building blocks we could accommodate close to 200 of these Zaplet ideas that the B-school students had come to us with.

By early 2000 the company was ready for the new CEO to decide the future; there were 27 different product managers, directing 30 developers writing code. The first CEO candidate selected decided at the last minute for personal reasons, not to take the job, and the search had to start again. As a result, the exploratory period extended some four or five months longer than Khosla had expected or intended. However, the exploration of various applications had convinced him that the best market would be enterprise, i.e., software for the internal operations of large organizations. Therefore he aimed the search towards CEO candidates with experience in that market.

In July, 2000, entering CEO Alan Baratz’s first task was to bring the exploration to a close and select a single direction for the company. After the first month on the job, Baratz reflected:

We have some great technology and everybody thinks that it’s applicable very broadly, but we don’t really know where this technology adds the most value. [The question] isn’t so much where does the technology have value as it is what’s the most compelling entry opportunity today? I believe that eventually the technology will be used as broadly as [in all the areas] the company has been trying to pursue. But we don’t have the resources today to do all the engineering, all the business definition and the business model work to go after all those areas.

Now that many options had been explored, and the enterprise market was seen to be the most promising, Baratz was prepared for a secondary set of decisions, including whether to deliver the software as a packaged application (e.g., like Microsoft’s Word) or to function as a platform company, enabling third party vendors to create the software applications (e.g., like Lotus Notes). For a small company—even with a lot of money in

²³ Applications using the Zaplet technology were called “zaplets.” According to the Zaplet website, “Zaplet Appmails are collaborative task-based, live software applications that are presented to business users in their email inbox, but in essence, are a shared window to a protected server where application functionality and data securely reside so that everyone sees the changes in real time.”

the bank from KPCB--the choice was critical. The broadest exploration was over. However, the knowledge gained during that period of experimentation continued to benefit the company as it moved into a time of reduced EC.

By mid-2000, the world changed. Money became the scarce resource, skilled people were more abundant as Internet-based companies closed their doors, and much of the frenzied activity eased, as concerns about longer-term survival outweighed the preoccupation with first mover advantage. However, survivors still needed EC. Entrepreneurs and their coaches focused on husbanding their resources, eliminating redundant or unneeded roles and skills, and stretched out their time schedules. EC had to be created out of the new slack in time—and to some degree, out of sweat equity, i.e. equity created by fewer people working longer hours. Companies that had built up EC with excess money and/or a surfeit of talented people were fortunate, as they still had enough capacity to continue the discovery process. (As noted later, many inexperienced entrepreneurs squandered their capacity and did too little exploration when they had it.)

ActivePhoto, which had built EC with modest investments from mentor capitalists and their friends, substituted time for money and sweat equity among the founders for more people. “I don’t care if you don’t sleep,” a coach told the group at one point, and only partially in jest. “Here’s what has to happen.” And he proceeded to outline the market exploration and technology evolution needed. One of the founders, Sebastian Turullols, spent much time working as an engineer himself as well as directing their other two part-time developers. A second founder, Valerie Smith, devoted her time to marketing and customer relations, and the third, Shane Dyer, took the role of CEO. However, a trained engineer himself, he also pitched in on the development tasks and when the company brought in a more experienced CEO, even assumed an engineering role fulltime for a period in order to keep the company going.

A Curvilinear Relationship between EC and Performance

Although so far in this paper we have emphasized the value of having enough EC to explore, given an extremely uncertain future as market and technology co-evolve, in fact both theory and observation suggest that the relationship between EC and performance is likely to be like an inverted U. That is, having too little EC stifles adaptation; having too much can result in wasted or misdirected resources. Let us first examine some of the issues that arise if EC is too constricted.

Issues of Inadequate Exploratory Capacity

As noted above, people, money and time are somewhat interchangeable. All innovations evolve from their initial forms, and fledgling businesses are no exception. Most of the coaches interviewed anticipated the discovery process. For example, one told the entrepreneurs that he expected three somewhat different business plans to emerge before the business stabilized; another told the entrepreneurs at the outset that they would go through several different sales forces. However, especially when investors are less

tolerant of the discovery and search process, the issue for an entrepreneur is having too little of all three elements of EC. In such cases, she must be extremely prescient or lucky to hit the exact value proposition and business model that will fit an evolving marketplace. It is much more likely that she will fail very early.²⁴ Thus some level of all three elements is necessary. However, it is useful to look at each of the three separately to understand the management issues involved.

Too Few People

In the years 1999-2000, even having abundant funding was no guarantee that an entrepreneur could hire the skills needed to explore business possibilities. Top-notch software architects in particular were in high demand and very scarce in the parts of the country bursting with new ventures, such as Silicon Valley.²⁵ Even people adept at *finding* skilled people were in such demand that well-known recruiters could pick and choose their assignments. Money, in short, was *not* a total substitute for having people already committed to the entrepreneurial cause. Those entrepreneurs who could attract top talent, either through their own efforts or because their coaches helped, were greatly advantaged—especially when the individuals hired were skilled in innovation, as were the first few software gurus hired away from Sun Microsystems and into Zaplet. This advantage held only if the skilled individuals were the right ones for an evolving business model, of course.²⁶

Drawing upon general theory about creativity, we see another possible draw-back to having too few people available for hire. Heterogeneous perspectives give birth to more diverse options for exploration than do homogeneous ones.²⁷ Even very smart people cannot be expert in many domains, and deep experience in an industry did not necessarily translate into an ability to see Internet applications.²⁸ For example, in the case of Ziptran described above, the entrepreneur had started two companies before and the coach had 28 years of experience in the software industry—yet the collapse of the Internet exchange market took the company down. One informant close to the company observed that there was little diversity of opinion and background among the founding members and speculated that this homogeneity was a handicap in creating business

²⁴ Startups have an advantage over entrenched competitors, as Christensen (1997) has argued, because the latter's established routines preclude enough discovery, even when they have adequate EC. Their core capabilities are simultaneously core rigidities (Leonard, 1998). On the other hand, new ventures suffer from a "liability of newness" (Stinchcombe, 1965) in that they often lack the routines and discipline that would guide the discovery process efficiently.

²⁵ Brown (2000).

²⁶ In the case of Zaplet, the entire original technical team was replaced in 2002, as the company evolved away from the initial architecture. Nonetheless, the starting team created powerful enough prototypes that the company was able to attract customers, i.e., these team members were an important contributor to the EC of the company.

²⁷ See discussion of the divergent thinking and creative abrasion that give rise to innovative options in Leonard and Swap, 1999.

²⁸ MacCormack 2001 found that experience in developing software in general didn't directly contribute to success of projects in developing software specifically for the Internet, but experienced project leaders were more efficient in using resources. That is, their expertise in development contributed to better process—not necessarily to better product content and outcomes in this new application area.

options. Research on entrepreneurial teams supports this speculation, finding that new ventures with entrepreneurial teams whose members disagreed and constructively discussed strategic issues outperformed those whose teams had a high degree of conformity and consensus.²⁹

Too Little Money

The prime reason that entrepreneurs seek out venture capital, of course, is to give the company time to find its niche and begin to turn a profit. Money can't buy more time directly, but it can translate into more and better hires, better location, superior equipment, more advertising—and of course high levels of funding also indicate someone's confidence in the venture. The main point here is that money enables discovery—time and funding for both experimentation and morphing.

A number of entrepreneurs in our sample rued not taking more money when it was so readily available. Arun Jain, founder of the Indian company Clips, had already surrendered the CEO position to a new hire when that individual decided not to accept a second round of promised funding. Observed Jain: "I believe in taking money from financial institutions when it is available so that it will be there when you need it, but the CEO didn't agree—and I didn't want to second-guess him." By the time that the need for the funding was critical, company sales had dropped and the VCs were no longer interested in providing their promised funds. Similarly, with hindsight, entrepreneur Alper Caglayan of PeopleStreet wished he had insisted on taking the larger amount of money offered them. "We turned it down, which was not a smart thing. I should have been more insistent on it. You know in the back of your mind that this gravy train is going to end, but you don't want to be the one articulating it."³⁰

As the economy slid downward, entrepreneurs had to drastically reduce their "burn rate," i.e. the rate at which they were spending money. For many first-time entrepreneurs, the necessity to focus on money as the bottleneck, the scarce resource, came as a shock. They did not know how to manage in that environment. However, they were forced to substitute time for money and people—resulting in a slowing of the discovery process and husbanding of resources. As we will discuss below, this discipline was welcomed by many investors, who saw it as a much needed correction to prior excesses. However, the sudden drought in money caught many by surprise, and curtailed essential exploration. The combination of the September 11, 2001 attacks and the failure of so many Internet companies paralyzed investor activity for months. PeopleStreet was a casualty. Unable to operate any longer on existing funds, Alper Caglayan reluctantly shut the business down.

Some of the entrepreneurs found that they needed to substitute time or people for money when the venture firms reacted to the failure of many startups in their portfolios and the rising cost of capital by drastically reducing new investments and by requiring

²⁹ West and Meyer (1998)

³⁰ Interview August 29, 2001.

more control in return for any funding. Danny Ertel, CEO of Vantage Technologies explained that he considered looking for more money to support the development of their technology platforms in 2001, but “we sort of put our toe in the water a few times and each time decided that the water was too cold and that we would have to give up too much of the company to get even a small amount of funding and it just wasn't worth it.”³¹

Too Little Time

People working under perceived very stringent time constraints are likely to shortchange the divergent thinking that creates many options, in favor of seizing upon the first likely one, and attempting to implement it.³² This observation stands in contrast to much popular thinking that people working under stress are more creative. In fact, careful research in a number of large companies suggests that extreme time pressure drives out creativity.³³ Moreover, sustained growth of a new venture hinges on the effective sharing of experience and ideas by talented employees.³⁴ However, effective knowledge sharing within teams requires substantial time.³⁵

Certainly in our sample, many of the entrepreneurs and their coaches were driven by a strong sense of limited time to seize their portion of a highly contested, constrained market. Hong Chen, founder and CEO of GRIC Communications recalls asking one of his advisors whether or not to accept a VC offer of funding that seemed to undervalue the company. Paul Huang, his advisor asked: “If you have \$15 million in front of you that you know you can get today, you have another \$150 million which you *might* get in the next few months, and you know you needed money, which one would you take?” Hong concluded that he would go with a smaller funding source, because speed was a more important criterion for him than the level of valuation. Noted Hong: “The important thing is not that you have less valuation, and more dilution, but that the money can build a successful company because you’re really moving fast.”

Issues of Too Much Exploratory Capacity

At the other end of the suggested convex curve lie the perils of having too much EC. While few entrepreneurs would complain about such abundance, there are serious managerial issues to be considered at this extreme as well. Again, let us consider the three elements separately, while keeping in mind that they are somewhat interchangeable.

Too Many People

There are at least two circumstances in which having too many people actually hinders discovery. The first is that noted over a quarter century ago by Frederick Brooks

³¹ Interview, September 19, 2001.

³² See Leonard and Swap, 1999, Chapter Three: Generating Creative Options.

³³ See Amabile and others, 2002 a and 2002 b.

³⁴ von Krogh and Cusumano (2001).

³⁵ von Krogh (2002).

as a problem when managers assumed they could solve a knotty software coding problem by assigning more people to it, much as one might if the issue were a bottleneck in a physical manufacturing process. Bringing more people into a given project when the objective is creation, not just production, actually slows the process down, because of the heightened demands for communication and coordination placed upon the innovating team members.³⁶ Of course, adding people to separate projects of exploration enlarges the pool of possible avenues for the company, as we saw with the case of Zaplet.

The second situation is one that hit a number of companies in our sample. They had adequate *numbers* of employees—but as the business model morphed, the match between the skills of their staff members and the needs of the newly redefined discovery and search goal atrophied. They were left with people on the payroll who were ill-suited by background and training to help deliver on the new value proposition. Thus, EC was limited by the kind of people they had in the company. For example, when managers at Collabrys experimented with selling their services through advertising agencies, it was critical to have someone who knew that industry well. Once it became apparent that ad agencies were not, in fact a good sales channel, the VP of Sales who was well-connected in that industry had little to offer and left the company. This kind of mismatch was most serious in locales where firing people is heavily discouraged. One of the entrepreneurs in India noted: “If in India you are laid off, if you are handed a pink slip, it’s a big thing You wouldn’t go out and tell your parents and your friends that you have been laid off because there’s a social element to it. People don’t want to talk about it.” However, even in job-hopping Silicon Valley, CEOs hesitated long before firing people they had just lured away from the Midwest of the U.S. and/or from more established businesses. In the second round of interviews we conducted, when asked for lessons learned, a number of CEOs commented that they didn’t fire people soon enough when the mismatch between needs and performance became clear.

Too Much Money

Can an innovative activity be over-funded? The answer would seem to be “yes,” both in general³⁷ and specifically for startups. Levesque argues compellingly that an incremental increase in funding does not lead to enhanced quality of the products developed by the new venture, but rather wasted resources.³⁸ We found this to be true in a few cases; some inexperienced entrepreneurs were so impressed with the amount of money invested in them at once that they wasted it on perquisites for employees or in

³⁶ Brooks, 1975; 1995. Interestingly, recent research on open source software development questions the “lawfulness” of Brooks’ proposition—at least if the project is designed from the beginning to accommodate a large number of developers. With the right infrastructure in place, and a very simple set of rules for coordination, groups of several hundred people can effectively contribute to the development of highly complex software products. For more on this, see a forthcoming paper by von Krogh, LeGrand, Leonard and Swap (2002) on EC breaking the traditional boundary of the firm.

³⁷ One of the reasons for the demise of many industrial labs in the U.S. in recent years was that the corporations could not capture the financial benefits of the inventions they spawned. This realization led to a re-focusing of investment on innovative activity much more closely tied to the market and cutting back many projects that were perceived to be over-funded relative to proven returns.

³⁸ See Levesque, 2000

lavish surroundings intended to impress customers and potential investors. In one Indian company in the sample, the entrepreneurs purchased automobiles for all the top management—a luxury that the CEO rued the next year when funding sources dried up. And investor K.O. Chia, as reported by Alex Chan, the Hong Kong entrepreneur he coached, surveyed offices and the contents of the trashcans of the company to make sure that the startup wasn't feeling too rich. K.O explained why he liked Unitech: "You have a reasonably presentable conference room, but the other areas are pretty basic--especially the work locations."³⁹ He was pleased by the investment in equipment for the engineers, but also noted that he saw Coke cans and used noodle containers in the rubbish bins, which he interpreted to mean that they worked late and frugally. Although most of the companies in our sample were similarly innocent of mindless ostentation, many contemporaneous failed startups would not have survived this kind of scrutiny. By late 2001 and early 2002, designer chairs and fancy desks were widely available in second-hand stores in the geographies we studied. Clearly those startup managers who wasted money on trying to match the bounty and appearance of much larger companies diminished EC—and part of the reason was that there appeared to be so much money available.

More serious, however, is the issue of whether having too much money can encourage frivolous experimentation. That also occurred in the general population of companies spawned during the Internet Bubble. Even in our small sample, some companies were born that were probably ill-conceived and in a less opulent time would probably have been unfundable. When we inquired of our informants in the year 2000 whether or not some companies were being started that were inherently and obviously flawed, the response we received was that the market will weed out the weak ones. Indeed, that happened. The inexperienced entrepreneur in one of our observed companies (XMarktheSpot) used investor funding to completely switch business models—without the prior permission or even knowledge of the board. The original business was enterprise software, sold successfully to several very large and eminent corporations (e.g., Hewlett-Packard and Ernst and Young). Discouraged with the long sales cycle involved and the need to help customer companies make the organizational changes necessary for implementing the software, the entrepreneur radically redirected the company. In their monthly meeting, to their astonishment, the board was presented with a PowerPointTM presentation of a totally new business (selling marketing services over the Internet, to Internet companies)⁴⁰. One could certainly argue that in this case, the investors might have been better off had they kept a tighter rein on the budget and discovery process.

Moreover, with hindsight, some entrepreneurs acknowledged that their EC was adequate—even if they didn't realize it at the time. Asked to reflect on what he might have done differently if he were to start the company over, Danny Ertel remarked: "Even if we'd had a lot more money for engineering early on, and we could have written code faster, we still could not have known then what we know now [based on pilots and

³⁹ Interview with Alex Chan, December 12, 2000.

⁴⁰ See Leonard and Kind, 2000 b.

early adopter feedback]; I think the product is better for how it has evolved."⁴¹ In this case, there was no lack of EC and the founders used it to obtain the feedback they needed to morph.

Too Much Time

Research on creative endeavors suggests that some bounds, including time horizons, are desirable. An open-ended timeframe risks evoking several very natural human behaviors. First, the process of entertaining options appeals to people with certain thinking styles.⁴² With no schedule dictating the point at which divergent thinking should switch to convergent mode, a team can continue experimenting and delay selecting a course of action far too long.⁴³ Psychological research also suggests that the longer someone delays delivery on a project, the more the person feels the need to justify the effort and so delays further.⁴⁴ In our sample, almost all the entrepreneurs felt under extreme time pressures—and no one believed that they had an abundance of time, so we have no observations from the field of these potential effects.

No Magic Formula for Determining the Optimal EC

The theory of a curvilinear relationship between EC and performance implies some kind of optimum. As is the case with many potential influences on performance, the exact optimal level of EC is difficult, if not impossible, to identify. That level will vary according to the business model, the industry and the external environment. But both behavioral theory and our observations argue for avoiding the hazards of the two extremes. Because we have followed the startups for only two years, it is too early to declare certain winners. We can identify various milestones they have passed; we know those that have survived, albeit often in a drastically altered form; we know those that have completely disappeared. See Figure 2, which presents the status of the companies as of mid-year, 2002. Among the more Internet-dependent, (the upper half of the figure), four are dead and a fifth was acquired in what the coach termed a “fire sale,” i.e. at a significant loss for investors. (We do not know the acquisition price of all those sold, but other investors in those companies acquired were at least satisfied with their investment and several considered the sale a real win). The company acquired at a loss, XMarktheSpot, was the one described above whose CEO abruptly made a radical change in the business model without first checking with his board and his coach. Once they decided to serve other Internet companies rather than established corporations, the founders were unable to make further changes and the company was acquired for the cost of their software. None of the five companies that died were able to morph. Having tied the fate of the company to a single market, they had nowhere to go if that market failed them. For many of the other companies, survival was success. That is, the category of “alive” in Figure 2 covers great variance in degree of success—but without extensive on-going research, it is not possible to be more precise. A number of the entrepreneurs

⁴¹ Interview, September 19, 2001.

⁴² Leonard and Straus, 1997.

⁴³ See discussion of setting priorities in Leonard and Swap, 1999, pp. 108 ff.

⁴⁴ Rubin, 1981.

interviewed listed the names of failed competitors and said that “we are the last ones standing” in the competitive space. As Figure 2 suggests, three of the companies (Clips, GoGo and GRIC) deserted their heavy dependence upon the Internet. Clips became a physically located retail outlet, instead of selling office supplies over the Internet. GRIC abandoned their foray into Voice Over Internet and concentrated on their telecommunications infrastructure. GoGo became what its founder had originally wished it to be: an “incubation of artists... find young artists very early and... sell the contract on them and make...money out of overrides and percentages.”⁴⁵

Thus we can say that survivors are those companies in which the entrepreneurs and their coaches managed to construct enough EC—and to use it to experiment or morph. We cannot judge how efficaciously they used that EC. One might argue that some of these companies had to do so much experimentation and morphing that they *shouldn't* have survived—but what criteria should be used to identify those companies *a priori*? Some very inefficient search processes may pay off for society and investors in that more options for potential uses of a technology are tried and eliminated or confirmed. Moreover, we may overestimate the wastage, because, at least with this latest occurrence of an evolving market, our tolerance for search tended to swing from cheering on too much experimentation, to decrying all of it as folly. Few systems involving human behavior are naturally self-correcting in a timely fashion; rather, we tend to react in extremes.⁴⁶ The same herd mentality that led to the “Internet Bubble” sent investors and critics galloping off in the opposite direction when the flaws in so many business models became apparent.

The more that investors favor “lean and mean” companies, optimized for operational efficiency, the less those investors will tolerate discovery. Moreover, many fast followers will essentially build on an innovator’s exploration—and some will salvage not only equipment but also excellent employees from the shipwreck. Yet, as argued at the outset of this paper, EC, however inefficient, is essential for innovation. By definition, innovation involves some difference from current activity, some uncertainty, some risk. Were every step along the way pre-determined and well-understood, the end point would be unlikely to be something new. Managers thus need to identify the sources of EC and manage them wisely.

Managing Tradeoffs Among the Elements of Exploratory Capacity

Exploratory Capacity is challenging to manage for at least three principal reasons: 1) The elements are not totally interchangeable, and in particular, it is not generally possible to substitute money and people for time; 2) Having *enough* people is often less

⁴⁵ Interview November 27, 2001.

⁴⁶ If one were to consider the history of investment booms and busts, this kind of extreme is not surprising and is analogous to what supply chain theorists have named the “bullwhip effect.” Extreme fluctuations of orders and inventory in a supply chain are shown to result when, absent a global view of the entire system they are operating in, managers make locally rational decisions that reverberate through a supply chain and lead to a very sub-optimal fit between supply and demand. Some of the effect is due to inadequate information or timely feedback and some to managerial behavior, as for example, hedging bets in anticipation of shortages.

problematic than having the *right* people at the right time for the particular type of exploration being undertaken; 3) Outside influences can dictate which of the three elements is in shortest supply and therefore where managers must focus their attention. That is, managers often have limited choice as to which scarce resource they must manage, and the less experience managers have, the more difficulty they may have responding to a type of resource scarcity they haven't coped with before. The following passages address each of these challenges in turn.

Time as Essential

Even an abundance of money and people cannot totally substitute for time in exploration, as the incubated companies in our sample found to their despair. Of the eight companies which received funding and help from incubators (which were also startups in their own right), six fell in the lowest third performance ratings of all 31 companies reported on here, as judged by the coach and entrepreneur. (See Figure 1). Moreover, of the seven incubators, all of which were themselves startup commercial endeavors, only four remain in business, and those four have drastically changed their business models. There were a number of reasons for this relatively poor performance⁴⁷ but a primary one was that the incubators were founded on a flawed premise: that the process of starting up a company (even with inexperienced entrepreneurs) was largely a matter of providing money and people. The incubators in our sample offered their startup companies various services, ranging from infrastructure (space, office equipment, minimal secretarial support) to standard professional services (legal, accounting) to more substantive technical and managerial consulting.⁴⁸ The assumption was that speed was all-important and that therefore *time* was the scarce resource to be managed. The incubators were to provide the knowledge embodied in people and access to the money. However, the experimentation and morphing so essential to startups in the face of tremendous uncertainty require feedback from the market—and that feedback takes time; there is often a substantial lag between launching a new product or service and digesting the market response. In other words, the incubator managers underestimated the need for market interaction in growing a company in times of co-evolution. (The coaches and temporary employees provided by the incubator did not always have deep or relevant knowledge, either—but that is a different issue.) The incubators could not create instant companies because innovations do not usually burst forth full-blown and complete. The exploratory capacity that incubators offered the companies was too imbalanced towards managing time as the scarce resource.

The Wrong People

As noted in the discussion above, throwing bodies at an innovation problem is not the answer to the need for exploration. Not only do *too many* people actually compound the managerial challenge, but calling one element of the exploratory capacity “people” is actually a shorthand way of referring to the knowledge that the people embody and share.

⁴⁷ Swap and Leonard, 2002.

⁴⁸ See Leonard and Kind, 2000 a. Garage.com was a California-based incubator whose motto was “Find them, Fix them and Fund them.”

Startup groups have to be creative, and as prior research on the topic has demonstrated, creativity is stimulated by diverse perspectives based on substantial knowledge.⁴⁹ In rapid morphing, companies often try to shift from one knowledge base to another—especially if they are in search of the right market for a technology. In many of the companies studied, the managers had the wrong skill mix at some point in time. A few inexperienced entrepreneurs had hired on the basis of friendship rather than ability, and therefore their employee base lacked both knowledge and experience. Two of the Indian entrepreneurs commented that it turned out some friends “couldn’t scale,” i.e., could not handle enlarged responsibilities as the company grew. However, even experienced entrepreneurs could not always foretell what kinds of knowledge they would need. They invested in expertise in one market, only to find it largely irrelevant in the more promising market they turned to. When Collabrys was focused on its identity as an e-publication, it was important to have publishing expertise and the company hired in some very senior people from the world of publishing. When this service proved less important than the resulting consumer choice profiles, publication took a back seat to market research skills.

Exogenous Events

Outside forces in the economy had a sharp and profound effect on the management of exploratory capacity during the time of our study. Managers were buffeted by the need to attend to first, scarcity of time and people in 1999-2000, and then, in 2001-2002, an abrupt and extreme scarcity of money. For inexperienced entrepreneurs, who had never lived through an economic downturn, the management challenge was especially difficult.

Stan Meresman, a founder or coach in 20 startups commented in the fall of 2001:

I can’t tell you how many companies in the last 18 months I’ve sat at board meetings where we say [to the entrepreneur]: “Assume that you can never raise any more money. Ever. Therefore, the cash we have has to last until we’re cash flow positive--which means we need to reduce the burn rate.... It stops the meeting cold. Then the entrepreneur blurts out something like: “well, we wouldn’t be able to do that unless we take out 25% of our people and not do this new project.” And [we say]: “Thank you for listening.” It takes a while to do it; the experienced entrepreneurs get it, do it, run with it. You come to the next board meeting and it is already implemented and done. With the inexperienced entrepreneurs, you have to go through it again, to explain again why the plan they’ve now presented, which had like a five percent cutback, still doesn’t get us to cash flow positive. [You tell them]: “So you want to push out another quarter or two before we go off the cliff, but it just doesn’t get us where we need to go.” (Of the companies for which we have the information,

⁴⁹ Leonard and Swap, 1999.

most cut back the number of employees they had at their largest point, which was almost always sometime in early 2000.)

Coping with these challenges will be difficult, but not impossible. A good starting point to find the optimal point of EC is for managers to ask themselves several critical questions, frequently and repeatedly:

- 1) Which of the three categories identified in Figure 1 apply to my business? Moving from left to right in Figure 1, businesses need increasing amounts of exploratory capacity, as a) the discovery process is more complex, b) is conducted under conditions of more uncertainty and c) is likely more prolonged depending upon whether I know my customer base, need to identify the best customer base, or need to create a customer base.
- 2) Do I have a “plan B,” i.e. a contingency plan for exploration, if my initial assumption about the market turns out to be wrong? Companies starting in the middle category (experimentation with various markets) automatically have such contingencies. Those starting from either of the other two positions do not necessarily have a second option in mind. It is interesting to note that the coach of the failed Ziptran company has gone on to found his next company with this in mind. From the beginning, he created several options for the use of his software platform and he was able to move rapidly from one potential market to another.
- 3) Do I have enough flexibility to address any one or more of the three potential bottlenecks in the discovery process—or have I assumed that one or more (people, time, money) will *not* be a bottleneck, and I have therefore locked myself into a position that leaves very little exploratory capacity?

Conclusion

All innovations require exploratory capacity. The greater the uncertainty about the technological nature and use of the innovation, i.e., the more that technology and market are co-evolving, the more important become both an adequate amount and competent management of exploratory capacity. While it is not possible to determine ahead of time the exact optimal amount of exploratory capacity, managers need to beware of both drought and excess—and observations from the field suggest some indicators of managerial pitfalls. Furthermore, while the three elements of exploratory capacity are somewhat interchangeable, there are hazards in assuming total substitutability. In particular, the experimental use of incubators to stimulate instant companies in the 1999-2001 period demonstrated that lots of people and money cannot obviate the necessity of time for learning, as the technology and market co-evolve.

Bibliography

Amabile, Teresa, Jennifer Mueller, William Simpson, Constance Hadley, Steven Kramer and Lee Fleming. "Time Pressure and Creativity in Organizations: A Longitudinal Field Study" Harvard Business School Working Paper, #02-073, 2002, a.

Amabile, Teresa M., Constance. N. Hadley, Steven J. Kramer. "Creativity under the gun," *Harvard Business Review*, 80 (8): 52-, 2002, b.

Bartlett, Christopher and Meg Wozny. *GE's Two-Decade Transformation: Jack Welch's Leadership*, Harvard Business School Case 9-399-150, rev: January 4, 2002.

Bahrani, Homa and Stuart Evans. "Flexible Re-cycling and High-Technology Entrepreneurship," *California Management Review*, 37 (3): 62-89 Spring, 1995.

Baldwin, Carliss Y. and Kim B. Clark. *Design Rules: The Power of Modularity*. Cambridge, MA: MIT Press, 2000.

Barron, Tom. "Wooing IT workers," *Training and Development*, 53 (4) 20-24, 1999.

Brooks, Frederick P. *The Mythical Man Month* New York: Addison-Wesley, 1975; 2nd Edition, 1995.

Brown, Erika. "Have friends, will hire," *Forbes*, 166 (12): 62, October 30, 2000.

Christensen, Clayton M. *The Innovator's Dilemma* Boston, MA: Harvard Business School Press, 1997.

Cooper, David P. "Innovation and reciprocal externalities: information transmission via job mobility," *Journal of Economic Behavior and Organization*, 45 (4): 403-425, 2001.

Gomes-Cassares, Benjamin and Dorothy Leonard. "Alliance Clusters in Multimedia: Safety Net or Entanglement?" in *Competing in the Age of Digital Convergence*, ed. David B. Yoffie. Cambridge: Harvard Business School Press, 1997.

Granstrand, Ove. "Towards a theory of the technology-based firm," *Research Policy*, 27 (5): 465-489, 1998.

Helfat, Constance E. and Ruth S. Raubitschek. "Product sequencing: Co-evolution of knowledge, capabilities and products," *Strategic Management Journal*, 21 (10-11): 961-979, 2000.

Levesque, Moren. "Effects of Funding and Its Return on Product Quality in New Ventures," *IEEE Transactions on Engineering Management*, 47 (1): 98-105, 2000.

Leonard, Dorothy and Elizabeth Kind. *Garage.com* (A) 9-601-064 (B) 9-602-093, 2000 a.

Leonard, Dorothy and Elizabeth Kind. *Verge Software (A)*, 9-601-065, *Verge Software (B): XMarkstheSpot* 9-601-066, 2000 b.

Leonard, Dorothy and Jeffrey Rayport. "Spark Innovation Through Empathic Design," *Harvard Business Review*, Vol. 75, Nov/Dec 1997. Reprint #97606.

Leonard, Dorothy and Walter C. Swap. *When Sparks Fly: Igniting Group Creativity*, Boston, MA: Harvard Business School Press, 1999.

Leonard, Dorothy and Walter C. Swap. "Gurus in the Garage," *Harvard Business Review*, November/December 2000. Reprint #R00609.

Leonard, Dorothy and Susaan Straus. "Putting Your Company's Whole Brain to Work," *Harvard Business Review*, Vol. 75, No. 4, 110-122, July/August 1997. Reprint #97407.

Leonard, Dorothy. *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation* Boston, MA: Harvard Business School Press, 1998.

Leonard-Barton, Dorothy. "Implementation as Mutual Adaptation of Technology and Organization," *Research Policy*, Vol. 17, No. 5, October 1988.

MacCormack, Alan. "Product Development Practices that Work: How Internet Companies Build Software," *Sloan Management Review*, Winter, 75-84, 2001.

MacCormack, Alan, Roberto Verganti and Marco Iansiti. "Developing Products on 'Internet Time': The Anatomy of a Flexible Development Process," *Management Science*, Vol. 47, no. 1, January 2001, pp. 133-150.

Rindova, Violina P., and Suresh Kotha. "Continuous "morphing": Competing through dynamic capabilities, form, and function," *Academy of Management Journal*, 44 (6): 1263-1280, 2001.

Rogers, Everett M. *Diffusion of Innovations* (Fourth Edition); New York: The Free Press, 1995.

Rubin, Jeffrey Z. "Psychological Traps," *Psychology Today*, March: 52-63, 1981.

Swap, Walter and Dorothy Leonard. *Transferring Expertise in Startup Companies: Forlorn Hope?* Harvard Business School Working Paper 03-020, 2002.

Utterback, James M. *Mastering the Dynamics of Innovation* Boston, MA: Harvard Business School Press, 1994.

von Krogh, Georg. "The communal resource and information systems," *Journal of Strategic Information Systems*, 11:85-107, 2002.

von Krogh, Georg and Michael. A. Cusumano. "Three strategies for managing fast growth," *Sloan Management Review*, 42 (2): 53-67, 2001.

West, G. Page III and G. Dale Meyer. "To agree or not to agree? Consensus and performance in new ventures," *Journal of Business Venturing*, 13 (5): 395-422, 1998.

Figure 1: *INITIAL* (Starting) Point for Business Model of Companies

<p>Dependence on Internet Technology For Delivery of Product or Service</p>	High	<p>Benefit Pt.; Unitech Tejas Qsupport Specialty MD Vantage Technology Office Tempo Care2; SinoHome Farm & Country; GoGo Clips; GRIC XMarkstheSpot</p>	<p>Softbook Edurite Zaplet e4e Netbig Vividence Aztec ActivePhoto</p>	<p>Vicinity Unimobile PeopleStreet Collabrys Ziptran iNabling</p>
	Low	<p>MondoMedia NapaStyle idlSystems</p>	<p>KEY to COLORS: <u>LEVEL OF SUCCESS</u></p> <p> HIGH MEDIUM LOW</p>	

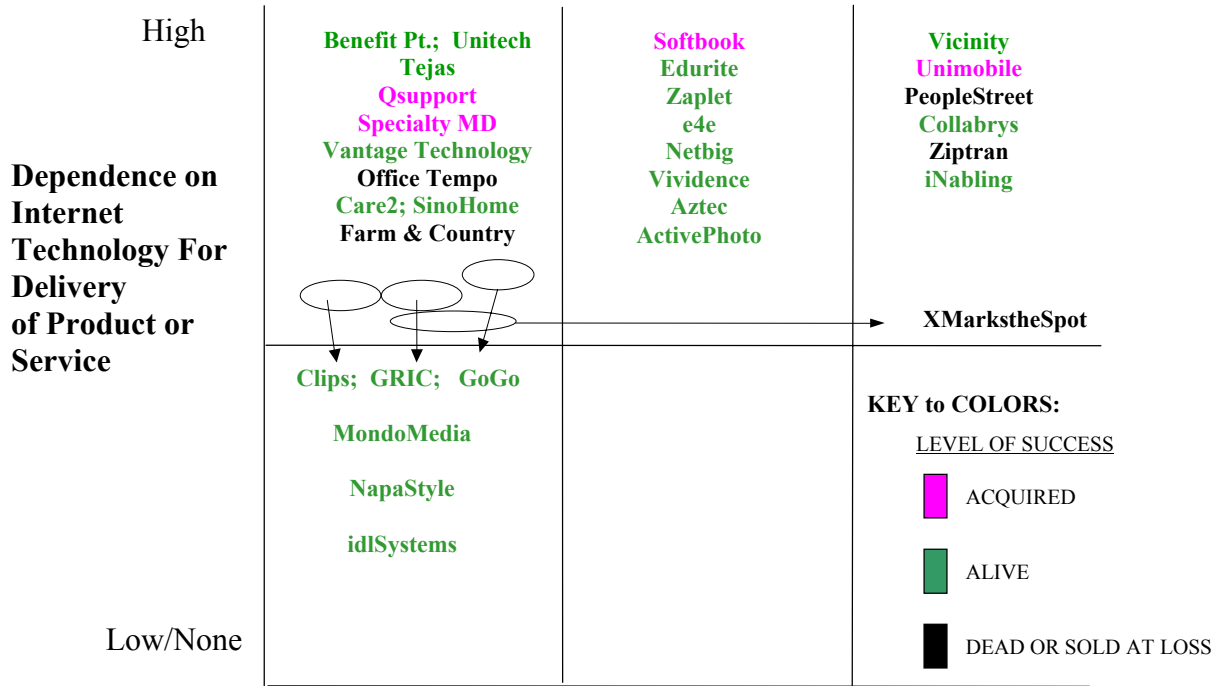
Degree to which Customer Base and Need for Innovation are known

Customer Base	Clearly identified	To be chosen	None extant
Market Need	Generic need exists	Several potential needs	Must be created
Market Strategy	Target Existing Market	Identify the Market	Envision the market
Key Action	Persuade market; beat Competition	Determine who values the technical solution most	Experiment, obtain feedback, educate users

Success Measures: Sum of self-reported measures from coach and from entrepreneur in response to the following questions in the second round of interviews (all three asked of the coach, one and three asked of the entrepreneur):

1. Compared to your expectations for [company X], how well has it done? (1= fell far below expectations; 4=about as expected; 7= Far exceeded expectations).
2. Compared to other companies you have mentored in the past, how successful would you say [company X] has been? (1=much less successful; 7=much more successful).
3. Compared to other Silicon Valley startups over the past three years, how successful is [company X]? (1=much less successful; 7=much more successful).

Figure 2: End Point (as of 2002)



Degree to which Customer Base and Need for Innovation are known

Customer Base	Clearly identified	To be chosen	None extant
Market Need	Generic need exists	Several potential needs	Must be created
Market Strategy	Target Existing Market	Identify the Market	Envision the market
Key Action	Persuade market; beat Competition	Determine who values the technical solution most	Experiment, obtain feedback, educate users