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Casual observers regard the emergent relationships between a venture capitalist and a product-development entrepreneurial firm, as most typically observed in Silicon Valley, as nothing more than the supply of risk capital to an independent minded entrepreneur. This chapter argues however that the truly unique role of venture capitalists is found in their information-mediating and governance functions, which can be understood only in the context of relationships between the "clustering" of entrepreneurial firms and (a club) of venture capitalists.

As we will describe in the first section of this chapter, the venture capitalists usually retain control blocks of shares in the entrepreneurial firms and exercise a broad range of governance roles in them, unless entrepreneurs have sufficient own funds at the outset. However, this does not mean that the entrepreneurs of product-development firms play a less autonomous role in information processing. Indeed, they are far more autonomous and innovative in the production of knowledge than the traditional research and development organizations within established firms. Also, their potential products can be often substitutes so that the competition among them fierce. On the other hand, as Saxenian [1994] documented, there is also a substantial degree of information sharing across those entrepreneurial firms. The clustering of entrepreneurial firms in Silicon Valley does not seem to be accidental. How do these ostensibly contradictory characteristics – competition in information processing on the one hand and information sharing on the other – co-exist as a coherent system, say, as the Silicon Valley model? How do we understand the unique innovative capacity of this model? What incentive impact does the apparently strong governance role of the venture capitalist have? Is there anything that the Silicon Valley model can do, which cannot be duplicated in either a single firm or atomistic markets? Can the Silicon Valley model be applicable elsewhere and in industries other than the high-technology industry?

This chapter submits that it is not sufficient for an understanding of these issues to look only at the property rights relationship between the venture capitalist and a single entrepreneurial firm. Instead, it is necessary to look at the multi-faceted relationships of a cluster of entrepreneurial start-up firms, on the one hand, and venture capitalists (as well as leading firms in respective niche markets setting an eye on successful younger ones for acquisition), on the other. The entrepreneurial firms in Silicon Valley compete in innovation and thus their activities are fundamentally substitutes. Therefore, their information processing activities need to be encapsulated from each other to excel competitors. However, different from older established integrated firms, such as onetime IBM, which conceived *ex ante* a concept for possible new product systems in a centralized manner, these firms are engaged in innovation efforts in particular niche markets in decentralized way. A new product system may be therefore evolutionarily formed by combining modular products *ex post* that evolve from such decentralized efforts. In order for such evolutionary selection is possible, common standards for interfaces among modular products need to be provided to make individual product attributes compatible.

Although the standardization of interfaces is much a product of architectures defined by dominant firms in niche markets and of industry standard-setting organizations, venture capitalists also plays no less important role in mediating information necessary for endogenously forming and setting standards *de facto* and spreading them in emerging markets. Below, I conceptualize the information systemic aspects of the Silicon Valley model, characterized by competition in information processing among entrepreneurial firms and as information mediation by venture capitalists, as V-mediated information encapsulation. As for any model, there are unique social costs involved in the Silicon Valley model, particularly the duplication of innovation efforts and expenditures. We will examine how the aspect of venture capital financing as a governance mechanism can or cannot cope with this problem.

The plan of the chapter is as follows. The first section assembles stylized facts about venture capital - entrepreneurial firm relationships as a basis for modeling. The second section presents a framework for comparing information systemic aspects of alternative R&D organizations and tries to understand the unique innovation capability of the Silicon Valley model. The third section then proceeds to the analysis of the venture capital governance as an institution for supporting such information system. Repeated tournaments among initially funded firms for refinancing necessary for the completion of projects, and the threat of termination of financial support by the venture capitalist, are seen to provide greater incentives for the entrepreneurs than under traditional financing. The fourth section discusses the incentives of the venture capitalist and other institutional characteristics of the Silicon Valley model. Conclusions follow.

1. Stylized Factual Background[1]

From the purely financial point of view, venture capital funds is an intermediary. It serves to intermediate in the supply of a large sum of investment funds increasingly from other financial intermediaries such as pension funds (45% in 1996), insurance companies and banks (6%), together with those from foundations and universities (20%), wealthy individuals and families (7%), corporations (18%), foreign investors (4%), etc., to mostly start-up entrepreneurial firms.[2]

As an intermediary, the venture capital process is unique in its legal structure. It is a system of partnership in the venture capital fund, in which there are two classes of partners: general and limited. The general partners act as organizers of the fund, accepting full personal responsibility and legal liability for fund management. Limited partners supply most of the capital but are not involved in the management and investment decisions of venture capital funds, which allows them to enjoy limited liability status as well as the advantage of avoiding double taxation.[3] General partners receive an annual fee of a few percent (2-3%) of the total capital committed and receive 15% to 25% of the realized capital gains for their much smaller contribution to funds. Funds are set up for a fixed period of time, say ten years, but in many cases management companies are formed and run by general partners to provide management continuity. Thus there can exist the usual principal-agent problems between limited and general partners, on which we will discuss in the end. This chapter does not explicitly differentiate between venture capital funds and venture capital companies, and simply refers to them as venture capitalists.

Venture capitalists seek promising investment projects, while potential entrepreneurs with planned projects but insufficient funds seek venture capital financing. There are more than two hundred venture capital companies in Silicon Valley alone, but experienced venture capitalists are said to receive over a thousand applications a year. Screening and search is not easy for either side, but suppose that a promising match is found. Unless the reputation of an entrepreneur is already known to a venture capitalist and a proposed project is judged to be certainly sound and promising, the venture capitalist initially provides only seed money to see if an entrepreneur is capable of initiating the project, while possibly extending aid to help his/her start-up. When a venture capitalist decides to finance a start-up, elaborate financing and employment agreements are drawn up between the venture capitalist and the entrepreneur.[4] These specify the terms of financing and the terms of employment of the entrepreneur as a senior manager (Testa 1997, Hellman 1998).

Usually, start-up financing involves consortium financing by several venture capitalists with one of them acting as a lead financier and manager. Among experienced and mutually known venture capitalists, the position of lead manager is rotated over different projects. This arrangement serves not so much as a mechanism of risk-diversification than as one of reciprocal delegation of monitoring among a group of venture capitalists. The reciprocal delegation may not only avoid the duplication of intense monitoring but also functions as a device to control possible shirking of monitoring by venture capitalists (Lerner 1994, Fenn, Liang and Prowse 1995).[5] If a lead venture capitalist shirks due diligence or is incompetent and more than a normal number of financed projects led by him/her fail, his/her reputation will be tarnished and he/she will lose opportunities for raising additional funds and participating in potentially profitable future projects organized by others. Up to the end of this chapter, I abstract from this reciprocal relationship among venture capitalists, and regard the relationship of an entrepreneur with venture capital funds as if it were with a single venture capitalist.

At the time of startup the venture capitalist commits only a fraction of the capital needed for the ultimate development of a project, with the expectation that additional financing will be made step-wise, contingent upon the smooth proceeding of the project, which may not be contractible – a process which Salman (1990) called "staged" capital commitment. Financing of venture capitalists normally takes the form of convertible preferred stocks or subordinated debt with conversion privileges (Fenn, Liang, and Prowse 1995, Gompers and Lerner 1996). They are paid before holders of common stock in the event of project failure, so venture capitalists are protected from downside risk. Also, they retain an exit option exercisable by refusing additional financing at a critical moment when a start-up firm needs the infusion of new funds to survive. On the other hand, a typical shareholding agreement allows an entrepreneur to increase its ownership share (normally in common stock) at the expense of investors if certain performance objectives are met. Fired entrepreneurs forfeit their claims on stock that has not vested.

The venture capitalists, lead as well as non-lead, are well represented on the board of directors of the start-up firms. Lerner [1994a] reports that venture capitalists hold more than one-third of the seats on the boards of venture-backed biotechnology firms – more than the number held by management or other outside directors. In addition to attending board meetings, lead venture capitalists often visit entrepreneurs cum senior managers at the site of venture-funded firms (see also Barry et al. 1990). They provide advice and consulting services with the senior management ranging from helping to raise additional funds, reviewing and assisting with strategic planning, recruitment of financial and human resource management, introduction of potential customers and suppliers, public relations and legal specialists, etc. They also actively exercise conventional roles in the governance of the start-up firms, often firing the founder-managers when needed. According to panel data compiled by the *Stanford Project on Emerging Companies (SPEC*) which collects panel data on 100 high technology start-up firms in Silicon Valley, the likelihood that a non-founder is appointed as CEO in the first 20 months of a company's life is around 10%; this likelihood increases to about 40% after 40 months and to over 80% after 80 months, to say nothing of companies going out of existence and thus not included in the sample.(Baron, Burton, and Hannan [1996], Hannan, Burton Baron [1996])

There are many business failures among entrepreneurial start-up firms.[6] Many failures crop up early, usually in the first one or two years. Frequent failures may be caused not only by over-zealous competition among ambitious entrepreneurs, but also because the venture capitalist itself may contribute to this. For example, William Salman and Howard Stevenson observed the following phenomena in an emerging segment of the computer data storage industry in the mid-1980s. “In all, 43 start-ups were funded in an industry segment that could be expected in the long run to support perhaps four.” Thus, ”’failure’ is at the very least endemic to the venture capital process, an expected commonplace event; in some cases, the process itself may even promote failure.”(Gorman and Sahlman [1989], p.238) In casual conversations in Silicon Valley, venture capitalists normally regard three successes out of ten initial funding reasonable. We will discuss in subsequent sections the social benefits and costs of the duplicated funding of development projects and high probability of failure.

If the project is successful, the relational financing terminates either with initial public offering (IPO), typically taking place five to ten years after the start-up, or with acquisitions by other firms. Venture capitalists decide when to go to a market for IPO, and supply needed marketing expertise. In order to control possible moral hazard, the lead venture capitalist remains as a board member after IPO. Capital gains are distributed between the venture funds and the entrepreneur according to their shares at that time. Experienced venture capitalists can time the IPO to occur when market valuation of portfolio firms is particularly high, while less experienced and less reputable venture capitalists may have incentives to bring a portfolio firm to market prematurely (Lerner, [1994]; Gompers [1995])

Some authors argue that the presence of active IPO markets is an essential element of the success of venture capital financing and product innovation therefrom, and that their absence may be responsible for the fact that other economies have a difficult time emulating the Silicon Valley phenomena (e.g., Bankman and Gilson [1996]). Although there may well be an element of truth in this claim, it is also important to note that recently successful start-up firms have been increasingly becoming the targets of acquisition by leading firms in the same market rather than going to IPO markets (e.g., see Stanford GSB case materials S-SM-27). These firms are often themselves grown-up entrepreneurial firms who have been successful in taking leadership in standard setting in their niche markets. They aim at acquiring successful start-up firms either to kill-off potential sources of challenges to their set standards, or to further strengthen their market positions by acquiring and bundling complementary products. These are said to have influence on venture capitalists in guiding their activities, especially toward the end of venture capital financing. From the view point of start-up entrepreneurs, they are said to prefer acquisition to IPO, when they have only a single innovative product line (Hellmann [1998a]).

Thus the venture capitalist performs the integrated functions of *ex ante* monitoring (screening of proposed projects to cope with the possible adverse selection problem), *ad interim* monitoring, and *ex post* monitoring (the verification of project result and the controlling decision as to which exit strategy is to be exercised) *vis-a-vis* venture-funded firms. *Ex ante* and *ad interim* monitoring of an entrepreneurial project requires professional engineering competence in specialized fields, while *ex post* monitoring requires financial expertise. The venture capitalists meet such needs and tend to focus on companies in specific industries. Although the venture capitalists play a dominant governance role in venture-backed firms, their property rights arrangements have complex elements of joint-ownership with provision of bilateral option rights: the venture capitalist's rights to exercise an exit option against the entrepreneur's interest in bad times, and the entrepreneur's right to exercise a stock option in good times. Control rights are voluntarily relinquished *ex ante* by the entrepreneur, particularly if (s)he is liquidity constrained at the outset (Hellmann [1998]). But as the project moves successfully, (s)he may regain control rights.

2. The Information Systemic Characteristic of the Silicon Valley Model

(A) Comparative R&D Organizations

The introductory section suggested that the venture capitalist is normally involved in the governance and managerial structure of the entrepreneurial start-up firm to an extent far beyond the provision of normal financing services and associated monitoring. However, for an understanding of the innovative nature of the Silicon Valley phenomenon, it is not adequate and appropriate to limit the scope of analysis merely to the bilateral relationships between the venture capitalist and an *individual* entrepreneurial firm. This may lead to a misplaced emphasis on the governing power of the venture capitalist. In order to understand the other important aspect of the venture capitalist as a catalyst of technological system innovation, we need to look at systemic relationships between the venture capitalists and a *cluster* of entrepreneurial firms as carriers of development projects.[7]

Although there are some notable difference in their internal organizational structure,[8] entrepreneurial start-up firms have a common feature regarding their relationships toward product markets. Instead of creating mutually competitive, stand-alone product systems of their own, they tend to be specialized in the development of innovative product designs that may constitute useful modules in the evolving industrial frame and thereby help them carve out niche markets or gain a better bargaining position vis-a-vis larger firms aiming to integrate. The standardization of interfaces is much a product of architectures defined by dominant firms (especially Intel and Microsoft in the current era) and of industry standard-setting organizations (such as SEMI, the Semiconductor Equipment and Materials International, and IETF, the Internet Engineering Task Force) as of coordination by venture capitalists. Similarly, firms like Sun are competing with products like Jini and Java to define the interface standards for emerging markets. Even the leading positions of established firms in respective niche markets may not be secure in highly uncertain and competitive technological and market environments. Rather, standards may be conceived to be evolutionarily formed and modified through the interactions of firms, large and small. This situation may impose two important information requirements on the side of entrepreneurial firms. They need to continually process and share wider information relevant to the evolving industrial frame, on one hand, and, on the other, each needs to integrate and encapsulate specific information crucial to its own module-product design to stay competitive.

To capture the information mediating role of venture capitalists in this non-hierarchical structure of product development and contrast it with R&D organization of traditional firms, let us first introduce a simple conceptual framework for comparative R&D organizations. Imagine a generic R&D system simply composed of the management, denoted as M, and two product design teams, denoted as Ti (i=a, b). The management is engaged in such tasks as development strategy, the allocation of R&D funds, etc., while the teams are engaged in the design of products, each of which is to constitute a component (say, a monitor, a hard drive, etc.) of an integral technological system (say, a laptop computer). The organizational environments are segmented as the first row of Figure 1. Namely, there is a systemic segment, E-s, say the availability of total R&D funds, emergent industrial standards, that simultaneously affects the organizational returns to decision choices by M as well as the T's. Next, there are the segments of environments that affect the organizational returns to new product design by Ti's, say engineering environments, which can be further divided into three subsets: E-e, common to both projects, and E-a and E-b, idiosyncratic to respective projects. Various segments of organizational environments can be processed and associated decision are made by M and Ti's in various manners to be specified momentarily.

Figure 1. Comparative Information Systemic Characteristics of R&D Organizations

Environment Organization	(E-s) Systemic (technological and industrial) environment	(E-e) Systemic-engineering environment	(E-i) Team-specific engineering environment
Hierarchical R&D organization	manager's task	system engineer's task	design team's task
Interactive R&D organization	information assimilation through feedbacks from project teams to management	information-sharing among project teams	individual project team's task
V-mediated information encapsulation	venture capital-mediated quasi-information assimilation	information encapsulation among entrepreneurial firms	

The product design involves the choice of "design attributes," such as depth vs. breadth, digital vs. analogue, cable vs. wireless transmission, etc. Design attributes may or may not be strongly connected between the two component projects. On the other, the farther intended designs are from existing standards, the costlier their development may be. In that sense the two component projects are competitive in the use of R&D resources. If the design attributes are strongly connected so that their designs of two component projects need to be coordinated in the same direction in spite of possible resource costs, then we say that "design projects of teams are complementary" (if not, "they are substitutes").[9] With the aid of Figure 1 we now present three stylized organizational models differentiated by ways in which the monitoring of the evolving systemic environment, as well as the information processing of engineering environments, are structured among organizational constituent units.

(i) Hierarchical R&D Organization. In this organization, M is the research manger of an integrated firm and Ti's are its internal project teams. Between them the intermediate agent IM, say the system engineer, is inserted between M and Ti's. M is specialized in monitoring the state of the systemic environment, E-s. Based on observations of these conditions, M decides on R&D expenditures and basic system development concept and its decision choice is communicated to IM. IM performs system analysis and basic design within the budget and other constraints imposed by M by processing the systemic engineering environment, E-e. Then it hands over its design choice to Ta and Tb. These component product design teams then resolve problems that arise in their respective design-specific engineering environments, E-i *(i=a,b*). This organization may be thought of as reflecting the essential aspects of the R&D organization of the traditional, large hierarchical firm, sometimes referred to as the "water-fall" model (Klein and Rosenberg [1986], Aoki and Rosenberg[1989]). It may be also considered as corresponding to what Hannan *et al* (1996) called the "factory model," which they rarely find implemented among the emergent entrepreneurial Silicon Valley firms they study.

(ii) Interactive R&D Organization. In this organization as well, M is the research manager and Ti's are interacting development teams. There is information sharing among them all regarding the systemic environment E-s. The two development teams collaborate on research and development affected by the systemic engineering environment E-e, while working individually on technical and engineering problems arising in their own segments of the engineering environment,

E-i (*i=a,b)*. Each project team thus has wide ranging information about environments, partially shared and partially individuated, on which their respective decision choice (product design) is based. This system may be considered as corresponding to what S. Klein conceptualized as the "chain-linked model" of innovation in that feedback mechanisms are operating across different levels and units (Klein and Rosenberg[1986]; Aoki and Rosenberg[1989]). Information assimilation may be thought of as being realized through the feedback of information from the lower level to the higher level, as well as through information sharing and joint development effort across design project teams on the same level. This system may be considered as akin to the coordination aspect of what Hannan *et al* called the "peer and cultural control model where the employees have extensive control over the means by which work gets done, etc." They found that some of the emergent Silicon Valley entrepreneurial firms internalize such a model.

(iii) The V-mediated Information Encapsulation. In this system, there is information sharing regarding the systemic environment among M and the Ti's, as in the interactive R&D organization. The difference is that in this case there is no information sharing between Ta and Tb regarding the engineering environments including systemic ones. Development designs are completely encapsulated within each of them and their new product design is based on individuated, differentiated knowledge derived from independent development effort. Such a model may be internalized within the firm, with each project team having strong autonomy in information processing and product design. However, I submit that this model captures in an embryotic form some aspect of relationships between venture capitalists and entrepreneurial firms, as well as those among entrepreneurial firms in Silicon Valley. In this interpretation, M is the venture capitalist

and Ti's are independent entrepreneurial firms. There is some degree of information sharing among them all about emergent industrial systemic environments, often mediated by the venture capitalists (even if they are not carriers of information themselves, they do often mediate contacts among entrepreneurs, engineers, university researchers, etc., in the valley). However, the degree of information sharing among them in this respect may be weaker in substance and amount than under the interactive R&D organizations. Therefore we may refer to this aspect as quasi-information assimilation, on which we will elaborate more below. On the other hand, technological information that are necessary for product design is generated within individual firms in an integrative manner and hidden from others until the completion of product design. Thus, this system is referred to as V-mediated information encapsulation.

(B) Comparative Information Systemic Performance of the V-mediated Information Encapsulation

(i) A Basic Proposition

We start with the case where three organizations face exactly the same organizational environments.[10] Each unit of the organizations processes information emergent in the assigned segment of the environments with some precision. For the Ti's level, this implies that each project team is engaged in development effort with some level of competence.[11] Based on its own information processing results, each unit then chooses its own decision variable (e.g., funds allocation, design specifications, etc.) according to a certain rule. Given a certain distribution of information processing competence across product development project teams for each organizational type, if there is a set of decision rules for one of the above organizations which yields a higher expected organizational returns than another organization, we say that the former organization is potentially *informationally-more-efficient* than the other for that distribution of information processing competence. In order to provide a benchmark for a dispassionate comparison, let us consider the case that the level of information processing competence by any agent about any variable is identical. Then, the following basic proposition hold:

Proposition 1. If and only if design projects are not complementary, the V-mediated information encapsulation becomes potentially informationally-more-efficient than hierarchical and interactive R&D organizations.[12]

If design projects are complementary, then the choices of design attributes of two project teams need to be coordinated in such a way that their choices fit each other. Such coordinated choices are internalized in the hierarchical and interactive R&D organizations, because information utilized by the project teams for decisions become assimilated, apart from idiosyncratic technological information. In hierarchical organizations, common information about E-e is contained in the hierarchically transmitted message originating from the intermediate system engineer, while in the interactive organization it can be extracted as an outcome of joint development effort or information feedback. These two organizations place relatively greater weight on the common knowledge in decision-making and are more likely to induce iso-directional choices in design variables. In contrast, in the V-mediated information encapsulation the observations of systemic technological information by the entrepreneurial firms are mutually hidden. Therefore, choices of decision variables by them would be less correlated in comparison to those of their counterparts.[13]

(ii) Endogenous Reduction of Attribute Complementarity by Interface Standardization. Attribute complementarity of design projects at the T2 level can be reduced and the compatibility of their products can be enhanced when the internal workings of individual products are modularized with simple mutual interfaces. Then *ad interim* coordination in design efforts across project teams becomes less imperative. Compatible interface design may be set centrally and *ex ante* (in the sense "before research and development") by the management of a large hierarchical R&D organization, or in some cases even by the government. But such centralized and *ex ante* approach may not yield a good outcome when the high degree of *ex ante* uncertainty involved in developmental design. In such case, emergent information in the process of development effort may be better utilized. One possible informational advantage of the interactive R&D organizations vis-a-vis hierarchical organizations may be their flexibility in fine-tuning interfaces in response to emergent information. However, in interactive R&D organizations *ad interim* adaptation (i.e., adaptation after development started but before design is completed) to emergent information is not in general limited to interface design but often involves simultaneous changes in the contents of product designs of individual project teams. Thus information load in this type of organizations can be high.

In the V-mediated information encapsulation, engineering information necessary for product designs are encapsulated so that the coordination of design extended to the content of products is not feasible, that is, products of Ti's (entrepreneurial firms) are modularized. However, as the proposition above suggests, the information efficiency of this system can be enhanced vis-a-vis interactive R&D organizations, if the interfaces of their products are standardized. We can envision that the information assimilation role of M (venture capitalist) is precisely to mediate the systemic information concerning emergent interface standards for modular products of Ti's (entrepreneurial firms) *ad interim*. Then, Ti's can adapt to emergent standards, even sometimes involved in the formation of de facto standardization, without their content design mutually affected. Thus, once the system of V-mediated information encapsulation and *de facto* interface standardization of modular-product design start to be combined, there will be a momentum to reinforce each other. The engineering environment advantageous to the V-mediated information encapsulation is endogenously generated by itself.

> *Proposition 2. As the interfaces of modular products are standardized ad interim in response to emergent systemic information, the informational efficiency of the V-mediated information encapsulation is enhanced. On the other hand, the V-mediated information encapsulation helps de facto standardization of interfaces to evolve. Thus, they are mutually reinforcing.*

(iii) The Evolutionary Nature of the Innovation Process under Information Encapsulation.

We have made a comparison of informational efficiency among alternative organizations, but the derived propositions are based on the assumption that each organization are composed of a fixed number of project teams (we assumed that there are only two teams, but the number can be any for the derived propositions to hold). However, this assumption fails to capture one essential aspect of the Silicon Valley model in comparison to hierarchical and interactive R&D organizations. An appropriate modeling should be that there are multiple competing teams (entrepreneurial firms) for each modular product design project in the Silicon Valley model.

Consider an innovation process of a large-scale, complex product system. Suppose that it can be hierarchically decomposed into several distinct steps, such as basic conceptualization, system analysis, detailed design, pilot manufacturing, testing, etc. Some steps such as design and pilot manufacturing may be further decomposed into sub-task units. In such a hierarchical decomposition, once a system concept is centrally conceived and a system design is drawn accordingly, even if some revision to the system comes to be perceived as necessary afterwards because of the occurrence of unanticipated events at a later stage, it may become too costly to redo the whole process from the beginning. Then the design may have to be only partially revised on an *ad hoc* basis at a later stage, sometimes losing the internal coherence and consistency initially intended. If a new generation of the product system is to be designed, the whole process may have to be repeated all over again, which takes time and resources.

The interactive R&D organization can possibly cope better with emergent unexpected events by the use of frequent feedback mechanisms between different stages of product development, as well as the collaboration in problem solving between teams engaged in interrelated tasks at the same level. In this type of organization, the product system may be continually improved, or accumulated learning from unexpected events at all development stages may be utilized for the design of a new generation of the system. However, once communications channels are set up between different developmental stages and task units, it may become difficult to change the basic organizational structure of development in a radical way such as to replace a group of tasks. Accordingly innovation in the product system may tend to be only incremental.

In contrast, if the system of V-mediated information encapsulation is composed of more than one competing teams for each project (that is, for each product design project, there exist many firms) at the outset, the generation of a product system may be made through the evolutionary selection of a team out of the many for each project in accordance with their emergent development outcomes. Such *ad interim* or *ex post* (i.e., after design processes are completed) selection becomes feasible because of the interface standardization. Innovation in the product system can then evolve without *a priori* centralized design and free from forces suppressing a radical departure from existing bundling patterns of modules. It may rapidly evolve from a relatively simple prototype system into an ever-more-complex system by flexibly re-bundling continually improved modular products from different entrepreneurial projects. Or, product systems may become more easily reconfigurable. An often invoked analogy to this possibility is Lego building blocks with their interlocking-cylinder faces. The number of objects that can be built with Lego is limited only by imagination (Pine 1993). The evolutionary selection under the V-mediated information encapsulation becomes particularly innovative when the prior uncertainty regarding engineering environments is particularly high or engineering landscape is rapidly changing. Under such situation, *ex ante* centralized design of product system in the hierarchical R&D organization may be very risky, while incremental innovation under the interactive R&D organization may not be able to realize a break-through innovation nor can catch up with the rapidly changing engineering environment.

However, the cost of such flexibility is the duplication of development efforts and expenditures supporting them. In the next section we analyze how the governance aspect of the Silicon Valley model tries to deal with this problem.

3. Governance of Innovation by Tournament

In the previous section, it was suggested that the efficiency and innovativeness of the mechanism of V-mediated information encapsulation is enhanced when design-attribute connectedness is reduced by the standardization of interfaces among products of the industry. However, by the nature of the mechanism, a standard of interfaces cannot be set entirely hierarchically or by any other centralized mechanism such as government regulations. Although the standardization of interfaces is largely a product of architectures defined by dominant firms and of industry standard-setting organizations, even the choices of those firms and organizations cannot be entirely free from emergent innovation and practices. In order for this evolutionary mechanism of *de facto* standardization to work, there must in turn be a mechanism by which information regarding the evolving industrial frame is collected, transmitted, and shared across competing firms. One of the important functions of the venture capitalist suggested by the preceding argument is precisely to mediate such a communication process. Based on this insight, the present section tries to explore in a game-theoretic framework how such a mechanism can be incentive-wise implemented by the venture capitalist and entrepreneurial start-up firms.

(A) The Structure of the Stage Game.

As background for the model below, imagine that time consists of an infinite sequence of stage games, each of which is played over three dates between venture capitalists and entrepreneurial firms. The venture capitalists live permanently, competing with each other to nurture valuable firms, while entrepreneurial firms start up at the beginning of date 1 of a stage game and exit by the end of date 3 either by going public, being acquired by other firms, or being terminated. When terminated, entrepreneurs can come back to the next stage game as new start-up firms. In this subsection, we do not explore the impacts that the repeated nature of the game may have on venture capitalists reputations, or the risk-taking traits of would-be entrepreneurs, and we concentrate instead on the analysis of the single stage game between one venture capitalist and multiple start-up firms, embedded in the repeated game. We take up the possible impacts of the repeated nature of the game and competition among venture capitalists in the next section.

We assume that before date 1 starts – thus outside the model– , a venture capitalist, denoted by VC, has screened many developmental projects proposed by cash-constrained, would-be entrepreneurs and selected some of them for start-up funding (*ex ante* monitoring). For simplicity's sake, there are only two types of projects and the VC has selected two proposals for each. The start-up firms are indexed by subscript *ij*, where i=a,b denoting a project, and j=1,2 distinguishing entrepreneurial firms. Hereafter we use a "start-up firm" and its "entrepreneur" as interchangeable terms. The entrepreneurs are *ex ante* symmetric in their parametric characteristics except for the project types they are engaged in. There are three dates within each stage game: the first corresponds to the phase of individual information processing – research and development – by entrepreneurs; the second to that of communications between entrepreneurs and the VC and associated design specification by the entrepreneurs; and the third to that of refinancing selection by the VC and project completion by selected entrepreneurs. At the end of date 3, the values of the entrepreneurial firms are realized and distributed between them and the VC according to contracts to be drawn in the beginning of date 1.

At date 1, each start-up firm funded by VC is engaged in research and development effort. The choice of entrepreneurial effort level at start-up firm ij is denoted by e_{ij} and its cost by $c(e_{ij})$ with the usual increasing marginal cost property. The actual levels of effort implemented by the start-up firms may afterwards be inferred as we will specify later, but are not verifiable in the courts, so that they are not contractible. The development effort of entrepreneur ij generates noisy one-dimensional information $_{ij}$ – research results– regarding uncertain engineering environment measured with the precision $_{ij}(e_{ij})$. The higher the effort level, the higher the precision of the entrepreneur's posterior estimates regarding the environment which it faces. The fixed amount of funding provided to each entrepreneur by VC at this date only covers the cost of information processing (including wages) at this date and is not sufficient for further product development.

At the beginning of the date 2, when uncertainties regarding the environments still persist, on the basis of research results obtained in date 1, the entrepreneurs tentatively specify product design attributes, with observable interface properties and performance characteristics y_{ij} from an one-dimensional set Yi $(i=a,b)$– let us call this observable portion of the design the external design specification. Besides information obtained in date 1, each entrepreneur needs to take into consideration in his own design how industrial standards are evolving – which relates to the segment of the environments E-s. In order to obtain information regarding others' choices, entrepreneurs engage in communication through the intermediary of VC, using external design specifications of products as verifiable messages with products' internal workings hidden. The VC mediates entrepreneurial communications, combined with his own assessment of the emerging industrial frame partially set by established leading firms. The entrepreneurs successively revise their design attributes, internal and external, in response to VC's message and others' open design specifications. Communications and revisions continue until the process converges to an equilibrium value $_{vc}$ measuring the environment E-s (we assume it does so within date 2). We regard this process as the process of entrepreneurs and the VC mutually improving and assimilating their estimates of the industrial environment, E-s. Suppose, for simplicity's sake, that the precision of their assimilated information is a function $_{s,vc}$(.) of the VC's mediating effort, $e_{s,vc}$. The cost of VC's mediating and monitoring efforts are represented by (e_{vc}) with the usual increasing cost property. Suppose that the precision of VC's information is observable to the entrepreneurs (but not court-verifiable). At an equilibrium entrepreneur ij specifies its product design attribute y_{ij} as a combination of the VC-mediated assimilated information $_{vc}$ and its own research results $_{ij}$ with respective weights equal to $_{vc}(e_{vc})$ and $_{ij}(e_{ij})$.[14]

At the beginning of date 3, the VC estimates which combination of a product design from each type is expected to generate higher value, if the respective firms are offered to the public, or acquired by an existing firm, at the end of the date. According to this judgement, the VC selects one proposal from each type of project for implementation and allocates one unit of available funds to each of them. The VC's decision is represented by $x = (x_{a1}, x_{a2}, x_{b1}, x_{b2})$, where $x_{ij} = 1$ if the *ij* product is selected for financing and $x_{ij} = 0$ if it is not. If $x_{ij} = 1$ then $x_{ik} = 0$ for $k \neq j$. The firms that are not selected by the VC exit.

At the end of date 3, the selected projects are completed and the VC offers the ownership of these firms to the public through markets or sold to an acquiring firm. At that time, all environmental uncertainty is resolved and the total market value, $V(x_{a1}y_{a1}, x_{a2}y_{a2}, x_{b1}y_{b1}, x_{b2}y_{b2}: E)$, is realizable, contingent on the state of environment E prevailing at that time. The realized value is distributed among the VC and the entrepreneurs. Let us denote the distributive share of the value to firm-*ij* by $_{ij}$ and that of VC by $_{vc} = 1 - S_{ij}\ _{ij}$. The payoff of each firm is then $_{ij}V$ - $c(e_{ij})$ ($i=a,b;\ j=1,2$) and that of the VC is $_{vc}V$ - (e_{vc}), assuming there is no discounting over dates within a stage game. The incentive of each agent is to maximize its own expected pay-off.

Summarizing, the date 1 strategies of the entrepreneurs are choices of effort levels for research. At date 2, entrepreneurs choose an open design attribute specification *y*'s based partially on results of their own research and partially on available information mediated by the VC, while the VC decides on the allocation of project implementation financing *x*'s in date 3. The VC expends effort in dates 2 and 3 for information mediation and capital market monitoring. In addition, before the beginning of the stage game, the VC and the entrepreneurs have to agree on the way in which realized values are to be distributed at the end of date 3.

The time line of this Venture Capital Game can be summarized as follows:

Figure 11.2. The Time Line of the Venture Capital Game

	before the game	date 1: development	date 2: design specification	date 3: refinancing selection	end of the game
entrepreneurs	contract agreement: start-up financing	development effort	design specification	exit or project implementati-on	value realization and distribution
venture capital			information mediation	selective final-stage financing	

(B) Incentive Impacts of Governance by Tournament.

We have imagined that toward the end of date 2 effort expenditures have been made by the entrepreneurs as well as by venture capitalist and that the resulting information has now become available to them. At that moment, the entrepreneurs and the VC alike are interested in maximizing their expected value. It was assumed that the contribution to expected value by individual entrepreneurs becomes estimable with some noise to the VC at date 3 after observing the external attribute specifications of the proposed design. Suppose the VC chooses one entrepreneur from each project for refinancing and project implementation if and only if that project is expected to yield higher value in her judgement. That is, the VC runs a tournament among entrepreneurs and only those who win in terms of their design's expected value creation get the refinancing necessary for the completion of their proposed design in date 3. At the time that winners are selected, a share $\ _{ij}= \ _{i} > 0$ is vested with the winning entrepreneur (i=1,2) and the unfunded entrepreneur forfeits any share ($\ _{ij}= 0$). We refer to this scheme as *VC's governance by tournament*.

As two entrepreneurial firms in the same project are assumed to be the same, if a mistake the VC may make in value estimates of entrepreneurial firms is believed to be unbiased, entrepreneurial firms in each project are expected to choose the same effort level *ceteris paribus* and have equal chances of being selected *ex ante* so that the entrepreneur's choice must satisfy the following first order condition: its marginal expected individual benefit of additional effort is equal to its marginal cost. The marginal expected individual benefit is composed of two parts: its share times the probability of being selected for refinancing times its marginal expected value contribution *plus* its share times the marginal increase in the probability of being selected for refinancing times its expected value contribution. Let us refer to the second term as the "tournament effect". Note that the second terms involves the *total*, not marginal, expected value contribution.

Let us compare this choice with the following alternative as a comparison benchmark. Suppose that the financier selects *ex ante* (i.e., before the date 1 begins) only *one* proposal from each type and promises each of them to be entitled to the same share $\ _{i}$ of the value V as realized by the winning entrepreneur at the end of the stage game. Besides, the financier neither mediates information assimilation across entrepreneurs nor selects/rejects projects *ad interim*. He might as well sell his own share *ad interim* to buyers in the market who do not have any capacity to be directly involved in the governance structure. Let us call this scheme the *arm's length financing contract*. As their effort levels are not observable, the effort choice of the entrepreneur would be described simply by the marginal expected value of effort being equal to the marginal cost of effort. Comparing the two condition, we see that, if the total value that the winning entrepreneur can produce is very large relative to the marginal effort product, then the governance by tournament can elicit higher development effort than under arm's length financing, even though his winning chance is one half and therefore not certain as under arm's length financing

Let us take the balance obtained so far from the view point of the VC. The VC's benefit from running a tournament is her share in the additional gains from the tournament effect. Her costs are :(1) duplicated start-up funding at date 1, and (2) intermediating and monitoring effort costs in date 2 and 3, which would induce more confidence by the entrepreneurs in her project selection. We can prove the following (see Aoki [1999] chapter 11 for a proof):

> *Proposition 3. If the total value created by entrepreneurial development efforts is expected to be high relative to marginal value (that is, the effort elasticity is small), then it is possible that, even for the same share allocation, the venture capitalist governance by tournament can elicit higher development efforts from entrepreneurs that can compensate venture capitalist for their duplicated start-up financing and interim monitoring costs.*[15]

There are unique social costs and benefits arising from venture capitalist governance by tournament that institutionalizes *ad interim* selection of projects. One cost is that of the duplication of research and development efforts by entrepreneurs that are sunk in date 1. The effort costs of entrepreneurs who do not win the tournament become deadweight losses. As just stated above, there is also the loss of the initial funding to them by the VC. The net balance between the deadweight losses and the benefits from increased effort by the entrepreneurs is not clear without a further parametric specification of the model. It might well be negative. Nevertheless, even in such a case venture capital financing may be preferred to arm's length financing by the VC as the preceding proposition indicates. If entrepreneurs are risk-lovers who place a high utility on an uncertain high value obtainable as the prize of the tournament, then venture capital contracting may be preferred to arm's length contracting by entrepreneurs as well in spite of the possibility of *ex post* bearing of the dead weight loss. I will discuss in the following sub-section how such risk-taking traits may be endogenously formed when governance by tournament is institutionalized.

As already argued, however, there is a unique social benefit from venture capitalist governance due to the possibility of *ad interim* selection of projects, particularly when technological uncertainty involved in project development is very high while design attribute complementarity between project types is low. So we may assert:

Proposition 4. Venture capitalist governance by tournament generates deadweight losses of loser's research and development efforts. On the other hand, it can configure ad interim a system of product design in response to the emergent state of engineering environments and this possibility creates unique system benefits in the absence of strong attribute complementarity between modular product designs which are not possible under other types of R&D organizations.

11. 4. Further Institutional Ramifications of the Venture Capital Governance

(A) Market Reputations and Club Norms of Venture Capitalists

Finally, we add a few words about the venture capitalist's incentives. In the model of the previous subsection, the venture capitalist's net pay-off within a stage game is $_{vc}\, E[V]$ - (e_{vc}), namely its shre in realized value minus its effort cost. Assuming that the VC maximizes the pay-offs only within the horizon of the current stage game, we derive the first-order condition: $_{vc}$ $E[dV/de_{vc}] =$ $'(e_{vc})$, that is, its share times the expected total value is equated with marginal cost. However, for optimality the condition ought to be: $E[dV/de_{vc}]=$ $'(e_{vc})$, that is, the marginal expected total value ought to be equal to the marginal cost. Evidently, under-supply of effort by the VC occurs. At this point, it becomes necessary to make explicit the repeated nature of venture capital financing, albeit vis-a-vis a different set of entrepreneurs in each stage game, and to make explicit the role of reputation and competition among multiple venture capitalists. As stated in section 1, venture capitalists are financial intermediaries who manage venture capital funds contributed by other financiers who lack expertise in administering the system of governance by tournament. Venture capitalists compete with each other in securing those funds for the formation of successive venture capital funds over time. At the same time, they invest together as a consortium in entrepreneurial start-up firms, while reciprocating the role of lead financier. In such situations, reputation mechanisms that operate in markets for the supply of funds, as well as among venture capitalists, can play an important role. If a venture capitalist fails to deliver a high value to its own investors at the contractual end of a fund, it will have difficulty in raising future funds. If she fails to do the same for the other venture capitalists who have delegated monitoring to her, she may be ostracized from future consortia through a club norm regulating reciprocal delegation of monitoring[16]. The benefits for the venture capitalist from pursuing the value maximization of current funds are not limited to a one time share in the current venture capital funds that they manage, but include the avoidance of losing their reputations in markets and clubs.

To see more formally the impacts of market competition and a club norm on venture capitalists' incentives, suppose that, if the realized value of a venture capital fund at the end of date 3 falls short of a threshold value $\underline{V}$, then the capacity of its manager (VC) to raise further funding and/or to join profitable consortia led by other venture capitalists from the next stage game on is weakened, and consequently her earning ability is lowered by some large amount. Suppose that the venture capitalist chooses her effort level in each period to maximize her own continuation value in the face of such possibility of punishment for the under performance. However, note that investors and other venture capitalists can observe only the realized value at the end of each period, but not her effort level. Under this situation, we can derive the following proposition.

Proposition 5. The decision of suppliers of funds regarding partnership renewal with venture capitalists on the basis of the previous records of their capital gains realization, as well as a club norm regulating their reciprocal delegation of monitoring, can elicit higher efforts from them. But this effect is reduced if the stochastic distribution of funds' final performances is widely spread.[17]

(B) Endogenous Risk-taking Traits of Entrepreneurs

If the venture capitalists remain active over multiple stage games, they will be able to accumulate expertise in administering governance by tournament: such as mediating information exchanges among entrepreneurs, and judging the compatibility of component product designs in a systemic context, hence helping them to configure a complex system in a self-organizing way. As a by-product of this process, the venture capitalists accumulate knowledge about the research and engineering competence and potential, as well as entrepreneurship, of the founders of start-up firms, partially independently of the success or failure of their particular product designs projects in a one time tournament. A failure of an entrepreneur to complete a design project in one round of a stage game may not necessarily have been due to his/her inherent incompetence, but might have been caused by sheer bad luck, lack of fit of his/her inherently good design with an evolving system, a slight lag in design completion, etc. Therefore, (s)he may be qualified to enter another tournament. Making such judgements (*ex ante* monitoring) is another important function of venture capitalists. The knowledge about would-be entrepreneurs obtained on site from past stage games may be helpful for selecting new competitors for a subsequent stage tournament. Thus there can be an important complementarity between *ad interim* monitoring and *ex ante* monitoring.

On the other hand, if potentially capable entrepreneurs can have reasonable expectations of being allowed to participate in subsequent tournament rounds in spite of past failures, their risk-taking attitudes may be endogenously enhanced. Namely, even if there is a chance of losing in a tournament, one may be tempted to repeatedly mount a challenge in new tournaments in the hope of getting a large prize someday. Thus one may say that the risk-taking traits of entrepreneurs under venture capital financing are shaped by the venture capital governance that may warrant such expectations.

Claim 1. The repeated play of the governance by tournament may endogenously shape the risk-tolerance trait of entrepreneurs, thus reducing the (private and social) costs of unsuccessful duplicated efforts.

(C) Complementarity between Venture Capital Governance and Mobile Engineers Markets

We have assumed that the venture capitalist has the ability to select a better entrepreneurial firm from each project at date 3 of each stage game. However, his/her expertise in judging the technological potential of entrepreneurial firms by him/herself may actually be limited. However, such shortcomings may be compensated for by the mobility of engineers across entrepreneurial firms. Ambitious and competent engineers may be constantly looking for a "cool" technology. If the research and development of a new entrepreneurial firm at date 1 is not generating a satisfactory outcome, it may be the engineers in that firm who can recognize this first. If other entrepreneurial firms are continually being organized to search for "cool" technology with the aid of VC financing, those engineers may then exit the slowed-down firm and move to a new firm. "The story in Silicon Valley is that people work for the Valley; they do not work for a firm"(Gilson[1997], p.1467) Such mobility of engineers provides negative momentum to the process of research and development of the slowed down firm and reveals its losing status in the tournament to the VC.[18] Thus we submit:

Claim 2 . The limited ad interim monitoring ability of venture capitalists to assess the *progress of financing projects may be supplemented by the signal given by engineers who exit ad interim from failing projects. On the other hand, the mobility of engineers from slowed-down entrepreneurial firms to new start-up firms is aided by the repeated play of the institution of venture capital governance by tournament. Thus, the venture capital governance and the highly mobile engineers markets are complementary.*

5. Conclusions

In this paper, we have argued that, in order to understand the unique governance role of the venture capitalists in the Silicon Valley model, it is not sufficient to take a look only at relationships between an entrepreneurial firm and a venture capitalist. Neither is it appropriate to regard the role of the venture capitalist simply as the supplier of risk capital. Since the truly revolutionary nature of the Silicon Valley model vis-a-vis traditional hierarchical or interactive R&D organizations lies in its ability to generate innovative product systems through the evolutionary selection of modular products generated by entrepreneurial firms in niche markets, it is crucial to take a look at multifaceted relationships between the venture capitalists, on one hand, and the cluster of entrepreneurial firms, on the other. In this paper, we have focused on the information structural relationship as well as governance relationships between the two and tried to identify social benefits and costs of the Silicon Valley model. The major social benefit is, as just said, the ability to generate innovative product systems when attribute complementarity among development projects is low. The major social cost is the duplication of research efforts and expenditures. This cost may be mitigated by the endogenous formation of risk tolerance attitude of entrepreneurs. One important insight of analysis is that the venture capital governance by tournament can elicit higher efforts from entrepreneurs, only if the amount of total prize for winners is very high. Therefore, the application of the Silicon Valley model may be limited to domains in which successful developmental projects are expected to yield extremely high values in markets. There is an element of lottery.

But, at the same time, the identification of conditions for the information efficiency of information encapsulation may have broader implications for corporate organizations in general. Because of the development of communications and transportation technology, even mature products (e.g., desktop computers, automobiles) are increasingly decomposed into modules, of which production and procurement become less integrated in comparison to traditional hierarchical firms (as represented by traditional American firms of a decade ago) or interactive firms (as represented by Japanese firms). This tendency renders compact modular organizations (either in the form of independent firms or subsidiaries) increasingly more efficient and viable. Various innovations in corporate governance appears to be evolving even in existing firms somewhat emulating the Silicon Valley model, such as governing subsidiaries with flexible coupling and decoupling, less operational intervention, but with tournament-like financial discipline. But this subject matter is beyond the scope of this paper.

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NOTES

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1.For relationships between venture capitalists and entrepreneurial firms in general, see Salman[1990], Bygrave and Timmons[1992], Gompers and Lerner [1996], Florida and Kenney [1998].

2.Figures in 1978 give a much different picture. In that year, individuals and families are the largest contributors to venture capital funds (32%), while pension funds' share was 15%. During the last twenty years, the so-called institutionalization of venture capital funds have proceeded.

3. It is known that the flow of funds into this organizational arrangement was given impetus by various tax measures which took place between the late 1970s and early 80s (such as the relaxation of the so-called "prudential rules" on the pension fund management, the reduction of capital gains tax in 1978 and 81, deregulation of initial public offering in 1978 and 79, etc.).

4.In 1997, more than 3,500 companies were newly registered in Santa Clara county, if not all of them venture capital financed firms.

5.In this aspect, the consortium has characteristics similar to those of the Japanese main bank system in its heyday. See Aoki [1993].

6.Between 1990 and 1997, about 21,000 new businesses were registered in Santa Clara county. About 7,000 entrepreneurial firms are said to currently exist. See Joint Venture[1988].

7. The total number of jobs in Silicon Valley were about 1.2 million in 1996. Even if we hypothetically assume that a half of these jobs are supplied by entrepreneurial firms estimated to number about 7,000, they are roughly in the same order of jobs supplied by IBM or GM at their height of employment. Thus, the comparison of a large integrated traditional firm and an individual entrepreneurial firms in Silicon Valley does not make much sense. A proper comparison ought to be between the former and a cluster of entrepreneurial firms.

8.The "internal" characteristics of the individual firms clustered in Silicon Valley are *not* uniform. By analyzing the *SPEC* panel data mentioned above, Baron, Burton and Hannan identified three types of organizational means of controlling and coordinating work used in their sample cluster of emergent entrepreneurial firms (Hannan *et al*, 1996, p.512-3):

- "peer control and cultural control" where the employees have extensive control over the means by which work gets done but little control over strategic directions, projects to be pursued, etc.;
- "professional control" based on the delegation to professionals of the right in both the means and strategic directions; and
- "managerial control" embedded in formal procedures and rules with supervisory monitoring.

9. Suppose that the design attributes of Ta and Tb, y_a and y_b, can be linearly aligned and their values are normalized in such a way that their existing standard values are set to zero. Assuming that the farther from the standard values the design attributes need to be set, the more costly it is, the value that the organization can create may be represented by the following quadratic value function:

$$V = V^* + g_s x + (g_s + g_e + g_a) y_a + (g_s + g_e + g_b) y_b - A x^2 + D x (y_a + y_b) - K (y_a + y_b)^2 - L (y_a - y_b)^2$$

where x denotes the decision choice of the research organization manager, M. The effects of attribute choices on expected organizational value depend on the stochastic environmental variables $_{i}$, representing the *i*-th component of environments *(i = s,e,a,b)*. A >0 represents the constraints imposed by M's limited resources (financial or managerial) leading to diminishing financial returns to scale; D (A>D>0) the degree of requirements of coordination between M and Ti's; K the degree of organizational strain placed by competition between T's in funds allocation arising from design innovation, and L the degree of attribute connectedness between the two design projects. If K > L (alternatively <0), then we say that design projects between the teams are complementary (alternatively substitute). This formulation may appear at first sight to be rather too specific, but it is actually very general as a quadratic approximation of a general value function.

10.In terms of the organizational value function introduced before, it is assumed that the parameters D, K, and L, as well as the stochastic distributions of environmental parameters, are the same for all three organizations.

11.The competence level of a design project team may be measured in Bayesian terms by the ratio of the prior variance of an observed environmental parameter to the variance of observation error.

12. Assuming the organizational value function assumed in the previous footnote, this proposition may be seen as an extension of a theorem due to Cremer [1990]. For the proof, see Aoki [1999], chapter 11.

13.The comparison of information efficiency between the hierarchical and interactive R&D organizations is not the immediate object of us. However, we can submit the following claim: If there are a large degree of disparity in the level of information processing competence among agents, it is informationally more efficient to place a more capable agent in the R&D manager. On the other hand, if competence levels are fairly homogenous among agents, interactive R&D organizations are expected to be informationally more efficient.

14.See Aoki [1999] .chapter 5 and 11 for the rationalization of the linearity assumption.

15. More precisely, the expectation of the entrepreneurs regarding the venture capitalist value assessment also matters. See Aoki [1999], chapter 11.

16.See Aoki [1999], chapter 4.1(B) for the club norm. Major venture capitalists in Silicon Valley cluster in a small office complex located on Sand Hill Road between Stanford University and route 280. They know each other very well and casually converse and have lunches together.

17.For a proof, see Aoki [1999], chapter 11.

18.I owe this point to Thomas Hellmann.

The crescendo of Silicon Valley libertarianism would come in the 1990s, with the inflation of the original internet bubble. Ideas that had been quietly percolating on bulletin boards and at hacker conferences in the Bay Area suddenly were embraced in mainstream culture. Empowered by that influence, public intellectuals from the tech sector offered up pronouncements that were genuinely antagonistic to the state, most famously John Perry Barlowâ€™s 1996 Declaration of the Independence of Cyberspace.Â Now, his vision for a new model of governance broke decisively from the anti-statism that had defined Barlowâ€™s declaration a decade before. The tech sector shouldnâ€™t dismiss the â€œweary giants of flesh and steelâ€ but, rather, should help government do a better job at delivering services. We call this new management model â€œThe Silicon Valley. Modelâ€. because that.Â the. information technology industries (which both demand and enable rapid. change). However, the model.Â This new modelâ€”called the Silicon Valley Model because it has been realized most fully by leading companies in the Valleyâ€”is shown to be a highly developed form of the â€œAdhocracyâ€ approach that was first identified decades ago. The chapter gives a conceptual description of the new model, with graphic illustration. It then compares this new model to a traditional bureaucratic model of big-firm management, showing how the two differ in key respects. Which companies in Silicon Valley are valued at $1 billion or more? Check our infographic to see all the unicorns.Â For a supposedly mythical creature, unicorns seem to be remarkably plentiful these days. In the San Francisco Bay Area alone there are, by our count, 174 of them. Of course, unlike the single-horned creature popular in ancient Chinese and Indian myth, the companies weâ€™re talking about are very real, and multiplying. Just how numerous they are is shown in the infographic below, which provides a birdâ€™s-eye view of companies in Silicon Valley valued at $1 billion â€“ the magical number that confers unicorn status â€“ or more: A population growing and migrating. What do we see? Program & Project Management. Silicon Valley Innovation & Entrepreneurship. More Workshop Detailsâ€¦ Executive Coaching Sessions.Â Rather than using the classic design thinking model of Empathizeâ€“Defineâ€“Ideateâ€“ Prototypeâ€“Test, we use the Why, Who, What and How model. More about our approach to Innovationâ€¦ OUR VALUE.Â the perspective and experience of Silicon Valley, to inspire creativity and risk-taking within the constraints of human and financial resources. OUR DREAM FOR OUR WORKING WORLD: We love to work with purpose-driven organizations committed to optimizing overall â€œsuccessâ€, starting with defining what exactly â€œsuccessâ€ is for their complex stakeholder universe. Silicon Valley is a region in the southern part of the San Francisco Bay Area in Northern California that serves as a global center for high technology and innovation. It corresponds roughly to the geographical Santa Clara Valley. San Jose is Silicon Valley's largest city, the third-largest in California, and the tenth-largest in the United States; other major Silicon Valley cities include Sunnyvale, Santa Clara, Redwood City, Mountain View, Palo Alto, Menlo Park, and Cupertino. The San Jose