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Knowledge, Innovation and Entrepreneurship: Business Plans, Capital, Technology and Growth of New Ventures in Austin, Texas

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Knowledge, Innovation and Entrepreneurship: Business Plans, Capital, Technology and Growth of New Ventures in Austin, Texas

by

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Dedication

To

George Kozmetksy (1917-2003)

The Innovation Navigator of Austin

and

Gerardus Mercator (1512-1594)

The Innovative Cartographer

Acknowledgements

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Austin, May 20, 2004.

Knowledge, Innovation and Entrepreneurship:
Business Plans, Capital, Technology and Growth of New Ventures in Austin, Texas

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This study addresses the themes of knowledge, innovation and entrepreneurship, all of them key factors that contribute to the development and growth of new ventures. The study focuses specifically on the impacts of business plans, initial sources of capital, and technology on the patterns of growth and development of a group of new ventures in Austin, Texas from 1990 to 2003. For the most part, these new ventures were in the early stages of their respective lifecycles and were analyzed through their stages of survival, growth, or demise. The enterprises conducted operations during a period that witnessed rapid business growth, and culminated through the rise and fall of the Dot-Com Bubble.

The relationships among their initial sources of capital, business plans, technology, and growth were collectively analyzed both quantitatively and qualitatively. The research involved a questionnaire survey of more than seventy-five Austin software enterprises. Additionally, in-depth interviews were conducted with seven key entrepreneurs and two venture capital investors. This study uses the *Resource-Based View*, and it categorizes styles of entrepreneurship, according to their initial sources of capital, into three major groups: self-funded, venture capital (VC) funded and corporation funded.

The findings demonstrate that the initial sources of capital significantly impact the selected styles of business plans. 50% of VC funded ventures, as opposed to 15% of self-funded ventures, started with formal business plans. Ninety percent of VC funded ventures that started with a formal business plan, however, used those plans for external communication with the third parties, essentially for funding purposes. One-year after startup, 55% of the VC funded ventures had developed formal business plans while 45% of them still followed informal business plans. One year after startup, among the self-funded ventures, only 20% of them developed formal business plans while 80% of them followed informal, but adaptive, business plans.

Only three ventures, out of the total sample group of seventy-five, started with patented technologies, but more than thirteen eventually registered patented technologies. An analysis of the role of patented technologies in the process of venture development suggests that new technology assumes a more critical role in the latter stages of enterprise development than it does during the initial stages. Patents, accordingly, appear to be more a result of growth rather than a basis for growth.

The overall rate of growth of VC funded ventures was about twice that of self-funded ventures. Self-funded ventures often proceed cautiously and try to grow in accordance with their limited resources in an evolutionary fashion. VC funded ventures may follow more ambitious patterns of growth, depending on the amount of initial capital at their disposal, but the presence of capital does not guarantee long-term sustainability.

The study concludes that formal business plans are used mostly as communication tools with external sources of capital and do not necessarily serve to guide operations. Formal business plans are, however, distinct from the *process of business planning*. The latter tends to be a creative, complex, and on-going attempt to envision potential courses of action for the development of enterprises, and is relatively unique for each case.

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Introduction

The core inquiry of this study concerns the factors that contribute to the development and growth of new ventures. Venture development is a complex process with numerous interacting factors. Innovation and entrepreneurship, however, are two critically important drivers that influence patterns of venture development. Knowledge flow is essential for innovation. The theme of this study, accordingly, is knowledge, innovation and entrepreneurship. The operational topic of the study, however, concerns the impacts of business plans, capital and technology on the patterns of growth and development of new ventures.

The study focuses on the role of business plans in the early stages of venture development in a group of enterprises in Austin, Texas, since the late 1980s. A business plan is a document that describes current and desired stages of a venture. There exists a wide typology for business plans, varying from formal (classical) business plans, to short business plans and one-page (back of napkin) business plans. Formal business plans prescribe a number of sequential procedures common to many types of ventures.

Chapter One includes the platform of inquiry for this study—consisting of the core inquiry, the premise, the theme, the context, the methodology, the theory, the models and the operational topic. Chapter Two describes the resources needed for new venture development and continues to articulate the theme of the study, which is knowledge, innovation and entrepreneurship. Chapter Three describes the major factors that affect enterprise development, as well as the process of content development that leads to the operational topic. Chapter Four begins with the data collection process for the study and then analyzes the main relationships among the factors selected in Chapter Three. Chapter Five presents major conclusions and suggests topics for potential future studies.

Appendix A—The Conceptual Structure—describes the conceptual structure of the study, which consists of the methodology, models and theories. Appendix B—The Austin Regional Development—describes space context (milieu) and Appendix C—The Austin Software and Information Industry: the Origin and Development—describes the industrial context of the study. Appendix D—Austin: the Galapagos Island of Venture Development—explains the importance of Austin as the regional context for this study. Additional appendices provide information about Chi-Square tests, the survey forms, interview questions, and questions for investors.

This study utilizes a conceptual structure consisting of methodology, theory and model. The *Model-Based* method is the methodological approach, and the *Resource-Based View* is the theoretical base. While the theoretical base has existed for some time, a new set of models is developed for this study. The *Innovation Navigation* model employs the analogy of navigation to explicate the process of innovation. The *Innovation Navigation* model classifies commercial innovation into four types: 1) Technological Innovation, 2) Market/Customer Innovation, 3) Creativity and Learning, and 4) Organizational Innovation (Organizational Change). Innovation covers all human endeavors. This study, however, concentrates on "commercial innovation," which concerns the aspects of innovation related to production (in its broad meaning) and enterprising.

Ph. D. dissertation studies often rely on mainstream (conventional) academic research methodologies, which tend to use the analytic approaches at their core. The analytic approach, as the study will demonstrate, may not allow us to explicate creative processes like knowledge generation and innovation. The Conceptual Structure (Appendix A) explicates the methodological basis of the study. In the dissertation the Conceptual Structure section, which explicates the methodological basis of the study, appears as an appendix to allow readers to concentrate on the main topic—which concerns venture development. In terms of sequence, the Conceptual Structure (Appendix A) should be consulted in accordance with Chapter One (the Platform of Inquiry).

The unit of analysis in the study is enterprise; accordingly the study concentrates on a group of new ventures in the region of Austin. The interactions between enterprise and regional development, however, are an integral part of this study, as innovation and venture development do not happen in a vacuum. Regional context indeed exerts a deep impact on the process of venture development. In the dissertation, the two sections that explicate the regional and industrial context of the study appear as two appendices, rather than two initial chapters to allow readers to concentrate on the main topic, which concerns venture development. In terms of sequence, the study of regional and industrial contexts (Appendix B and C) should be consulted after reviewing the Conceptual Structure.

The terms "venture", "venture capital", "business" and "corporation" are used frequently in this study. For the sake of clarity, in this study, "VC" is used for venture capital firms, "venture" is used for young enterprises, "business" is used for mature enterprises, and "corporation" is used for large enterprises.

Chapter One: The Platform of Inquiry

An exploratory study is a creative and complex process with many open loops and closed feedbacks. This Chapter plots the *Platform of Inquiry* of the present study. The platform of inquiry of this study consists of the following sections: 1) Core Inquiry, 2) Premise, 3) Theme, 4) Contexts, 5) Methodological Approach, 6) Models, 7) Theory, 8) Operational Topic, 9) Dissertation Title, and 10) Process.

CORE INQUIRY

"*What are the factors that impact the growth and development of new ventures*?" is the core inquiry of this study. Numerous factors, such as technology, capital, talent, founders' backgrounds and personalities, business cycle, regional structure, market turbulence, industry structure, legal procedure, etc. contribute to the development and growth of new ventures. A significant number of prior studies assume that technology plays the key role in the growth of new ventures. This view of the vital role of technology in the process of venture development has been manifested in numerous science and technology programs (OECD, 1991) and linear models of technology development (Kline, 1991). This study, rather, suggests that venture development is a complex process with numerous interacting factors, and that technological determinism or linear modeling might tend to oversimplify the nature of venture development.

PREMISE

The study takes the liberty to describe the contexts on which the research is based on as well as the process of developing the operational topic from the core inquiry. The approach used in this study to explicate the connections between the core inquiry, the theme, the contexts, the process, and the operational topic is different from many studies.

Some analytic studies tend to select the main questions of their research from a narrow set of independent and dependent variables and then conclude with a set of prescribed (almost arbitrary) linear causal relationships between the variables. Relying on the rubric of *ceteris paribus* "all else being equal," their conclusions tend to be narrow or often out of context.

This study differs from that approach, because a fundamental premise is that in the real world "all else is not necessarily equal." Articulating the links between core inquiry, theme, context, process and operational topic may divulge many of the "else" factors that indeed could be very important. If a study identifies some important factors, but is not able to address them, then the un-addressed factors are "beyond the reach" or "out of scope" of the study, like uncharted areas in the early modern maps. Accordingly, the researcher becomes aware of the existence and potential role of "out of reach" or "out of scope" factors. *Ceteris paribus* may obscure the uncharted areas.

To demonstrate the key role of the uncharted areas in the process of exploration, "*Ceteris Paribus* as a Premise for Mapping," in Appendix A, illustrates a map of the world drawn in 1544 by Batista Agnese. The map demonstrates the existence of vast uncharted areas, left blank, in North America and Central Africa. The uncharted areas were indeed vital for the next rounds of exploration. The cartographer of the map did not assume *ceteris paribus* "all else being equal."

THEME

The study utilizes the view that *innovation* and *entrepreneurship* are two critically important drivers that influence patterns of venture development. In addition, this study regards innovation as a very broad phenomenon. Accordingly, technological innovation is only one kind of innovation among a wide spectrum of other innovation typologies (Tidd, Bessant and Pavitt, 1977). Looking at innovation as a knowledge phenomenon, this study classifies innovation into four major types: 1) *Technological Innovation*, 2) *Market/Customer Innovation*, 3) C*reativity and Learning*, and *4) Organizational Innovation*.

Entrepreneurship integrates the different aspects of innovation together for venturing and enterprise development. The study categorizes styles of entrepreneurship, according to the initial sources of capital, into three major groups: 1) *Self Funded*, 2) *Venture Capital (VC) Funded*, and 3) *Corporation Funded*. The theme of the study, accordingly, becomes *knowledge*, *innovation* and *entrepreneurship*.

CONTEXTS: REGIONAL (SPACE), INDUSTRIAL AND TEMPORAL

Venture development does not happen in a vacuum. Regional structures (milieu, space), industrial systems and temporal contexts deeply impact patterns of venture development. A comprehensive study of venture development has to address the role of regional structures, the industrial structures (which is unique to each economic sector) and temporal contexts. This view that venture development relates to the internal resources and capabilities of venture and enterprises, as well as to the external interactions with the regional structures, is indeed a framework of this study. Although national and global parameters affect regional development, the growth of employment therein is due to the collective growth of employment in enterprises that are active in the region. The software industry is the industrial context and the region of Austin is the regional context (milieu) for this study. Appendix B and Appendix C cover a brief review of the development of the Austin region and a review of the development of the Austin software industry.

Temporal Context: The study emphasizes the early stages of venture development in Austin, Texas between 1990 and 2003. This time span covers different periods: 1992-95, a period of fast growth, 1995-96, a period of slow growth, 1997-2002, a period of fast growth and then fast decline (the Dot-Com Bubble), and since the late 2002, a period of slow decline / slow growth. The 1997-2000 period has been characterized as one of unique technological, business and employment growth; accordingly, generalizing the results of this time span to other time periods or to other regions should be done with care.

METHODOLOGICAL APPROACH

As its methodological (conceptual) approach, this study uses a model-based method. Compared with conventional research methods, which tend to be concerned mainly with the links between phenomenon (reality) and theory, the *Model-Based* method, like a baseball game, consists of four bases: *Phenomenon* (Reality), *Model*, *Theory* and *Application* (Solution). The distinction between model and theory is the main characteristic of the Model-Based method. Accordingly, models behave as a platform for theory development, but theories can also enhance the depth and scope of their corresponding models. The Model-Based method is consistent with the *Diamond Model for Professional Science*, articulated by Andrew Van De Ven (2000). Appendix A includes further information about the *Model-Based* method.

MODELS

This section covers a brief review of the *Innovation Navigation* and *Bio-Organizational Venture Lifecycle* models, which are used as the base-models in this study. Appendix A covers further description of the two models. The *Innovation Navigation* model, by using the analogy of navigation, depicts the process of innovation in a new context. The *Innovation Navigation* model classifies commercial innovation into four types: 1) T*echnological Innovation*, 2) M*arket/Customer Innovation*, 3) *Creativity and Learning,* and 4) *Organizational Innovation*.

The *Bio-Organizational Venture Lifecycle* model consists of seven stages: 1) *Inception*, 2) *Fledgling* (the Valley of Death), 3) *Adolescence*, 4) *Maturity*, 5) *Rejuvenation*, 6) *Demise* and 7) *Turbulence*. The transition from each of those stages to another one does not happen smoothly, as the S models of technology development suggest. Due to the complexity of the real world, the transition between the stages, even inside each stage, is often punctuated with turbulence rather than with smooth courses of action.

THEORY

This study uses the *Resource-Based View* as its theoretical base. Edith Penrose has been widely acknowledged as the key player in providing the intellectual foundations for the *Resource-Based View of the Firm*. *The Theory of Growth of the Firm* (Penrose 1959) looks at firms as broad sets of resources and the growth of firms involves exploitation of existing resources and development of new ones. Penrose notes that

> a firm is more than an administrative unit; it is also a collection of productive resources the disposal of which between different users and over time is determined by administrative decision. When we regard the function of the private business firm from this point of view, the size of the firm is best gauged by some measure of the productive resources it employs (1959: 24).

The Resource-Based View has been used predominantly to study mature businesses and large enterprises, accordingly comes the term *Resource-Based View of the Firm*. This empirical study, as we will explore later, will use the Resource-Based View in the context of new ventures in their early stages of lifecycles. This approach may indeed open a new venue for the *Theory of Development of New Ventures* to link it with the studies on the *theory of entrepreneurship*.

Many scholars have noted that entrepreneurship lacks a substantial theoretical foundation (Garnsey, 2002). For instance, Bygrave and Hofer emphasize that the major challenge facing entrepreneurship researchers is to develop models and theories based on a solid empirical foundation (Bygrave and Hofer, 1991). Making new theories about the nature and behavior of knowledge and entrepreneurship is very challenging, but not impossible. Peter Drucker, in *Post-Capitalist Society*, for instance, indicated:

> How knowledge behaves as an economic resource, we do not yet fully understand; we have not had enough experience to formulate a theory and to test it. We can only say so far that we need such a theory. We need an economic theory that puts knowledge into the center of the wealth-producing process (1993).

Consistent with the structure provided by the Resource-Based View, this study organizes the enterprise resources into five groups; 1) Natural Resources, 2) Physical Resources, 3) Financial Resources, 4) Knowledge Resources, and 5) Human Resources. Building on the above resource structure, the study classifies the factors that have strong impacts on the development of new ventures into six major groups: industry, location, stage of venture development, sources of financial capital, innovation and change, and founders' backgrounds.

OPERATIONAL TOPIC

The study concentrates on software ventures in the Austin region in the early stages of their lifecycles. Accordingly, the following question denotes the operational topic of this study: *What is the impact of business plans, capital, and technology on the patterns of venture growth and development?* In this study, sources of capital are related to styles of entrepreneurship and business plans are related to organizational innovation.

The data collection for this study was performed in two stages: a survey stage and an interview stage. The survey stage deals with business plans, capital, technology, and growth patterns. The interview stage elaborates on the critical aspects that developed during the survey stage.

DISSERTATION TOPIC:

Knowledge, Innovation and Entrepreneurship: Business Plans, Capital, Technology and Growth of New Ventures in Austin, Texas—the topic of this dissertation—is a combination of the Theme and the Operational Topic of this study.

PROCESS:

The main stages of the Platform of Inquiry are listed here in a linear and sequential format. The actual procedure, however, was more like a funnel, or a reverse whirlpool, from the core inquiry to conclusions, back and forth many times and in a very complex manner.

SUMMARIZING THE PLATFORM OF INQUIRY

1. **Core Inquiry**: Factors that contribute to the development of new ventures
2. **Premise**: All else is not necessarily equal
3. **Theme**: Knowledge, innovation and entrepreneurship
4. **Contexts**: Regional (space), industrial and temporal
5. **Methodological Approach**: The *Model-Based* Method
6. **Models**: *Gray Box*, *Innovation Navigation* and *Bio-Organizational Lifecycle*
7. **Theory**: The *Resources-Based View*
8. **Operational Topic**: Impacts of business plans, capital, and technology on patterns of development of new ventures
9. **Process**: Connecting core inquiry, theme, contexts and operational topic
10. **Dissertation Title:** A Combination of the Theme and the Operational Topic

Chapter Two: The Resources for Enterprise Development

This chapter begins with the analysis of the enterprise resources, which are organized into five groups: natural resources, physical resources, financial resources, knowledge resources and human resources. The chapter concludes with the theme of the study, which is "knowledge, innovation and entrepreneurship."

CLASSIFICATION OF ENTERPRISE RESOURCES

This study uses the *Resource-Based View* as its theoretical base[1]. Resources, which are the basic elements for the analysis of enterprises, are organized in this study into five major groups:

1. **Natural Resources** – the material and energy resources occurring in nature that can be used to produce. Examples include air, water, oil, coal, and electricity.
2. **Physical Resources** – the means that can be used to produce wealth. Examples include artifacts, machinery and equipment.
3. **Financial (Capital) Resources** – cash and other financial assets that are needed to do business. Examples are the initial capital to start a new venture and other capital resources needed for the development of existing enterprises.
4. **Knowledge Resources** – the intangible assets that are needed for production and enterprise. Examples are data, information, skills, and values.
5. **Human Resources** – people that are engaged in and contribute to production. Examples are labor, as well as managers and specialists.

The five groups of enterprise resources are non-linearly interrelated. The non-linear interrelations among enterprise resources have been reviewed in "Dynamic Model of Production, and Evolution of the Knowledge Economy" (Mahdjoubi, 2004). Enterprise

[1] The theoretical basis of this study is discussed as part of the Platform of Inquiry in Chapter One.

resources, accordingly, can best be conceived as a *Gray Box* model rather than a *Black Box* model. The Black Box model consists of three main sections: 1) *Input*, 2) *Output*, and 3) *Function* (Process). The Black Box model assumes that *Functions* have fixed structures that do not change over time, and that *Functions* predictably convert the *Inputs* into the *Outputs* over and over again. The relationship between *Input* and *Output* is causal. The Gray Box model, rather, consists of five sections: 1) *Inward*, 2) *Outward*, 3) *Inside*, 4) *Outside*, and 5) *Overall*. Unlike the Black Box model, the relationships among the five sections of the Gray Box model are interactive and they are non-linearly interrelated[2].

NATURAL AND PHYSICAL RESOURCES IN THE SOFTWARE INDUSTRY

Software is the industrial context for this study. Software development directly consumes almost no material and an extremely limited amount of energy (electricity). Consequently, in the software industry natural resources, such as material and energy, have a minimal competitive role, if any. Obviously in the study of material- and energy-intensive industries, for instance oil and aluminum, natural resources—along other enterprise resources—play a key role.

Regarding physical resources, software enterprises often use general-purpose machinery (such as Personal Computers) and almost all enterprises have access to them. Physical resources, consequently, are also an excludable factor in the development of software enterprises. Physical resources often provide no advantage in the software industry. Some software firms develop internal software packages to enhance and facilitate their processes. As data is the main ingredient of software packages, internal software packages are considered as part of knowledge resources in this study.

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[2] For further information about the *Black Box* and the *Gray Box* models, see appendix A.

FINANCIAL RESOURCES

Financial resources include cash and other financial assets that are needed to do business. A wide range of sources may provide the financial and capital resources needed for setting up and then developing new ventures. Financial resources may include the personal funds and credits of the entrepreneurs and their families, friends and associates, angel investors, venture capital institutions, commercial banks, state or federal grants (e.g. SBIR, Small Business Innovation Research program), existing corporations, etc. In this study, based on the sources of capital, ventures are organized into the following groups:

- Self-Funded (Bootstrap) Ventures
- Venture Capital (VC) Supported Ventures, that include two subgroups:
    a. VC Funded Ventures
    b. VC Backed Ventures
- Corporation Funded Ventures

Self-Funded Ventures

Self-funding (bootstrapping) is a means of financing a new business venture though acquisition and use of internal resources without raising equity from external sources of capital like venture capital institutes or venture capital banks. Self-funded ventures rely on the capital resources, credits and debts of the founders and their families, friends and associates. Self-funded ventures also are called “bootstraps” (Bhide, 1992), “personally funded ventures” and “internal equity” (Ou and Haynes, 2003).

Venture Capital (VC) Supported Ventures

Venture Capital (VC), according to Kortum and Lerner, is an “equity or equity-linked investment in young, privately held companies, where the investor is a financial intermediary who is typically active as a director, advisor, or even a manager of the firm" (2000: 676). Bagley and Dauchy indicate that although VC is a well-known form of financing, it is relatively uncommon, as most new ventures are self-funded. Yet, because VC is used to finance many high-profile startups, it receives a great deal of attention (1998).

VC supported ventures, in this study, are those enterprises that VC firms and VC banks have invested in during any given stage of their lifecycle. The VC supported group is further classified under two subgroups: 1) *VC Funded* and 2) *VC Backed*. VC funded and VC backed ventures are distinctively different, based on the time of VC investment in the venture.

VC Funded Ventures

VC funded ventures, in this study, are funded by venture capitalists in the *early* stage of the venture's development, prior to a positive cash-flow and/or a sustainable sales record. VC investors typically have invested in the business plans and business ideas of the VC funded ventures, often during the first year of the venture's establishment. Many VC funded ventures could not exist without VC investments, even for one year. Compaq and Lotus are examples of very successful VC funded ventures.

VC Backed Ventures

VC backed ventures, on the other hand, are those self-funded ventures that VC investors have invested in during the *later* stages of their venture lifecycle, when the ventures already had a positive cash-flow and/or a sustainable sales record. Such VC backed firms typically receive financial support more than one year after their establishment. In this respect, VC backed firms, depending on their structures, may behave more or less like self-funded (bootstrap) ventures rather than VC funded ones.

Dell and Microsoft are examples of successful self-funded ventures that VCs invested in at a later stage of their lifecycle, when both had sustainable sales records.

The proposed classification of VC supported ventures into *VC funded* and *VC backed*, based on positive cash-flow and/or sustainable sales record, is a new type of categorization. Commonly, there are many overlapping terminologies to classify VC investments, such as *Seed*, *Startup*, *Early Stage*, and *Later Stage* (Van Osnabrugge and Robinson, 2000: 19), *Mezzanine*—the financing round before an anticipated public offering (Bagley and Dauchy, 1998), *Bridge* (Sohl, 1999: 106), and *Real* and *Filler* (Nesheim, 2002: 110). Runka and Young (1987) in "A Venture Capital Model of the Development Process for New Ventures," analyzed the perceptions of the CEO or managing directors of 73 U.S. venture capital firms about the key features of the development of new ventures. They concluded: "Sufficient consensus was found on the aspects of the development process for a "venture capital model" of this process to be constructed. The model consists of five sequential stages: 1) Seed, 2) Start-up, 3) Second Stage, 4) Third Stage, 5) Exit Stage." This source also reviews the distinguishing characteristics of each stage, from the view point of VC investors, based on key development goals and benchmarks, and major risks associated with each stage.

Corporation Funded Ventures (Corporate Venturing)

Corporation funded ventures are cases in which existing corporations invest in their own internal departments or direct subsidiaries. Block and MacMillan, in *Corporate Venturing*, consider six major characteristics of corporation funded ventures: 1) the new ventures are initiated or conduced internally, 2) they will be managed separately at some time during their life, 3) they include activities that are new to the corporate enterprise, 4) they involve significantly higher risk of failure or large losses than the organization's base businesses, 5) they involve greater uncertainty than the base business, 6) they are taken for the purpose of increasing sales, profit, productivity, or quality (1995). "Swimming in Newstreams: Mastering Innovation Dilemmas," (Kanter, 1989) reviews a case study of nine corporation funded ventures that he called "internal ventures." The paper includes historical cases like the Raytheon New Products Center, and Eastman Kodak New Opportunities Program.

"Know the Limits of Corporate Venturing," a very recent article in *Financial Times* of August 9, 2004 by Campbell and Birkinshaw, classifies the models of corporate venturing (corporation funded ventures) into four main groups: 1) Harvest Venturing: Turning spare corporate resources into cash, 2) Ecosystem Venturing: Making minority investments to help ventures that are part of the ecosystem of existing business. 3) Innovation Venturing: Stimulating entrepreneurial activity within an existing function of an existing business unit and 4) Private Equity Venturing: Participating directly in the VC/private equity industry. Campbell and Birkinshaw's article, which is part of *Financial Times* Summer School series, covers a succinct review of corporate venturing (corporation funded ventures) and then come to the following main conclusion:

> Almost all units set up to create new opportunities for a company fail to develop any significant new businesses, but that is not to say that the techniques are useless—they can be harnessed for other purposes (2004:9).

Styles of Entrepreneurship and Initial Sources of Financial Capital

The word *entrepreneur* originates from the French word, *entreprendre*, which means "to undertake." In business studies, entrepreneurship often means to start a new venture. The concept of entrepreneurship, however, has been used in a very wide range of other professions from art to non-profit institutions.

Conventionally entrepreneurship is divided into two major groups: *entrepreneur* and *intrapreneur*. An entrepreneur is an independent person who organizes, operates, and assumes risks for a business venture, while an intrapreneur is a person within a large corporation who takes direct responsibility for turning an idea into a profitable finished product through assertive risk-taking and innovation (dictionary.com).

In this study, styles of entrepreneurship are associated with the initial sources of financial capital. The above classification of entrepreneur versus intrapreneur is a classification of entrepreneurships based on initial sources of financial capital. Entrepreneurship, in the above classification, includes self-funded and VC funded entrepreneurs, and intrapreneurship includes corporation funded entrepreneurs (intrapreneurs). As we will study later, styles of entrepreneurship are broader than the above two groups. *Self-funded entrepreneurs* behave very differently than *VC funded entrepreneurs*. In addition the behavior of *intrapreneurs in large corporation* is not the same as the behavior of *intrapreneurs in medium enterprises*.

The Spectrum of New Ventures

The typology of the three major groups of new ventures—self funded, VC funded and corporation funded—often creates a continuous spectrum rather than disconnected dichotomies. The distinction between VC funded and corporation funded ventures in some cases is blurred. For instance, some corporations have established VC arms, such as *Dell Venture* and *Intel Capital*. On the other hand, some corporations use self-funded and VC funded procedures for their new corporation based initiatives. *Radical Innovation*, for instance, suggests that corporations may pursue both bootstrapping (self-funding) and VC-styled support in funding their new internal initiatives (Leifer, O'Connor and McDermott, 2000). *Radical Innovation* also makes a comparison among the corporation funded ventures in Lucent's New Ventures Group, Nortel's Business Ventures Group, and Procter & Gamble's Innovation Leadership Team (Leifer et al., 2000: 207).

Literature Review on Studies of Sources of Capital and New Venture Development

Amar Bhide from Columbia University has conducted extensive studies on startups (Bhide, 1992, 1994 and 2000). *The Origin and Evolution of New Businesses* (Bhide, 2000) categorizes startup ventures into five groups: 1) marginal startups, 2) promising startups, 3) VC backed startups, 4) corporate initiatives, and 5) revolutionary ventures. This classification, however, mixes the sources of capital (VC backed startups, and corporate initiatives) with the level of technology (for example revolutionary ventures). A distinction between the sources of capital and technological abilities facilitates a better understanding of the patterns of venture development. In addition, Bhide (2000) makes no distinction between VC funded and VC backed ventures.

The impact of sources of capital on the profitability of new ventures has been reviewed in "New Venture Strategy and Profitability" (Shepherd, Ettenson, and Crouch, 2000). This source, however, concentrates on VC funded initiatives and does not compare them with self-funded and corporation funded ventures. "Venture Capital Financing and the Growth of Startup Firms" (Davila, Foster and Gupta, 2003) is a recent paper that reviews the evolution of employee growth at the time of a round of financing. In this study the headcount factor is used as a proxy for growth. The paper concludes that "changes in valuation have a significant positive relationship with changes in employee headcount of the startup" (Davila et al. 2003: 10). The paper concentrates on a group of businesses mostly from Silicon Valley in the period of 1994-2000. This period has been characterized as one of unique technological, business and employment growth; accordingly, generalizing the results to other time periods or to other regions should be done with care. *The Origins of Entrepreneurship* (Case, 1989) summarizes the results of a long survey on entrepreneurship, and it describes some major factors that influence entrepreneurship. While the article deals with the practical aspects of entrepreneurship, it is not academically rigorous enough to possess theoretical value.

KNOWLEDGE RESOURCES

The previous section reviewed the role of financial resources in the process of venture development; this section examines the role of knowledge resources. The role of knowledge in enterprise development has been studied under the umbrella name of *The Knowledge-Based View of the Firm*. The Knowledge-Based View of the Firm, developed in the 1990s, is an extension of the Resource-Based View of the Firm, discussed in the Platform of Inquiry (Appendix A). In addition, the term knowledge also accommodates service factors such as research, engineering and design.

Grant argues that, "of all the diverse resources that a firm possesses, knowledge is perhaps the most important internal resource" (Grant 1996). Accordingly, the flow of knowledge is the primary basis for the growth of firms and the development of societies. Nonaka in an paper in *Harvard Business Review* "maintains "successful companies are those that consistently create new knowledge, disseminate it widely through the organization and quickly embody it in new technologies and products. The activities define the 'knowledge creating' company, whose sole business is continuous innovation" (Nonaka 1991: 96). Nonaka thus emphasizes the key role of knowledge in the process of innovation. Nonaka and Takeuchi in *The Knowledge Creating Company* argue that the Knowledge-Based View is a cross-disciplinary perspective that combines several streams of research—for instance epistemology, management, economics, and the information sciences (Nonaka and Takeuchi, 1995).

Many studies of the 1970s and 1980s looked at knowledge as a layer in the hierarchy of "data, information, knowledge, and wisdom." Knowledge generation, accordingly, was considered as an activity based on the ability to process data and information. In the mid-1990s, *The Knowledge Creating Company* (Nonaka and Takeuchi, 1995) added the "tacit" dimension to the mainstream management studies. The distinction between tacit and explicit knowledge is based in turn on ideas of Michael Polanyi (1966). Polanyi stated the truism that "We know more than we can tell" in order to emphasize the nature of tacit knowledge. This new view of knowledge argues that information typically makes up the "explicit" aspects of knowledge. Tacit knowledge covers the non-explicit (implicit) aspects of knowledge, such as the embedded values and skills of the company's employees and affiliates. According to *The Knowledge Creating Company,* "explicit knowledge can be articulated in formal language" while "tacit knowledge is hard to articulate with formal language" (Nonaka & Takeuchi, 1995). The book views *knowledge* as the basic unit of analysis for explaining the firm's behavior. The core features of *The Knowledge Creating Company* (Nonaka & Takeuchi, 1995) are these:

- An emphasis on knowledge creation, not on knowledge per se
- A vivid distinction between "explicit knowledge" and "tacit knowledge"
- The role of non-Cartesian epistemologies for further development of tacit knowledge

To expand the scope of knowledge and its interactions with innovation, the present study further classifies knowledge into three categories:

- Knowledge that humans generate and then document, owing to human intellect and curiosity, such as science and literature
- Knowledge that humans generate and then document as records, such as census data and statistics
- Knowledge that humans generate to make a change

The above three groups of knowledge overlap. Innovation relates mostly to the third group, knowledge for change, as change and innovation are deeply interrelated. Innovation also relates to group one and two of knowledge in the above list. This study concentrates on the third group, the knowledge that we generate to make a change and to innovate. Innovation requires both tacit knowledge (values and skills) and explicit knowledge, based on the typology of Michael Polanyi.

Knowledge to Innovation: Bridging the Gap

Technological innovation has often been defined in the context of the introduction of new products or new technologies (Rogers, 2003). It is, however, common wisdom that the process of innovation is much broader than technological innovation. Innovation is like a funnel where numerous ideas, attempts and efforts are needed to lead us to just a very limited number of successful products. By looking at innovation as a knowledge phenomenon it would be possible to study the process of innovation from a very new vista.

Knowledge and innovation are interconnected; innovation is always based on the application of new (generation and process) knowledge. The application of new knowledge should also lead to change and innovation. This approach on the links between knowledge and innovation is compatible with the following perspective:

> Knowledge holds the key to generating innovation. … Innovation is a process in which the organization creates and defines problems and then actively develops new knowledge to solve them. … This view of innovation suggests that organization should be studied from the viewpoint of how it creates knowledge, rather than with regard to how it processes information (Nonaka & Takeuchi, 1995).

This study defines commercial innovation as the *success-oriented flow of knowledge in action*. The flow of knowledge includes its generation (creation), processing and dissemination, and application. Owing to the intrinsic interactions between knowledge and innovation in the above definition of innovation, the study builds the foundation for a conceptual bridge between *knowledge management* and *management of innovation*. Compatible with the *Innovation Navigation* model (see Appendix A) in this study, commercial innovation is organized into four interrelated groups: 1) T*echnological Innovation*, 2) M*arket/Customer Innovation*, 3) C*reativity and Learning,* and 4) O*rganizational Innovation* (Organizational Change).

HUMAN RESOURCES

The previous section examined the role of knowledge resources in the process of venture development. This section reviews the role of human resources, which include all the people who work in a production system. The term human resources also includes labor in conventional economic studies. Human resources play a key role in enterprising and new venture development.

In the proposed classification for enterprise resources into five major groups—natural, physical, financial, human, and knowledge—human resources and knowledge resources are separate and distinct, but they are intrinsically related to each other. Humans generate, process, and refine knowledge. Through the flow of knowledge—generation, process, and refinement—humans add value as well as develop themselves. Learning (which includes education and training) is a two-way bridge between knowledge and human resources. Learning, in this context, includes both individual and organizational (social) aspects of human development.

Due to the extreme complexity of the role of human resources in the process of enterprise development, a comprehensive study of human resources is beyond the main scope of this study. Consistent with the premise of "all else is not necessarily equal[3]," the study, however, considers the role of human resources a key player in the process of

[3] See Appendix B for the role and importance of the premises of "all else is not necessarily equal."

venture development. In this study, the role of human resources is almost like a semi-charted area.

THEME OF THE STUDY: KNOWLEDGE, INNOVATION AND ENTREPRENEURSHIP

The study excludes natural and physical resources from the scope of its research, as the two factors have limited impacts on the development of the software industry. The study regards human resources as a very important factor, but a comprehensive study of the role of human resources is beyond its main scope. The study, accordingly, concentrates on the role of two factors: financial resources and knowledge resources.

In the study, innovation is defined as the *success-oriented flow of knowledge in action*. Entrepreneurship, which is associated with the initial financial capital resources, as well as the personalities of the founders, integrates the different aspects of innovation together for venturing and enterprise development. Innovation and entrepreneurship both posses human and knowledge dimensions. The theme of the study, accordingly, becomes *knowledge, innovation* and *entrepreneurship*. The study deals with the practical aspects of knowledge, rather than knowledge *per se*, or information and data processing.

SUMMARY

1. The study classifies enterprise resources into five major groups: natural resources, physical resources, financial resources, human resources and knowledge resources.

2. Styles of entrepreneurship are associated with initial sources of financial capital. New ventures, based on their original sources of capital, are organized into three major groups: Self-funded (bootstrap), VC funded and corporation funded.

3. Innovation is defined as the flow of knowledge in action, which accords with the study's emphasis on knowledge, innovation and entrepreneurship.

4. The next chapter is about the major factors affecting venture development.

Chapter Three: Major Factors Affecting Venture Development

Chapter Two described the process of connecting the enterprise resources to the theme of the study. Chapter Three describes the major factors that strongly impact venture development. This chapter also includes the following headings: the operational topic, business plans and organizational innovation, growth indicators, the structure of the survey form, and factor analysis of the survey study.

MAJOR FACTORS AFFECTING VENTURE DEVELOPMENT

The theme of the study is 1) knowledge, 2) innovation and 3) entrepreneurship. The study divides its contexts[4] into three groups: 1) industry, 2) space and 3) time. The factors that have strong impacts on the development of new ventures, accordingly, are a combination of the contexts and the theme. In this study, major factors that affect venture development are categorized into six major groups[5]:

1) **Industry**
2) **Location**
3) **Stages of venture development**
4) **Initial sources of financial capital**
5) **Innovation and change**
6) **Founders' backgrounds**

1. Industry

The industrial system that is relevant to each type of industry exerts a strong impact on the growth of new ventures in the given industry. For instance, the industrial

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[4] The context of the study is discussed in the Platform of Inquiry (Chapter 1).

[5] Natural and physical resources have been excluded in this study; as they make no advantage in the software industry, see Chapter 1. In other types of industry, natural and physical resources may be added to the above six group.

system of the pharmaceutical industry is different from that of the software industry. The Food and Drug Administration (FDA) governs the pharmaceutical industry. The software industry, however, has no governing body like the FDA. The following note, in *Only the Paranoid Survive*, serves to explain the key role of industrial systems in the process of venture development:

> The structure of the industry composes of an unstated set of rules and relationships, ways and means of doing business. … If you have been in the industry for a long time, knowing these things has become second nature. You do not even think about them; you just know that is the way things are (Grove, 1999: 134).

In the software industry, compared to the pharmaceutical industry, there exist fewer barriers to entry. The rate of change and innovation of products in the software industry, is also very fast

2. Location

The social and regional structures where the new venture is located can also have strong impacts on the growth of new ventures. Some regions are more hospitable to the new ventures of specific types of industries. The region of Austin, Texas, for instance, has been more hospitable to the software industry than to metallurgical industries.

3. Stages of Venture Development

A new venture, even a one-person enterprise, is an organization. As such, it follows a set of phases, which are considered as stages in the *Bio-Organizational Venture Lifecycle* model. The Bio-Organizational Lifecycle Venture Model is further discussed in Appendix A. The venture lifecycle is organized into the following main stages: 1) *Inception*, 2) *Fledgling* (Valley of Death), 3) *Adolescence* 4) *Maturity*, 5) *Rejuvenation*, 6) *Demise* and 7) *Turbulence*. Each of the seven stages of the Bio-Organizational

Lifecycle model has a key *development characteristic*, which is also briefly discussed in Appendix A.

4. Initial Sources of Financial Capital

Initial sources of capital, which provide financial resources to set-up and then support new ventures, are among the most influential factors in the patterns of growth and development of new ventures. Initial sources of capital may include personal funds of investors, angel investors, venture capital (VC) institutions, and existing corporations.

5. Innovation and Change

Innovation and change play a key role in the growth and development of new ventures. Innovation, in this study, includes: 1) Technological Innovation, 2) Market/Customer Innovation, 3) Creativity and Learning, and 4) Organizational Innovation. Technological innovation is also broader than patents or Research-and-Development (R&D).

6. Founders' Backgrounds

Founders of new ventures have unique backgrounds and characteristics, which individually and collectively impact the growth and development of new ventures.

Operational Topic of the Study

By concentrating on software ventures in the Austin region in the early stages of their lifecycles, this study excludes three factors from the above list: industry (software), location (the Austin region), and stages of venture development (inception and fledgling). These three factors are common among all cases.

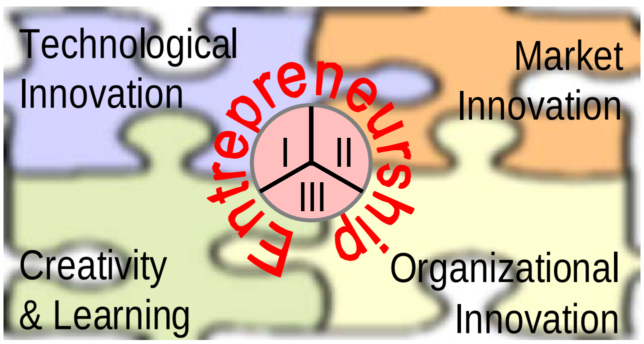
The study consists of two stages: survey and interview. The survey stage of the study focuses on three sub-factors related to innovation and initial sources of capital:

- **Patents**: A sub-factor related to **technological innovation**.

- **Business Plans**: A sub-factor related to **organizational innovation**.
- **Initial Sources of Capital**: A sub-factor related to **styles of entrepreneurship**.

The three sub-factors selected for the survey stage of the study, as in Figure 3.1, are indeed compatible with the *Innovation Navigation* model discussed in detail in Appendix A.

Figure 3.1: The *Innovation Navigation* Model and Entrepreneurship



Styles of Entrepreneurship

I. Self-funded Entrepreneurs
II. VC-funded Entrepreneurs
III. Corporation-funded Intraprenerus

This study focuses on *the impact of business plans, capital and technology on the patterns of growth*, which is the operational topic of study. The study further concentrates on the role of formal business plans in the early stages of venture development in a group of ventures in Austin, Texas.

The survey stage of this study does not cover all factors that impact the development of new ventures. For example, the founders' backgrounds (personal and organizational characteristics of the founders), as well as market/customer innovation, and creativity and learning are important factors that certainly impact the patterns of venture development. The study of these factors, however, is beyond the scope of the survey stage of this study.

BUSINESS PLANS AND ORGANIZATIONAL INNOVATION

A business plan is a document that describes current and desired stages of a venture. Business plans, in this study, are associated with organizational innovation, as business plans are related to the manner that a new venture organizes and reveals itself. Business plans, *per se*, are not indicators of technological innovation, market innovation, or creativity and learning. There exists a wide typology for business plans, varying from formal (classical) business plans, to short business plans and one-page (back of napkin) business plans.

A formal (classical) business plan generally consists of a formal document that summarizes the operational and financial objectives of a business and contains detailed plans and budgets that show how the business' objectives are to be realized. A formal business plan typically incorporates of the following sequential procedures a: 1) marketing study, 2) technology forecasting, industrial structures, and production systems, 3) personnel, human resources, and management team, and 4) financial analysis. A formal business plan is a procedure common to many types of businesses, as briefly described above. Timmons argues that formal business plans are used primarily for two purposes: raising capital and to provide a means of guiding growth (Timmons, 1994: 176). Formal business plans are an integral part of many MBA programs and a central feature of some academic entrepreneurial programs.

The importance of formal business plans in the growth and success of new ventures, however, has been questioned in many studies. William Sahlman, in "How To Write a Great Business Plan" argues that on a scale of 1 to 10, formal business plans actually rank no higher than 2 as a predictor of a new venture's successes. "Sometimes the more elaborated and crafted the document, the more likely the venture is to flop, for lack of a more euphemistic word" (Sahlman, 1997: 97). Arthur Rock downgrades the importance of formal business plans in the success of firms and emphasizes the importance of execution. Rock then claims "Good ideas are a dime a dozen. Good execution and good management are rare" (Rock, 1987). Arthur Rock is the famous venture capitalist who provided funding for Fairchild Semiconductor in the 1950s, Intel and Teledyne in the 1960s, and Apple Computer in the 1970s. The conventional wisdom embedded in most formal business plans is the assumption that new businesses should be planned in detail prior to their startup and that those details will serve as an harbinger of success.

Bhide, in "How Entrepreneurs Craft Strategies," argues on the basis of a study of nearly one hundred companies that most entrepreneurs spent little effort on their initial formal business plan (1994). Bhide indicates that among the companies he studied, 41% had no formal (classical) business plan at all, 26% had just a rudimentary, back-of-the envelope type plan, 5% had merely worked up financial projections for investors, and only 28% had written a full-blown, formal business plan (1994: 152). Bhide in this pioneering paper, however, makes no distinction between formal business plans and the process of business planning, as well as major applications of business plans, and potential relationships between business plans and initial sources of financial capital.

The Origin and Evolution of New Businesses (Bhide, 2000), which is a continuation of "How Entrepreneurs Craft Strategies," examines the impact of sources of financial capital on business plans. Bhide argues that most bootstrap (self funded) ventures are based on quick improvisation and rarely on prior formal business plans. At the other extreme, corporation funded ventures "follow a much more rule-based and structured approach" to business planning (2000:26). VC funded entrepreneurs, Bhidle argues, “rely more on anticipation and planning and less on improvisation and adaptation (2000: 142). While this claim seems to have some merit, it is not that simple. For instance, Gordon Moore and Bob Noyce established Intel in July 1968 based on a “one page business plan and based on the one page business plan, Arthur Rock lined up $2.5 million, in less than two days” (Intel Museum). The following case study of “3Com Corporation” also demonstrates that some venture capitalists look beyond formal business plans.

> In October 1980, 3Com began to seek venture capital in order to begin developing hardware products. In February 1981, 3Com received the first round funding of $1 million from VC investors who looked beyond the formal plan and were attracted by Metcalfe’s vision and charisma, as well as his team’s strong technical talent (Chesbrough, 2002: 81).

Lumpkin, Sharader and Hills (1999) addresses the question “Does Formal Business Planning Enhance the Performance of New Ventures?” by using mailed questionnaires to discern potential links between planning and performance among 54 new entrant and 40 established firms in two Southwestern states. The paper concludes, “Correlation analysis indicated no significant correlation between using a formal written plan and performance.” The paper also addresses the type of planning that contributed to performance as firms aged, and concluded “that planning may not need to be in the form of a written business plan.” The paper also includes a fairly substantial literature review of the sources on the role of business plans.

“Longitudinal Analysis of Relationships Between Planning and Performance in Small Australian Firms” (Gibson, Cassar, and Winghan, 2001) summarizes the responses from 2,956 Australian businesses, over a four-year period, about their planning performance relationships. The paper concludes that there is not a relationship between the introduction of planning and subsequent performance and “planning is more likely to be introduced into a small firm *after* a period of growth, rather than *before* a period of growth." The study indicates, "Wholesale encouragement of formal business planning by the small business sector does not appear warranted."

Burn Your Business Plan (Gumpert, 2002) summarizes the results of a study of 42 venture capitalists. While the book deals with some practical aspects of business plans, it is not academically rigorous enough to possess theoretical value. In "Pre-Startup Planning and the Survival of New Small Businesses," Gary Castrogiovanni (1996) reviews a long bibliography of the pre-1996 major sources that relate to formal business planning, but he presents few new ideas on the topic.

Lovallo and Kahneman, in their study of "planning fallacy," provide an eloquent criticism of formal business plans that serves to amplify this researcher's findings.

> When forecasting the outcomes of risky projects, executives all too easily fall victim to what psychologists call the planning fallacy. Studies that compare the actual outcomes of capital investment projects with managers' original expectations for those ventures show a strong tendency toward over-optimism. An analysis of start-up ventures in a wide range of industries found, for example, that more than eighty percent failed to achieve their market-share target. … The cognitive biases that produce over-optimism are compounded by the limits of human imagination. No matter how detailed, the business scenarios used in planning are generally inadequate. The reason is simple: Any complex project is subject to myriad problems–from technology failures to shifts in exchange rates to bad weather – and it is beyond the reach of the human imagination to foresee all of them at the outset. As a result, scenario planning can seriously understate the probability of things going awry (Lovallo and Kahneman, 2003).

This observation, however, should not be construed to mean that planning, as a process, is unnecessary or counterproductive, but rather that formal business plans usually have their limitations.

GROWTH INDICATORS

Although the concept of growth has been studied for a long time, there are no standard indicators for enterprise growth. There exist, rather, a wide range of enterprise growth indicators such as employment (number of employees), sale, profit, market-share, and so on. Each indicator not only influences studies on growth and development, it also impacts the process and patterns of growth and development, as human systems tend to grow further along the desired indicators.

In this study, growth is quantifiable based on the total number of employees in each enterprise. Garnsey, in *The Growth of New Ventures,* states that "many of the studies use number of employees as a growth indicator" (2002: 111). Gibson, Cassar and Winghan, in "Longitudinal Analysis of Relationships Between Planning and Performance in Small Australian Firms", also indicate that the number of employees is a common non-financial performance measure (2001).

Small and medium size software businesses in Austin are mostly private and they are generally reluctant to disclose their financial data and profitability records. Consequently, this study concentrates on employment as a key indicator of growth, along with other available growth parameters available to the public.

For the study of growth, both the total number of employees and the rate of growth of employment are important. Consequently this study looks at two types of growth indicators:

- Total number of employees at the time of questionnaire completion (Winter 2003)
- Rate of growth of employment: Ratio of the total number of employees in winter 2003 and the age of venture

TEMPORAL SCOPE OF THE SURVEY STUDY

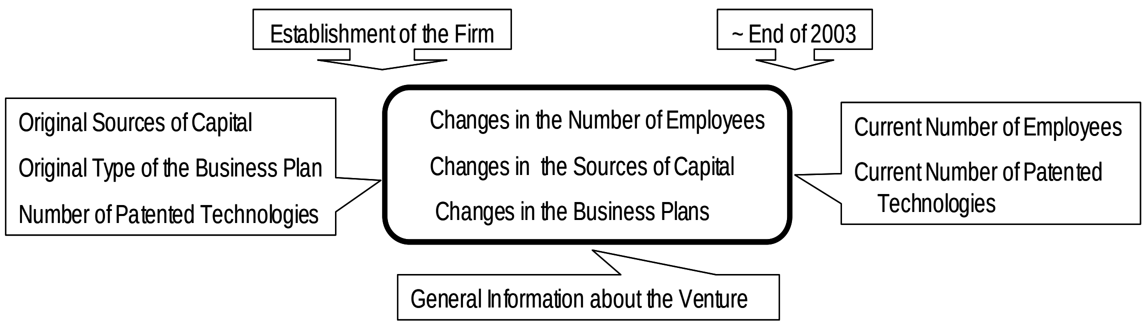
Because the emphasis of this study is on the early stages of venture development, four factors in the survey stage (i.e., Business Plans, Patents, Capital, and Number of Employees) are each examined at three time intervals:

- At the time of establishment of the venture;

- Between the time of establishment of the venture and the time of questionnaire completion (Winter 2003); and
- At the time of questionnaire completion.

A combination of the above four main factors (sources of capital, business plans, patented technologies, and number of employees) and the three time intervals is presented in Figure 3.2.

Figure 3.2: Main Factors and Time Spans



UNIT OF ANALYSIS

The unit of analysis, as used herein, is not a factor that impacts the actual process of enterprise development, but it does influence the scope of the studies on enterprise development. In the survey stage of the study, the enterprise (firm) is the unit of analysis. In the interview stage the founder(s) is the unit of analysis. The interviews, however, follow the evolution of each venture from inception to its maturity or demise. The intention of the interviews is to identify the main factors contributing to the development of each enterprise. The goal of the interview stage of investigation, as *Case Study Research suggests*, is to "retain the holistic and meaningful characteristics of the real-life cycle of the business under investigation" (Yin, 1994: 3). In the survey stage of the study, comparative analysis is used out of the desire to understand complex phenomena. Comparative study is suggested when "a how and why question is being asked about a contemporary set of events over which the investigator has little or no control" (Yin, 1994: 9). The interviews stage use both "focused" and "open ended" questions.

STRUCTURE OF THE SURVEY FORM

A copy of the Survey form used in this study constitutes Appendix F. The Survey form consists of 24 questions that can be organized into six groups:

General Information about the Venture

This group includes questions unique to each venture, like the year in which the venture was founded, and founders' names.

Information about Number of Employees

This group covers questions about current number of employees and changes in the number of employees since start-up. Information about the number of employees at different time intervals yields estimates about the size of an enterprise and its rate of growth. The number of employees is the indicator that is associated with growth of a firm.

Information about Sources of Financial Capital

This group classifies sources of founding capital and how the sources of capital evolved. Initial and later sources of capital may include: personal resources, angel investors, venture capitalists, existing corporations, bank loans, and the SBIR (Small Business Innovation Research) program.

Information about Business Plans

This group includes questions about initial types of business plans, when a venture was founded, and how it evolved:

- Information about initial types of business plans
- Information about main applications of formal business plans

- Information about the implementation of formal business plans during the first year of operation
- Information about cases that did not develop full formal business plans
- Information about development of the plan and vision for a company after the first year

Information about Patented Technologies

This group addresses the following alternatives:

- Information about the number of patented technologies of a company, at the time a company was founded
- Information about currently patented technologies of a company
- Information about potential patents—the technologies that have not been patented, but could be patented if a company pursues them

Concluding Questions

This group seeks information about other cases or other potential questions.

FACTOR ANALYSIS OF THE SURVEY STUDY

As it was discussed before, the survey stage of this study is based on four factors: 1) Business Plans, 2) Sources of Capital, 3) Patents, and 4) Growth. Multiple relationships between any two of the four factors are depicted as a matrix, Figure 3.3. Relationships between the factors in this study are symmetric; for instance the relationship between A and B is the same as the relationship between B and A. Accordingly, half of the depicted relationships are grayed.

Figure 3.3: Matrix of Relationships
among the Four Factors of the Survey Study

	1	2	3	4
1		●	●	●
2	●		●	●
3	●	●		●
4	●	●	●	

Based on Figure 3.3, there are up to six direct (one-to-one) relationships between each pair of the factors:

1. 1-2: Relationship between **Sources of Capital** and **Business Plans**
2. 1-3: Relationship between **Sources of Capital** and **Patents**
3. 1-4: Relationship between **Sources of Capital** and **Growth**
4. 2-3: Relationship between **Business Plans** and **Patents**
5. 2-4: Relationship between **Business Plans** and **Growth**
6. 3-4: Relationship between **Patents** and **Growth**

There are four relationships among each set of three factors:

7. 1-2-3: Relationships among **Sources of Capital, Business Plans,** and **Patents**
8. 1-2-4: Relationships among **Sources of Capital, Business Plans,** and **Growth**
9. 1-3-4: Relationships among **Sources of Capital, Patents Technologies,** and **Growth**
10. 2-3-4: Relationships among **Business Plans**, **Patents,** and **Growth**

There is one relationship among all four factors:

11. 1-2-3-4: Relationships among **Sources of Capital, Business Plans**, **Patents,** and **Growth**

In total there are potentially 11 relationships related to the four factors in this study. It is interesting to note that for two factors there is only one relationship, for three factors there are three relationships, for four factors there are eleven relationships, and for five factors there are up to twenty-six relationships. This simple calculation may explain why some academic studies tend to confine themselves to two or three factors. Or alternatively, some academic studies identify numerous factors, but they examine only the direct relationships between each pair by using "Regression Analysis." In the latter case, the multi-relationships among the factors are mostly ignored.

SUMMARY

1. The chapter organized the procedure of data collection into two stages: survey and interview. The survey study concentrates on four major factors: capital, business plans, technology and growth. The information from the interviews is used to elucidate the conclusions of the survey stage.
2. The next chapter deals with the process of data collection and analysis of the relationships among the factors related to the study's topic.

Chapter Four: Data Collection and Relationships Analysis

Chapter Three reviewed the factors of organization. Chapter Four describes the process of data collection and relationships analysis. The data collection for this study is performed in two stages: a survey stage and an interview stage. The survey stage deals with business plans, capital, technology, and growth patterns. The interview stage elaborates on the critical aspects that developed during the survey stage. This chapter also includes some conclusions from the analyzed data.

DATA COLLECTION PROCEDURES

This study uses eight procedures for data collection: 1) secondary information sources on Austin software enterprises, 2) websites of the focal companies, 3) websites of local newspapers, 4) cold calls to founders and executives, 5) taking part in meetings and sessions related to software industry and venture development, 6) networking with Austin civic entrepreneurs, 7) survey, and 8) interview.

Secondary Information Sources on Austin Software Enterprises

A long list of software companies in Austin was compiled through the review of numerous secondary sources. These sources included but were not limited to the Greater Austin Chamber of Commerce, Austin Software Council, and Austin Technology Council. The complied list includes information about existing and defunct software companies, the latter constituting the companies that shut down, were acquired, merged, moved out of Austin, etc. prior to this research.

Websites of the Focal Companies

Based on the compiled list, the website of each company was checked and individually reviewed. Relevant information for each company was included in the compiled list.

Websites of Local Newspapers

The Austin American-Statesman and *The Austin Business Journal* are two important periodicals in Austin, Texas. Both periodicals report on major business events in the Austin region. Websites of the two periodicals serve as on-line archives for the past activities of business ventures in this region. On-line archives of both journals were used to generate data about existing as well as defunct software ventures and to describe their evolution. The compiled list of software companies in Austin was updated based on information gathered in this stage. The final list includes about 200 existing and defunct software companies in Austin. Among the 200 ventures, five of them are publicly traded companies. The majority of Austin software companies are privately held. Direct contact provides primary data, which is a more suitable method for research data collection from private companies

Cold Calls to Founders and Executives

The first thirty enterprises were selected from the compiled list, thus providing a degree of randomness in the selection, since the companies were listed merely by name rather than by size or other quantitative dimensions. The researcher attempted to talk (by telephone) with their founders or executives, and engaged ten executives in a series of phone conversations. Of these, about one-third responded and completed the questionnaire. Voice messages were left for the other twenty individuals. Response rates were about 10% among the individuals for whom voice messages were left. Follow-up survey forms were sent by FAX and conventional mail to the twenty individuals; the response rate was zero.

Software executives are extremely busy, and due to the highly competitive nature of this business, they are reluctant to respond to cold calls, as Andy Grove (1999) also describes in *Only the Paranoid Survive*. It became evident that relying on the cold call approach would not allow this researcher to collect the type of data needed for this study. New methods of data collection, accordingly, were improvised.

Taking Part in Meetings and Sessions Related to Software Industry and Venture Development in Austin

Between March and December 2003, the investigator attended as many as 40 meetings and sessions related to the software industry and new venture development in Austin. During these sessions, he met some of the founders and executives of software firms in Austin and asked them to complete the questionnaire. The response rate in these cases was approximately 50%. In these meetings and sessions related to the software industry and new venture development also it was possible to network with numerous Austin civic entrepreneurs, who became instrumental in getting the researcher connected to the founders and executives of various Austin software ventures.

Networking with Austin Civic Entrepreneurs

Dr. George Kozmetsky often compared “civic entrepreneurs” with “business entrepreneurs.” Business entrepreneurs, he said, are the ones who make money. “Civic entrepreneurs are those who have made it, and look for the satisfaction of giving back to society. The satisfaction is not money; rather the satisfaction is to see others make it” (Marshal, 2000). Networking with Austin civil entrepreneurs not only provided the researcher with valuable insight; Austin civil entrepreneurs also introduced him to the busy founders and executives of various key Austin software ventures. Based on the introductions from these Austin civic entrepreneurs, the researcher then contacted the founders and executives of Austin software ventures and asked them to complete the questionnaire. Backed by the trust that was generated through the introductions of the Austin civic entrepreneurs, the response rate in these cases was about 85%.

SURVEYS

So far, more than 75 ventures, out of a short list of about 110, have taken part in the survey stage. Ventures that completed the survey forms are listed in Appendix I. Among the surveyed ventures, there are firms that ceased to do business or were acquired. Nevertheless, their founders provided information about the early stages of their development. The emphasis of this study is on the early stages of venture development[6] (Inception, Fledging, and Adolescence). The early stage of development for each venture is, however, compared with its most recent stage. In more than 80% of cases, the original founders have completed the forms, even in instances in which they are no longer active in the ventures.

INTERVIEWS

The emphasis of this study has been on the survey stage. Data gathered in the interview stage, however, has been used to elucidate the findings gained later in the survey stage. More than 60 people were encountered in relation to the data collection procedure of this study. Appendix J covers the list of people who were encountered. Of these, the researcher interviewed and tape-recorded seven entrepreneurs, and two VC investors.

Interviews with founders and executives provided a rich source of information on the Inception (pre-startup) and Fledging stages of development of the subject ventures. A

[6] See the *Bio-Organizational Lifecycle* model in Appendix C for a review of the different stages of enterprise development.

comparable study, *Research and Development Abroad by U.S. Multinationals* (Ronstadt, 1977) used a comparative study to analyze the R&D activities of seven U.S.-based multinational organizations abroad. Ronstadt's study showed how the particular purpose of each foreign R&D unit affected their size, location, investment timing, and their administrative affiliations with the other units of the same organization. Ronstadt (1977) concentrates on the foreign subsidiaries of U.S. corporations.

This study, however, concentrated on early-stage development of homegrown software ventures in Austin, rather than just on mature businesses. The emphasis has been on interviewing the founder(s) of each venture and elucidating their entrepreneurial practices. From that perspective, this research also acts a comparative and longitudinal study of entrepreneurship. The interviews encompassed the following topics: innovation capabilities, founders' backgrounds, reactions and responses to the economic downturn of 2001; and the role of regional support.

ANALYSIS OF THE TOTAL POPULATION AND THE SAMPLE POPULATION

Unlike many studies in which the composition of the total population is not known, the Texas Workforce Commission provided aggregated data about the composition of the Austin Software Industry (SIC 373) in 2000. This aggregated dataset is sorted into two classes: 1) Number of Businesses and 2) Number of employees. According to the total number of employees, the two classes (number of businesses and number of employees) are categorized into the following size groups based on the number of employees: 1-4, 5-9, 10-19, 20-49, 50-99, 100-249, 250-499, and 500+. The study, however, regroups the same data, based on the size of enterprises, into four major groups: 1) **Micro Enterprises**: 1-4 employees, 2) **Small Enterprises**: 5-49 employees, 3) **Medium Enterprises**: 50-499 employees, and 4) **Large Enterprises**: 500 and more employees.

Figure 4.1 depicts the size of enterprises and employment in the total population of the Austin software industry based on the dataset provided by the Texas Workforce Commission. Figure 4.1 demonstrates that micro enterprises, with one to four employees, represent more than 60% of the total enterprises in the Austin software industry, but they employ fewer than 5% of software industry employees. This ratio of about 60% of all enterprises to 5% of employment represented by micro ventures is not unique to the Austin software industry. A separate unpublished study by the present researcher demonstrates that the ratio of about 60% of all enterprises to 5% of employment in micro ventures is a pattern common to many industries and regions.

Figure 4.1: Total Population:
Size of Enterprises and Employment in the Austin Software Industry

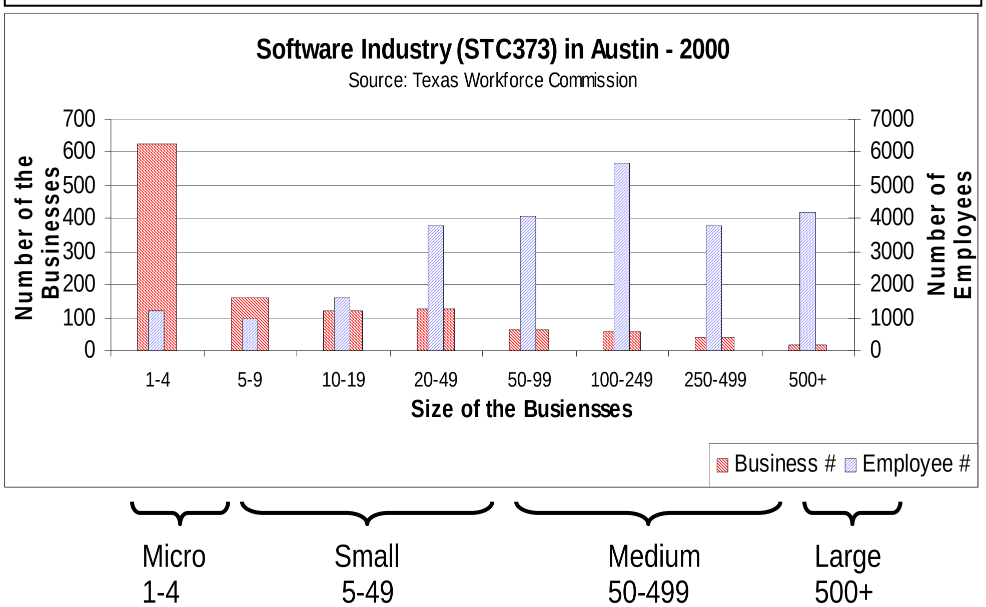


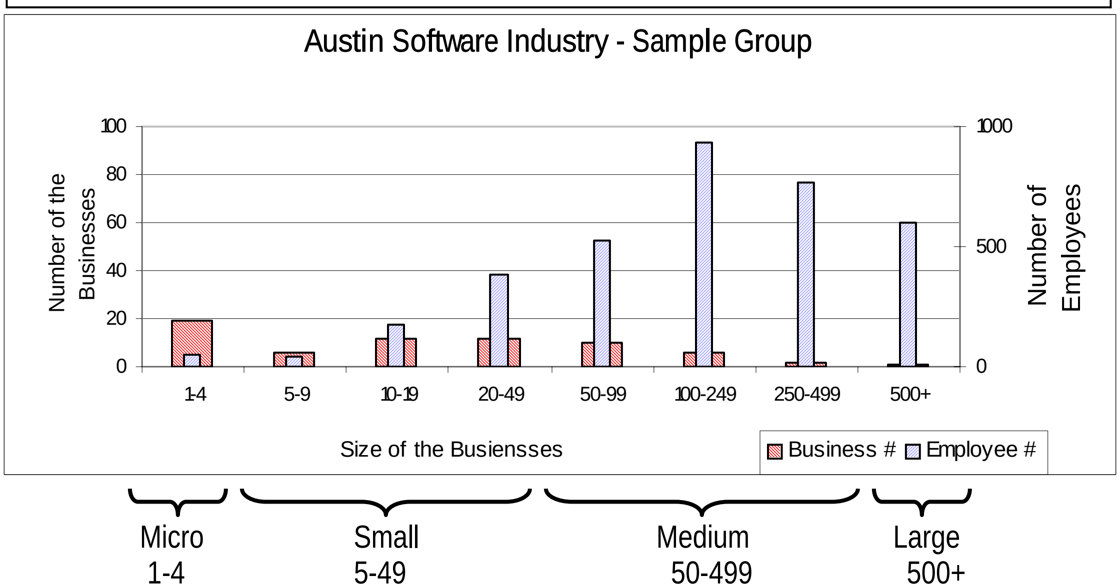
Figure 4.1 also demonstrates that large enterprises with more than 500 employees are fewer than 3% of total enterprises, but they employ about 20% of software industry employees. Small and Medium software enterprises in the Austin region constitute the middle group between Micro ventures and Large enterprises. Small and Medium

enterprises make up about 35% of total software enterprises in Austin, but they employ more than 75% of the employees.

As this study explores the relationships between venture and regional development, it concentrates on the homegrown software ventures in Austin. Accordingly, the study excludes the branch offices of enterprises not headquarted in Austin, irrespective of their sizes.

As part of the data collection procedure for the study, more than 75 software enterprises took part in the survey phase; they are referred to as the Sample Group. The relationships between the number of firms and employees in the Sample Group are depicted in Figure 4.2. The Sample Group includes a wide range of software enterprises founded by using different sources of capital. The list of surveyed enterprises appears in Appendix I.

Figure 4.2: Sample Group:
Size of Enterprises and Employment in the Austin Software Industry



A comparison of Figure 4.1 and Figure 4.2 in the range of small and medium (5 to 499 employees) demonstrates that the composition of the Sample Group and Total

Population are comparable. A comparison of Figure 4.1 and Figure 4.2 in the range of Micro Ventures (with one to four employees) demonstrates that the composition of the Sample Group and Total Population are not proportional, and micro ventures are underrepresented in the Sample Group. Compared with the small- and medium-size enterprises, the ratio of Sample to Total Population for micro enterprises is about one-fourth of the same ratio for small- and medium-size enterprises. As discussed before, the emphasis of the study is, however, on small and medium enterprises.

DATA ANALYSIS OF INITIAL SOURCES OF FINANCIAL CAPITAL

The study characterizes ventures based on their sources of capital into three main groups: 1) Self funded, 2) Venture Capital (VC) supported, and 3) Corporation funded. Among the 75 companies participating in this survey, one of them is a member of the communication industry, and information about two others was not satisfactory; thus they will not be analyzed in this study.

Among the 72 companies analyzed, 41 of them are self-funded. Twenty-nine of them are VC supported; venture capitalists invested in those 29 ventures during different stages of their lifecycles. Two ventures are corporation funded; they started as the subsidiaries of existing corporations. Due to the limited number of corporation funded ventures that took part in the study, a separate statistical analysis of the corporation funded ventures is not possible.

Further analysis of the two corporation funded ventures (as part of the interview stage), however, demonstrated that medium-size corporations established both of them. From the style of business planning and patenting their technologies, the two corporation funded ventures behaved like self-funded ventures. Accordingly, the two corporation funded ventures herein are included in the self-funded ventures group. Table 4.1

demonstrates the age of ventures at the time of VC investment. This table is in ascending order.

Table 4.1: Age of Ventures at the Time of VC Investment

Age of Ventures, at the Time of VC Investment
1 Month
1 Month
1 Month
1 Month
1 Month
4 Months
4 Months
6 Months
6 Months
6 Months
9 Months
10 Months
11 Months
11 Months
11 Months
1 Year
1 Year
1 Year
1 Year and 1 Month
1 Year and 4 Months
1 Year and 4 Months
The Gap of One Year–discussed in the text– exists here, between 1 Year and 4 Months and 2 Years and 4 Months
2 Years and 4 Months
2 Years and 10 Months
6 Years
7 Years
7 Years
18 Years
21 Years
Average Age of the Ventures at the time of VC Investment: 2.8 Years
Median Age of the Ventures at the time of VC Investment: 10 Months (0.8 Year)

The *average* age of the ventures at the time of VC investment is 2.8 years and the *median* age of the ventures at the time of VC investment is ten months (0.8 years). The difference between the *average* and *median* age demonstrates that the age distribution of the ventures at the time of VC investment is highly skewed. Thus, one needs to divide the range of VC supported venture into more homogenous sub-groups to explain the behaviors and patterns of each sub-group separately. The next section explains the distinction between the two major sub-groups of VC supported ventures.

VC FUNDED AND VC BACKED VENTURES IN THE AUSTIN SOFTWARE INDUSTRY

Figure 4.3: Classification of the Sources of Capital

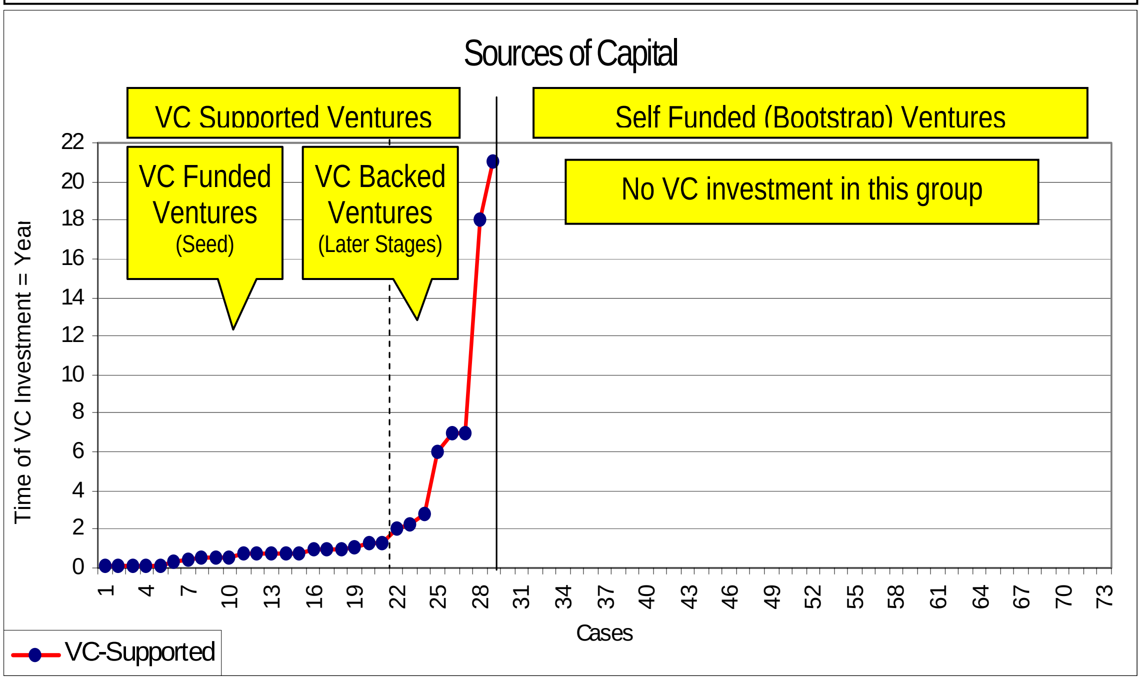


Figure 4.3, which is based on the same data as Table 4.1, demonstrates the age of the VC supported ventures at the time of VC investment for participants in the survey. A detailed study of Table 4.1 (Age of the Ventures at the Time of VC Investment) and Figure 4.3 clearly demonstrates that there is a gap of one year between enterprises younger than "one year and four months" (16 months) and older than "two years and four

months" (28 months). Accordingly, VC supported ventures are broken down into two sub-groups: 1) ventures that were younger than one year and four months (16 months) at the time of VC investment, and 2) ventures that were older than two years and four month (28 months) at the time of VC investment. The third group in Figure 4.3 includes the self-funded ventures without any VC investment thus far.

Ventures Younger than 16 Months: Twenty-one VC investments occurred when the ventures were less than 16 months old. In the present study, this group of ventures is referred to as VC funded ventures. VC funded ventures, in some studies, are referred to as Seed Stage and Early Stage investments (Van Osnabrugge and Robinson, 2000: 19). Among 20 VC funded ventures in the study, the average age of the ventures at the time of VC investment is about seven months, and the median age of the ventures at the time of VC investment is about eight months. Although the median and average numbers are very close, the distribution of the above factors does not correspond to a normal distribution or bell-shaped curve.

Ventures Older than 28 Months: Eight VC investments occurred when the ventures were more than 28 months old. In this study, this group is referred to as VC backed ventures. VC backed ventures, in some studies, are referred to as Later Stage investment (Van Osnabrugge and Robinson, 2000: 19). Among the eight VC backed ventures in the study, the average age of the ventures at the time of VC investment is about 8.3 years and the median age of the ventures at the time of VC investment is six years. The difference between the median and average age of the ventures at the time of VC investment in this group indicates that they are more homogeneous than the overall VC supported group, but that they are less homogenous than the VC funded group. Figure 4.3 also indicates that the VC backed group, by itself, consists of three sub-groups, each with two or three members. The limited number of cases in the three sub-groups of VC backed ventures does not permit a separate analysis for each sub-group.

Investments in VC funded ventures often happen when new ventures are in the early stage of their lifecycle. VC funded investments often happen prior to achieving a positive cash-flow or sustainable sales record when venture capitalists invest in ideas rather than in products with actual sales records. Investments in VC backed ventures happen when ventures are in the later stages of their lifecycle. Investments in VC backed ventures often happen after the companies have achieved positive cash-flow and/or sustainable sales records and venture capitalists invest in products with actual sales record, rather than just ideas and plans.

The distinction between VC funded and VC backed ventures is a key feature of this study. Based on the studies for this dissertation, as well as other studies of the present researcher, the distinction between VC funded and VC backed ventures has seldom been reviewed in academic studies. Some practitioners of venture development, however, are familiar with the difference between the two groups[7].

It is a key hypothesis of this study that the initial types of investment (associated with the styles of entrepreneurship) have strong impacts on the patterns of venture development. Using the term hypothesis, here, does not mean that this study uses the Black Box[8] model—with linear causal relationships between the input and output factors—as its base model.

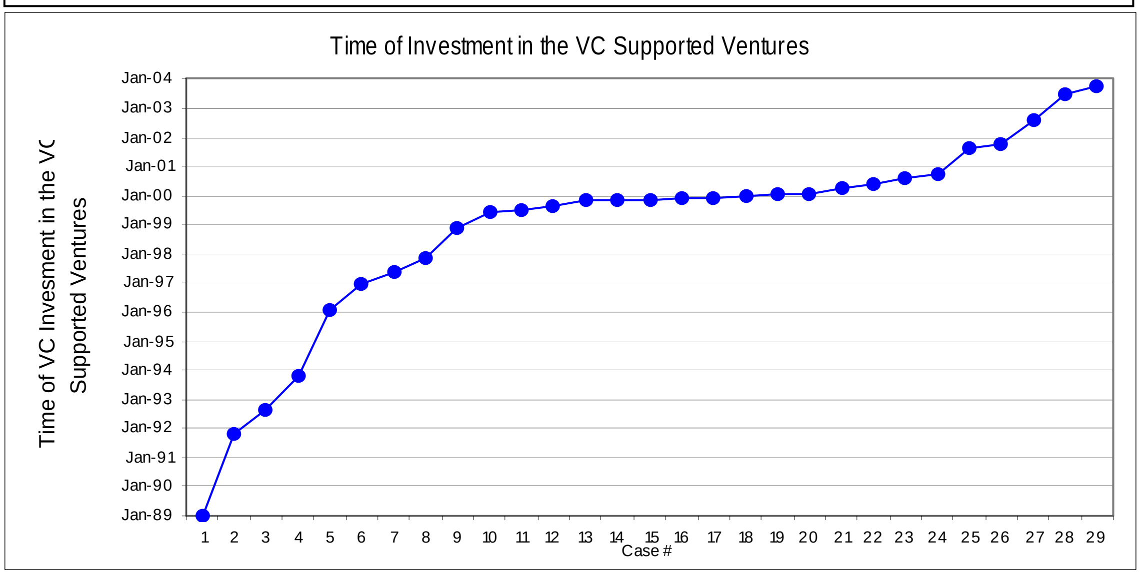
[7] Interview with informant No. 7, who is a VC investor. The distinction between VC funded ventures (investments in ideas) versus VC backed ventures (investments in actual products) was discussed first in this interview.

[8] The Black Box model is described in Appendix A – The Conceptual Structure.

DATA ANALYSIS OF THE TIME OF VC INVESTMENT

Figure 4.4 depicts the time (month-year) of VC investments in 29 VC supported ventures. The figure demonstrates that eight investments happened between 1989 and 1998. Between January 1999 and December 2000 there were 17 VC investments. The concentration of 6 investments in just 2 months—November and December 1999—is puzzling. This observation, on the concentration of VC investment in 1999 and 2000, is compatible with the general pattern of VC investment in Austin picking up during 1999 and 2000, as discussed in Appendix C. This period has been referred to as the Dot-Com Bubble. Since 2001, the number of VC investments in Austin software firms has decreased drastically compared to the peak of 1999 and 2000.

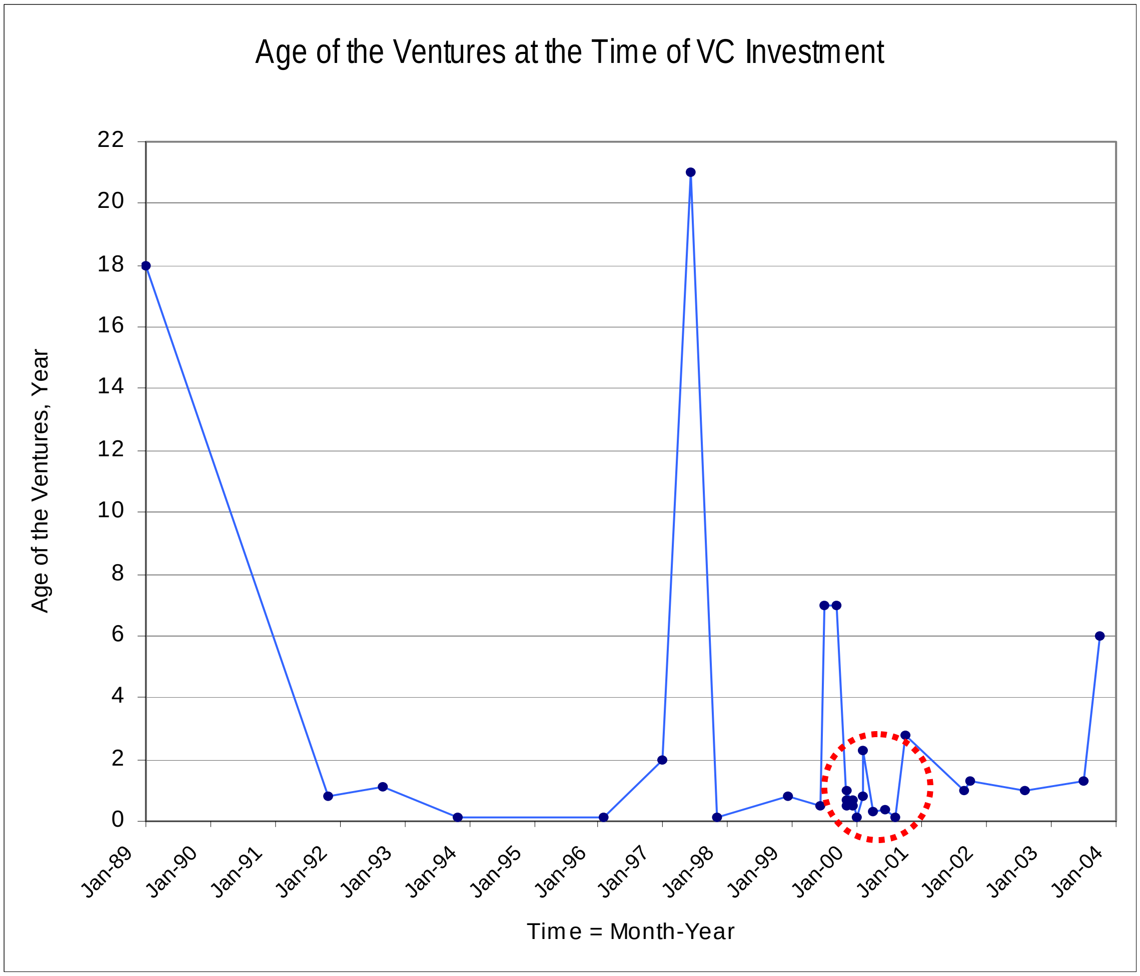
Figure 4.4: Time of Investment in the VC Supported Ventures



DATA ANALYSIS OF THE AGE OF VENTURES AT THE TIME OF VC INVESTMENT

Figure 4.5 depicts the age of ventures at the time of VC investment. This figure demonstrates that during the Dot-Com Bubble (1999 and 2000) among the Sample Group the number of VC investments drastically increased. During the same period, the age of the ventures at the time of VC investment also decreased considerably. This observation implies that during the Dot-Com Bubble, VC firms predominantly invested in Seed Stage (VC funded) software ventures. Since January 2001, not only has the total number of VC investments decreased drastically, but the VC investments have often been in mature ventures (VC backed ventures). This change of pattern in VC investments (decreasing number of total VC investments, and fewer investments in the early stage VC funding) potentially impacts future regional economic development programs in Austin.

Figure 4.5: Age of the Ventures (in Years) at the Time of VC Investment



The drastic change in the patterns of VC investment prior to and after the economic boom of late 1990s is not unique to the Austin software industry. This pattern mirrors the description of change of VC investments in the late 1980s. Van Osnabrugge and Robinson determined: “After the 1987 stock crash, the VC industry shifted its investment focus away from start-ups and early-stage firms, in favor of mature ventures” (2000: 49).

MICRO ENTERPRISES

As discussed in the previous section, according to their sources of capital, ventures may be classified into three groups: 1) VC funded ventures in which VCs invested in companies younger than 16 months of age, 2) VC backed ventures in which VCs invested in companies greater than 26 months of age, and 3) Self-funded ventures without VC investments[9]. The ventures, according to their sizes (number of employees), are also organized into three groups: 1) micro enterprises with 1 to 4 employees, 2) small and medium size enterprises with 5 to 499 employees, and 3) large enterprises with 500 employees or more. The matrix combination of the two types of classification (sources of capital and size) provides a better base for the comparison of the self-funded ventures and VC funded ventures (which are all in the range of 5 to 499 employees). The focus of this study is on small and medium enterprises with 5 to 499 employees. Large enterprises, with 500 or more employees, are excluded from the survey study as they are better studied on a case-by-case basis.

RELATIONSHIPS BETWEEN INITIAL SOURCES OF CAPITAL AND PATTERNS OF GROWTH

In the study there are two indicators of growth: “current number of employees” and “overall rate of growth” (current employee number / current age of the venture).

[9] In this study, the self-funded group includes also two corporation funded ventures that have characteristics similar to the self-funded ventures, as discussed before.

Statement 1

This study hypothesizes that initial sources of capital impact patterns of growth.

Statement 1: *Sources of capital in the early stage of development of new ventures impact their later patterns of growth.*

Statement 1A: *VC funded ventures tend to have a higher rate of growth than self-funded ventures.*

To demonstrate the validity of the above statements, the following data for each venture are calculated:

- Current Employee Number
- Current Age of the Ventures
- Rate of Growth (Current Employee Number / Current Age of the Ventures)
- Age of the Ventures at the time of VC Investment

Table 4.2 summarizes the above information for the four groups of ventures: 1) VC funded-ventures, 2) VC backed ventures, 3) Self-funded ventures and 4) Micro ventures[10].

Table 4.2: Comparison of the Patterns of Growth and Sources of Capital

	VC Funded (Seed Stage)	**VC Backed** (Later Stage)	**Self Funded**	**Micro Ventures**
Number of Ventures	18	5	25	23
Total Employment in Fall 2003, in Persons	1154	717	1024	56
Average Number of Employees, in Persons	64	143.4	41	2.4
Current Average Age, in Years	5.3	17.9	7.5	5.2

[10] Table K.1 (which appears in Appendix K) covers more detailed information about the enterprises that took part in the survey stage.

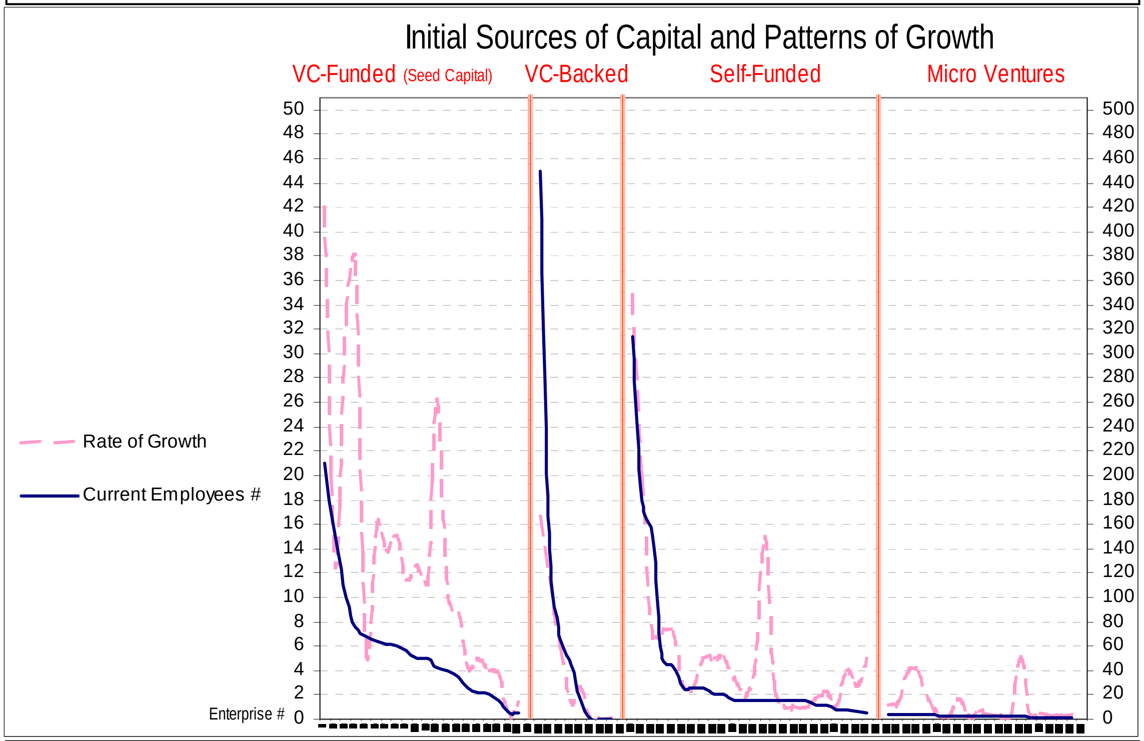
Average Rate of Growth, in Persons /Year	12	7.7	5.5	1.1

The total numbers of employees (in the second row) in the first three groups of Table 4.2 are comparable: VC funded = 1154 persons, VC backed = 717 persons, and self-funded = 1024 persons. This implies that the economic impacts of the first three groups tend to be comparable. The total number of employees in the micro venture group is 56 persons. This suggests that the micro venture group has very limited economic impact, but this group provides the stream of new ventures and is essential for new venture development.

A comparison between the average number of employees and the average rate of growth among the four venture groups demonstrates interesting patterns: The average number of employees (third row) for each group is: VC funded = 57.7 persons, VC backed = 143.4 persons, self-funded = 43 persons, and micro venture = 2.4 persons. Apparently the average number of employees in the VC funded and self-funded groups is comparable: 64 versus 41. The average "rate of growth" (current employee number / age of the venture) for VC funded and self-funded groups, however, is different: VC funded = 12 (persons/year), VC backed = 7.7 (persons/year), and self-funded = 5.5 (persons/year). A comparison of the above data indicates that the average rate of growth of VC funded ventures is about two times (12/5.5 = 2.2) that of self-funded ventures. "Venture Capital Financing and the Growth of Startup Firms" (Davila et al. 2003) describes a study of a group of businesses mostly in Silicon Valley in the period of 1994-2000. In this study, the average growth rate of VC funded ventures is about 2.2 times that of self-funded ventures. The average growth rate for VC funded ventures is about 16.5 employees per year, versus 7.2 employees per year for self-funded ventures in that study.

The difference between the average rate of growth in VC funded and self-funded ventures validates statement 1A, for ventures employing 5 to 499 people. This statement does not imply that VC funded ventures always grow faster than any self-funded venture.

Figure 4.6: Initial Sources of Capital and Patterns of Growth.
Rate of Growth is explained by numeric values in the left column (from 0 to 50).
Current Employee # is indexed in the right column (from 0 to 500).



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

The relationships between the sources of capital and growth patterns can be observed better in a figure than in a table. Figure 4.6 depicts the relationships between sources of capital, patterns of growth (total number of employees and rate of growth), current age, and age at the time of VC investment, among the four main groups of ventures: VC funded, VC backed, self-funded and micro ventures.

The number of employees and the average rate of growth in the VC backed ventures are atypical compared to VC funded and self-funded ventures: The average rate of growth (number of employees/year) of VC backed ventures is comparable with self-funded ventures: 7.7 versus 5.5. The average number of employees in the VC backed ventures, however, is different from both VC funded and self-funded ventures. Based on the above data, the proposed dividing line between VC funded and VC backed ventures in this study appears to be justifiable, as it demonstrates the distinctive characteristics of VC funded versus VC backed ventures.

RELATIONSHIPS BETWEEN INITIAL SOURCES OF CAPITAL AND ORIGINAL STYLES OF BUSINESS PLANS

Exploring the relationship between "initial sources of capital" and "original styles of business plans" is one of the key intentions of the study, in which the original styles of business plans are organized into the following groups: 1) Formal (classical) business plans[11], 2) Short business plans[12], 3) Work-up financial plans, 4) One-page plans (back-of-the-envelope type), and 5) No conventional business plans. The above classification for original business plans corresponds to the classification of business plans in "How Entrepreneurs Craft Strategies" (Bhide, 1994: 152). The commonalities between the classification of business plans in the two studies (Bhide's study and the present study) make it possible to compare the results of the two studies.

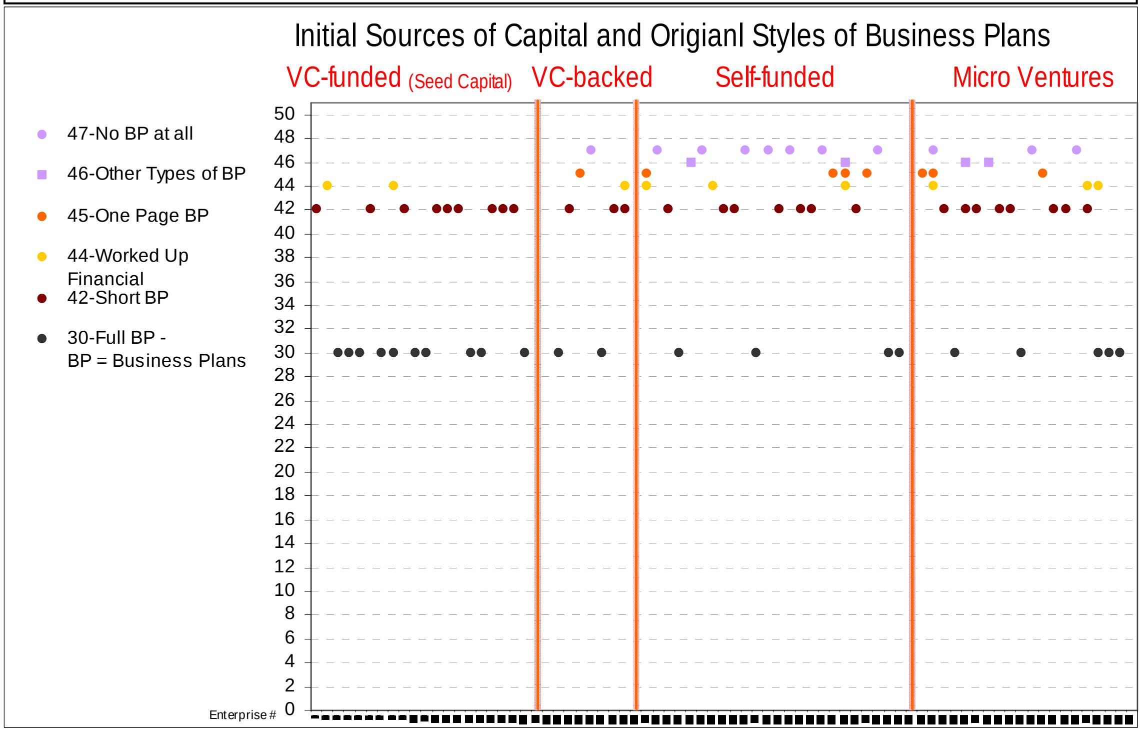
Statement 2

This study hypothesizes that the initial sources of capital impact the original styles of business plans.

[11] According to the questionnaire for the survey study, a "full-blown formal (classical) business plan" consists of market study, technology forecasting, and financial analysis.
[12] According to the questionnaire for the survey study, a "short business plan" consists of a brief description of the technology and a brief description of potential markets, without a detailed market study and financial analysis, and it is about 5-10 pages.

Statement 2 A: *VC funded new ventures have a greater tendency to develop formal (classical) business plans, and self-funded new ventures have a lesser tendency to develop formal (classical) business plans.*

Figure 4.7: Initial Sources of Capital and Original Styles of Business Plans
The factors are explained by the various numeric symbols in the left column (from 0 to 50)



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

Lines 30, 42, 44, 45, 46 and 47, in Figure 4.7, present data about the original style of business plans for each venture. Figure 4.7 demonstrates that among 20 VC funded ventures, 10 of them started with “formal business plans” (or 50%). Among the 28 self-funded ventures, however, only 4 of them started with “formal business plans” (about 15%). Figure 4.7 also demonstrates that no VC funded venture started with “no conventional business plans,” while seven (or 25%) of the self-funded ventures started with “no conventional business plans.” This simple calculation supports the main assertion of this study, that initial *sources of capital impact the styles of business plans, and VC funded ventures have a greater tendency to develop formal business plans*.

In respect to short business plans, however, there exists less of a distinction between VC funded and self-funded ventures. In this study nine VC funded ventures (45%) started with short business plans, compared with seven self-funded ventures (25%) that started with short business plans.

Chi-Square Relationship between Initial Sources of Capital and Original Styles of Business Plans

Table 4.3 demonstrates the "observed data" between "Original Sources of Capital" (VC Funded Ventures versus Self Funded Ventures) and "Styles of Business Plans" (Formal Business Plans versus Non-Formal (Other Types) Business Plans).

Table 4.3: Observed Data Between Initial Sources of Capital and Original Styles of Business Plans

	Formal Business Plans	Other Types of Business Plans
VC Funded Ventures	**10**	**10**
Self-Funded Ventures	**4**	**24**

$$\chi^2 = 7.27$$

The calculated Chi-Square[13] value for the relationships between "Initial Sources of Capital" and "Original Styles of Business Plans" is equal to 7.27. This Chi-Square value is higher than 3.48, which is α level (p-value of 0.05 for 1 degree of freedom). The value of Chi-square for this case (7.27) is even higher than 6.63, which is p-value of 0.01 for 1 degree of freedom. This calculation for Chi-Square demonstrates a strong

[13] Appendix D covers information about the conceptual background of Chi-Square and calculation of the Chi-Square values for this study.

association between initial sources of capital and original styles of business plan for the enterprises that took part in this study.

Impact of Original Styles of Business Plans on the Patterns of Growth of VC Funded Ventures

To review the impacts of formal business plans on the patterns of growth of VC funded ventures, the rate of growth and current number of employees of the 10 VC funded ventures that started with formal business plans and the 9 VC funded ventures that started with short business plans are compared. The average rate of growth of the first group (10 VC funded ventures that started with formal business plans) is 13.9 persons / year and the average rate of growth of the second group (9 VC funded ventures that started with short business plans) is 14.8 persons / year. The average number of current employees for the first group is 51.7 persons and the average number of current employees for the second group is 54.8 persons. The χ^2 test for the first case (average rate of growth) is 0.08 and the χ^2 test for the second case (average number of current employees) is 0.10. Both Chi-Square values are lower than 3.48, which is α level (p-value of 0.05 for 1 degree of freedom). In both cases, the difference between the two groups is not significant. This calculation implies that developing formal business plans per se have no significant impact on the potential patterns of growth among the VC funded ventures that participated in this study.

PATTERNS OF BUSINESS PLANS IN THE LATER STAGES OF VENTURE LIFECYCLES

Another key question of the survey relates to patterns of business plans in the later stages of venture lifecycles. This question seeks to explain patterns of business plan development as ventures mature. In the survey form, respondents were directed to select only one of the responses:

- Question: After the first year, how was the plan and vision for this company transformed?

1. The transformation was mostly based on formal (classical) business planning.
2. The transformation was mostly based on adaptation without formal planning.

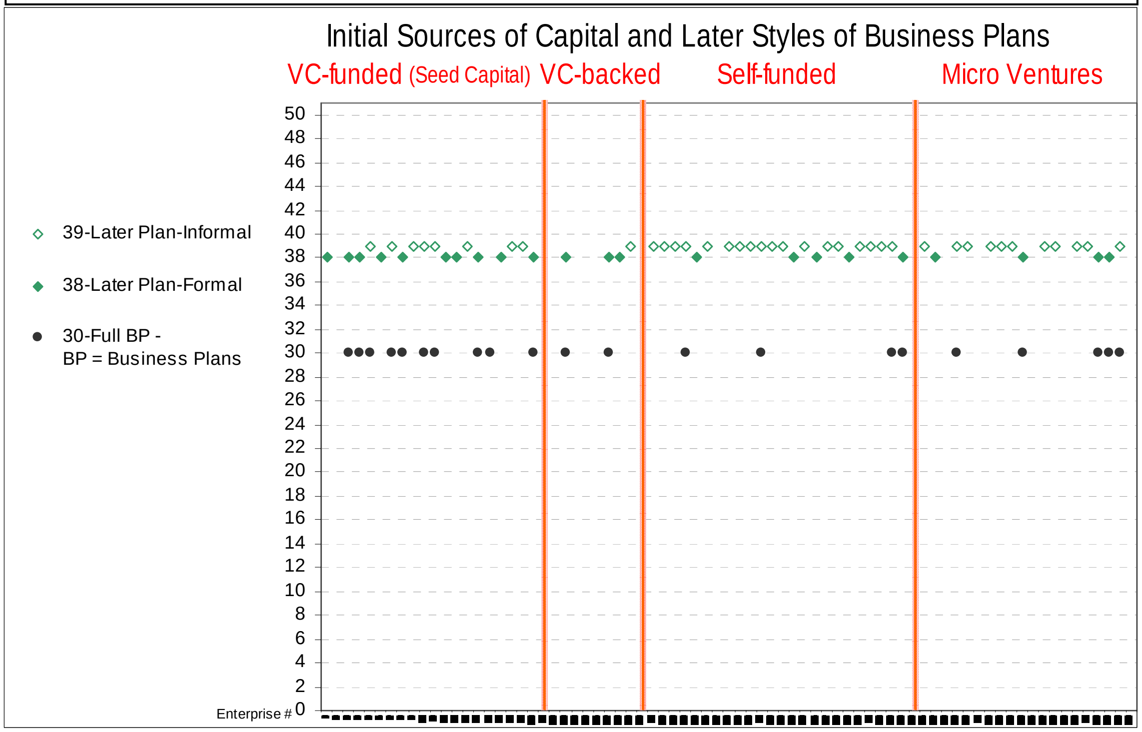
Statement 3

This study suggests that one-year after startup, new ventures tend to develop their business plans into something less formal and more adaptive.

Responses to the question related to the patterns of business plans in the later stages of venture lifecycles are marked in lines 38 and 39 of Figure 4.8. Eighteen VC funded ventures responded to this question. Ten of them (55%) marked the first alternative (based on formal business plans) and eight of them (45%) selected the second alternative (based on informal business plans). Among the VC funded ventures the nature of business plans after the first year (formal versus informal business plans) is compatible with the nature of business plans before startup in that half of them started with formal business plans and half of them started without formal business plans. On the other hand, among the 23 self-funded ventures that responded to this question, five of them (20%) marked the first alternative (based on formal business plans) and eighteen of them (80%) selected the second alternative (based on informal business plans). This calculation supports Statement 3.

Interestingly enough, the nine VC funded ventures that marked the first alternative (based on formal business plans) all belong to the same group of 10 VC funded ventures that started with formal business plans. Among the 5 self-funded ventures that selected the second alternative (based on informal business plans) only one of them belongs to the original four self-funded ventures that started with formal business plans. This observation may imply that VC funded ventures follow a more structured format while self-funded ventures follow a more evolutionary format in the later stages of their lifecycles.

Figure 4.8: Initial Sources of Capital and Later Styles of Business Plans
The factors are explained by the various numeric symbols in the left column (from 0 to 50).



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of the text might be black.

Chi-Square Relationship between Initial Sources of Capital and Later Styles of Business Plans

Table 4.4 demonstrates the "observed data" between "Original Sources of Capital" (VC Funded Ventures versus Self Funded Ventures) and "Later Styles of Business Plans" (Formal Business Plans versus Informal Business Plans).

Table 4.4: Observed Data Between Initial Sources of Capital and Later Styles of Business Plans

	Formal Business Plans	Informal Business Plans
VC Funded Ventures	**10**	**8**
Self-Funded Ventures	**5**	**18**

$$\chi^2 = 4.97$$

The calculated Chi-Square value for the relationships between Initial Sources of Capital and Later Styles of Business Plans is equal to 4.97. This Chi-Square value is higher than 3.48, which is α level (p-value of 0.05 for 1 degree of freedom). This calculation for Chi-Square demonstrates a significant association between initial sources of capital and later styles of business plans among the enterprises that took part in this study.

MAIN APPLICATIONS OF FORMAL (CLASSICAL) BUSINESS PLANS

Another key question of the survey concerns the main applications of the formal (classical) business plan. This question served to clarify the main intentions of the founders, who had already developed formal business plans in the startup of their new ventures. The main applications of the formal business plans are classified into two groups, and the respondents were able to select one or both of them, as this classification is not mutually exclusive:

- Question: In your opinion, <u>if this company started with a formal (classical) business plan</u>, what was the <u>main</u> application of that business plan?

1. For external communication with the third parties such as VC investors, banks, government agencies, etc.
2. Practical internal guide for implementation.

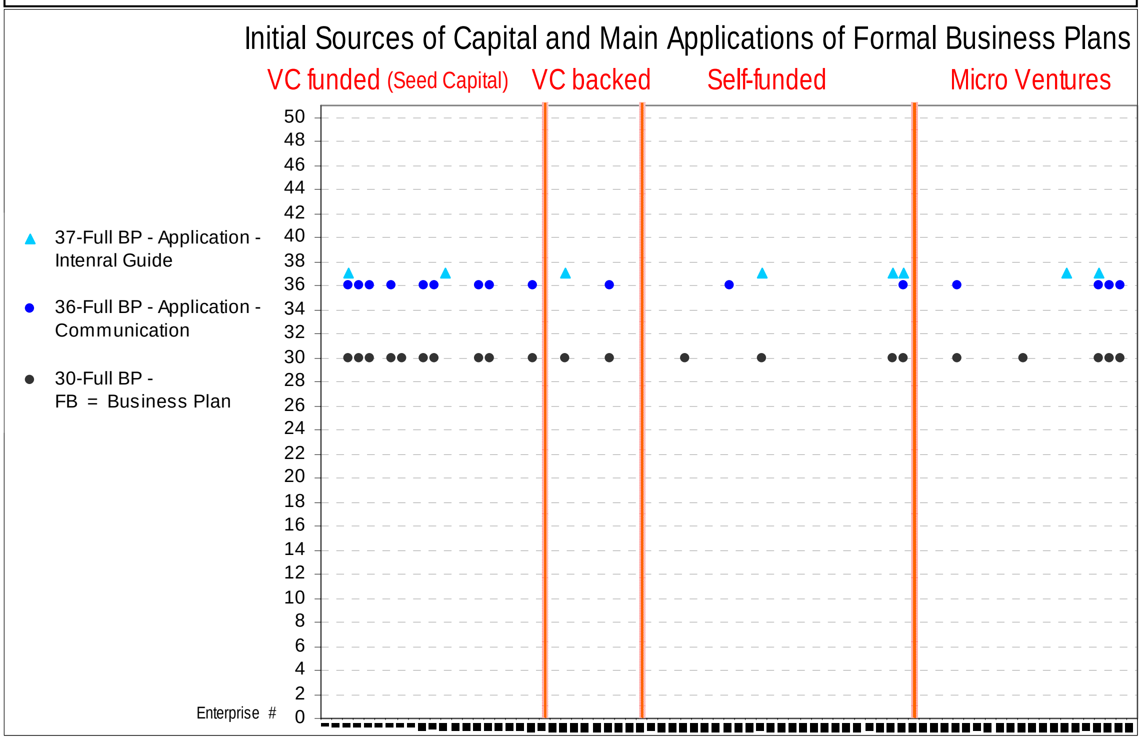
Statement 4

This study suggests that the sources of capital impact the main application of formal (classical) business plans.

Statement 4A: *VC funded ventures have a greater tendency to use their full (classical) business plans for communication with third parties.*

Statement 4B: *Self-funded ventures have a greater tendency to use their formal business plans for practical internal guidance.*

Figure 4.9: Initial Sources of Capital and Main Applications of Business Plans
The factors are explained by the various numeric symbols in the left column (from 0 to 50)



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

The responses to the question related to the main applications of formal business plans are marked in lines 37 and 37 of Figure 4.9. The Figure demonstrates that nine of ten (90%) VC funded ventures that started with a formal business plan used them for “external communication with the third parties.” Only two of them (20%) used the formal business plans as “practical internal guidance for implementation.” Only one VC funded venture used the formal business plan for both “external communication with the third parties” and “practical internal guidance for implementation.” VC funded ventures often use formal business plans for communication with third parties to seek external sources of capital.

2 of the 4 (50%) self-funded ventures that developed formal business plans, however, used the formal business plan for “external communication with the third parties” and 3 of the 4our (75%) self-funded ventures used it for “practical internal guidance for implementation.”

The limited number of cases that responded to this question falls below the threshold for the application of a Chi-Square test. Thus, the existing data do not fully support or reject Statement 4, that the initial sources of capital impact the main application of formal business plans. Nevertheless, the representations in Figure 4.9 imply a strong tendency for VC funded firms to deploy their formal business plans for communication with external sources of capital. Figure 4.9 also illustrates that the limited number of self-funded ventures that developed formal business plans, deployed the formal business plans both for external communication and internal managerial guidance tool.

IMPLEMENTATION OF THE FORMAL BUSINESS PLANS

In addition to the development and evolution of formal business plans, the patterns of implementation of formal business plans also are important. To have a better understanding of the patterns of implementation of formal business plans, the following question was asked in the survey form:

- Question: If this company started with a full formal (classical) business plan, how was that plan implemented during the first year of operations?

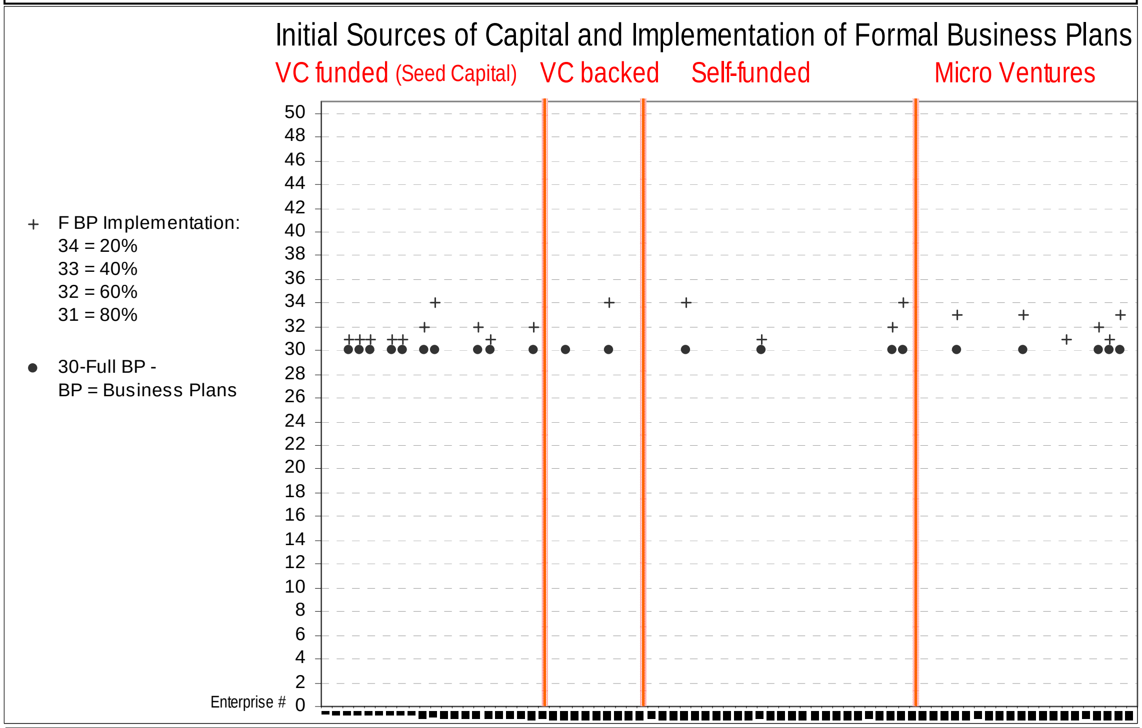
1. Almost as planned
2. Major changes in the original plan
3. Strong changes in the original plan
4. Drastic changes in the original plan

Statement 5

This study hypothesizes that the ability to implement a formal business plan is associated with initial sources of capital.

Responses to the question related to the implementation of formal business plans are marked in lines 31, 32, 33 and 34 of Figure 4.10. 10 VC funded ventures responded to this question; 6 of them (60%) selected the first alternative (almost as planned), 3 of them (30%) selected the second alternative (major changes), and one of them (10%) selected the fourth alternative (drastic changes). Interestingly enough, the same 6 ventures that selected the first alternative (almost as planned) also used formal business plans in the next stages of development of the ventures. Among the 4 self-funded ventures that started with a formal business plan, only one of them (20%) was able to implement the business plan almost as planned, one of them (20%) was able to implement the business plans with "major changes" and two of them (50%) selected the fourth alternative (drastic changes). The limited number of cases in this test fall below the threshold for the application of a Chi-Square test. Thus, the existing data do not fully support or reject the above Statement 5 that the ability to implement formal business plans is associated with the initial sources of capital.

Figure 4.10: Initial Sources of Capital and Implementation of Formal Business Plans
The factors are explained by the various numeric symbols in the left column (from 0 to 50)



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

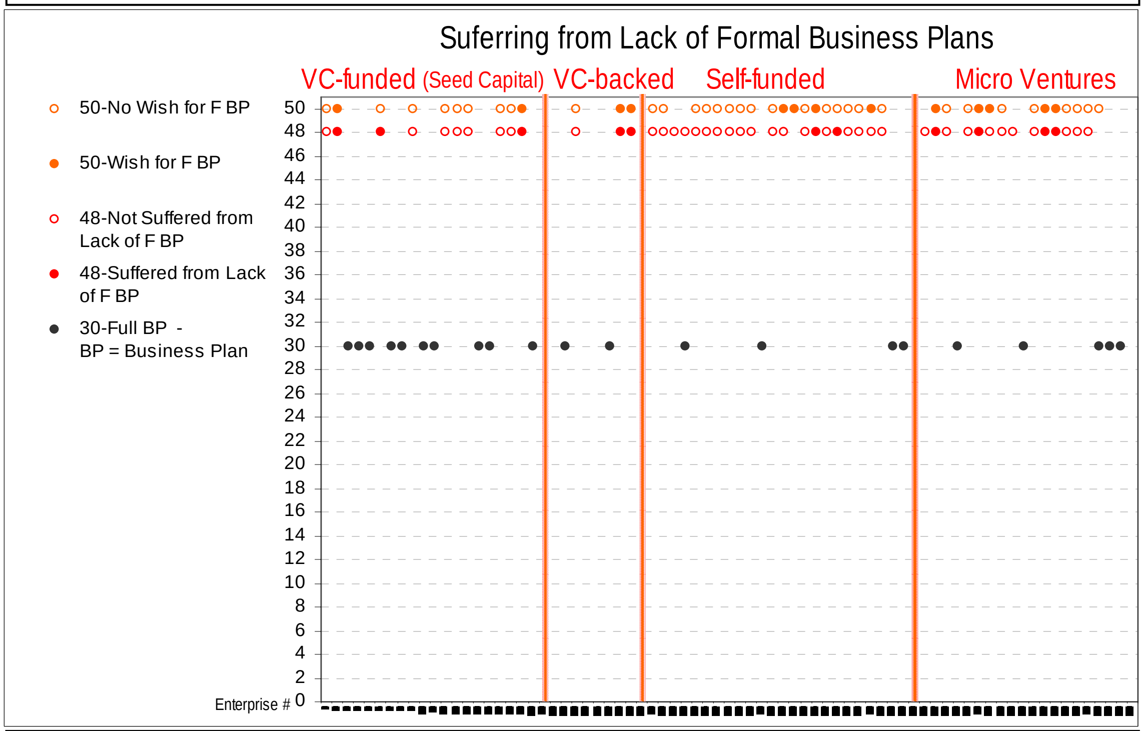
SUFFERING FROM LACK OF A FORMAL BUSINESS PLAN

To understand better the roles and potential impacts of formal business plans, the survey asked the following two questions. In each case, the respondents were instructed to select only “Yes” or “No”:

- **Question**: If this company did not start with a formal business plan, *did the company suffer* from not having a formal business plan?
- **Question**: If this company did not start with a formal business plan, do *you wish* it had a formal business plan?

The responses to the above questions are marked in lines 48 and 50 of Figure 4.11. Analysis of the data demonstrates that most respondents who did not start their ventures with formal business plans do not think that they had suffered from a lack of formal business plans (90% of self-funded ventures and 70% of VC funded ventures). Along the same line of thinking, only 20% of VC funded entrepreneurs who did not start with formal business plans wish they had, compared with about 15% of self-funded entrepreneurs. This simple calculation implies that most entrepreneurs are satisfied with what they have done in using the different styles of business plans.

Figure 4.11: Suffering from Lack of Formal Business Plan
The factors are explained by the various numeric symbols in the left column (from 0 to 50)

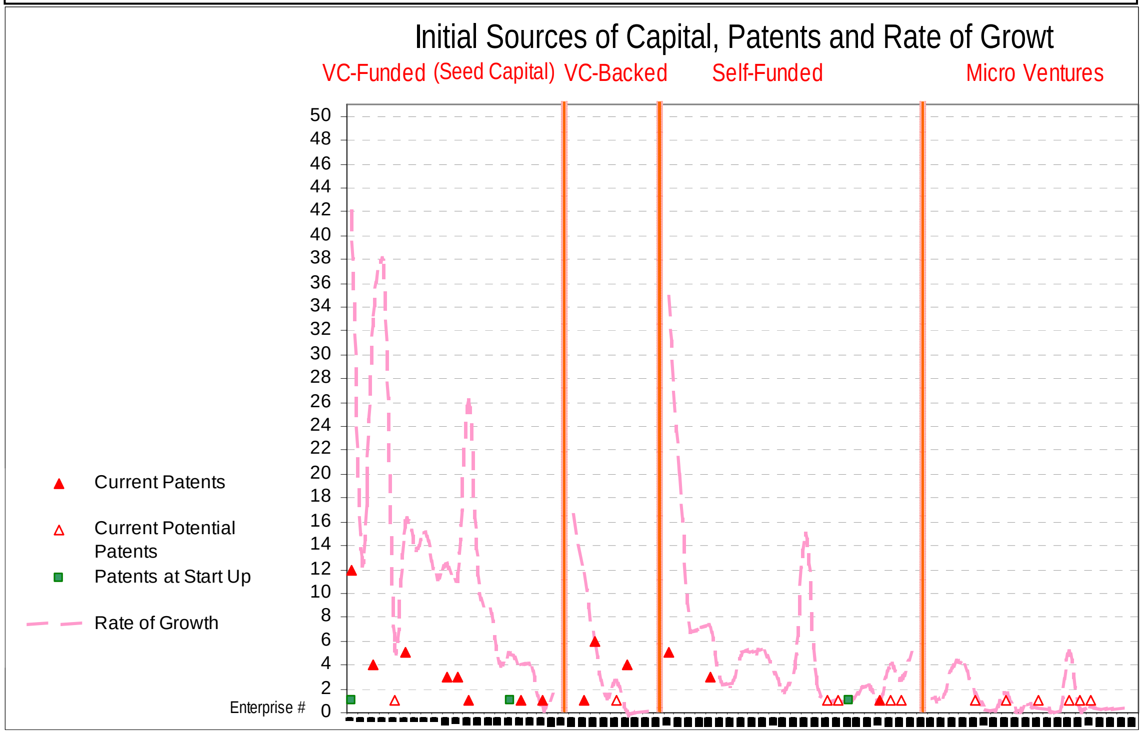


Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

RELATIONSHIPS BETWEEN INITIAL SOURCES OF CAPITAL, PATENTS AND RATE OF GROWTH

The survey included questions regarding patented technologies. The participants were asked to indicate whether they started their ventures with patented technology (or technologies), as well as their current number of patents (both patent applications and registered patents). In addition, the survey asked participants to estimate their potential patents—technologies that the respondents think are patentable, but have not been patented. Figure 4.12 demonstrates data about the patents related to each enterprise[14]. The data about the number of patents (at start-up, current, and potential) are marked in lines 1 to 12 of Figure 4.12.

Figure 4.12: Initial Sources of Capital and Patents
The factors are explained by the various numeric symbols in the right column (from 0 to 50)



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

Figure 4.12 demonstrates that there are only three ventures (out of a total of 72 ventures) that started with patented technologies. The rate of growth of two of the enterprises that started with patented technology is below the average rate of growth. *The*

[14] Detailed information related to patents, as well as rate of growth is available in Table J.1, in Appendix J. The Table includes the following information about all enterprises that took part in the study: Current Employee Number; Rate of Growth (ratio of current employee number / current Age); Number of registered patents for each venture; Potential Patents.

data indicate that there are no direct relationships between number of patents at start up and later patterns of growth.

Growth or Patents: Which One Comes First?

Figure 4.12 also demonstrates a modest association between rate of growth and current patents, especially among the VC funded ventures. Although technology plays a key role in venture development, it does not appear to be the case that patents *per se* are the key factors in the success of new ventures in their early stages of development. Numerous papers and studies have reviewed the role of patents in the growth of businesses, but they have mostly reviewed mature businesses and very large enterprises.

Patents and growth often have feedback and closed-loop relationships with each other. Each one may nurture the other one. In this context, a key question is “Growth or Patent: Which one comes first”? Are patents a source or a cause of further growth, or conversely, does growth provide the resources to apply and register patents? An analysis of the ventures that took part in this study and started with registered patents may provide an answer to this puzzle. Figure 4.12 indicates that, among the ventures that responded to the question related to patents in the survey form, only three ventures had registered patents at the time of their startup (Cases No. 1, 16, and 48). Among the three ventures, only one of them is a high growth venture (Case No. 1). This comparison indicates that, in the early stages of venture development, patents do not necessarily promote growth. If patents were considered to be a correlate of growth, there should be a strong association between patents at the time of start-ups and the later growth of the ventures that started with patents. There are, however, more patents registered during later stages of the venture lifecycles. This pattern implies that growth is a better justification for ability to register and secure patents.

Patents and Micro Ventures

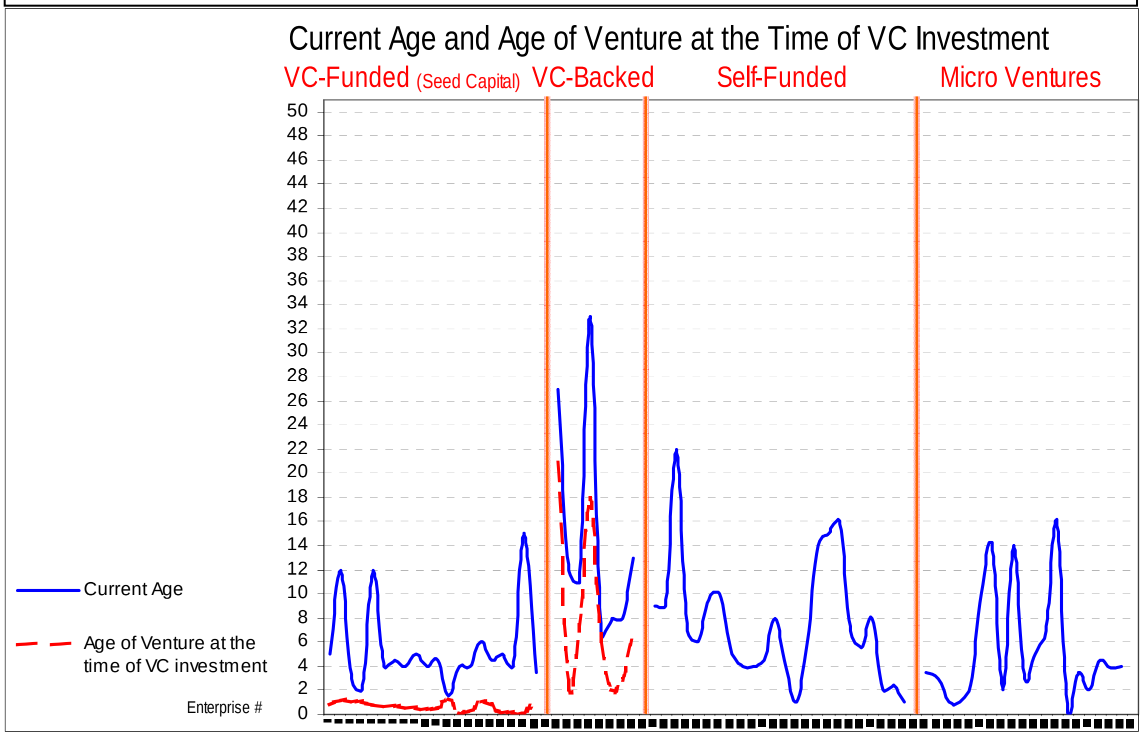
Figure 4.12 also demonstrates that ventures with "potential patents" are concentrated among the micro and very small ventures (with fewer than 20 employees). Figure 4.12 demonstrates that there are 6 micro ventures that marked the section on potential patents, compared to only one medium-size venture (with about 60 employees) that indicated it has a potential patent that has not been registered. In addition, as it was discussed in the section on comparing the Total Population and a Sample Group, micro ventures in this study are underrepresented. The ratio of Sample to Total Population for micro enterprises is about one fourth of the same ratio for small and medium-size enterprises. It means the responses in the micro venture group should be multiplied by four to provide a better base for comparison with the small- and medium-size enterprises group. This observation of the high number of micro ventures with potential patents may imply that, in the early stage of venture development, too much attention to patents might act more as a hindrance than a help. Alternatively, new ventures with high technological capabilities may be acquired by mature firms rapidly and thus they do not develop their own portfolio.

Current Age and Age of Ventures at the Time of VC Investment

Previous sections of this chapter have reviewed the characteristics of each venture at the time of startup, as well as their most recent characteristics. To have a better understanding of the patterns of evolution of each venture, Figure 4.13 depicts the current age of each enterprise, as well as the age of each venture at the time of VC investment, if that is applicable.

Figure 4.13 demonstrates that VC funded ventures, with a mean age of 5.3 years, are among the youngest existing ventures. VC backed ventures, with a mean age of 17.9 years, on average are the oldest existing ventures. The mean age of the self-funded ventures, which have not yet received VC investments, is 7.5 years. The mean age of micro ventures is 5.2 years. The mean age of micro ventures (5.2 years) is comparable with VC funded (5.3 years), as well as self-funded ventures (7.5 years). The mean age of micro ventures (5.2 years) may indicate that many ventures start as micro ventures but do not grow fast and stay as micro ventures, irrespective of their ages.

Figure 4.13: Initial Sources of Capital and Current Age
The factors are explained by the various numeric symbols in the right column (from 0 to 50)

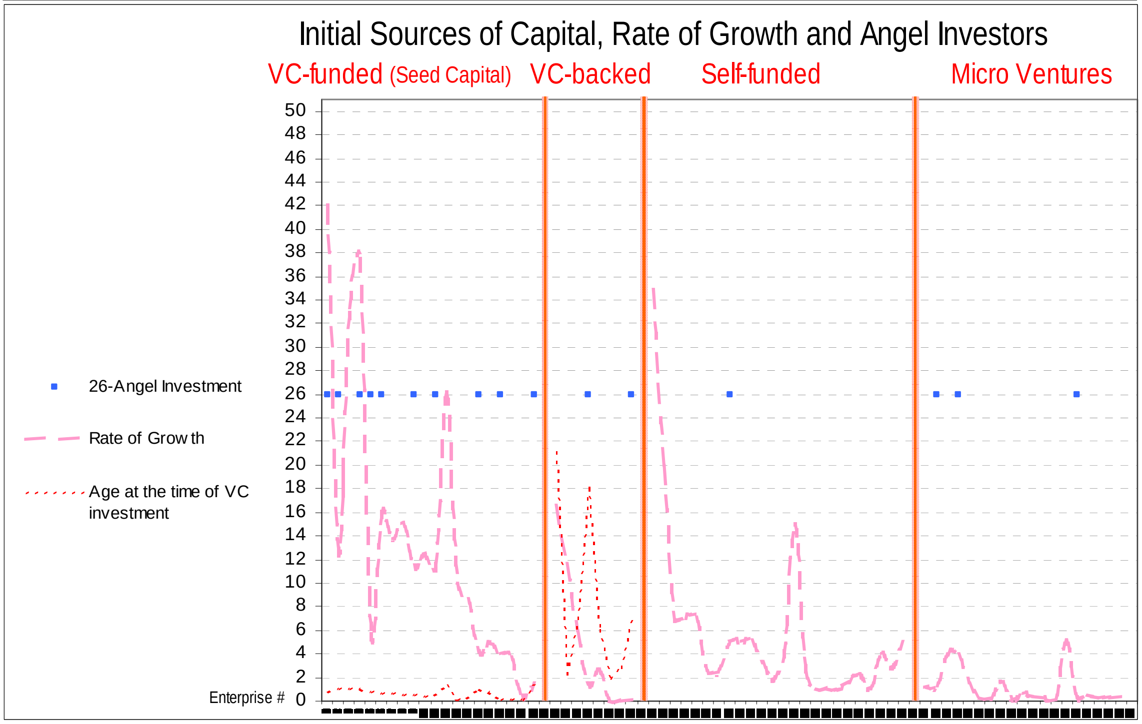


Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

INITIAL SOURCES OF CAPITAL, INDIVIDUAL INVESTMENT (ANGEL), AND RATE OF GROWTH

Angel investors are wealthy individuals who provide capital to start-up ventures. Angel investors are distinct from VC firms, which are investment organizations. According to *The Money of Invention* "While angels perform many of the same functions as venture capitalists, they invest their own capital rather than that of institutional and other individual investors” (Gompers Lerner, 2001: 249).

Figure 4.14: Initial Sources of Capital, Angel Investment and Rate of Growth
The factors are explained by the various numeric symbols in the right column (from 0 to 50)



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

In this study, angel (individual) investors invested in 16 of the ventures. A detailed review of the data indicates that 10 individual (angel) investments were related to VC funded ventures, two investments were related to VC backed ventures, and four investments were related to self-funded ventures. The above description of patterns of investment demonstrates that individual (angel) investments occurred often among VC funded ventures. Among the VC funded cases, it does not seem that there exist major differences in the Rate of Growth and Age at the Time of VC Investment between Angel Investments cases (marked in line 26) and other cases.

REACTION TO THE ECONOMIC DOWNTURN OF 2001

The reaction to the economic downturn of late 2000 and early 2001 (after the Dot-Com Bubble burst) was a topic of discussion in the interview questions of this study. The impact of the Dot-Com Bubble on the behavior of the software enterprises in Austin was also discussed in many meetings with the entrepreneurs and venture development specialists. As this study focuses on the behavior of self-funded versus VC funded ventures, it is relevant to consider the reactions to the economic down turn of 2001.

Table 4.5: Reaction to Economic Downturn of 2001

	Number of Ventures	**Total Number of Employees in Late 2000 (Just before the Peak of the Dot-com Bubble)**	**Total Number of Employees in Fall 2003 (or the most recent data)**	**Changes in the Number of Employees between Late 2000 and Late 2003, %**
VC Funded	20	1071	1155	+ 0.08%
Self-Funded	24	1171	1024	- 0.13%

$\chi 2 = 0.85$

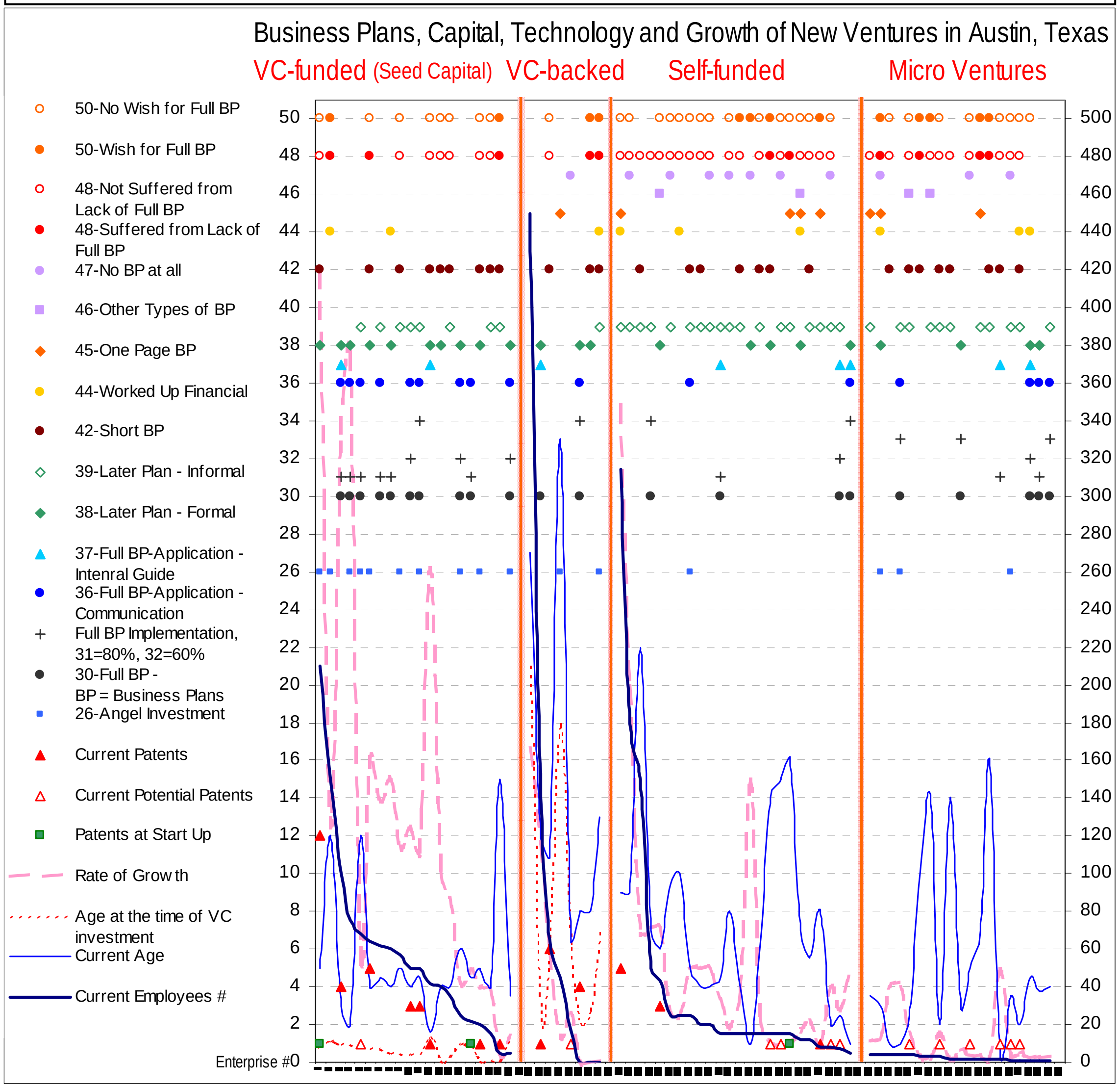
Table 4.5 compares the Total Number of Employees in late 2000 (just before the peak of the Dot-Com Bubble) and the Total Number of Employees in late 2003. The data demonstrates that the 20 VC funded ventures had 1155 employees in late 2003, while in late 2000 they had about 1071. The difference between the two employment numbers corresponds to approximately a 0.08% rise. On the other hand, the 24 self-funded ventures employed about 1171 employees in late 2000, while in late 2003 they had about 1024 employees, which corresponds to about a 0.13% fall. The Chi-Square value for the above table is equal to 0.85. For significance at the .05 level, the Chi-Square value should be greater than or equal to 3.84.

A conclusion is that the analysis is not able to trace a significant difference in the collective behavior of VC funded versus self-funded ventures in relation to the economic downturn of 2001. This analysis, however, is not consistent with the total employment reduction in the Austin information sector that has occurred since early 2001. Between January 2001 and January 2003, for instance, the Austin information sector suffered a loss of about 14% in its workforce. This pattern of employment reduction is discussed in more detail in Appendix C.

COMBINED DATA IN ONE FIGURE

Figure 4.15 compiles all the data in one figure. Combining all the data in one figure makes it possible to make further analysis based on all of the factors that are presented.

Figure 4.15: Combined Data in One Figure
Current Employee # is indexed in the right column (from 0 to 500).
Other factors are explained by the various numeric symbols in the left column (from 0 to 50)



Each number on the horizontal axis (1 to 75) represents an enterprise.
Owing to a software problem, the numbers in the print or PDF version of this text might be black.

SUMMARY AND CONCLUSIONS

1. This chapter describes the data collection procedures for the study.

2. The study divides the participating ventures into three groups: 1) VC funded ventures that gained VC investment when they were less than 16 months old, 2) VC backed ventures that gained VC investment when they were more than 28 months old (a gap of one year exists between the two groups), and 3) Self-funded ventures that have not received any VC investment.

3. The chapter demonstrates that between 1999 and 2000 (the Dot-Com Bubble) patterns of VC investment in the Austin software firms were unusual. During this period, the number of VC investment cases drastically increased and the age of the ventures at the time of VC investment also decreased considerably. During the Dot-Com Bubble, the VCs predominantly invested in the VC funded (Seed Stage) ventures. Since January 2001, not only the total number of VC investments has decreased drastically, but the VC investments have often been in mature ventures (VC backed ventures).

4. The chapter demonstrates that the average rate of growth (current employees number / current age of the ventures) of VC funded ventures is about 2.2 times that of self-funded ventures.

5. Initial sources of capital impact the selected styles of business plans. VC funded new ventures have a greater tendency to develop formal (classical) business plans, and self-funded new ventures have a greater tendency to develop one-page business plans.

6. Initial sources of capital deeply impact the main application of formal business plans. VC funded ventures have a greater tendency to use their formal (classical) business plans for communication with third parties. Self-funded ventures,

however, have a greater tendency to use their formal business plans for practical internal guidance.

7. The ability to implement the formal business plans is also associated with the initial sources of capital. VC funded entrepreneurs are better able to implement their formal business plans.

8. Most entrepreneurs are satisfied with their original styles of business plans.

9. The next chapter covers major conclusions and potential future studies.n

Chapter Five: Major Conclusions and Potential Future Studies

Chapter three covered the body of data analysis incorporated into this study. The chapter reviewed the following topics: 1) relationships between initial sources of capital and patterns of growth, 2) relationships between styles of business plans and sources of capital, 3) main applications of formal (classical) business plans, 4) implementation of the formal business plans, 5) patterns of business plans in the later stages of venture lifecycles, and 6) relationships between patents and growth.

Chapter Four described the major conclusions as well as potential future studies. This chapter covered the following topics: 1) formal business plans as a communication tool (suit and tie), 2) rate of growth and sources of capital, 3) growth or patents: which one comes first, 4) changing patterns of ventures in their lifecycle, and 5) corporation funded ventures by medium size enterprises.

Overall, this study has reviewed the early stages of venture development in Austin, Texas between 1990 and 2003. This time span covers a period of fast growth, a period of slow growth, a period of fast growth, and then fast decline (the Dot-Com Bubble). The 1997-2000 period has been characterized as one of unique technological, business and employment growth; accordingly, generalizing the results of this time span to other time periods or to other regions should be done with care. The distinctive characteristics of the Dot-Com Bubble (1997-2001) and the subsequent Dot-com Crash (2001-2002), however, do provide an opportunity to study the process of venture development in economic boom and bust.

MAJOR CONCLUSIONS

In conclusion, this study has pointed to the following major conclusions: 1) Formal Business Plans as a Communication Tool (Like Suit and Tie), 2) Patents also as a

Communication Tool, 3) Rate of Growth and Sources of Capital, 4) Evolution of Ventures in their Lifecycle, and 5) Corporation Funded Ventures by Medium Size Enterprises.

Formal Business Plans Mostly Act as a Communication Tool (Like Suit and Tie)

The findings of Chapter Four demonstrated that many academic studies and courses have overemphasized the role of "formal business plans" as a practical internal guide essential for venture development. Instead, formal business plans serve largely as a communication tool to secure external sources of capital, as the section on the Main Application of Formal Business Plans (Figure 3.8) demonstrated. The study has also demonstrated that VC funded ventures have a greater tendency to develop formal business plans prior to initiating new ventures than do self-funded ventures.

In this investigator's discussions with interviewees, it appeared that many entrepreneurs and venture capitalists were well aware of the deficiencies of formal business plans. One entrepreneur compared formal business plans with a "suit and tie" that one wears on formal occasions[15]. He said, "We prepared the business plan, like a suit and tie, to demonstrate that we know and follow the rules of the game." Then, he added, "When we finalized the business plan, nobody read it." The same entrepreneur also emphasized the role of the process of business planning. He said that although nobody read the final document, "thinking about the business plan helped us to clear many problems before the start up." Some venture capitalists also are aware of the limitations of formal business plans. One VC investor in an interview stated, "I am more interested to see practical Power-Point presentations." He, then added, "I am more interested in two things: market and team. I am not interested in technology[16]" This

[15] Interviewee No. 4
[16] Interviewee No. 6

venture capitalist, thus, stresses the importance of effective, well-conceived business planning. Teamwork and appropriate strategic initiatives, all of which might be implicit in good business planning, are normally absent from many formal business plans. Another interviewee said, “Everyone knows how to cook a business plan[17].”

The following case serves as an example to describe how Ken Olson, the co-founder of DEC (Digital Equipment Corporation, the famous VC funded venture) used the formal business plan to secure venture capital from AR&D in 1957. At that time, Olson was 31 years old and he had more than seven years of technical and managerial experience, but he had no experience in setting up a new venture.

> [The AR&D staff] gave us three pieces of advice: Do not use the word computer, because *Fortune* magazine said no one is making money in computers. … The promise of five per cent profit on sales in our initial presentation is not enough; raise it … so we promised ten per cent. … Promise fast results, because most of the AR&D board members were over 80. So we promised to make a profit in one year (Olson, 1987: 8, appeared in Roberts, 1991: 7).

Roberts then continues, “With the business plan thus revised to meet the investors’ stated prejudices, the AR&D board approved the investment in Digital Equipment Corporation of $70,000 for which they took 70% of the authorized stock” (Roberts, 1991: 7).

Patents also Act as a Communication Tool

Patents and growth have closed-loop relationships, and often feedback each other. Based on the data from Figure 4.12, “Growth or Patents: Which One Comes First?”, the last section in Chapter Four demonstrates that growth is a better justification for the ability to register and secure patents. Figure 4.12 also demonstrates an association between the number of patents and initial sources of financial capital. 8 VC funded ventures (40%) had patents, compared with only 3 self-funded ventures (15%).

[17] Interviewee No. 9

Considering the attention of VC funded ventures devoted to their external communication relations, as discussed under "Formal Business Plans as a Communication Tool," one can conclude that VC funded ventures may have leveraged the use of their patents as a communication tool with third parties, particularly with investors. This topic was discussed with three interviewees. One interviewee, who is a VC funded entrepreneur, indicated that he applied for patents because "patents can potentially support the efforts for the next round of capital as well as for marketing[18]". Another interviewee indicated that, from his perspective, "patents act as a deterrent force, like an Atom Bomb, to discourage would be opponents[19]". He then added, "When are you small no one cares about you. When you start to grow, you need to protect your flanks." Another entrepreneur[20] compared patents with "flagged land mines". He added, "Patents are defensive tools and you pay to expose your patents to almost everyone." He continued, "To register patents, you spend your money and disclose your technology, to protect yourself from would be competitors from a specific angle and hoping that nobody is going to attack you from that specific angle. What if nobody is going to attack you from specific angle?"

Based on a sample of 530 companies in Middlesex County, Massachusetts, Kortum and Lerner, in "Does Venture Capital Encourage Innovation?" (1998), reported the impact of venture capital on patented inventions throughout twenty industries over a span of three decades. They concluded that the, "amount of venture capital activity in an industry significantly increases its rate of patenting." This observation is indeed consistent with the findings of this study. Using a regression analysis, however, the authors concluded that "Venture capital has had a substantial impact on innovation in the

[18] Entrepreneur No. 5
[19] Entrepreneur No. 4
[20] Entrepreneur No. 9

U.S. economy" (Kortum & Lerner. 1998: 36). This conclusion, however, is biased because the authors extrapolated the observation from one county (Middlesex, Massachusetts) to the whole nation (U.S.). They also over-stretched the relationships between patenting and innovation. Innovation is broader than just technological innovation, and patents do not cover all aspects of technological innovation. As the present study demonstrates, VC funded ventures have stronger tendencies to patent and they also have stronger tendencies to pursue formal communication relationships with the external sources of capital.

Rate of Growth and Sources of Capital

The sources of capital in the early stages of the lifecycle of a new venture (VC funded versus self funded) drastically impact the rate of growth of new ventures. In their early stages, VC funded ventures grow faster than self-funded ventures. Figure 3.5 and Table 3.2, for instance, demonstrate that in this study the average rate of growth (current number of employees/current age of the venture) of VC funded ventures is about two times that of self-funded ventures.

A key factor in a realistic process of business planning is the distinction between the average rates of growth in the VC funded ventures versus self-funded ventures. In the early stages of their lifecycle, VC funded ventures potentially have a higher rate of growth, but they are also prone to fluctuations in the external investment patterns. As reported in Chapter Three, fluctuations in the external investment patterns have a stronger impact on the seed stage investments (VC funded ventures) than on later stage investments (VC backed ventures).

Evolution of Ventures in their Lifecycles

The emphasis of this study is on the development of new ventures during the early stages of their lifecycles. The structure of new ventures in the early stages of their lifecycles (as described in Chapter Three) plays a key role during later stages of development. This study demonstrates that new ventures adapt their operating pattern and behaviors, as they grow through the different stages of their lifecycles: The following patterns of adaptation were observed:

1. Changing patterns of technology, from relying on non-patented technologies to patented technologies. Self-funded ventures, compared with VC funded ventures, have a reduced tendency to register patents.

2. External investments have distinct patterns in economic booms and busts. After the Dot-Com Bubble of 1999 and 2000, venture capitalist tended to make later-stage investments (VC backed ventures) rather than early-stage investments (VC funded ventures).

Corporation Funded Ventures by Medium Size Enterprises

Existing studies on corporation funded ventures often concentrate on the internal investments of large enterprises or corporate venturing (for instance, Block and MacMillan, 1995; Bhide, 2000). The characteristics of corporation funded ventures in medium size enterprises have rarely been reviewed. It appears that the studies on corporation venturing assume that corporation funded ventures by medium-size enterprises are not significant and they behave like corporation funded ventures by large enterprises. This study, in contrast, demonstrates that corporation funding by medium-size enterprises, from the standpoint of business planning and their approach toward registered patents, share many commonalties with self-funded ventures.

SUGGESTED FUTURE STUDIES

In conclusion, this study pointed to the needs for further in-depth studies in the following areas: 1) The Valley of Death, 2) The Process of Business Planning, 3) Personalities of Self-Funded Entrepreneurs versus VC Funded Entrepreneurs, and 4) Role of Luck and Serendipity in Venture Development, 5) MBA Courses on Innovation and Entrepreneurship, and 6) The Study of the Near-Failures.

The Valley of Death

The period after the start-up of a new venture and before it reaches a sustainable break-even point—where the new venture gains sustainable positive cash flow—also is called the *Valley of Death*[21] (the Fledgling stage). The Valley of Death contains a very high mortality rate, as many ventures are not able to cross sustainable break-even points and then become visible players on the enterprise landscape. Reugg and Feller in *A Toolkit for Evaluation of Public R&D Investment* make the following statement, which supports the need for further study of the "Valley of Death":

> Findings from two studies reinforce the view that there is a "Valley of Death" where insufficient funding for early stage, high-risk technologies exists despite large inflows of private ventures funding (2003: 136).

After successful ventures pass the break-even point and they grow up to become visible and traceable, they are beyond the Valley of Death stage. An interviewee[22] referred to the Valley of Death (Fledgling stage), as the "Ghost Stage," as the ventures in this stage are almost invisible! Another interviewee[23] called the Fledgling Stage (the Valley of Death) the "Under the Radar Stage." There exists a challenge and a paradox in the study of ventures in the Valley of Death (the Fledgling stage): when new ventures are

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[21] The Valley of Death is discussed as part of the *Bio-Organizational Lifecycle* model in Appendix D.
[22] Entrepreneur No. 9
[23] Entrepreneur No. 1

in the Valley of Death, typically they are not traceable (they are under the radar), and when ventures are grown up and traceable, they are no longer in the Valley of Death (the Fledgling stage). The study of the Valley of Death is likewise a potentially fruitful topic for future research.

The Process of Business Planning and Action Plans

In Chapter Three this study referred to the distinction between "formal business plans" and the "process of business planning." The process of business planning is a creative and complex attempt to envision and map the potential trajectory of a business and tends to be unique for each firm. The process of business planning for a new venture should provide a real plan of action and survival kit for entrepreneurs on how to prepare themselves for the challenges of the early stages of venture development–the Inception and Fledging stages. The process of business planning should lead to action plans rather than formal plans. Drucker indicates that Napoleon allegedly said, "No successful battle ever followed its plan." Yet Napoleon also made action plans for every one of his battles (Drucker, 2004: 60).

The process of business planning is influenced by the founders' personalities, potential initial sources of capital, how to develop and improvise proper survival strategy, and how to find proper paths to cross the Valley of Death. A key observation of this study is that the process of business planning is an important, but relatively un-explored topic.

Personalities of Self-Funded Entrepreneurs versus VC Funded Entrepreneurs

The section of Personalities of Entrepreneurs (in Chapter Three) referred to the key role of human resources and the personalities of the founders in the process of new venture development. Human resources in this study are a semi-charted area. The same chapter also demonstrated the key role of the initial sources of financial capital (VC funded versus Self funded) in the styles of entrepreneurship, and the patterns of growth and development of new venture. As the study continued, it became more evident that the personalities of the founders and the styles of entrepreneurship are inter-connected. As one interviewee indicated, self-funded entrepreneurs and VC funded entrepreneurs are like "two different types of animal[24]."

It would be interesting to integrate the role of founders' personalities in the patterns of growth and development, and this would be a fruitful topic for future research. In the case of VC funded ventures, not only the personalities of the founders, but also the personalities of their VC investors, as well as the culture, organization, and priorities of the VC investment firm might also impact the growth patterns of new ventures.

Role of Luck and Serendipity in Venture Development

In venture development luck plays a key role. New ventures, by their nature, deal with uncertainty and the unknown. Some successful ventures chance upon an attractive long-term formula quickly, while others encounter several false leads first. Some unlucky ventures die in their early stages even though they might have had promising prospects. Interviewee No. 2, a VC investor, underlined the role of luck in the process of venture development and stressed the risky nature of new venture development. Accordingly, the role of serendipity and luck in venture development appears to warrant the need for future investigation.

There are interesting connections to be made in the study of the process of business planning and the study of the Valley of Death stage, the role of personalities of self-funded versus VC funded entrepreneurs, and the place of luck and serendipity in venture development.

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[24] Entrepreneur No. 9

Courses on Innovation and Entrepreneurship

Formal business plans have taken on such a large role in the financing of start-up and early-stage firms that many "how to" books have been written on the subject. Many, if not most, university "entrepreneurship" courses are dominated by the preparation and evaluation of formal business plans. Yet, as Roberts indicates, "Little objective analysis has been done on their contents or impact on investor decision making" (Roberts, 1991:198). Many educational programs appear to have a tendency to underplay the essential role of self-funded ventures and to overemphasize the need for securing external capital. Executive master's and MBA programs, however, should address the deficiencies and limitations of the formal business plans, as well as the role of the process of business planning in venture development. A proactive course on innovation and entrepreneurship might also give due attention to the Fledgling Stage (The Valley of Death) compared to the Adolescence Stage (Growth Stage) and initial sources of capital[25].

The Study of the Near-Failures[26]

New ventures in their Fledging stages face challenges that could lead to their demise. Bill Gates, for instance, describes the fatal event in the Fledgling stage of Microsoft:

> In 1975 Microsoft started out in Albuquerque, New Mexico. MITS (located in Albuquerque) was the first company to sell an inexpensive personal computer to the general public. In return for the software, MITS gave Microsoft royalties and office space during the first year. But after MITS was acquired by another company, it stopped paying. We had no income for a year and were basically broke. …

[25] A proposed course entitled "Innovation Commercialization and Entrepreneurship," developed by the present researcher, addresses some of the topics discussed in this section. The proposed course, however, still needs further elaboration.

[26] The concept of "Near Failure" is from Dr. Robert Ronstadt, who introduced it to the present author.

> After that episode, Microsoft has been perpetually cash flow positive. In fact, I developed a rule: We always have to have enough cash on hand to be able to run the company for at least a year even if no one pays us. The MITS experience, suddenly having no income, made me conservative financially, a trait that persists to this day (Gates, 1996: 44).

The above description demonstrates that even Microsoft passed from a stage of near-failure in its early stage of development. In 2003, Microsoft had accumulated more than $50,000,000,000 cash in reserve. Apparently Microsoft has institutionalized its early experiences of near-failure.

As part of the interviews for this study, the entrepreneurs were asked about any early- or near-failure episodes. One interviewee[27] referred to the unexpected departure of a technical partner that could have led to the failure of the whole venture.

There exist potential links between the ability to surpass the early failures and the survival strategies in the Fledgling stage of new venture development. It appears that new ventures that followed an aggressive growth strategy could not tolerate an early stage failure. In an aggressive growth strategy an early stage failure may lead to a total collapse, like a failing rocket after lift-off. On the other hand, pursuing a slow growth and under-the-radar strategy may give new ventures a better chance to cope with their early stage failures, although they may face more challenges later due to lack of capital.

[27] Entrepreneur No. 3

Epilogue

In conclusion, this study indicates that styles of entrepreneurship, based on initial sources of capital, are critical in the evolution of new ventures. New ventures, according to their initial sources of capital, were organized into three main groups: self-funded (internal sources of capital), VC funded (external sources of capital), and corporation funded. In relation to external sources of capital, it can be noted that *when* new ventures receive venture capital investment appears to be very important. In the case of VC funded ventures, which receive venture capital in the *early* stages of their lifecycle, the funding has a fundamental and durable impact on the behavior of the venture, its *modus operandi*, and its patterns of growth. It is, however, somewhat surprising that the overall rate of growth of these VC funded enterprises is only twice as fast as that of their self-funded cohort enterprises. A common perception has been that VC funded ventures grow up to ten times faster than self-funded ventures. This common perception appears to be an illusion.

The findings of this study suggest the need to devote proper attention to the diverse behaviors of self-funded and VC funded ventures, since they each follow distinctive patterns of growth. Self-funded ventures often proceed cautiously and try to grow in accordance with their limited resources, in an evolutionary fashion. VC funded ventures may follow more ambitious patterns of growth, depending on the amount of initial capital at their disposal. Some VC funded ventures are able to leapfrog the Valley of Death, and grow like "precocial birds[28]." But the presence of capital does not guarantee long-term sustainability. The availability of abundant initial capital might be

[28] "Precocial birds" are relatively mature at birth, and they are capable of moving around on their own soon after hatching.

associated with unrestrained spending. Those self-funded enterprises that are able to cross the *Valley of Death* appear to have a relatively high degree of resilience and survivability.

Additionally, many MBA educational programs appear to have a tendency to underplay the essential role of self-funded ventures and overemphasize the need for developing formal business plans and securing external capital. Likewise, many business incubators might follow the same pattern of underestimating the key role of self-funded ventures and over emphasizing the role of formal business plans. Accordingly, many MBA programs and business incubators might not really help new ventures survive their perilous journey through the *Valley of Death*.

Throughout the study, this researcher noted that the common perception about the role of *new technology* in the early stages of venture development also appeared to be misleading. While new technology does appear to assume a more critical role in the latter stages of enterprise development, its contributions to the early stages of development of new ventures appears to be overrated. Various monographs devoted to the central role of new technology in the initial stages of enterprise development need to be read critically. Other factors, such as prudent organization, sound management, and marketing innovation, perhaps, appear to fulfill equally important roles.

All in all, innovation covers a broad conceptual arena, and one that extends far beyond technological innovation. In this study, the truly innovative enterprises were successful in integrating organizational, human resources and marketing innovation with their technological thrusts. These innovative enterprises also regarded their R&D (Research-and-Development) and patent undertakings as *components* of their broad innovative endeavors. These broadly innovative enterprises also appeared to possess a penchant for sound, methodical, and sustainable managerial operations, with an eye to evolutionary growth. It is noteworthy that some exemplary self-funded enterprises were able to cross the Valley of Death, adapt to the changing conditions in a relatively evolutionary way, and to survive and flourish.

Appendix List

Appendix A -
The Conceptual Structure

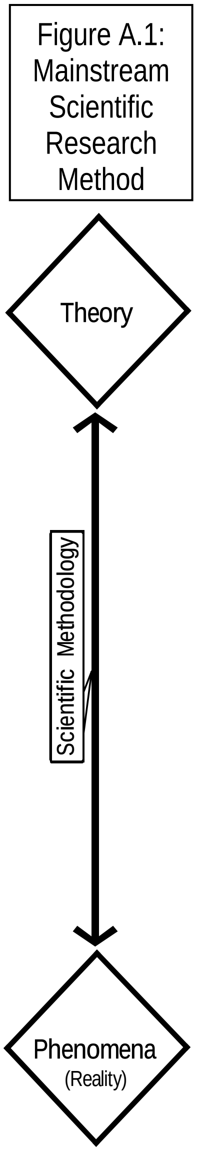
The conceptual structure of this study consists of the methodology, models and theories. The theoretical base of the study—the *Resource-Based View***—**has been reviewed in Chapter Two. This section (Appendix A) includes a brief review of the methodological approach and the models for the study. The section begins with a description of the *Model-Based* method.

In accordance with the *Model-Based* method, this study regards modeling as a key tool for developing creative concepts and explicating new relationships. Unlike some other studies that do not explain the models that they use, this study explicates the models used. Two models are directly used in this study: the *Innovation Navigation* model and the *Bio-Organizational Lifecycle* model. The two models, however, are based on the foundation of other models, which are described in the appendix. This section demonstrates that changing the structure of models allows new venues to emerge.

THE MODEL-BASED METHOD

Mainstream academic research methods often are concerned with the procedures for developing theories by "specifying relationships among variables, with the purpose of explaining and predicting the phenomena" (Kerlinger, 1973: 9). The efforts of the mainstream academic research methods to make direct connections between theory and phenomena are depicted in Figure A.1.

Andrew Van de Ven in *Professional Science for a Professional School* (Van De Ven, 2000) articulates the *Diamond Model for Professional Science* with four bases: *Phenomena* (Reality), *Model*, *Theory* and *Application* (Solution.) A distinction between theory and model is one of the most important characteristics of the Diamond model,



which also depicts four main relationships among the above bases: 1) phenomena and model, 2) model and theory, 3) theory and application, and 4) application and reality.

Additional relationships can be articulated in the context of the Diamond model that provides the foundation of the *Model-Based Methodology*: A relationship "between phenomena and theory" and another one "between model and application." Compared to the analytic research methodology of science, which connects phenomena and theory, one can imagine design as a synthetic methodology for art, technology, and management that connects model and application.

A paradigm consists of a *grand model,* which defines the framework for the study, and a *validation method* that justifies which behaviors are accepted in the context of the paradigm and according to the model. It is important to note that academic scholars and practitioners use two distinct paradigms, or "frames of reference", according to Shrivastava & Mitroff (1984).

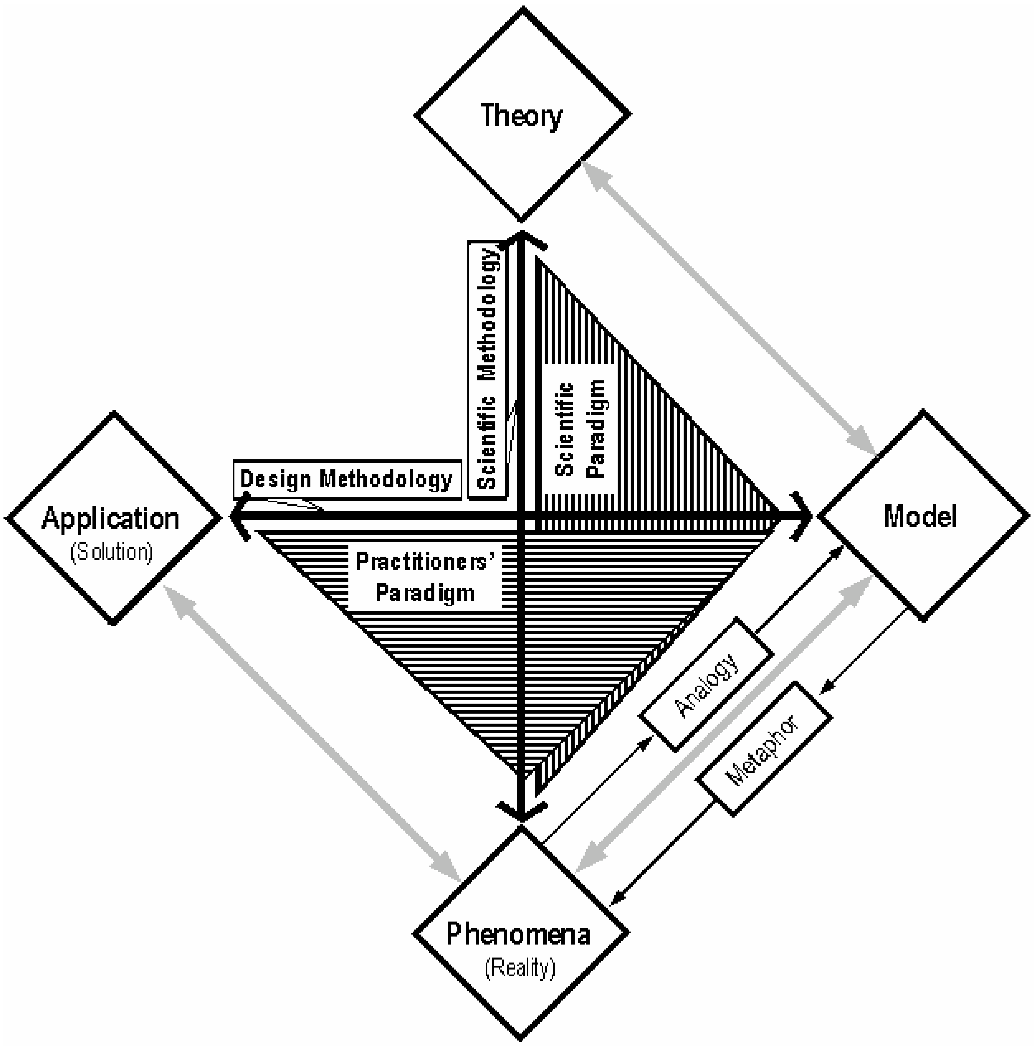
In the context of the Diamond model, two types of paradigms are distinguishable: 1) the *Academic (Scientific) Paradigm* and 2) the *Practitioners' Paradigm*. The *Academic Paradigm* consists of the triangle of phenomena (reality), model, and theory by using scientific methodology and aims to develop new theories. The *Practitioners' Paradigm* consists of the triangle of phenomena (reality), model, and application by using design methodology and aims to develop new solutions and applications.

The combination of the two paradigms, the Academic (Scientific) Paradigm and the Practitioners' Paradigm, demonstrates that there is a natural gap between theory and practice. A direct connection (bridge) between theory and practice still does not seem pervasive, although it has often been advocated. Indirect connection between theory and practice via models, offers a challenging possibility. Such connections between theory and practice, where models play a pivotal role, may require new conceptual frameworks beyond conventional scientific research methods. Theoreticians often claim, "there is nothing more practical than a good theory." Some practitioners reply, "in theory there is nothing more practical than a good theory. In practice this is just a theory." Creating synergies between the two paradigms of scientists and practitioners is essential to establish better connections between theory and practice.

The relationship between phenomena (reality) and model is not necessarily a straightforward procedure, but metaphor and analogy can facilitate the explication of the relations between model and phenomena. It can be argued that metaphor and analogy work somewhat differently in relation to a model (or a concept); metaphor is used mainly to "explain" the relationship and analogy to "explore" a new relationship. In this context, metaphor can be perceived as a stage from model to phenomena, and analogy a stage from phenomena to model.

The integration of the above relationships (original Diamond model, scientific and design methodologies, analogy and metaphor, and scientific versus practitioners' paradigms) provides a new methodological approach, here referred to as the Model-Based method (see Figure A.2). This approach is apparently more flexible than the mainstream scientific research method (Figure A.1), which concentrates on the direct links between theory and phenomena (reality). The Model-Based methodology, however, covers the main aspects of the mainstream scientific research method. This approach is called the *Model-Based* method in order to underline the key role of models in integrating scientific and practical studies.

Figure A.2: The *Model-Based* Method



The analytic-scientific methodology has deeply impacted the disciplinary structure of the sciences[29]. By integrating the scientific and design methodologies, however, the *Model-Based* methodology can be used in disciplinary, interdisciplinary, and cross-disciplinary studies. When the knowledge of scientists and practitioners is combined, it could produce a dazzling synthesis that profoundly advances both theory

[29] See "A Brief Study of the Cartesian (Analytic) Method" in this Appendix.

and practice. The desired synthesis, however, does not occur according to linear procedures that almost always proceed from theory to practice.

In earlier papers, the Model-Based methodology was referred to as the Grounded Model methodology. This name change reflects the independence of the Model-Based methodology from the Grounded Theory methodology. In this section only the main characteristics of the Model-Based methodology were discussed. Details of the conceptual background behind the Model-Based methodology are available at “Bridging Theory and Practice, a Dilemma,” Mahdjoubi (2002).

CETERIS PARIBUS AS A PREMISE

Ceteris paribus is a Latin term, which often has been translated as "all else being equal." To demonstrate the key role of *Ceteris paribus* (all else being equal) as a premise, two world maps are compared. Figure A.3 is a map of the world drawn in 1544 by Batista Agnese. Apparently this map is not yet complete, as it demonstrates the existence of vast uncharted areas, left blank, in North America and Central Africa. The uncharted areas were indeed vital for the next rounds of exploration. In spite of the vast uncharted areas, the above map provides a fairly comprehensive view of the World in a new projection. By depicting the scope of the uncharted areas, the cartographer's premise was not *ceteris paribus* "all else being equal."

Figure A.3: A Map of the World Drawn in 1544

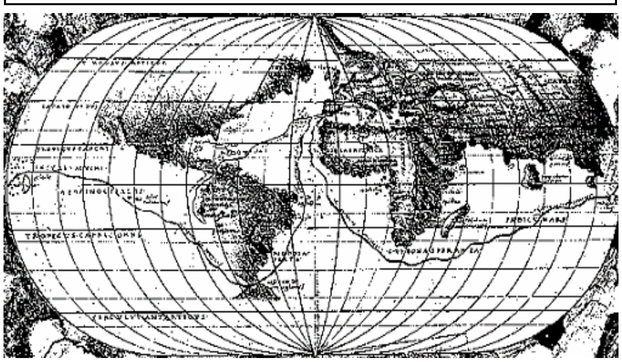


Figure A.4 is a map of the world drawn in 1363 by Ranulf Higden. The Mediterranean Sea covers the left, and the Red Sea and Mesopotamia are on the right side of this map. Following the dominant belief of that time, the world is depicted as flat and the Holy Land, by intention, is located at the center of the map. This map includes almost no uncharted area. The cartographer's premise was likely *ceteris paribus*.

Figure A.4: A Map of the World Drawn in 1363

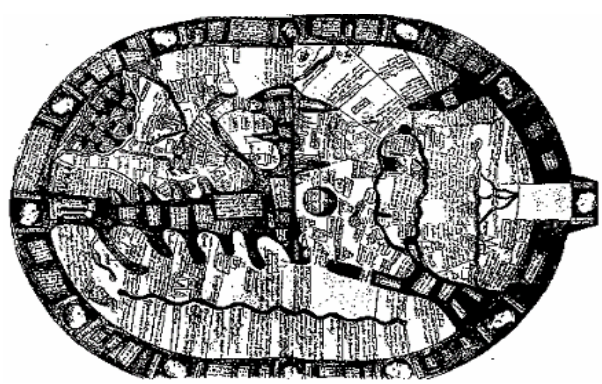


Figure A.5: Evolution of the Map of the World

Diagram No. 1 shows part of a Roman road map of the 1st century AD. This road map depicts the routes between the major cities of the Roman Empire and the approximate distances along the roads. As the cartographer lacked an overall vision of the shapes of land and sea, these masses are distorted almost beyond recognition. In this part of the road map, North Africa and the Mediterranean Sea are located in the lower section. The middle section covers part of Italy (the city of Rome in the middle), and Adriatic Sea and Balkans are shown in the upper section.

Diagram No. 2 is the Map of the world drawn in 1363 by Randulf Higden. Mediterranean Sea covers the left, Red Sea and Mesopotamia are in the right side of this map. Following the dominant belief of that time, the World is depicted flat and the Holy land located at its center. This map is primarily a representation of some territories in the Old World. There is no scale in this map, and naturally no measurement is possible to be based on it.

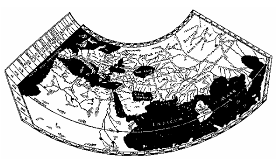


Diagram No. 3 is the map of the world drawn in 1520. Persian Gulf and Caspian Sea are located almost in the middle of this map. Mediterranean Sea covers the left side, and North Africa and North Indian Ocean occupy the lower part of this map. Although the knowledge of Asia, Africa and Indian Ocean is vague and fanciful, this map has a relatively accurate knowledge of the contours of the Mediterranean coastline. This map is based on the writings of the Greek geographer, Ptolemy, who lived around 150 AD. Ptolemy was the first to use a system of regularly spaced coordinates on maps to be used as a type of scale.

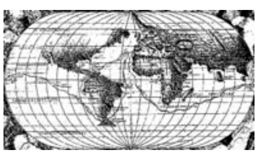


Diagram No. 4 is the map of the world drawn in 1544 by Batista Agnese. America has been inserted to the world map, however Australia and Antarctica are still terra incognita. The undiscovered areas in North America and Central Africa have been left unmarked. The Magellan's voyage, who for the first time circumnavigate the globe, is marked here. This map, which looks to Earth as a sphere rather than a flat subject, is based on presentation of a systematic scale to make measuring possible.

Diagram No. 5 is the map of the world drawn in Robinson projection. This map depicts what we commonly consider as the 'World'. Although this map may include a scale, which makes the comparison of different regions possible, its measurement for navigation is inaccurate.

Diagram No. 6, the map of the world in Mercator projection, is the widely used navigation chart. In this projection the longitudes are parallel vertical lines and the latitudes are parallel horizontal lines. By drawing a straight line between two points and using a compass, a navigator can determine the sailing direction between those points. The distances can be measured directly and easily. This map, named after its designer Gerardus Mercator, has been considered the masterpiece of navigational charts since its development in the 17th century.

Diagram No. 7: The Earth as seen by the Apollo 17 astronauts, 1972

To corroborate the “premise” and the “intention” of the map, in Figure A.4 the cartographer depicted the Nile, for instance, from west to east, rather than from south to north. Depicting the Nile from south to north, which was known then, would have exposed vast uncharted areas in Central Africa, and moved the center of the map southward. Figure A.3 and Figure A.4 are indeed two maps from “The Evolution of the Map of the World,” Figure A.5, which demonstrates the evolution of the major world maps and brief conceptual premises behind each one.

A BRIEF STUDY OF THE ANALYTIC METHOD AND CARTESIAN APPROACH

Epistemology in philosophy is the study of the theory of knowledge, which goes back to ancient Greek, but philosophy by itself can be traced back to 2000 BCE in ancient Near East. Since the 17th century a main issue in the epistemology of Western philosophy, however, has been rationalism versus empiricism. Rationalism claims that knowledge can be obtained deductively by reasoning and empiricism says that knowledge can be attained inductively from sensory experiences. René Descartes, a French rationalist philosopher, argued that the main source and final test of knowledge was deductive reasoning based on self-evident principles, or axioms (Nonaka 1995). Descartes in *Discourse on Method* (1637) indicated the foundation of the analytic (scientific) method, as follows:

1. Accepting only what is clear in one’s own mind, beyond any doubt.
2. Splitting big problems into smaller ones.
3. Arguing from the simple to the complex.
4. Checking when one is done.

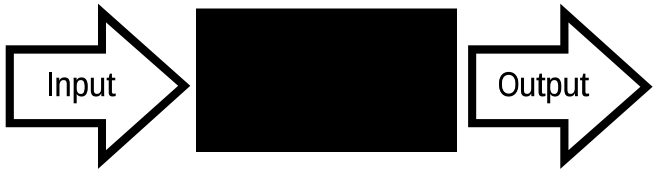
“Splitting big problems into smaller ones” is indeed a pillar of the analytic (Cartesian, scientific) method, as the term “analysis” (*dissolving* in Latin) indicates. Capra in *The Turning Point* (1983) explains that the essence of Descartes’ approach is the analytic method of reasoning, which consists in breaking up phenomena into pieces. Accordingly, this approach has become an essential characteristic of modern scientific thought and has proved extremely useful in the development of scientific theories. Capra then argues that “overemphasis on the Cartesian method has led to the fragmentation that is characteristic of both our general thinking and our academic disciplines and to the widespread attitude of reductionism in science—the belief that all aspects of complex phenomena can be understood by reducing them to their constituent parts” (1983. 59).

Descartes’ work, along with that of Galileo, Newton, Bacon, and others, established the analytic-scientific approach towards knowledge. Galileo was a pioneer in combining experimentation with the use of mathematical language. Capra indicates that the conceptual framework created by Galileo and Descartes was completed by Newton, who developed a consistent mathematical formulation of the mechanistic view of nature. From the second half of the 17th century to the end of the 19th century, the mechanistic Newtonian model of the universe dominated all scientific thought. The natural sciences, and to a large extent the humanities and social sciences, accepted the mechanistic view of the classical physics as the correct description of reality and modeled their own theories accordingly (Capra, 1983).

THE BLACK BOX MODEL

The *Black Box* model (Figure A.6) has been used, as a base model, in many studies and disciplines. The Black Box model consists of three main sections: 1) *Input*, 2) *Output*, and 3) *Function* (Process). The Black Box model assumes that *Functions* have fixed structures that do not change much over time, and that *Functions* predictably convert the *Inputs* into the *Outputs* over and over again. If we can find the rule of a *Function* one time, then it is applicable indefinitely, and we can predict the behavior of the *Output* by knowing the *Input* and *Function*.

Figure A.6: The *Black Box* Model



Science in Action (Latour, 1987) describes the key role of the Black Box model in the process of science and technology development. Latour indicates "the word *black box* is used by scientists whenever a piece of machinery or a set of commands is too complex. In its place they draw a little box about which they need to know nothing but its input and output" (Latour, 1987: 2). Anderson and Hosking (1992) also make a reference to challenges of "theorizing relational processes in ways which do not rely on the traditional input-output model of organizations as entities" without explicating the Black Box basis of the "input-output model." They claim "in contrast to the traditional perspective, what emerges is, in principle, not predictable or designable" (Anderson & Hosking, 1992: 3).

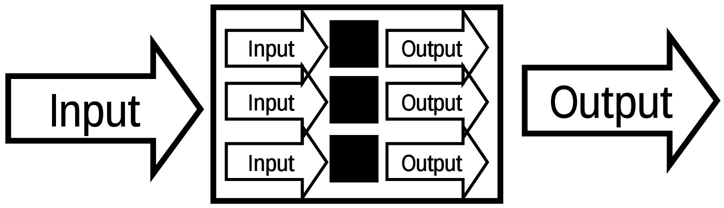
The Black Box Model and the Cartesian (Analytic) Approach

The Black Box model is consistent with the Cartesian (analytic) approach of "splitting big problems into smaller ones[30]," and *ceteris paribus*[31] "all else being equal." Accordingly, each system is inside a super-system (environment) and it may contain many sub-systems, each one independent from the others. Consequently, the Black Box model assumes that the system under study is inside a super-system, and that the system under study can be (and indeed, is) separated from any other parallel systems (*ceteris paribus*). Inside a Black Box system there might be other sub-systems, but they also behave as a series of baby (mini) Black Boxes, and they are separable from each other.

[30] See "A Brief Study of the Cartesian (Analytic) Method" in this Appendix

[31] See "*Ceteris Paribus* as a Premise" in this Appendix.

Figure A.7: The *Black Box* Model
and the Cartesian (Analytic) Approach



The Black Box Model and the Mathematical Function

The Black Box model also is consistent with the analytic scientific research method of linear causality and dependent and independent variables: **Input = independent variable** or **cause**, and **Output = dependent variable** or **effect** (Figure A.8). Theories that look for linear structures and "linear cause and effect" propositions follow a Black Box model, although many may not articulate the Black Box as their base model.

Figure A.8: The *Black Box* Model and the Mathematical Function

The Black Box model has extensive applications, for instance in mathematical modeling. Function (**f**) in the mathematical relationship of **Y** = **f** (**X**) is a representation of the role allocated according to a Black Box model to convert the **Input** (**X**) into the **Output** (**Y**). Bennett and Briggs, in *Using and Understanding Mathematics*, state it thus:

> It may be helpful to think of a function as a box with two slots, one for input and one for output. A value of the independent variable can be put into the box through the input slot. The function inside the box operates on the input and produces the corresponding value of the dependent variable, which appears as output from the box. A function describes how a **dependent variable** changes

> with respect to one or more **independent variables**. When there are only two variables, we often summarize them as an ordered pair with the independent variable first: (independent variable, dependent variables). We say that the dependent variable is a **function** of the independent variable. If x is the independent variable and y is the dependent variable, we write the function as: Y = f (X) (2002: 500).

The Black Box model, although very useful, is not a universal model that is always applicable to everything; nonetheless many academic and practical studies have assumed that it is. While the Black Box model may provide useful simulations for most material and energy transformations, the Black Box is not the model of choice for creative phenomena such as knowledge generation and innovation. A Black Box model—that predictably transforms Inputs into Outputs—cannot fully simulate human creativity, because a creative mind is able to provide unpredictable outcomes. Thus, we face a challenge and paradox: the Black Box model does allow us to explicate creative and generative phenomena; however, without the Black Box, we could be disconnected from the Cartesian (analytic) approach which indeed is based on the Black Box model and has been the pillar of the scientific method.

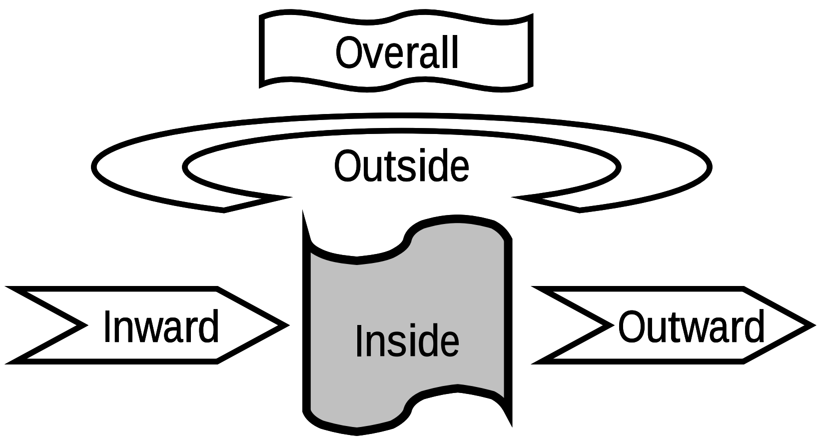
THE GRAY BOX MODEL: AN ALTERNATIVE TO THE BLACK BOX MODEL

To remedy the shortcomings of the Black Box model in dealing with the creative characteristics of innovation, this study proposes a new configuration called the *Gray Box* model (Figure A.9). This name is used to emphasize the transparency of this model in contrast to the opacity of the Black Box model. The Gray Box model consists of five sections: 1) *Inward*, 2) *Outward*, 3) *Inside*, 4) *Outside*, and 5) *Overall*.

Using the terminology of the systems approach, a Gray Box system may include many baby Gray Boxes, but they interact with each other. The relationships among the Gray Box systems are not necessarily linear, hierarchical, and predictable. The interactions among Gray Box systems are complex, but they are not random or chaotic.

In a Gray Box system, the transformation process may change due to the interactions inside the Gray Box system, as well as the interactions that the Gray Box system has with the Outside and other parallel Gray Box systems.

Figure A.9: The *Gray Box* model



The structure of the Gray Box model was described first in the following paper: *Using the Gray Box Model to Explore the Relationships Between Knowledge Management and E-Business* (Mahdjoubi and Tomak, 2001). This study uses the *Gray Box* as a base model to articulate the process of venture development and innovation. The Gray Box model is distinct from the famous *Black Box* model that has acted as a base model in numerous academic studies and disciplines.

THE GRAY BOX MODEL VERSUS THE BLACK BOX MODEL

The Gray Box Inward and Outward sections are similar to the Black Box Input and Output sections. The terms Inward and Outward, however, imply flow and movement. The Gray Box Inside section is comparable to the Black Box Function factor. Unlike the fixed Function factor, the Inside section is able to change and evolve. The changing characteristic of the Inside section affects the transformation process between

Inward and Outward. The Gray Box Outside section is comparable to the Black Box environment, but the Inside and Outside sections may have interactive relationships. As such, the Outside system can transform the nature of the Inside section (for example natural evolution), which then changes the conversion of Inward into Outward. On the other hand, the Inside also may change the behavior of the Outside system (for example, pollution). The Gray Box Overall section integrates the interactions among the other four sections. The Overall section is used to integrate the interactions among the different sections of the goal-seeking and proactive-organizing entities, which will be discussed later in this appendix. Deliberate change of the Overall section is used in strategy development. Using computer science terminology, the Gray Box model is reverse-applicable to the Black Box model. For instance, if the Inside section does not change, and if a given phenomenon is isolated from Outside, then we will have a simple Black Box.

A main conclusion of this section is that the analytic method, Cartesian approach, and causal relationship are pertinent to the study of phenomena that can be presented by a Black Box model and in the condition of *Ceteris Paribus* as a premise. The Black Box model, however, is not able to present the creative characteristics of innovation and knowledge generation. Accordingly, researchers may need to develop new models as well as new non-analytic methodologies and non-Cartesian approaches to study the processes of innovation.

CLASSIFICATION OF ENTERPRISE ACTIVITIES

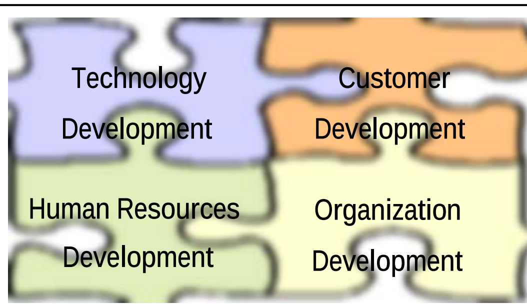
The Gray Box model is used to make a new classification for enterprise activities. Looking at an enterprise as a system for the flow and process of knowledge (Nonaka, 1995), the activities of an enterprise can be categorized into four major groups: 1) *Technology,* 2) *Customers/Market,* 3) *Human Resources (People)* and 4) *Organization*.

The four major groups of enterprise activities (Technology, Customer/Market, Human Resources and Organization) are classified in a linear and sequential format. These four groups of enterprise activities are compatible with the Gray Box model.

- **Technology** acts like the **Inward** section,
- **Customer/Market** is related to the **Outward** section,
- **Human Resources** (People) hold the **Inside** section, and
- **Organization** covers the **Overall** and **Outside** sections.

Similar to the Gray Box model, the interactions between the four major groups of enterprise activities (Technology, Customer/Market, Human Resources and Organization) are non-linear. The four major groups of enterprise activities interact with each other like the pieces of a puzzle, as depicted in Figure A.10: The *Enterprise Activities* Model. In addition the above four major groups may change their position. For instance, the feedbacks of customers, may act like a new technology.

Figure A.10: The Enterprise Activities Model

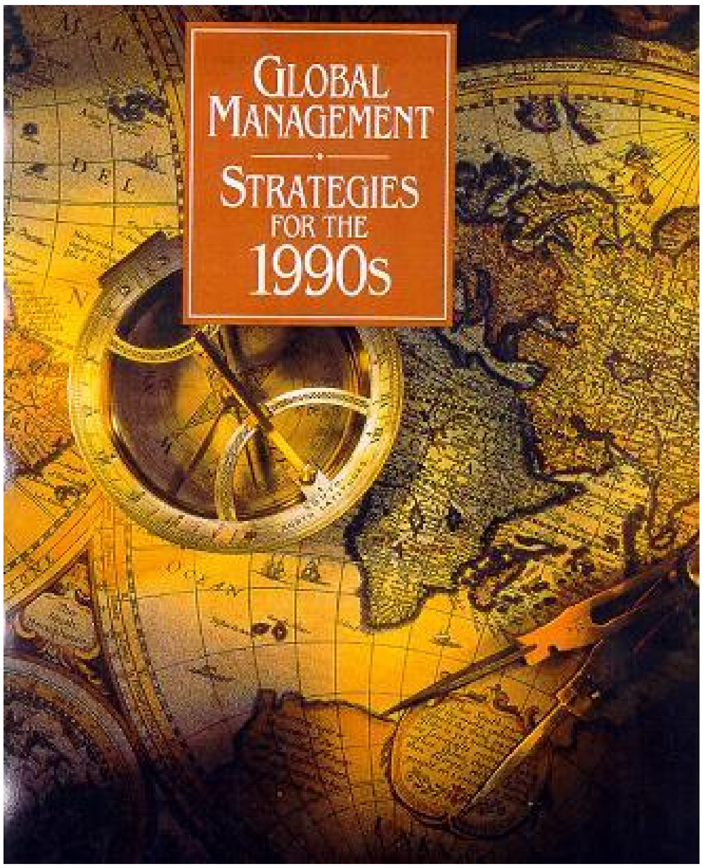


As discussed before, the Gray Box model is reverse-applicable to the Black Box model. By using a Black Box model, the main enterprise activities will be confined to Technology and Customer (Market). One could argue that the studies that confine strategy to technology and market are indeed based on a Black Box view for enterprising, although they rarely articulate the Black Box as their base models.

The *Enterprising Activities* model (Figure A.10) looks at the major enterprise activities in the context of their present (current) situations. We need to integrate the role of "decision-making for the future" and "performance metrics of the past" into the above model to make it more practical. The *Enterprise Navigation* Model (next section) tackles this challenge.

THE ENTERPRISE NAVIGATION MODEL

Figure A.11: *Fortune*, July 26, 1993 Cover Page

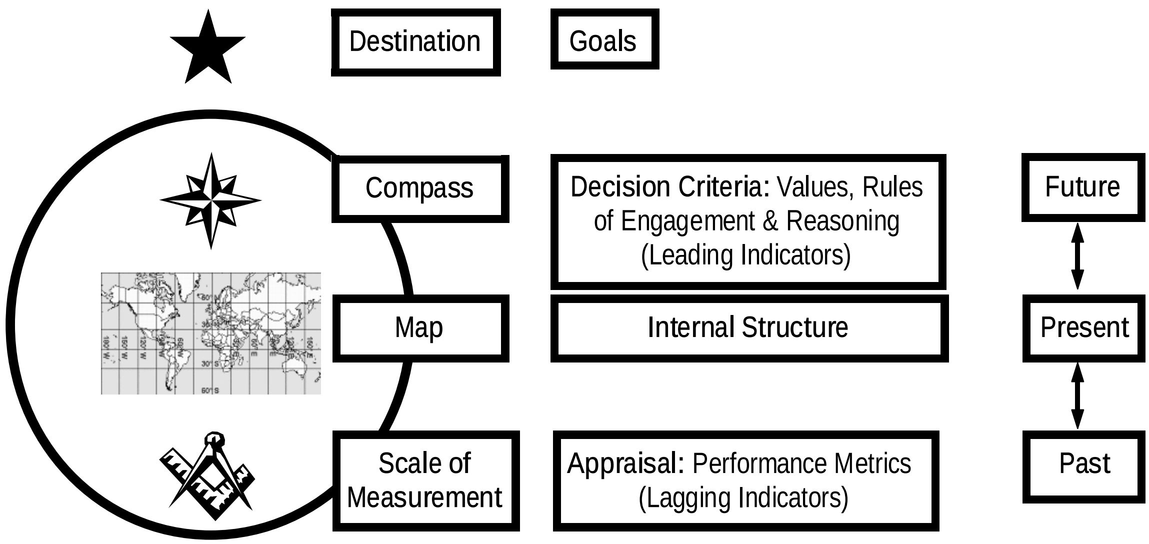


The metaphor of navigation often has been used to explain management concepts and ideas. For instance, the July 26, 1993 issue of *Fortune* magazine includes a special section on strategy, which includes a picture of a map, a magnetic compass, and a divider (Figure A.11). *Fortune*, however, does not elaborate potential interrelations between the two systems: "navigation" and "global management." The picture acts like a simple metaphor. In addition, the metaphor of navigation has been used in the title of a wide range of books, such as *Navigating Complexity* (Battram, 1998), *Navigating Change* (Hambrick et al. 1998), and

Strategy Safari (Mintzberg et al. 1998). Amidon & Mahdjoubi (1999) elaborate a structured view on the application of the navigational analogy to business strategy.

Intellectual Capital (Edvinsson, 1997) uses the *Knowledge Navigator* as a metaphor to explain the management of Intellectual Capital, which refers to the efforts to explain the role of knowledge in business performance metrics and a new style of financial analysis. *Corporate Longitude* (Edvinsson, 2002) further extended the metaphor of navigation to articulate the role of Intellectual Capital (analogous to longitude) compared with conventional financial analysis (analogous to latitude).

Figure A.12: Enterprise Navigation Model



Longitude is the angular distance on the earth's surface, measured east or west from the prime meridian at Greenwich, England. Latitude is the angular distance north or south of Earth's Equator. Cartographers and navigators locate geographic locations by marking their latitude and longitude.

The Enterprise Navigation model uses the analogy of navigation to develop a new model that is able to explain the management of goal-seeking and proactive-organizing business entities. Navigation is based on three fundamental tools: 1) Compass, 2) Map, and 3) Scales of Measurement. Compass, Map and Scales of Measurement employ interactive relationships with the future, present, and past.

The management of goal-seeking and proactive-organizing entities require three sets of fundamental tools: 1) decision criteria: values, rules of engagement, and reasoning, 2) internal structure and communities of practice, and 3) appraisal. Decision Criteria, Internal Structure, and Appraisal, similar to the Compass, the Map, and Scales of Measurement, have interactive and continuous relationships with the future, present and past. An analogous comparison among the above parallel sets explains the *Enterprise Navigation* model, as depicted in Figure A.12.

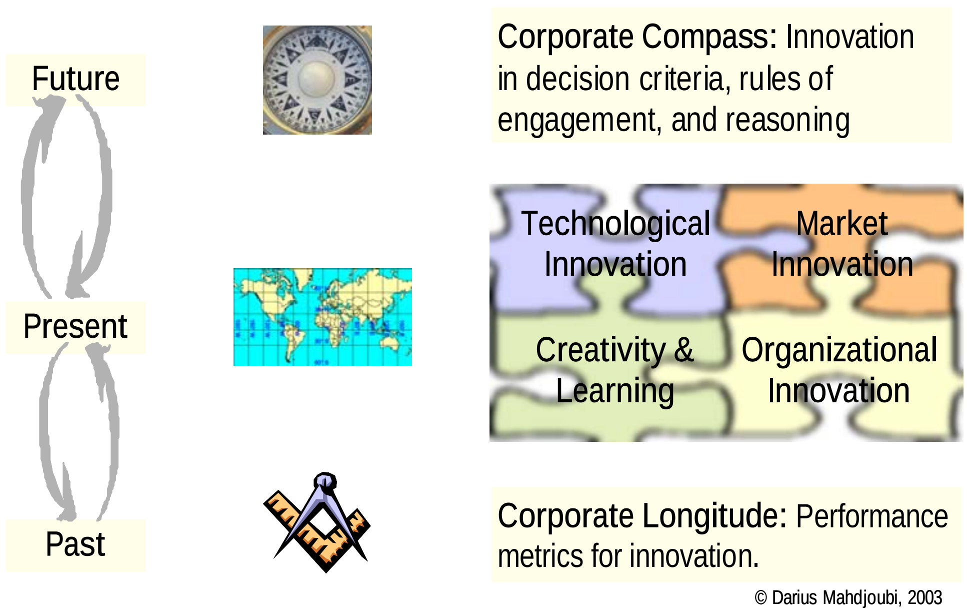
In the Enterprise Navigation model, decision criteria (values, rules of engagement, and reasoning) are like a compass directed towards the future. 2) The internal structure and communities of practice are similar to maps that are directed towards the present. 3) Appraisals are like scales of measurement that let us quantify past achievements. In addition, Goals in management are comparable to Destination in navigation. In the earlier stages of this study the Enterprise Navigation model was referred to as the *Knowledge Navigation* model.

The structure of the Enterprise Navigation model is described further in *Knowledge Sensitive Performance Metrics* (Harmon and Mahdjoubi, 2001). An early description of the Enterprise Navigation model appeared in *An Atlas for Knowledge-Innovation* (Amidon and Mahdjoubi, 1999). In addition *The Mapping of Innovation* (Mahdjoubi, 1997) reviewed a structure for enterprise navigation as it relates to enterprise information processing.

THE INNOVATION NAVIGATION MODEL

The categorization of enterprise development into four groups (*Technology, Customers, Human Resources (People)*, and *Organization)* is applicable to the three aspects of the Enterprise Navigation model, i.e. Map, Compass, and Scales of Measurement. For instance, the enterprise structure (Map) should cover sections on *Technology Development*, *Customer Development*, *Human Resources Development*, and *Organizational Development*.

Figure A.13: The *Innovation Navigation* Model



Innovation occurs in all aspects of enterprise activities. Defining commercial innovation as the *success-oriented flow of knowledge in action*, and using the Enterprise Navigation model as described above, commercial innovation may be further organized into four interrelated groups: 1) *Technological Innovation*, 2) *Market/Customer Innovation*, 3) *Creativity and Learning* (Human Resource Development), and 4) *Organizational Innovation* (Organizational Change). The above configuration provides a new classification for innovation which also is consistent with the Gray Box model described earlier: Technological Innovation acts like the Inward section; Market Innovation is related to the Outward section; Creativity and Learning holds the Inside section, and Organizational Innovation covers the Outside and the Overall sections. This configuration links the Gray Box model to the *Enterprise Navigation* model. In addition the chart includes *Corporate Longitude* (Innovation in Performance Metrics), and *Corporate Compass* (Innovation in Values, Decision Criteria, Rules of Engagement, and Reasoning). This configuration, as depicted in Figure A.13, is called the *Innovation Navigation* model.

Astute observation will note that the above groups possess have non-hierarchical and non-linear relationships with each other. The *Innovation Navigation* model satisfies the non-hierarchical and non-linear requirement of trans-disciplinary knowledge generation, suggested by Gibbons et al. (1994). For instance, Corporate Compass—Innovation in value systems, decision criteria, rules of engagement, and reasoning—comes first, because it acts like a compass and points towards future actions. Corporate Longitude—Performance metrics for innovation—comes at the bottom of the figure, because it acts like a scale of measurement and relates to appraisal of past achievements. The four groups of innovation are located in the middle of Figure A.13, and they act like the different continents of a Mercator map, juxtaposed onto each other.

The Mercator map is the widely used navigational chart, named after its designer Gerardus Mercator (1512-1595), has been considered the masterpiece of navigational charts since its development in the 16th century. In the Mercator projection the longitudes are parallel vertical lines and the latitudes are parallel horizontal lines. By drawing a straight line between two points and using a compass, a navigator can determine the sailing direction between those points. The distances can be measured directly and easily. The map in the middle of Figure A.13 is also in Mercator projection.

The above three enterprise groups (Corporate Compass, Innovation, and Corporate Longitude), have time structures related to the future, present, and past, as they are related to Compass, Map, and Scales of Measurement in the navigation system.

THE INNOVATION NAVIGATION MODEL AND ENTREPRENEURSHIP

The Innovation Navigation model provides a new classification for the different types of innovation. As it was described before, innovation is a concept much broader than technology, as innovation encompasses all aspects of a venture. Entrepreneurship is another concept that deeply impacts the process of venture development. Innovation and entrepreneurship, indeed, interact with each other, as Peter Drucker in *Innovation and Entrepreneurship* writes, "Innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or service" (1985:18).

The integration of innovation and entrepreneurship is essential for a successful innovation commercialization. Innovation without entrepreneurship tends to accentuate science, and entrepreneurship without innovation tends to emphasize classical accounting. The combination of entrepreneurship in the *Innovation Navigation* model, as in Figure A.14, demonstrates the key role of entrepreneurship that integrates the different aspects of commercial innovation. Entrepreneurship is indeed like a dimension perpendicular to the innovation plate.

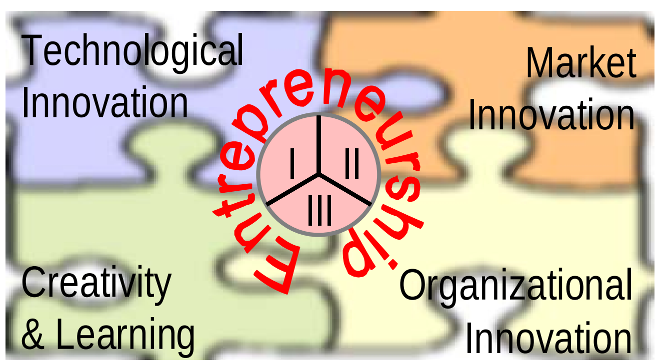
As it was discussed in background studies for venture development (Chapter Two), sources of capital also act as an indicator of the styles of entrepreneurship. Based on sources of capital, this study categorizes entrepreneurship into three major groups:

I. Self-Funded (Bootstrap) Entrepreneurs: Self-funding (bootstrapping) is a means of financing a new business venture though the acquisition and use of internal resources without raising equity from external sources of capital like venture capital institutes or venture capital banks.

II. **VC Funded Entrepreneurs**: Venture capital (VC) is a fund-raising procedure to exchange equity (ownership) in return for financial investment. The VC funded ventures are funded by venture capitalists in the early stage of the venture's development, prior to a positive cash-flow and/or a sustainable sales record. VC investors typically have invested in the business plans and business ideas of the VC funded ventures often during the first year of the venture's establishment.

III. **Corporation Funded Intrapreneurs:** Corporation-funded ventures are cases in which existing corporations invest in their own internal departments or direct subsidiaries.

Figure A.14: The *Innovation Navigation* Model and Entrepreneurship



Styles of Entrepreneurship

I. Self-funded Entrepreneurs

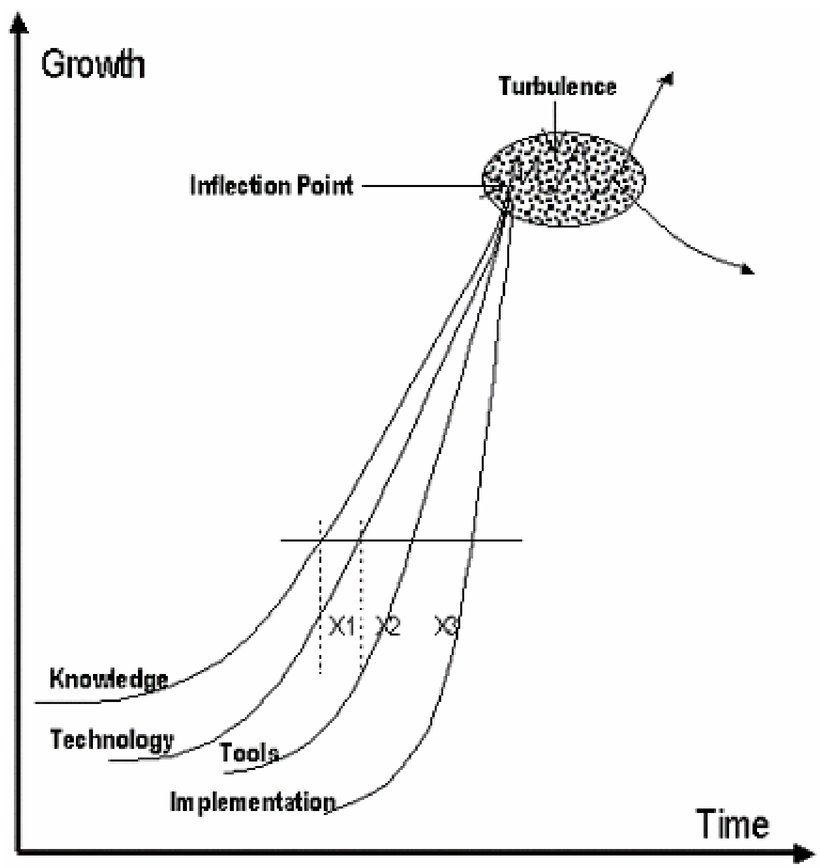
II. VC-funded Entrepreneurs

III. Corporation-funded Intraprenerus

THE KOZMETKSY EFFECT MODEL

C.V. Ramamoorthy, in "A Study of the Service Industry – Functions, Features and Control", coined the term *Kozmetsky Effect* model. Ramamoorthy categorizes the process of technology commercialization into four broad phases: a) knowledge generation, b) technological innovation, c) tools development and design methodologies and d) implementation and manufacturing (2000: 890), Figure A15.

Figure A.15: The Kozmetksy Effect Model



Ramamoorthy defines latency as "the time differences between two successive phases during a specific instance of growth of a technology" (2000: 891). Ramamoorthy then argues:

> The latencies between the four types of phases get reduced or compressed with a maturing technology. … The knowledge and technology curves get closer and closer to the tool development and implementation curves. … This convergence of knowledge and technology curves the phase latencies shrinks and may ultimately coalesce. This convergence of knowledge and technology curves creates an inflection point (2000: 891).

Citing the pioneering studies of Dr. George Kozmetsky, Ramamoorthy calls this convergence of the knowledge, technology, tools and implementation curves to an inflection point the "Kozmetsky Effect" (2000: 891). The study of the information sector in Austin (in Appendix C) demonstrated that growth is an outcome due to the complex interactions of many factors. Technology is not the only factor that impacts growth.

The Kozmetsky Effect model, however, is very insightful as it depicts the role of the inflection point in connecting linear and non-linear (complex) stages of venture development. *The Economic Transformation of the United States, 1950-2000* (Kozmetsky and Yue, 2002) provides further insight into the non-linear characteristic of the turbulence stage after the inflection point. Kozmetsky and Yue claim:

> The inflection points may trigger explosive growth or they may lead to demise. For established companies, the strategic inflection point will generate opportunities to rise to new heights as well as risks to fall to the ground. For emerged companies the strategic inflection point will offer opportunities for growing quickly as well as risks of being wiped out completely. The strategic inflection point represents a time period of confusion in a chaotic environment (2002: 73).

From this perspective, the Kozmetsky Effect is like a combination of the classical S shape models of technology development and complex systems. From another perspective, the Kozmetsky Effect model has commonalities with the Paradigm Shift, as Thomas Kuhn suggested in *The Structure of Scientific Revolutions* (Kuhn, 1970). Andrew Grove in *Only the Paranoid Survive* makes a reference to the *Inflection Point* from a mathematical perspective. "Inflection point happens when the rate of change of the slope of a curve (second derivative) changes sign. In physical terms, inflection point is where a curve changes from convex to concave, or vice versa" (Grove, 1996: 32). This view on the role of inflection points may be used as the first step for the mathematical modeling of turbulence in real world phenomena.

THE KOZMETSKY EFFECT MODEL AND COMPLEXITY

A very interesting feature of the Kozmetsky Effect is the distinctive patterns of growth on the two sides of the inflection point. Prior to the inflection point, it seems that growth follows smooth patterns. After the inflection point and inside the turbulent stage, however, growth is like the railway trails in amusement parks with sharp curves and steep inclines. Before the inflection point, growth is more like riding up in the inclined elevator of the Eiffel Tower. Inside the turbulence stage, however, the pattern of growth becomes like a roller coaster–as one entrepreneur described it. In this respect, the pattern of growth after the inflection point (inside the turbulent stage) seems to be like the "edge of chaos" in "complex systems." A brief review of complex systems is useful to explain this point of view.

According to *Complex Adaptive Systems: A Nominal Definition*, "a complex system behaves according to three key principles: 1) order is emergent as opposed to predetermined, 2) the system's history is irreversible, and 3) the system's future is often unpredictable" (Cooley, 2003). The complex outlook is in contrast to the deterministic Newtonian-Cartesian approach that is based on predictability and reversibility.

Agents are the basic building blocks of a complex system. Agents are autonomous or semi-autonomous units that seek to maximize some measure of goodness, or fitness, by evolving (deliberatively or adaptively) over time. Cooley, in *Complex Adaptive Systems* argues:

> Agents scan their environment and develop schema representing interpretive and action rules. These schema are often evolved from smaller, more basic schema. These schema are rationally bounded: they are potentially indeterminate because

of incomplete and/or biased information; they are observer dependent because it is often difficult to separate a phenomenon from its context, thereby identifying contingencies; and they can be contradictory (Cooley, 2003).

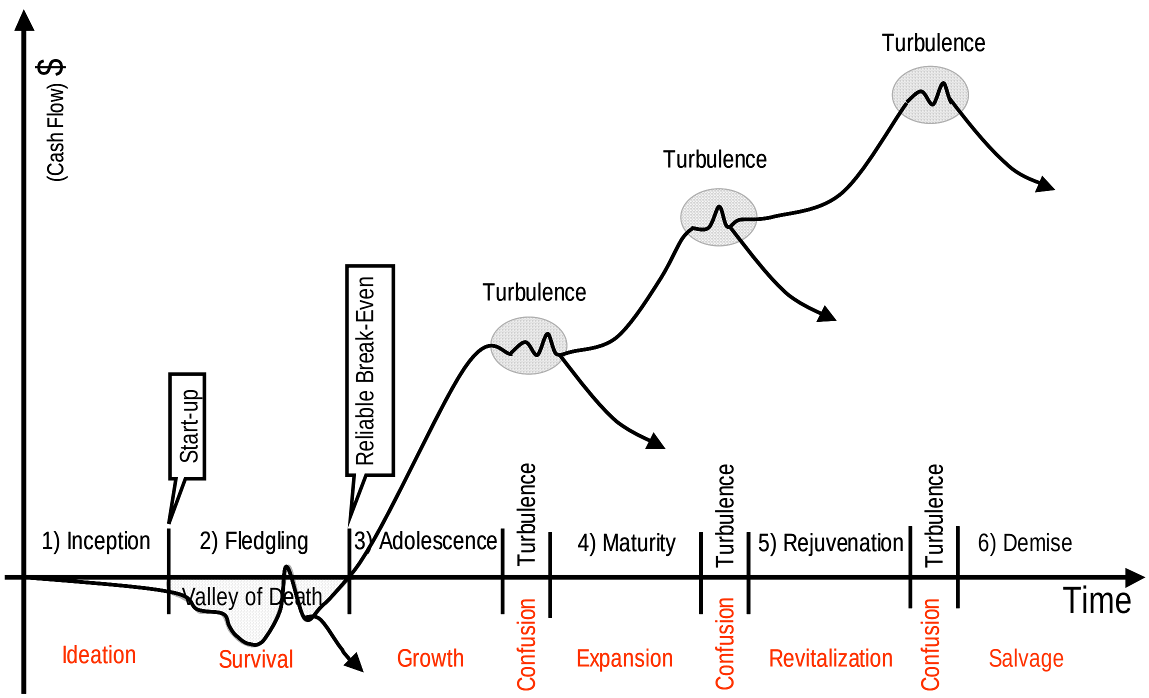
COMPLEX RESPONSIVE SYSTEMS

Complex systems may be further categorized into two sub-groups: a) Complex Adaptive (Reactive) Systems and b) Complex Deliberative (Proactive) Systems. Complex Adaptive Systems react to change by evolving. Complex Deliberative Systems redefine their goals, proactively reorganize the resources, and creative deliberate courses of action to seek their goals. Natural systems are mostly reactive; they adapt to change by evolving themselves. Some human-made systems proactively engage with change. Complex Responsive Systems use a combination of complex deliberative (proactive) and complex adaptive (reactive) approaches. Human creative systems are both creative and adaptive. Business enterprises and business innovation are cases of complex responsive (deliberative and adaptive) systems.

THE BIO-ORGANIZATION LIFECYCLE MODEL

A new organization, even a one-person venture, often follows a set of common stages. Using the analogy of biological lifecycles, the stages of a new organization are referred to as the *Bio-Organization Lifecycle* model, which consists of the following main stages: 1) *Inception*, 2) *Fledgling*, 3) *Adolescence*, 4) *Maturity*, 5) *Rejuvenation*, 6) *Demise*, and 7) *Turbulence* (Figure A16).

Figure A.16: The Bio-Organization Lifecycle Model



The dividing line between stages is at best fuzzy and the time during which an enterprise can be classified in a particular stage varies widely among enterprises. Yet, the relative stage of evolution strongly influences the behavior and pattern of enterprises in many aspects from technology development to financial capital requirement, as each stage characterized by distinctive features.

The *Bio-Organization Lifecycle* model, proposed here, is not a form of predestinations, but it depicts major commonalities among ventures. The suggested model, however, does not advocate a one-size-fits-all approach that is always applicable to all ventures. Any organization, indeed, has a unique lifecycle. The model, rather, intends to explicate the main characteristic of each stage of venture development that may vary from organization to organization.

1. **Inception** covers the period from the initial idea of a new organization to its actual startup. During the Inception stage the founders have the highest level of free will to think and sometimes daydream about the new organization. Ideation is the main characteristic of this stage. But the founders must realize that the moment they cross the startup threshold and enter the next stage (Fledgling – The Valley of Death), the rules that govern a new organization change. The best use of the Inception stage is to become ready for the challenges of the next stage, Fledgling (Valley of Death).

2. **Fledgling** *(The Valley of Death)*: The period after the actual startup of a new organization and before it reaches a sustainable break-even point–where the new organization gains positive cash flow–is called the Fledgling Stage. This stage also is called the *Valley of Death*, due to the high mortality rate among new organizations in the Fledgling stage. During the Fledgling stage and inside the *Valley of Death*, a new organization, like a new baby, relies on the resources of its founders. During the Fledgling stage the *survival* of the new organization becomes the main challenge that confronts the founders. A survival strategy for this stage defines how a newborn organization is able to use the available capital resources to allow it to cross the *Valley of Death*. The *Valley of Death* can continue for an indeterminate period of time. If a new venture is not able to reach the sustainable break-even point, it will die after using the capital resources at its disposal. It will be lost in the *Valley of Death*. It is as simple as

that. But if a venture is able to cross the *Valley of Death*, it becomes resilient, like steel. The reality of the *Valley of Death* is harsher for self-funded (bootstrap) ventures as they do not have the safety nets of venture capital and corporation funded ventures. In the *Valley of Death*, new ventures need to acquire income sources. The income might not be from the core products, but rather from a related product or service, but as long as it helps the new baby venture to cross the Valley of Death, it should be taken into consideration.

3. **Adolescence** covers the stage after the fairly sustainable Break-Even point to become a major player in the niche market the venture has selected. During this period, growth in the main product and market that the venture started becomes the primary challenge the new venture faces.

4. **Maturity** follows the stage of Adolescence. During this stage expansion becomes the main challenge. Expansion may happen in the context of new products and/or new markets.

5. **Rejuvenation**: Some mature firms are able to rejuvenate themselves to grow and expand further. Rejuvenation may happen many times, as some old organizations have demonstrated.

6. **Demise**: Old soldiers may never die, but ventures, like humans, the minute that they are born, appear to be destined to die. The dilemma, however, is when and how! Demise may happen after any of the stages described above. In this classification, however, Demise is sequenced after Rejuvenation.

7. **Turbulence (The Age of Chaos)**: The transition from each of those earlier stages to another does not happen smoothly, as the S models of development depict. Due to the complexity of reality, the transition between those stages, even sometimes inside each stage, occurs with non-linear and turbulent changes rather than with smooth courses of action. The concept of non-linear and turbulent transition from one stage to another

one has been borrowed from the Kozmetksy Effect model, which was discussed before. The Fledgling stage is inherently turbulent and indeed it may have associations with "the edge of chaos" in complexity. No wonder the Fledgling Stage also is called the *Valley of Death*. The experiences gained in the turbulent periods of the Fledgling stage, if internalized to become policy and culture, could be useful to prepare for future turbulent stages.

Using cash-flow (revenues minus costs) as a surrogate for venture development (growth), Figure A.16 depicts different stages of the Venture Lifecycle. The idea of using the financial stream as a surrogate for development (growth) in the context of an enterprise lifecycle is adapted from *Chart of Timing of Venture Capital Financing* (Fitzpatrick, 1991). Many other sources also have used Fitzpatrick's chart, for instance, Cardullo (1999).

DEVELOPMENT CHARACTERISTICS IN THE BIO-ORGANIZATION LIFECYCLE MODEL

It is common wisdom that new ventures in their early stages of development (Inception and Fledgling) behave differently compared to the next periods when they grow and become profitable. Each of the seven stages of the Bio-Organization Lifecycle model has a key development characteristic. The development characteristics of the stages are located in the lower part of Figure A.16, and they are marked in red (or gray) color font. The key development characteristics of each stage of Bio-Organization Lifecycle are organized into the following list:

- **Ideation**: Key characteristic of the **Inception** *Stage*.
- **Survival**: Key characteristic of the **Fledgling** *Stage (The Valley of Death)*
- **Growth**: Key characteristic of the **Adolescence** *Stage*
- **Expansion**: Key characteristic of the **Maturity** *Stage*.
- **Revitalization**: Key characteristic of the **Rejuvenation** *Stage*

- **Salvage**: Key characteristic of the **Demise** *Stage*
- **Confusion**: Key characteristic of the **Turbulent** *Stage*.

INTENTION AND STRATEGIES FOR VENTURE DEVELOPMENT

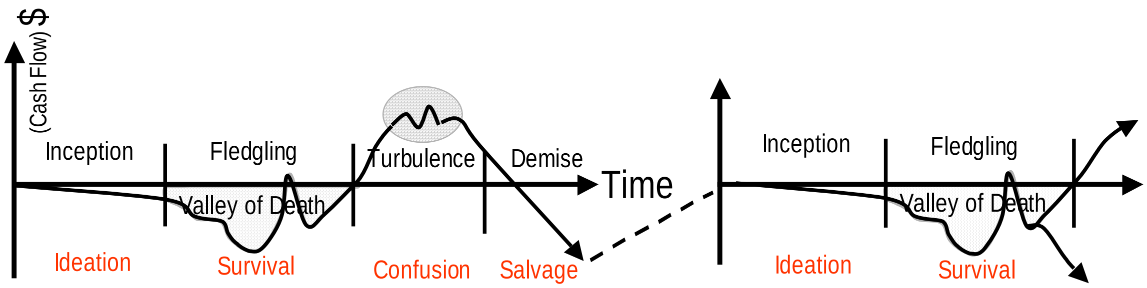
In each stage of venture development, a deliberate strategy or an intention should address the main characteristic unique to the stage. Intention and strategies should provide a guide on how to complete each stage and be prepared for the next one. According to the intention or selected strategy, the other aspects of venture development, such as innovation, should be selected. Utilizing the analogy of exploration for venturing (venture development), then the innovation system acts like a navigational system. This approach connects the *Bio-Organization Lifecycle* model and the *Innovation Navigation* model.

LEARNING FROM PREVIOUS FAILURES AND NEAR FAILURES

All entrepreneurial ventures are not fully successful and the aftermath of a business's demise isn't pretty at all. The entrepreneurs are often in debt and the future might be in grave doubt, and some even might lose their self-esteem. Shuman & Rottenberg (1999) suggests, "In the Silicon Valley, like the gold rush, while a few struck it rich, the vast majority went bust. For all the great success stories to come out of Silicon Valley, it has spawned many, many failures." Shuman & Rottenberg, nevertheless, indicate "even in failure all that entrepreneurial effort does not necessarily go to waste" (1999).

The demise of new ventures, however, is not necessarily the end for many entrepreneurs. Persistent entrepreneurs have often learned from the experiences and nevertheless went on to initiate new ventures as a result of experiences gained largely from their failures and near-failures, to regroup their resources and to initiate new ventures. Experiences gained from previous failures can be used as a basis for future successes, Figure A.17.

Figure A.17: Learning from Previous Failures and Near-Failures to Start New Ventures



Appendix B -
The Austin Regional Development

This section covers a brief review of the development of the Austin region, the Austin Technopolis, and a pilot study on growth and innovation in Austin. The regional study is conducted to explicate the geographical context of the study of the growth and innovation of new ventures.

The Development of the Austin Region: A Brief Review

The rapid development of Austin in the 1980s and 1990s has been investigated in a number of studies *Regional Case Study: Austin, Texas or "How to Create a Knowledge Economy"* (Miller, 1999); supported by the Delegation of the European Commission to the United States, provides a short but fairly comprehensive view on the development of Austin in 1980s and 1990s. *Historical and Empirical Study of Austin's Economic Growth*, a master's thesis by Janghoi Kim (2002), reviews the development of the Austin region from an endogenous growth perspective.

In 1957, the Austin Area Economic Development Foundation created a "blueprint for the future" that set out to recruit new industries. The economic development program began to yield its first results in 1963, as IBM located its Selectric typewriter facilities in Austin. Texas Instruments (TI) followed in 1967, Motorola in 1974 and AMD in 1979. Other small satellite factories followed the main players. Until the early 1980s, Austin had achieved success as a branch plant location for major manufacturing operations.

Since the early 1980s, however, Austin has been able to transform itself from a branch plant location into an innovation hub. In 1984, Microelectronics and Computer Technology Corporation (MCC) located its headquarter and main facilities in Austin. In 1984, 3M relocated the first of three innovation divisions to Austin. In 1988, SEMATECH, a semiconductor research consortium, chose Austin for its site. This consortium served to attract Applied Materials, a leading manufacturer of semiconductor equipment, to locate a facility in Austin, which had the effect of luring numerous suppliers to Austin as well. Korean Samsung Electronics' building of a plant in 1996 strengthened this trend. Dell, the homegrown computer company may be viewed as the culmination of these efforts.

Austin's high-tech economy in the 1980's and 1990's relied on three main industries: 1) Computers and Peripherals, 2) Semiconductors and Electronics, and 3) Software Development. According to Miller (1999) in the late 1990s, high-tech employment in Austin was broken down as follows: 1) Computers and Peripherals: 31%, 2) Semiconductors and Electronics: 22%, and Software Development: 21%. Other high-tech industries: 26%. In contrast to the semiconductor industry, which almost all of the manufacturers are transplants, much of the Austin software industry is homegrown.

Table B.1 demonstrates the total employment change in the Austin region between 1990 and 1998 (Source: Adapted from ES-202 Data System by Labor Market Information Department and Texas Workforce Commission (11/2000).

Table B.1: Total Employment Change in Austin MSA between 1990 and 1998

SIC Code	SIC Name	Average Employment (90)	Average Employment (98)	Employment Change 1990-1998	% Employment Change 1990-1998
Total (=Agricultural + Non-Agricultural)		381,734	596,109	214,375	56.2%
Agricultural Industries		2,323	4,517	2,194	94.5%
Total Non-Agricultural Industries		379,411	591,592	212,181	55.9%
Total Manufacturing		49,829	82,484	32,655	65.5%
High Technology Manufacturing		27,496	51,711	24,216	88.1%
355	Special Industry	1	2,831	2,830	283025.0%

	Machinery, NEC				
357	Computer and office Equipment	11,608	19,814	8,207	70.7%
366	COMMUNICATIONS EQUIPMENT	2,575	3,303	729	4535.0%
367	Electronic Component and Accessories	10,334	21,856	11,522	111.5%
38	Instruments and Related Products	2,978	3,907	929	31.2%
283	Pharmaceuticals	2,088	1,980	-109	-5.2%
Total Non-Manufacturing		218,424	380,327	161,903	74.1%
High Technology Services		15,804	34,367	18,563	117.5%
737	Computer and Data Processing	3,650	14,475	10,824	296.5%
87	Engineering, Research and management Services	12,153	19,892	7,739	63.7%
Government		111,159	128,782	17,623	15.9%
Federal		12,834	10,081	-2,754	-21.5%
State		58,177	61,934	3,757	6.5%
Local		40,148	56,767	16,620	41.4%

THE AUSTIN TECHNOPOLIS

Austin is also regarded as a model *technopolis*. The term technopolis has been used to explain the relationships between enterprises (new ventures and mature businesses) and regional development in high growth regions like Silicon Valley. According to *Creating the Technopolis* "the modern technopolis is one that interactively links technology commercialization with the public and private sectors to spur economic development and promote technology diversification" (Smilor, Kozmetsky and Gibson, 1988). *Emergence of Technopolis* argues that "there are two important conditions necessary for the development of a technopolis: the presence of a knowledge or growth center and the existence of an environment that supports innovation" (Preer, 1992). Along the same line of thinking, Aydalot and Keehte claim "local environments play a major if not determinant role as incubators of innovative activity. The firm is not an isolated agent of innovation: it is one element within the local industrial milieu which supports it" (Aydalot and Keehte, 1988: 9). In "The Science and Process of Entrepreneurship" Butler provides an historical view of the regional context of entrepreneurship development and he argues that regional advantage concentrates on the creation of firms that are able to create wealth and jobs through innovation (2003:88).

Anna Lee Saxenian, in *Regional Advantage,* compares the regional innovation system of Silicon Valley in California with Route 128 around Boston, Massachusetts. Saxenian concludes that Silicon Valley's regional advantage is mostly due to its open networks of communication and exchange across firms compared to the vertically integrated and more closed structure of Route 128 companies. These somewhat contrasting industrial systems in Silicon Valley and Route 128, Saxenian argues, affected the rate of new startups and time-to-market for new products (Saxenian, 1994). *Regional Advantage* is a very interesting source, but it concentrates on only two exceptional regions (Silicon Valley and Route 128), and it does not elaborate on the internal structures and capabilities of the firms of these regions.

Nauwelaers and Reid, in *Innovative Regions*, analyzed the role of regional innovation systems in regional and national development (Nauwelaers and Reid, 1995: 7). The importance of regional structures in the context of national systems of innovation has been further studied in "Regional structures of Innovation and Regional Development," a paper by Andreas Cornett (2002). The above sources, however, do not elaborate on the interactions inside enterprises and between them and their regions.

A PILOT STUDY ON GROWTH AND INNOVATION IN AUSTIN

As part of the proposal stage of this Ph.D. study, an extensive pilot study was conducted on growth and innovation in the Austin, TX. The pilot study includes a historical analysis of the evolution of the Austin region since 1940, and an analysis of the development of the Austin region in the 1990s. The pilot study indicates that small and medium size enterprises provide about 75% of employment in the Austin software industry. By definition, small and medium size enterprises employ between 5 to 499 employees. The pilot study also indicates that Austin small and medium size software enterprises are fairly young. The founders and early managers of these enterprises mostly still work in the Austin area; consequently, data can be gathered about the startup and early stages of development for many of these enterprises.

Austin small and medium size software enterprises use different information technology platforms and provide a wide range of information services. Austin software enterprises have different styles of entrepreneurship based on their sources of capital. These enterprises have been established according to different styles of business plans. Data on diversity in the sources of capital, styles of business plans, and technological platforms, along with the availability of founders and managers, would it possible to conduct a thorough study on the development of Austin small and medium size software enterprises. The study can cover the venture lifecycle from pre-startup to maturity.

The pilot study also demonstrated the patterns of Complex Responsive Systems in the development of the Austin region.

1. The system's history is irreversible.
2. The system's future is unpredictable, as current study indicates.

3. In the context of a region and an industrial sector, each enterprise acts like an agent, which interacts with the internal system (the enterprise) and with the external systems of the region, the nation, and the globe.

4. The order of growth is responsive. The pilot study demonstrates that there have been both deliberative efforts for the growth and development in the Austin region as well as emerging, as discussed in “Complex Responsive Systems” (Appendix A).

The pilot study pointed to a need for an in-depth study of the growth patterns of the software industry in the Austin region. The software industry thus became an industrial context for the in-depth study, but the analysis was performed in the space context of the particular region of Austin, Texas. This geographic proximity of the firms permits the gathering of fresh data about relations between the regional and enterprise development.

Appendix C - The Austin Software and Information Industries: the Origin and Development

This section covers the development of the software industry in Austin and briefly reviews the development of the Austin information industry since the early 1990s. The software and information industries are served to explicate the industrial context of the study in relation to the growth and innovation of new ventures.

THE SOFTWARE INDUSTRY

Broadly defined, software includes programs and instructions that modify or run computer hardware. Commonly, software products are classified into the following main market segments: 1) standard (packaged) software that is sold to general users, 2) customized software solutions, 3) embedded software, and 4) internet and networking systems. The firms active in the software industry can be organized into the following groups: 1) producers of computer systems, 2) independent computer services firms, 3) independent software vendors, 4) training firms, 5) headhunters and job placement agencies related to software specialists, and 5) consulting services related to computers and networks.

Defining the boundaries and size of the software industry and tracing the evolution of the industry's structure is difficult. The reason is because most data collected pertain only to the traded software, or software produced by one enterprise for sale to another. It is often difficult to distinguish between computer services and computer software. Embedded software, or software that is incorporated into hardware such CPUs, printers, cellular phones, and PDAs, is another source of ambiguity in the role of the software industry. Almost half of Motorola's engineering workforce, for instance, deals with software design, but Motorola is commonly considered a hardware firm.

Software is a relatively new industry that has experienced rapid change in market structure and growth. The rapid increase in the computation and communication capabilities and reductions in the cost of hardware have been instrumental in expanding the range of software applications. In the 1960s, computer hardware, such as CPUs, disk drivers, printers, made up to about 80% of the cost of a computer systems. The cost of software made up the rest. Today the situation is almost the reverse. Business may pay up to 80% for software and related services such as training, upgrading, troubleshooting, and maintaining.

Another difficulty in the study of the software industry is a deficiency in industrial classification systems. In the Standard Industrial Classification (SIC) system, for instance, software is grouped under SIC 737 (computer and data processing services). This segment includes a wide range of activities, such as programming, software customization, data processing and data entry. Prior to 2000, employment and economic data about the software industry in the State and Federal databases was organized according to the SIC.

In the mid 1990s, the governments of the U.S., Canada, and Mexico jointly developed the North American Industrial Classification System (NAICS) to provide statistical comparability about business activity across North America and to replace the SIC system. In the NAICS classification the information industry (NAICS 51) consists of software and data processing, telecommunications and publishing. The Texas Workforce Commission and U.S. Bureau of Labor Statistics currently base their employment data on the NAICS classification. For the region of Austin, however, there is no detailed data about employment in software, rather there is aggregated data about the information industry, as a whole. This shortcoming makes the study of the software industry in Austin more challenging.

THE DEVELOPMENT OF THE SOFTWARE INDUSTRY IN AUSTIN

The development of the software industry in Austin has been the main topic of the following documents: *Greater Austin Software Industry Report* (Gibson, Long, and Kozmetsky, 1993), *The Austin Software Industry: An Engine for Economic Development?*, a master thesis by Ruth Cardella (1999), and *Origin and Formation of the Software Industry in Austin*, an unpublished report by Michi Fukushima (2004). The present section of this study has extensively benefited from this source.

Compared with some other regions in the U.S, like Boston, MA and Silicon Valley, CA, the Austin software industry is fairly young. In the 1960s and 1970s the Austin software industry was fairly small, but since the early 1980s, it has grown up rapidly. According to Cardella between 1980 and 1996, software employment went from accounting for less than 0.7% to over 2% of total employment (1999: 55). *The Economist,* in a special issue about high-tech regions, indicated, “Austin’s future increasingly depends on its software companies. Its main areas of software expertise are in multimedia, semiconductors, education and databases” (*The Economist*, March 29, 1997: 14).

According to the Software Industry Association in 2000 Austin ranks 20th in the U.S. with 31,450 software engineers. Adjusting for difference of population in each area, however, Austin ranks seventh in the U.S. regions in terms of the density of software engineers per capita, following Boulder, CO, Silicon Valley, Washington D.C., Seattle, and Boston (Table C.1. Source: Software Industry Association).

Table C.1: Density of the Software Engineers in Year 2000

Metro Area	Density US = 100
Boulder-Longmont, CO	619
San Jose, CA	563
San Francisco, CA	403
Washington, DC-MD-VA-WV	304
Seattle-Bellevue-Everett, WA	288
Boston, MA-NH	270
Austin-San Marcos, TX	267
Raleigh-Durham-Chapel Hill, NC	259
Denver, CO	240
Middlesex-Somerset-Hunterdon, NJ	238

There are many factors that have contributed to the rapid growth of the Austin software industry and these factors interact with each other in a complex context. This study, nevertheless, reviews the roles of four main players that have had impact on the development of the software industry in Austin: 1) The University of Texas at Austin, 2) Texas Instruments, 3) IBM-AIX, and 4) MCC.

The University of Texas at Austin

The University of Texas at Austin (UT-Austin) has played a critical role in developing the entry-level talent that is a key ingredient of the software industry. In 1966 UT-Austin established the Department of Computer Sciences (CS department), which was initially a graduate program to develop computer scientists. In September 1974, the Department added an undergraduate program and provided for 350 undergraduate computer science majors.

In late 1960s, UT-Austin established the Computation Center, which provided access to the state of the art computing capabilities for the students and faculty. The Computation Center used the "Control Data 66100" computer, which was one of the most powerful analytical machines at that time, but the operating system and software that

Control Data supplied did not meet all the departments' needs, and it was difficult to use. Students and faculty needed to develop the required software and almost rewrote Control Data's operating system. By customizing the software for themselves, faculty members and students learned a great deal. That was a unique experience, unparalleled in many other universities.

The department of Electrical and Computer Engineering is the second largest undergraduate program at UT-Austin and has ranked in the top 10 Electrical & Computer Engineering departments in the country for over a decade. Other UT-Austin institutes, such as the Institute for Innovation, Creativity and Capital (IC^2), the Austin Technology Incubator (ATI), and the Software Quality Institute played key roles in sustaining and enhancing the software industry in Austin.

IC^2 is a trans-disciplinary "Think and Do" tank devoted to solving unstructured problems. As a research unit at UT-Austin, IC^2 is focused on knowledge exploration, dissemination, and application across a broad range of academic and applied areas. Dr. George Kozmetsky (1917-2003) founded IC^2 in 1977. Many studies have praised Dr. Kozmetsky as a legendary character who played a key role in the development of Austin. Miller indicates, "One of the most influential individuals in the development of Austin development has been Dr. George Kozmetsky" (1999). A co-founder of Teledyne in Silicon Valley, Dr. Kozmestky came to Austin in 1966 to become Dean of UT-Austin's College of Business Administration to 1982. Dr. Kozmetsky then founded IC2 in 1977 and stayed there, as CEO and then Chairman to the last days of his life (2003).

Austin Technology Incubator (ATI) was founded in 1989, as a subsidiary of IC^2. ATI currently operates as a non-profit incubator and provides business resources and professional services to selected business start-ups. The incubator occupies part of the MCC building, which belongs to UT-Austin. ATI has been a learning laboratory for hundreds of Texas entrepreneurs and students to practice and study the process of technology commercialization. So far, the ATI has graduated 65 companies.

In studies on the development of software industry in Austin, very often, excess emphasis has been placed on the role of software developers and computer engineers, while almost no reference is made to the role of other contributors. Like other industries, technological innovation includes only one aspect of software development, and to develop a strong industry in a region, many non-technical aspects should be taken into consideration. For example Kay Hammer, the co-founder of Evolutionary Technologies International (ETI), has pursued her formal education in English, but made notable contributions to software development at Texas Instruments (TI) and Computer Technology Corporation (MCC) and became the co-founder of Evolutionary Technologies International (ETI[32]).

In spite of UT-Austin's emphasis on research, almost no prominent software technology in Austin appears to be based on UT-Austin's research. This key point was mentioned in some interviews, as part of this study.

Texas Instruments

Texas Instruments (TI) is widely referred to as the original "Training Institute" for Austin software development. TI's Austin office hired many new university graduates at entry level technical positions and provided them training relevant to their technical specialization. After five to eight years of work experience, many left TI for other jobs or to start their own businesses.

In 1966, Texas Instruments started Advanced Scientific Computer (ASC), a large computer development program. The main intention of the ASC project was to develop state-of-the art computer systems for scientific purposes. This project was originally

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[32] ETI will be discussed in more detail later.

stared in Dallas. In 1969, TI decided to move this project to Austin to secure a qualified labor force. Most hardware engineers who worked in the ASC project were transferred from Dallas. TI, nevertheless, hired many software engineers in Austin, especially students graduated from UT-Austin. TI also hired a large number of computer engineers from University of Colorado, and the State University of New York. The total number was estimated to be about 100. The ASC project ended around 1975. After that, engineers working on the project dispersed and moved on to other TI projects. Some of the software engineers who had come to Austin went back to Dallas. However, many of them stayed in Austin and worked for other large companies or started their own ventures. This group made a strong nucleus for the fledgling Austin software industry.

IBM-AIX Project

Since 1967 IBM has been one of the largest private employers in Austin. In the late 1960s, the original IBM manufacturing facility made magnetic tape typewriters to sell to the state government. In 1972, IBM's Austin branch made memory typewriters that used a basic memory board. In 1983, the IBM facilities in Austin began to assemble computers. In 1984, IBM also selected Austin as the main location to develop AIX, the IBM version of the UNIX operating system.

In the early 1980s, there were not many programmers and software engineers in Austin who were familiar with the UNIX operating system. Accordingly, IBM brought in many experienced programmers and software engineers from outside the company and other places to undertake this task. IBM often recruited students directly out of colleges and trained them within the organization. For the AIX project IBM, however, relied on temporary hires and beginning 1984 it made contracts with recruiting companies, such as Pencom[33], which were specialized in UNIX personnel. Recruitment continued through

[33] Pencom was the first graduate company from the Austin Technology Incubator (ATI).

1992 and at its peak included more than 500 programmers and software engineers. After the termination of the development of IBM-AIX, more than 130 of the UNIX programmers and engineers who had worked for IBM as contractors stayed in Austin. They contributed to the development of other software companies like Tivoli, Tandem, and Motiv.

In 1992 IBM changed its “no lay-off” policy. Between 1993 and 1997 IBM Austin was involved in three major lay-offs. The lay-offs, in some respects, provided new local resources for the growth of the Austin software industry. Some laid-off specialists started their own companies, or they joined newly established ventures, taking advantage of local opportunities and contributing to the further development of the Austin software industry.

Selection of Austin as the main base for IBM-AIX, although very important for the development of the Austin software industry, has not been documented historically. There are, nevertheless, different observations on this key influence. According to Edward (Ted) Taylor “IBM management saw Austin as a place where the UNIX project could be conducted in relative seclusion. UNIX was not a very politically correct decision for IBM and they wanted to keep this project away from there more ‘mainstream’ facilities in New York” [34] . Ted Taylor was an executive in Pencom Systems Incorporated, a recruiting company in New York, specializing in UNIX specialists (Fukushima, 2004).

There are, however, others who think that IBM located its AIX project in Austin because “labor cost in Austin was not expensive compared to other regions and there was a large labor pool there supplied by UT-Austin” [35]. IBM AIX was a key player in the

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[34] Interview with Edward Taylor by Michi Fukushima. (Fukushima, 2004)
[35] Interview with Charlie Jackson by Michi Fukushima. (Fukushima, 2004)

development of the Austin software industry as the project stimulated the diffusion of technical, technological, and managerial talents throughout the region(Fukushima, 2004).

Microelectronics and Computer Technology Corporation

A watershed event in Austin's high-tech development occurred in 1984 when the city won the nationwide competition for Microelectronics and Computer Technology Corporation (MCC). In 1983 MCC had been established as the first private sector high technology consortium to promote U.S. technological leadership in electronics. A year later, MCC chose Austin over 57 cities in 27 states as its headquarters and main research facility. Following an organized campaign, the Texas stakeholders put together a package of incentives worth more than $25 million. This included a university-financed facility and laboratory leased to MCC at minimal cost (Miller, 1999). Following the MCC win, other firms began to locate to Austin.

MCC helped the Austin software industry in many aspects and it relocated many software specialists to Austin. Many of these individuals stayed in the area and contributed to the further development of the Austin software industry. MCC also brought scientific and administrative talents to the Austin software industry. In 1987, the number of MCC employees hit a peak of more than 400 individuals. Afterwards, MCC decreased its workforce and since the early 2000s it has become dormant.

When MCC was founded, Admiral Robert Inman, the first CEO and Chairman of the Board, insisted on hiring qualified researchers not only from the shareholder companies, but also from research universities, federal laboratories, and non-shareholder corporate laboratories. As a result, 65% of MCC's researchers came from non-shareholder companies, about 20% came from universities and government laboratories, and the rest came from the shareholder companies (Fukushima, 2004).

MCC's employee turnover rate fluctuated with the consortium's leadership. Under the helm of Inman (1983-86), long-term pre-competitive research was emphasized, and MCC was a comfortable place for researchers. The rate of turnover at that time was under 3%. Under the second director, Grant A. Dove (1987-1990), MCC changed its policy and focused on more business-oriented activities, such as technology transfer and fundraising. During this period the rate of turnover shot up to 30%, although the total number of researchers remained stable.

Craig Fields, the next director of MCC between 1990 and 1994, changed MCC's policy again and emphasized "distributed R&D, early buy-in of project-based research activities, technology transfer through specific plans, the value of member company diversity, entrepreneurial behavior, and spin-out companies" (Gibson and Rogers, 1994). Fields encouraged researchers to spin out companies, and some MCC spin-outs were created under his leadership, although very rare of them survived.

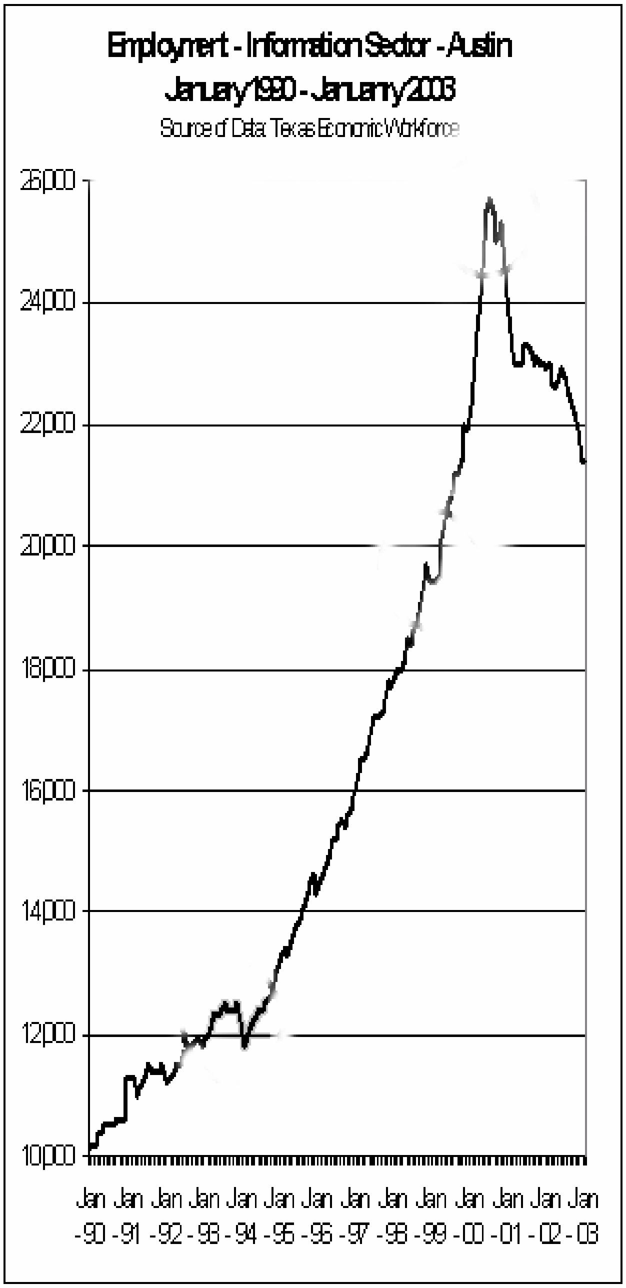
Because MCC was doing cooperative research, in its early stages of development, under the helm of Inman, spin-outs were not its main purpose and MCC's administration didn't have a consistent policy on spin-out. If researchers wanted to spin-out, they faced difficulties. For instance, Evolutionary Technologies International (ETI), the most prominent spin-out from MCC, encountered numerous obstacles. Kay Hammer, the co-founder of ETI in *Workforce Warrior* (2000) describes the challenges she faced in making the first spin-out based on an MCC technology. Many other spin-outs based on MCC technologies did not survive at all. Some MCC employees, however, were able to set up independent software companies. Overall the rate of spin-outs from MCC has been far less than IBM-AIX.

EMPLOYMENT GROWTH IN THE AUSTIN INFORMATION SECTOR

The section covers a review of the employment growth in the Austin information sector. The Austin information sector, is compared with the information sectors of five other regions. Venture funding in Austin is reviewed to explicate its key role in the growth and development of the information sector.

As discussed before, the Texas Workforce Commission and the U.S. Bureau of Labor Statistics currently provide employment data according to the NAICS classification. The employment data, however, does not go beyond year 1990. The information sector in the NAICS classification consists of software and data processing, telecommunications and publishing. The employment data about Austin, however, includes the aggregated employment data about the information sector and it is not broken down to the sub-sectors of software and data processing,

Figure C.1: Employment Growth in the Austin Information Sector



telecommunications and publishing. Accordingly, this section concentrates on the employment growth of the Austin information sector to demonstrate patterns of employment growth.

In the 1990s, the Austin information sector enjoyed a rapid rate of growth with two short-term stagnations in 1994 and 1999, as Figure C.1 demonstrates. Between January 2001 and January 2003, the Austin information sector, however, faced a major slump in employment, suffering a loss of more than 3600 jobs, about 14% of its workforce (data source: Texas Workforce Commission Website). This downturn was not confined to the information sector; it was indeed the greatest economic challenge to the entire Austin region in recent history. Understanding the growth patterns of the information sector and its potential recovery is crucial for the further development of the Austin region.

The rise of the Austin information sector in the 1990s, and then its dramatic fall after January 2001, provide an opportunity to compare the patterns of development in both periods of boom and bust. Accordingly, this study conducts its operational topic (impacts of business plans, capital, and technology on the patterns of enterprise growth and development) in the context of the Austin information industry.

EMPLOYMENT GROWTH IN THE AUSTIN REGION

To gain a better understanding of the patterns of development in the Austin region, Figure C.2 compares the patterns of growth of employment in eight sectors, all in the Austin-San Marcos Metropolitan Statistical Area. A Metropolitan Statistical Area (MSA), according to the U.S. Census Bureau, “is a large population nucleus, together with adjacent communities having a high degree of social and economic integration with that core” (U.S. Census Bureau Website). The Austin-San Marcos MSA consists of the following counties: Bastrop, Caldwell, Hays, Travis, and Williamson. The Texas

Workforce Commission is the source of data for Figure C.2. In the figure, the sectors are based on the *North American Industrial Classification System* – NAICS, discussed before.

Figure C.2: Growth of Employment in Austin

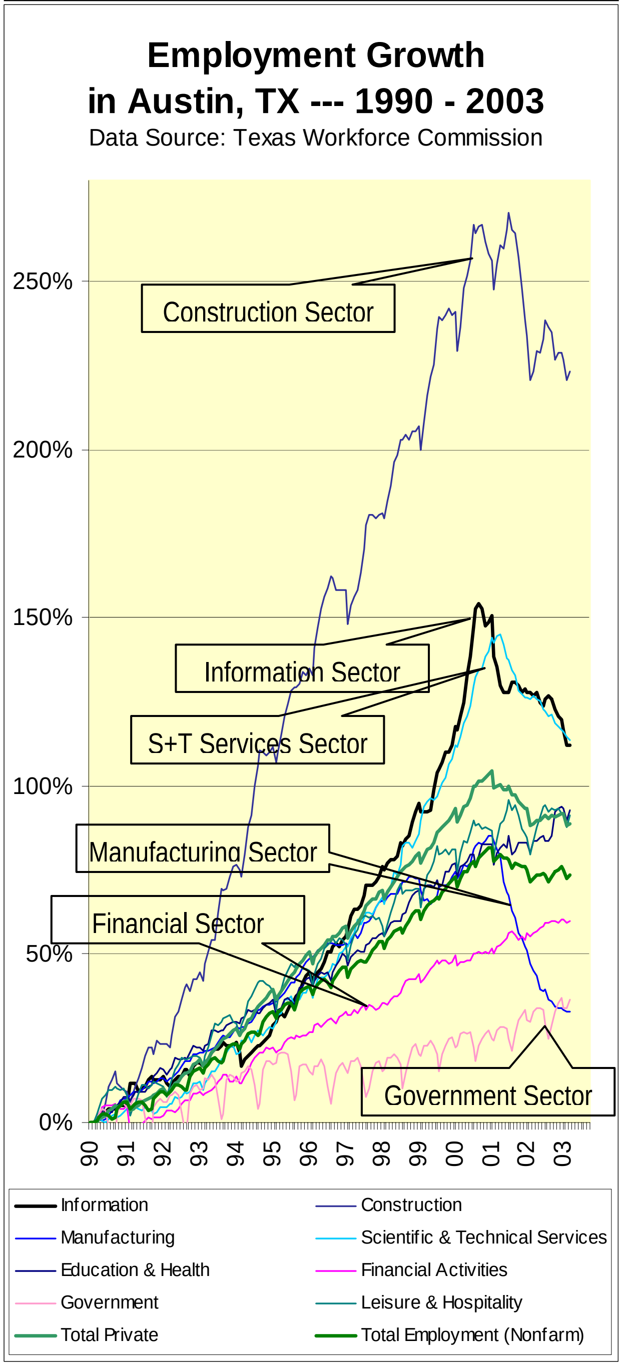


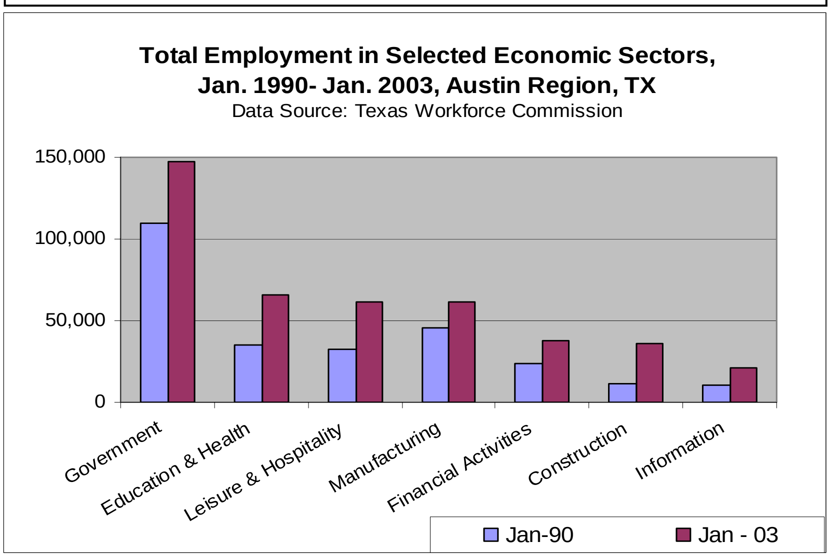
Figure C.2 demonstrates that the scientific and technical (S+T) services sector had a growth pattern that mirrors the information sector. The manufacturing sector had a growth pattern similar to the information sector. The manufacturing sector enjoyed a fast rate of growth between 1994 and 2000 with a short slump in January 1999 and a deep downturn in 2001 that has continued beyond January 2003.

Figure C.2 also demonstrates that in the 1990s the rate of growth of the construction sector in Austin surpassed the information sector without major technological innovations in construction. This indicates that technological innovation is not the *only* factor that contributes to the growth of employment in an economic sector.

The growth patterns in all economic sectors of Austin were not rapid and their downfalls were not also fast. During the 1990s the growth of the financial sector in Austin, for example, was gradual and it did not face the sharp economic downturn that the information sector experienced.

In the study of employment growth, one also should pay attention to the total employment figures in each sector. Figure C.3 compares the total employment in Austin's major economic sectors between January 1990 and January 2003. In spite of their rapid growth in the 1990s, the information and construction sectors still constitute a small fraction of total employment in the Austin region. Between January 1990 and January 2003, the slow-paced and less turbulent education and health sector surpassed the fast-paced and turbulent high tech manufacturing sector. The government sector had a modest growth in the 1990s, but much less than the growth of total private employment in total employment. The government sector with over 150,000 employees, as Figure C.3 indicates, is still the major source of employment in the Austin region.

Figure C.3: Total Employment in the Austin Economic Sectors



EMPLOYMENT GROWTH IN THE INFORMATION SECTOR OF SIX REGIONS

A high rate of growth in employment in the information sector in the 1990s followed by a sharp economic downturn since January 2001 was not unique to Austin. A similar pattern also occurred in Silicon Valley. The Silicon Valley Network, in *Index of Silicon Valley,* indicates:

> Between second quarter 2001 to second quarter 2002, employment declines across all clusters; software is hardest hit. Overall, Silicon Valley's driving industry clusters lost 22% of jobs, declining from 484,000 to 396,000. Software the greatest job losses, from 128,000 jobs to 101,000 jobs. The second largest decline was in Semiconductor and Semiconductor Equipment Manufacturing, which lost 16,000 jobs. Computer and Communication Hardware Manufacturing lost 15,600 jobs (2003: 12).

Figure C.4: Employment Growth in the Information Sector of 6 Regions

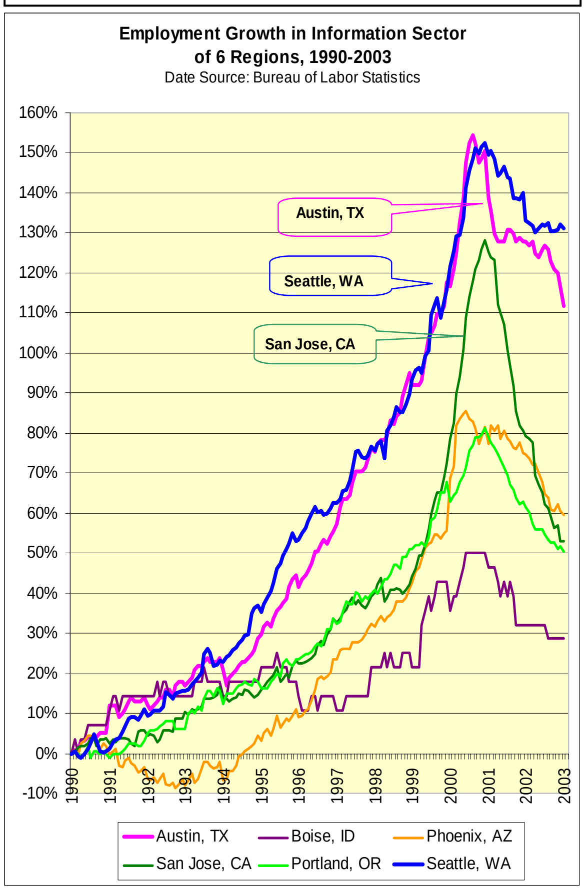
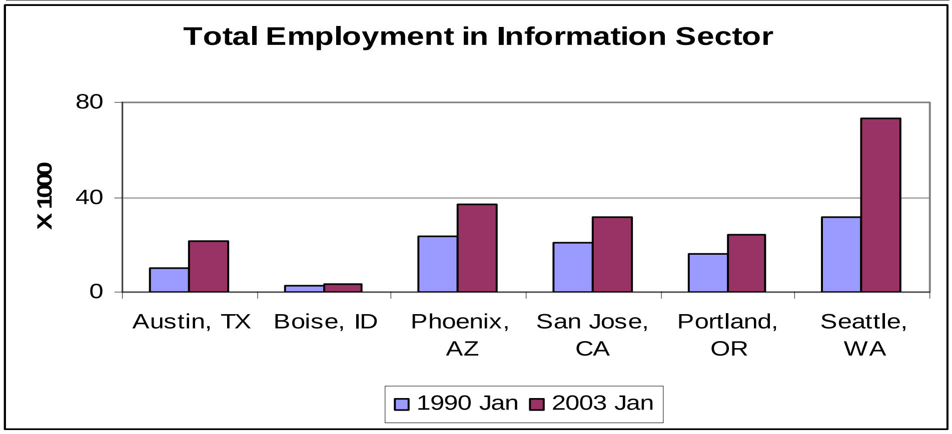


Figure C.4 depicts the growth in the information sector of six regions: Austin, TX, Boise, ID, Phoenix, AZ, Portland, OR, San Jose, CA and Seattle, WA. Figure C.4, which is based on data from the U.S. Bureau of Labor Statistics Website, clearly indicates similar patterns in all six regions: a high rate of growth in the 1990s and then a sharp downturn since January 2001. The sharp spike in San Jose and the relative stability of the condition in Seattle, however, is noticeable.

It should be noted that between January 1990 and January 2003 the total employment increase in Seattle was

41,400, as demonstrated in Figure C.5. This number is almost the same as the total employment gain in five other regions combined between January 1990 and January 2003, which is 45,000. It demonstrates that the rate of growth in the 1990s, the decline since January 2001, and the total employment in each region are not linearly associated.

Figure C.5: Total Employment in the Information Sector of 6 Regions



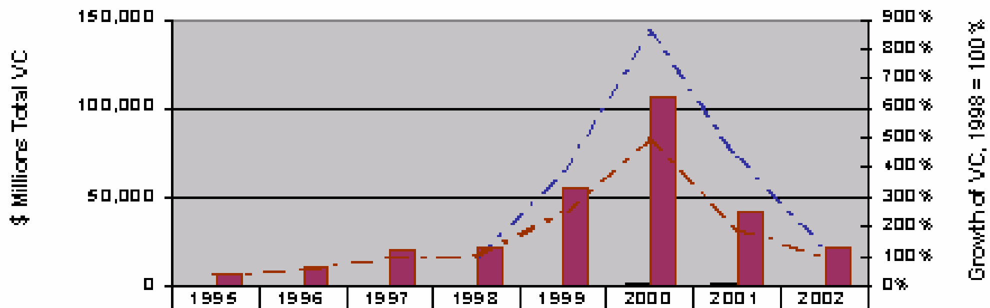
VENTURE CAPITAL FUNDING IN AUSTIN

Venture capital (VC) is a fund-raising procedure that exchanges equity (ownership) in return for financial investment. Venture capital often has been cited as one of the main drivers for business growth and regional development. High-tech growth in the Austin region has been fuelled in part by the supply of venture capital to this region. In the 1980's and early 1990's, there were few venture capital firms in Austin. However, in the mid-1990's many venture capital firms emerged in Austin.

Figure C.6 depicts the total amount of venture capital investment in Austin (source: Angelou Economics) and in the U.S. (source: Venture Economics Website: March 31, 1993) since 1995, as well as the rate of growth in each case. This figure indicates that between 1998 and 2002 the venture capital investment in Austin and in the U.S. followed similar patterns. For instance, there was a surge of investment between

1998 and 2000. Between 1998 and 2000 venture capital investments in the U.S. increased 490% from $21 billion to $106 billion, and during the same period of time, venture capital investment in Austin increased 860% from $265 million to about $2.3 billion. Although during this period of time venture capital investments in Austin were about one to two percent of total U.S. venture capital investment, the rate of growth of venture capital investment in Austin was almost double the rate of growth in the U.S.

Figure C.6: Venture Capital Funding the U.S. and Austin



	1995	1996	1997	1998	1999	2000	2001	2002
VC in Austin				265	1,008	2,280	1,136	350
VC in U.S.	7,690	11,250	19,500	21,750	55,500	106,500	42,000	21,200
VC Growth in Austin				100%	380%	860%	429%	132%
VC Growth in U.S.	35%	52%	90%	100%	255%	490%	193%	97%

After 2000, the total amount of VC investment in the U.S. has dropped drastically. The total amounts of VC investments, in the years 2000, 2001, and 2002, respectively, were about $106 billion, $40 billion, and $21 billion. Compared to the boom years of 1999 and 2000, between 2000 and 2002, the total amount of VC investment in Austin has decreased almost two times faster than the average U.S. decrease in investment.

Since 2001, in addition to the total amount of VC investment, the nature of venture funding in Austin also has changed. According to Hawkins, in the third quarter of 2002 “existing and running companies took in 80 percent of the investments in Austin and the other 20 percent went to early-stage deals. That is a shift from the third quarter of 2001, when half of the money invested in Austin was pumped into early-stage deals." Hawkins then continued, "Software companies continued to absorb the lion's share of the venture capital investment in Austin. In the third quarter of 2002, Austin software firms received 40 percent of total venture investments; nationally, software companies received 22 percent of venture investments" (Hawkins, 2002). Venture capitalists in the first quarter of 2003 invested about $3.8 billion compared to about $6 billion in the first quarter of 2002, according to a recent survey by Venture Economics. The Austin area absorbed about $53 million dollars in venture capital during the first quarter of 2003.

A comparison of Figure C.6 (venture capital investment) and Figure C.2 (growth of employment in the Austin region) demonstrates the association between venture capital investments and the patterns of growth in the information industry, as well as some other economic sectors in Austin. For example, VC investment in Austin experienced a rising trend in the mid and late 1990s and peaked in the year 2000. The Austin information sector employment also had a rising trend in the mid and late 1990s, as well as a peak in the year 2000. Between January 2001 and January 2003, Austin's VC investment and information sector declined drastically.

Following this line reasoning, the surge of growth in the Austin Information sector between January 1999 and January 2001 can be attributed, at least partially, to the injection of capital resources. There are, however, numerous other factors that contributed to the growth of the Austin Information sector; the injection of venture capital resources is only one factor in a very broad set of factors. Some experts attribute the growth of the Austin Information sector in the late 1990s to Y2K influences, as well as to new applications for the Internet and Web.

A preliminary conclusion of the review of the above data indicates that the Austin information sector shares common patterns with some other sectors in Austin, such as the science and technology (S+T) sector and the construction sector, as well as with the information sector in other regions. The existence of the above common patterns then justifies further study of the Austin information industry. The lessons learned from the examination of the Austin information sector can be used to better understand the process of venture and regional development in Austin as well as in other locations. As we will see later in "Austin: the Galapagos Island of Venture Development," Austin also possess unique characteristics that facilitate the study of the interactions between new ventures and regional development.

SUMMARY

1. This section studies the development of the Austin software and information sectors and the regional and industrial context for the enterprise development study.

2. In the 1990s, the Austin information sector enjoyed a rapid rate of growth. Between January 2001 and early 2003 the Austin information sector, however, suffered a severe downturn.

3. The growth patterns in all economic sectors in Austin were not rapid and the downfalls were not also fast. For instance, during the 1990s the growth of the financial sector in Austin was not rapid, and this sector did not face the sharp economic downturn that the information sector faced.

4. The growth of employment, as an outcome, is due to numerous factors, including technological innovations and the diffusion of capital resources.

5. A study of comparative patterns of growth between information and construction sectors demonstrated that in the 1990s the Austin construction sector's rate of growth was greater than that of the information sector. The growth of the construction

sector in the 1990s is more likely related to the injection of capital resources into this region, somewhat akin to that of the information sector.

Appendix D -
Austin: the Galapagos Island of Venture Development

Austin is selected as the regional context for this study because Austin has been a rapidly growing region for the last 20 years. The process of regional development—that might have taken more than 60 years in Silicon Valley and as long as 100 years, or more, in the Boston region—happened in Austin in about 20 years. Beginning in the early 1980s, Austin has changed from a mostly university- and government-centered city into a vibrant and innovative region. Austin has grown and attracted numerous advanced technology enterprises, including those in the areas of software, semiconductors and computers. During this relatively short period of time, many new ventures in Austin have started up, grown, and become mature and some of the new ventures have shut down or been acquired. The majority of the founders of those ventures, however, are still in this region. This unique characteristic of Austin further justifies the present study on venture development in this region, as Austin has been referred to as the *Galapagos Island of Venture Development*.

The Galapagos is a cluster of thirteen volcanic islands located on the Equator, roughly 600 miles (1000 km) west of the South American coast of Ecuador. The Galapagos Islands' fame is related to Chares Darwin's short trip aboard the *H.M.S. Beagle* in September of 1835. The Beagle spent five weeks in the Galapagos charting the archipelago. In the meantime, Darwin made careful observations about the geology and biology of the Islands and he noted local variations among the birds and other animals he encountered. Darwin later developed his theory of evolution based largely on the observations of the species in the Galapagos Islands. After almost twenty-five years of deliberation, in 1859, Darwin set forth the theory in his book *On the Origin of Species by*

Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life or *The Origin of Species* for short.

Darwin's theory of evolution is premised on the study of the variations in the characteristics of the members of a species and the generalization of those patterns of evolution among the species. The Galapagos Islands provided a historical laboratory for Darwin to make a set of longitudinal studies of biological evolution based on a comparative study of species.

It was not accidental that Darwin was able to develop his theory of evolution largely based on the observations of a limited number of species in the Galapagos Islands; the Islands have unique characteristics for the natural evolution of species:

1. The Galapagos Islands are volcanic; geologically they are young islands with an old basis.

2. The Galapagos Islands are semi-isolated from the main land. This means that the species were able to migrate to Galapagos Island, but their later evolution was localized.

3. The Galapagos Islands enjoy mild a climate in spite of being near the Equator. The mild climate allowed the migrated species to survive, grow, and sustain themselves.

4. The ocean water around the Galapagos Island is rich in nutrients and it provides the sources needed for the growth of the network (chain) of species around, and in the Islands.

Similar to the Galapagos Islands, at least metaphorically, the region of Austin has unique characteristics that may provide a fertile ground for the development of new views on venture and regional development:

1. Austin's new industrial base is fairly recent; the rapid growth of new ventures in Austin has happened in about twenty years, since the early 1980s. Austin, however, has an old intellectual basis, like The University of Texas at Austin. Most of the main players in the recent evolution of Austin, from a college town to an innovation hub, are still around and it is possible to get first-hand information from them. A similar process of regional development in Silicon Valley might have taken more than sixty years, and even longer around Boston. Many original entrepreneurs and players in Silicon Valley and Route 128 have passed away; consequently first-hand information about the development of the original ventures that catalyzed regional development in Silicon Valley and Boston is more difficult to collect. Building on the analogy of the Galapagos Islands, Austin not only acts like a natural laboratory for the study of evolved ventures, but it also is rich in the fossils of dead ventures.

2. Similar to the Galapagos Islands, Austin is semi-isolated from big centers of technology development, like Silicon Valley, Route 128, even Dallas and Houston. It means many people who migrated to Austin stayed in Austin and they contributed to the further development of the city. Direct human interactions facilitate trust and the transfer of tacit knowledge, which are essential for innovation and development. Austin, however, was not completely isolated. Modern communication systems, for instance the Internet, allowed Austin immigrants to stay in touch with the forefront of advanced technologies. Later, the people who migrated to Austin founded many new ventures. Some of the ventures survived and were able to grow to become mature enterprises. Some of the new ventures were acquired, or died and dissolved. Interestingly enough, the majority of the founders and executives of mature and dissolved enterprises are still in Austin.

As discussed in Appendix C, the growth of the Austin software industry, for instance, is mostly attributed to projects like MCC, IBM-AIX, and Texas Instruments, which provided many one-way migrations to Austin. MCC brought scientific and administration talent plus visibility to Austin. IBM-AIX brought technical, technological, and managerial talents to Austin. SEMATECH (SEmiconductor MAnufacturing TECHnology) started as a joint initiative between fourteen U.S.-based semiconductor manufacturers and the U.S. government to solve common manufacturing problems by leveraging resources and sharing risks. In 1988 Austin was chosen as the site for SEMATECH.

3. Similar to the Galapagos Islands, Austin enjoys a tolerant society as well as a mild climate. The hospitable social and environmental conditions permitted the migrated talents to grow and flourish.

4. The existence of some financial resources in the form of early angel investors and later venture capitalists, similar to the rich waters around the Galapagos Islands, helped the growth of a network (chain) of new enterprises. In addition, UT-Austin provided fresh graduates needed for venture and regional development.

In spite of the commonalities, Austin and the Galapagos Islands are distinct in numerous other aspects. The evolution of species in the Galapagos Islands has happened as a natural process; the development of Austin, however, has been both evolutionary and deliberate. In the 1980s, for instance, the development of Austin, to a great extent, was based on a series of deliberate actions, such as luring MCC and then SEMATECH to Austin. The development of Austin, however, was not all due to a series of planned actions, and although the city of Austin enjoyed a high rate of growth, the Austin-San Antonio Corridor (a term coined by the late George Kozmetsky) is still a dream rather than a reality.

The Darwinian approach is not the only theory of evolution, and indeed a pure Darwinian approach does not fully explain all aspects of human development. But just as the Galapagos Islands have provided a fertile ground for new theories of natural evolution, so does Austin for ideas about new venture and regional development.

The researcher's residence in Austin was another reason to select Austin as the regional base for this study. As data collection for this study is based on direct networking with the founders and executives of the firms, it was crucial to have personal contacts with them. Residing in Austin is essential for this purpose.

Appendix E -
The Chi-Square Test

The Chi-Square (χ^2) is a non-parametric test of statistical significance for bi-variant tabular analysis. The main issue that the Chi-Square test addresses is whether any relationship in the sample data is strong enough to justify making inferences about the larger population from which the sample has been drawn. The Chi-Square (χ^2) test is well summarized by Vaughan, 2003.

In a statistical analysis format, the Chi-Square test explains the nature of the observed relationships among the variables. The Chi-Square test can be used to figure out relationships among, or independency between, variables. The most common use of the Chi-Square test is to test for differences between proportions. The Chi-Square test can be based on a matrix with many columns and many rows. The precise calculation of the Chi-Square (χ^2) test is given by following relationship:

$$\chi^2 = \Sigma\ [(\text{Observed Frequency - Expected Frequency})^2 / \text{Expected Frequency}]$$

The degree of freedom is calculated as (Number of Row – 1) X (Number of Column –1). For a 2 X 2 matrix the degree of freedom is 1. The critical value of the Chi-Square test with 1 degree of freedom for a p-value of 0.05 (95% confidence = α level) is 3.84, and the critical value of the Chi-Square test with 1 degree of freedom for a p-value of 0.01 (99% confidence) is 6.63.

In addition to the Chi-Square test, this study in Chapter Four also uses simple comparative analysis between the data related to the set of two factors (for instance Initial Sources of Capital and Style of Business Plan) to demonstrate relationships between them.

Chi-Square Value between Initial Sources of Capital and Original Styles of Business Plans

Table E.1 demonstrates the "observed data" between "Initial Sources of Capital" (Self-funded Ventures versus VC funded Ventures) and "Original Styles of Business Plans" (Formal Business Plans versus Other Types of Business Plans).

Table E.1: Observed Data Between Initial Sources of Capital and Original Styles of Business Plans

	Formal Business Plans	Other Types of Business Plans
VC Funded Ventures	**10**	**10**
Self-Funded Ventures	**4**	**24**

Table E.2 demonstrates expected frequency between "Initial Sources of Capital" and "Original Styles of Business Plans" among the same group of ventures.

Table E.2: Expected Frequency Between Initial Sources of Capital and Original Styles of Business Plans

	Formal Business Plans	Other Types of Business Plans
VC Funded Ventures	**5.8**	**14.1**
Self-Funded Ventures	**8.2**	**19.8**

$$\chi^2 = \Sigma\ [(\text{Observed Frequency - Expected Frequency})^2 / \text{Expected Frequency}]$$

$$\chi^2 = (10-5.8)^2 / 5.8 + (8.2-4)^2 / 8.2 + (14.1-10)^2 / 14.1 + (24 - 19.8)^2 / 19.8$$

$$\boldsymbol{\chi^2 = 7.27}$$

Chi-Square Relationship between Initial Sources of Capital and Later Styles of Business Plans

Table E.3 demonstrates the "observed data" between "Initial Sources of Capital" (Self-funded Ventures versus VC funded Ventures) and "Later Styles of Business Plans" (Formal Business Plans versus In-Formal Business Plans).

Table E.3: Observed Data Between Initial Sources of Capital and Later Styles of Business Plans

	Later Formal Business Plans	Later In-Formal Business Plans
VC Funded Ventures	**10**	**4**
Self-Funded Ventures	**10**	**18**

Table E.4 demonstrates expected frequency between "Initial Sources of Capital" and "Later Styles of Business Plans" among the same group of ventures.

Table E.4: Expected Frequency Between Initial Sources of Capital and Later Styles of Business Plans

	Later Formal Business Plans	Later In-Formal Business Plans
VC Funded Ventures	**6.6**	**11.4**
Self-Funded Ventures	**8.4**	**14.5**

$$\chi^2 = \mathbf{4.72}$$

Chi-Square Relationship between Original Styles of Business Plans and Rate of Growth in the VC Funded Ventures

Table E.5 demonstrates the "observed data" between "Original Styles of Business Plans" (Formal Business Plans versus Short Business Plans) and "Rate of Growth" among the VC funded ventures.

Table E.5: Observed Data Between Original Styles of Business Plans and Rate of Growth among the VC Funded Ventures

	Number of Cases	Rate of Growth
Formal Business Plans	**10**	**13.9**
Short Business Plans	**9**	**14.8**

χ^2 **= 0.08**

Chi-Square Relationship between Original Styles of Business Plans and Current Number of Employees in the VC Funded Ventures

Table E.6 demonstrates the "observed data" between "Original Styles of Business Plans" (Formal Business Plans versus Short Business Plans) and "Current Number of Employees" among the VC funded ventures.

Table E.6: Observed Data Between Original Styles of Business Plans and Current Number of Employees among the VC Funded Ventures

	Number of Cases	Rate of Growth
Formal Business Plans	**10**	**51.7**
Short Business Plans	**9**	**54.8**

χ^2 **= 0.10**

Appendix F -
The Survey Form

Please send back the completed questionnaire by fax or e-mail to Darius Mahdjoubi. This study is registered at the University of Texas at Austin (a copy of IRB form can be sent upon request) and the sources of all information will be kept confidential.

Darius Mahdjoubi
The School of Information
The University of Texas at Austin
1 University Station - D7000
Austin TX 78712-0390
E-mail: <dariusm@mail.utexas.edu> - Fax: 512-471-3971, Tel: 512-471-2718

****

1. Name of the company:
2. Major activities or services of this company:
3. Time that the company incorporated: Month (__________) and year (________).
4. Time and place that the company was founded, if it is different from the month and year that it was incorporated: Month (______) and year (________) in ______ (Place).
5. Name of the founder(s) of this company:
6. Your name and position in this company:
7. Date that you completed this form:
8. Approximate total number of employees of this company:
   a. End of 2003:
   b. End of 2002:
   c. End of 2001:
   d. End of 2000:
   e. End of 1998:
   f. End of 1996:

g. End of 1994:

9. In your opinion what were major sources of capital <u>during the first year</u> after this company was founded. *Please check all that apply*:

[ ] Personal resources of capital from the founders and their families and friends,

[ ] Angel investors, as sources of capital

[ ] Venture Capitals, as sources of capital

[ ] Corporations as sources of capital

[ ] Bank loans as financial resources

[ ] SBIR

[ ] Other resources of capital, please specify.

10. When founded, was this company a subsidiary or a department of a corporation?

[ ] Yes [ ] No

11. If this company was founded as a subsidiary or a department of a corporation, please indicate the name of the corporation.

12. Did this company receive Venture Capital (VC) finance? Yes [ ] No [ ]

13. If this company received VC, please indicate month (_________) and year (________)of the first stage of the VC.

14. In your opinion, please indicate the type of business plan that this company started with. *Please check all that apply*:

[ ] A formal (classical) business plan, consisting of market study, technology forecasting, and financial analysis.

[ ] A short plan (say about 5-10 pages) consisting of a brief description of the technology and a brief description of potential markets, without a detailed market study and financial analysis.

[ ] Worked up financial projections for potential investors?

[ ] A one page (back-of-the envelope) type plan?

[ ] No conventional business plan.

[ ] Other? Please describe.

15. In your opinion, <u>if this company started with a full-blown formal (classical) business plan or a short plan</u>, what was the **<u>main</u>** application of that business plan?

[ ] For communication with the third parties such as banks, government agencies, etc.

[ ] A practical internal guide for implementation.

16. In your opinion, <u>if this company started with a full-blown formal (classical) business plan</u>, how was that plan implemented during the first year of operations?

[ ] Almost as planned (say more than 80% of the plan for the first year was actually implemented).

[ ] Major changes in the original plan (say about 50-80% of the plan for the first year was actually implemented).

[ ] Strong changes in the original plan (say about 20-50% of the plan for the first year was actually implemented).

[ ] Drastic changes in the original plan (say less than 20% of the plan for the first year was actually implemented).

17. In your opinion, <u>if this company did **not** start with a full-blown formal business plan</u>, did the company suffer from not having a formal business plan?

[ ] Yes [ ] No

18. In your opinion, <u>if this company did **not** start with a full-blown formal business plan</u>, do you wish it had a formal business plan?

[ ] Yes [ ] No

19. <u>After the first year</u>, how was the plan and vision for this company transformed?

[ ] The transformation was mostly based on formal (classical) business planning.

[ ] The transformation was mostly based on adaptation without formal planning.

20. In your opinion, did this company start with patented technology?

[ ] Yes. This company started with (__________) patent (s).

[ ] No. This company did not start with patented technologies.

21. Does this company currently have patents?

[ ] Yes . Currently this company has applied for (_____) patent and have registered (____) patents.

[ ] No. Currently this company has no patents

[ ] No. Currently this company has no patents, but its technologies are patentable if we pursue it.

22. If you are familiar with other companies in Austin that might be interested in participating in this study, please list the name of the company and a contact person below.

23. Any other question that you suggest?

24. Your further comments, please:

Appendix G -
Interview Questions

The first set of questions for the interviews are the same as questions for the survey section.

INNOVATION CAPABILITIES OF THE VENTURE

25. When you started this business, what was the technology that you started with?
26. How different was that technology from the competitors' technology?
27. What was the source of that technology, and how did you get the idea about that technology?
28. Was that technology based on a patent?
29. How many patents has this business?
30. Did you apply or received R&D tax credit
31. When you started this business, what were the innovation advantages of this business?

FOUNDER'S AND CEO'S BACKGROUND AND THEIR PHILOSOPHY AND VISION

32. What was your professional background, prior to starting this business?
33. What were your previous experiences in starting a new venture, prior to starting this business?
34. How did you find ways to learn from the challenges you faced in this business? Learning for your failures and near-failures, as well as your successes? Could you classify the types of your near-failures that you faced?
35. Were there any small initial changes that later made big differences in this business?

ROLE OF THE UNIVERSITY OF TEXAS AT AUSTIN AND OTHER REGIONAL STRUCTURES IN THE DEVELOPMENT OF THE VENTURE

36. Why did you initiate this business in Austin?
37. If you could start this business again, would you start it in Austin or in another city? Where? Why?
38. In what aspects the University of Texas at Austin was important in the development of this business?
39. In what aspects other regional support was important in the development of this business?

REACTIONS AND RESPONSES TO THE ECONOMIC DOWNTURN OF 2001

40. What did you do in this firm to react to the changes after 2001? How they were different from what you did before?
41. When did you come to conclusion that the recent economic change (late 2000 and early 2001) is not short-lived and is going to stay for a longer period of time?
42. How different is this recent economic downturn compared to the others that you have seen before?
43. What are you understanding and observations for the sources of this economic change? What was the source of economic growth in Austin in the 1990s?

Appendix H - The Questions for Investors

1) What are your main criteria for investing in a new venture?
2) How important is the role new technologies in your decisions to invest in a new venture?
3) How important is the role of patents in your decisions to invest in a new venture?
4) How important is the role of having formal business plans in your decisions to invest in a new venture?
5) How important is the role of professional backgrounds of founders, prior to starting this business
6) What do you think of the main reasons behind the rise and fall of employment in the Austin information sector?

Appendix I -
List of the Enterprises that Participated in the Survey Stage

1	**13 Colonies Software**
2	**212 Studios**
3	**360 Commerce**
4	**Athens Group**
5	**Austin Data Works**
6	**Avanti**
7	**Aviri**
8	**B2Gsource**
9	**Big Lever Software**
10	**Black Lab**
11	**Calavista**
12	**CCI-Triad**
13	**Clear Commerce**
14	**Clear Orbit (BPA Systems)**
15	**Colabornet**
16	**Collective**
17	**Concero Inc.**
18	**Convio**
19	**Coremetrics**
20	**Daedalus Group**
21	**Dolphin Group Technologies**
22	**eBlox**
23	**Egeria Design**
24	**Emerging Leaders Network**
25	**Enspire**
26	**ETI**
27	**Exterprise Inc**
28	**Forward Vue Technologies**
29	**Grande Communication**
30	**Guard IT**
31	**Hyperformix**
32	**Intesil Americas**
33	**Inventes**
34	**iVEEA LLC**
35	**Journee**
36	**Ki-Soft**
37	**Knowledge Discovery One**
38	**Less Network**
39	**Lombardi Software**
40	**MIP**
41	**Magdesign**
42	**Momentum Software**
43	**Momentum Technical**
44	**Motion Computing**

45 **NetQos**
46 **Netsolve**
47 **Newisys**
48 **NewsStand**
49 **Novoua (Lares)**
50 **OnRamp**
51 **Optive Research**
52 **Pavilion**
53 **PeopleAdmin**
54 **Percpetive Sciences**
55 **Photoddex**
56 **Pixel Magic**
57 **Pragma**
58 **Quick Arrow**
59 **Raak Technologies**
60 **S3PT**
61 **SciComp**
62 **Sematic Design**
63 **Siberlink**
64 **SigmaTrak**
65 **Smarte Price**
66 **Smarte Solutions**
67 **Technology Futures**
68 **TeraQuest**
69 **Tonic**
70 **Tower Technology**
71 **Trade Technologies**
72 **Traq Wireless**
73 **USSI**
74 **Vignette**
75 **Webify**
76 **Whisper Wire**
77 **Zebra**

Appendix J -
List of the Interviewees

1. **George Kozmetsky**: Chairman, IC^2 (Institute for Innovation, Creativity and Capital), UT-Austin[36]
2. **Bobby Inman**: Chair in National Policy, LBJ School of Public Affairs, UT-Austin
3. **Ed Taylor**: CEO, Collective Technology
4. **Neil Webber**: Co-founder, Vignette
5. **Miller Hicks**: President, RMH.
6. **Carolyn Stark**: Executive Director, Austin Technology Council
7. **Bill Bishop**: Staff Writer on Innovation, Austin American Statesman
8. **Carolyn Purcell**: Chief Information Officer, State of Texas
9. **Susan Davenport**: Greater Austin Chamber of Commerce
10. **Gordon Walton**: Vice President, Sony Online Entertainment
11. **Craig Fryar**: Entrepreneur in software industry
12. **Laura Kilcrease**: CEO, Triton
13. **Jamie Rhodes**: CEO, Austin Usability
14. **Douglas Neuse**: Vice President, Hyperformix
15. **Herb Krasner**: Director, Center for Advanced Research in Software Engineering, UT-Austin
16. **Frank Milton**: IBM BCS Partner, U. K. Director of PWHC Surveys on Innovation
17. **Katherine Hammer**: CEO, ETI
18. **Robin Curle**: CEO, Zebra Imaging
19. **Michael Clifford**: CIO, Whole Foods Market

[36] UT-Austin stands for The University of Texas at Austin.

20. **Randolph Bias**: Associate Professor, School of Information, UT-Austin
21. **David Gibson**: Director of Research, IC^2, UT-Austin
22. **Glynn Harmon**: Professor, School of Information, UT-Austin
23. **Robert Ronstadt**: Vice President of Technology Commercialization, Boston University
24. **Claudia Chidester**: Lecturer, School of Information, UT-Austin
25. **Chris Engle**: Vice President, Angelou Economics
26. **Stacey Higginbotham**: High-Tech Columnist, Austin Business Journal
27. **Rob Adams**: Partner, Austin Ventures
28. **Kent Hemingson**: Director, Quality Management Consortium. UT-Austin
29. **Joel Wiggins**: Director, Austin Technology Incubator
30. **Scott Uhrig:** CEO, Whiterock Partners.
31. **John Wolper**: Manager, IBM Extreme Blue
32. **Elaine Wetmore:** CEO, Austin Entrepreneurs Foundation
33. **Bobby Afshin:** Consultant, Schon Technologies.
34. **Mark McCary**: Senior Manager, Grande Communications
35. **Les Belady**: CEO, Eutecus
36. **Mike Mayeux**: CEO, Novotus.
37. **Gary Cowsert**, Manager, CCI-Triad
38. **Andrew Dillon**: Dean, School of Information, UT-Austin
39. **David Gerhardt:** President, Capital Network, Austin
40. **Gary Cadenhead**: Director, MootCorp. UT-Austin
41. **Keith Moe**: Angel Investor and former COO, 3M
42. **James Ronay**: CEO, Ronay Enterprises
43. **Paul Schumann**: CEO, Glocal Vantage, Inc.

44. **Donna Prestwood**: Consultant
45. **Raymond Yeh**: CEO, Fun-Soft
46. **Bijoy Goswami**: CEO, Aviri
47. **James Galbraith**: Professor, JBJ School of Public Affairs, UT-Austin
48. **Anthony Ambler**: Chairman, Department. of Electrical and Computer Engineering, UT-Austin
49. **Ben Streetman**: Dean, College of Engineering, UT-Austin
50. **Paul Toprac**: Consultant, Selling Events
51. **Steve Nichols**: Associate Vice President of Research, UT-Austin
52. **Pike Powers**: Attorney at Law
53. **Leslie Martinich**: President, Competitive Focus
54. **Randi Shade**: CEO, Austin Entrepreneurs Foundation
55. **Brad Zehner**: Director, MSSTC Executive Master Program
56. **Alex Cavalli**, Deputy Director, IC^2, UT-Austin
57. **Fred Patterson**: The SBIR Coach
58. **Denny Hamill**: VP Nanotechnologies (Ex-Chairman of MCC)
59. **Steve Portnoy**: CEO, Nichibei Consulting
60. **Neal Kocureck**: CEO, St. David's Health Care System
61. **Peter Zandan**: Managing Director, Public Strategies Inc.

Appendix K -
Combined Data about Initial Sources of Capital, Growth, and Patents

The table K.1 is organized into four groups: VC funded, VC backed, Self-funded and Micro Ventures. In each group, the information is in descending order according to the current number of employees. The list of self-funded ventures includes two corporation funded ventures, by two medium size corporations. The list of the VC backed ventures includes three ventures that no longer exist, so in the table they are marked with zero employees. It was possible, however, to contact the founders of the three ventures, and they provided information about the whole lifecycle of the ventures.

Table K.1: Data about Initial Sources of Capital, Growth, and Patents

Current Employee Number	**Rate of Growth** (Current Employee Number / Current Age	**Starting Patent**	**Registered Patents Number, Current**	**Potential Patent**
VC Funded				
210	42	1	12	
150	12.5			
100	33.3		4	
75	37.5			
68	5.7			1
64	16.0		5	
62	13.8			
60	15.0			
57	11.4			
50	12.5		3	
50	11.1		3	
42	26.3		1	
40	10.0			
35	8.8			
25	4.2			
22	4.9			

20	4.0	1	1	
15	3.8			
5	0.3		1	
5	1.4			
VC Backed				
450	16.7			
140	11.7		1	
65	5.9		6	
45	1.4			
17	2.6			1
0	0.0		4	
0	0.0			
0	0.0			
Self Funded				
314	34.9		5	
180	20.0			
150	6.8			
50	7.1			
43	7.2		3	
25	2.6			
25	2.5			
25	5.0			
20	5.0			
20	5.0			
15	3.3			
15	1.9			
15	3.8			
15	15.0			
15	2.5			
15	1.1			1
15	1.0			1
15	0.9			
12	1.7	1		
12	2.2			
8	1.0		1	
8	4.0			1
7	2.8			1
5	5.0			
Micro Ventures				
4	1.1			
4	1.3			
4	4.0			

4	4.0			
4	1.6			1
3	0.3			
3	0.2			
3	1.5			1
2	0.1			
2	0.7			
2	0.4			1
2	0.3			
2	0.1			
2	5.0			1
1	0.3			1
1	0.5			1
1	0.2			
1	0.3			
1	0.3			

References

Amidon, Debra and Darius Mahdjoubi. (1999). "An Atlas for Knowledge-Innovation". In *Handbook of Business Strategy*. New York: Faulkner & Gray.

Angelou Economics. (2002). *2003-2004 Economic & Technology Forecast*. Austin: Angelou Economics

Aydalot, Philippe and David Keeble. (1988). "High Technology Industry and Innovative Environments in Europe". In Aydalot, Philippe and David Keeble (Editors). *High Technology Industry and Innovative Environments: The European Experience*. London: Routledge.

Bagley, Constance and Craig Duchy. (1998). "Venture Capital". In Sahlman, William et at. (Editors). *The Entrepreneurial Venture*. Second Edition. Boston: Harvard Business School Press.

Battram, Arthur.(1998). *Navigating Complexity*. London: Industrial Society

Bennett, Jeffrey and William Briggs. (2002). *Using and Understanding Mathematics: A Quantitative Reasoning Approach*. Boston: Addison Wesley

Bhide, Amar. (1992). "Bootstrap Finance: The Art of Start-ups." *Harvard Business Review*, V 70, N 66, November-December: pp. 109-117.

Bhide, Amar. (1994). "How Entrepreneurs Craft Strategies that Work." *Harvard Business Review.* March-April. pp. 150-161.

Bhide, Amar. (2000). *The Origin and Evolution of New Businesses.* Boston: Harvard Business School Press.

Block, Zenas and Ian MacMillan, (1995). *Corporate Venturing: Creating New Ventures within the Firm*. Boston: Harvard Business School Press.

Butler, John Sibley. (2003). "The Science and Process of Entrepreneurship." Appeared in *Inside the Minds: The ABCs of Entrepreneurship.* Aspatore Books

Bygrave, William and Charles Hofer. (1991). "Theorizing about Entrepreneurship." *Entrepreneurship Theory and Practice.* Vol 16, No. 2, 13-22.

Campbell, Andrew and Julian Birkinshaw. (2004). "Know the Limits of Corporate Venturing". *Financial Times*. August 9, 2004, Page 9.

Cardella, Ruth. (1999). *The Austin Software Industry: An Engine for Economic Development?*. Master thesis. Austin: The University of Texas Austin.

Cardullo, Mario. (1999). *Technological Entrepreneurism*. Baldock, England: Research Studies Press.

Case, John. (1989). "The Origins of Entrepreneurship". *Inc. Magazine.* June. p 51.

Castrogiovanni, Gary. (1996). "Pre-Startup Planning and the Survival of New Small Businesses". *Journal of Management*. Vol. 22, No. 6, pp. 801-822.

Chesbrough, Henry. (2002). *Open Innovation*. Boston: Harvard Business School Press.

Cooley, Kevin. (2003). *Complex Adaptive Systems: A Nominal Definition.* www.eas.asu.edu/~kdooley/casopdef.html

Cornett, Andreas. (2002). *Regional Systems of Innovation and Regional Development.* Dortmund, Germany: European Regional Science Association, 42nd European Congress

Davila, Antonio, George Foster and Mahendra Gupta. (2003). "Venture Capital Financing and the Growth of Startup Firms." *Journal of Business Venturing*. 18 (December 2003). pp. 689–708

Descartes, René. (1637). *Discourse on Method.* Translated by Desmond Clarke. 1999. London: Penguin Books.

Dictionary.com. (2003). http://dictionary.reference.com/

Drucker, Peter. (1993). *Post-Capitalist Society*. New York: Harper-Business.

Drucker, Peter. (2004). "What Makes an Effective Executive." *Harvard Business Review.* June 2004.

Edvinsson, Leif and Michael Malone. (1997). *Intellectual Capital: Realizing Your Company's True Value by Finding Its Hidden Roots*. New York. Harper Collins.

Edvinsson, Leif. (2002). *Corporate Longitude: What Do You Need to Know to Navigate the Knowledge Economy*. Sweden: Book-house Publishing.

Fitzpatrick, Peter. *Chart of Timing of Venture Capital Financing*. (1991). Potomac, MD: Peter Fitzpatrick.

Fortune. (1993). The cover page for a special section on strategy. July 26.

Fukushima, Michi. (2004). *Origin and Formation of the Software Industry in Austin*. A Report for Grand-in-Aid for Scientific Research, Funded by the Japan Society for the Promotion of Science (JSPS). Part of this report is published in Japanese.

Garnsey, Elizabeth. (2002). “The Growth of New Ventures.” Appeared in Pitelis, Christopher (Editor). (2002). *The Growth of the Firm: The Legacy of the Firm*. Oxford: Oxford University Press.

Gates, Bill. (1996). *The Road Ahead.* New York: Penguin Books.

Gibbons, Michael, Peter Scott, Helga Nowotny, Camille Limoges, and Simon Schwartzmann. (1994). *New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage Publications Inc.

Gibson, Brian, Cassar, Gavin and Dianne Winghan. 2001. *USASBE/SBID Annual National Conference*. “Longitudinal Analysis of Relationships Between Planning and Performance in Small Australian Firms.” Orlando, Florida.

Gibson, David, Cherie Long and George Kozmetsky. (1993). *Greater Austin Software Industry Report*. Austin, TX: IC2 Institute.

Gibson, David and Everett Rogers. (1994). *R&D Collaboration on Trial: the Microelectronics and Computer Technology Corporation*. Boston: Harvard Business School Press

Gompers, Paul and Joseph Lerner. (2001). *The Money of Invention: How Venture Capital Creates New Wealth*. Boston: Harvard Business School Press

Grant, Robert. (1996). “Toward a Knowledge-Based Theory of the Firm”. *Strategic Management Journal*. 17: Winter, pp. 109-122

Grove, Andy. (1999). *Only the Paranoid Survive*. New York: Randon House

Gumpert, David. (2002). *Burn Your Business Plan*. Needham, MA: Lauson Publishing.

Hambrick, Donald, David Nadler and Michael Tushman. (1998). *Navigating Change*. Boston: Harvard Business School Press

Harmon, Glynn and Darius Mahdjoubi. (2001). *Knowledge Sensitive Performance Metrics*. Washington D. C.: Annual Conference of the American Society of Information Science and Technology.

Hammer, Kay. (2000). *Workforce Warrior*: New York: AMACOM Books.

Hawkins, Lori. (2002). *Austin Sees New Wave of Investing.* Austin: Austin American Statesman. October 29, 2002.

Hosking, Dian Marie and Neil Anderson. (1992). “Organizing Change and Innovation.” Appeared as Chapter 1 in Hosking, Dian Marie and Neil Anderson (Editors). (1992). *Organizing Change and Innovation: Psychological Perspectives and Practices in Europe*. London: Routledge.

Intel Museum. (2004). http://www.intel.com/intel/intelis/museum/index.htm

Kanter, Rosabeth Moss. (1989). "Swimming in Newstreams: Mastering Innovation Dilemmas." *California Management Review*. Summer 1989. pp. 45-69.

Kerlinger, F. N. (1973). *Foundations of Behavioral Research.* Second Edition. New York: Hold, Rinehart and Winston.

Kim, Janghoi. (2002). *Historical and Empirical Study of Austin's Economic Growth*. Master thesis. Austin: The University of Texas Austin.

Kline Stephen. (1991). *Models of Innovation and Their Policy Consequences*. In Kingery, David (ed). 1991. *Japanese/American Technological Innovation*. New York: Elsevier

Kortum, Samuel and Josh Lerner. (1998). *Does Venture Capital Spur Innovation?*. Working Paper No. 6846. Cambridge, MA: National Bureau of Economic Research.

Kortum, Samuel and Josh Lerner. (2000). Assessing the Contribution of Venture Capital to Innovation. *RAND Journal of Education.* Vol. 31, No. 4, Winter 2000. pp. 674-692.

Kozmetsky, George and Piyu Yue. (2002). *The Economic Transformation of the United States, 1950-2000.* Austin: IC^2 Institute

Kuhn, Thomas. (1970). *The Structure of Scientific Revolutions.* Second Edition. Chicago: The University of Chicago Press

Lastrucci, Carol. (1963). *The Scientific Approach: Basic Principle of the Scientific Method*. Cambridge. Schenkman Publishing

Latour, Bruno. (1987). *Science in Action*. Milton Keynes ; Philadelphia : Open University Press

Leifer, Richard, Gina O'Connor and Christopher McDermott. (2000). *Radical Innovation: How Mature Companies Can Outsmart Upstarts.* Boston: Harvard Business School Press

Lovallo, Dan and Daniel Kahneman. (2003). "Delusions of Success". *Harvard Business Review*. Vol. 81, Issue 7, July.

Lumpkin, G.T, Rodney Sharader and Gerald Hills. (1998). "Does Formal Business Planning Enhance the Performance of New Ventures?" Babson Entrepreneurship Conference. Frontier of Entrepreneurship Research. Gent, Belgium. Appeared in

Frontiers of Entrepreneurship. (An Online Journal). http://www.babson.edu/entrep/fer/papers98/VII/VII_A/VII_A_text.htm).

Mahdjoubi, Darius. (1997). *The Mapping of Innovation*. Toronto, Canada: Joint Adjustment Committee of Etobicoke.

Mahdjoubi, Darius. (2002). "Bridging Theory and Practice, a Dilemma." *6th International Conference on Technology Policy and Innovation*. Kasai, Japan

Mahdjoubi, Darius. (2004). "Dynamic Model of Production, and Evolution of the Knowledge Economy." In Amidon, Debra, Piero Formica and Eunika Mercier-Laurent (Editors). *Knowledge Economics: Emerging Principles, Practices and Policies*. Tartu: Tartu University Press

Mahdjoubi, Darius and Kerem Tomak. (2001). *Using Gray Box Model to Explore the Relationships Between Knowledge Management and E-Business*. International Conference on Intellectual Capital and E-Business, McMaster University, Hamilton, Canada

Malizia, Emil, and Edward Feser. (1999). *Understanding Local Economic Development*. New Brunswick. Center for Urban Policy Research.

Marshall, Deborah. (2000). Civic Entrepreneurs. *Anchorage Daily News*. (2000). March 25. http://alaskainvestnet.org/investor-article1.html

Miller, Jonathan. (1999?). *Regional Case Study: Austin, Texas or "How to Create a Knowledge Economy*. Washington, DC: Delegation of the European Commission to the United States. http://www.eurunion.org/partner/austin.htm

Mintzberg, Henry, BruceAhlstrand and Joseph Lampel. (1998). *Strategy Safari*. New York: Free Press

Nauwelaers, Claire and Alasdair Reid. (1995). *Innovative Regions?: A Comparative review of methods of evaluating regional innovation potential*. Luxembourg: European Commission

Nesheim, John. (2000). *High Tech Start Up: The Complete Handbook for Creating Successful New High Tech Companies*. New York: The Free Press

Nonaka, Ikujiro. (1991). "The Knowledge Creating Company". *Harvard Business Review*. 69. 6 (November- December). 96-104

Nonaka, Ikujiro and Hirotaka Takeuchi. (1995). *The Knowledge Creating Company*. New York: Oxford University Press.

OECD. (1991). *Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*. Paris: OECD

Olson, Ken. (1987). "The Spirit of Entrepreneurship." *Technology Review*. August/September.

Ou, Charles and George Haynes. (2003). Uses of Equity Capital by Small Firms. A working paper of the Small Business Administration.

Penrose, Edith. (1959). *The Theory of the Growth of the Firm*. Oxford: Oxford University Press.

Polanyi, Micheal. (1966). *The Tacit Dimension*. New York: Anchor Books.

Preer, Robert. (1992). *Emergence of Technopolis: Knowledge-Based Intensive Technologies and Regional Development*. New York: Praeger.

Ramamoorthy, C. V. (May 2000). "A Study of the Service Industry – Functions, Features and Control". *IEICE Transactions on Communications*. Vol. E83–B, No. 5. pp. 885-902.

Roberts, Edward. 1991. *Entrepreneurs in High Technology*. New York: Oxford University Press.

Rock, Arthur. (1987). "Strategy vs. Tactics from a Venture Capitalist". *Harvard Business Review.* November-December. P. 63-67

Rogers, Everret. (2003). *Diffusion of Innovations*. New York: Free Press

Ronstadt, Robert. (1977). *Research and Development Abroad by U.S. Multinationals*. New York: Praeger

Ruegg, Rosalie and Irwin Feller. (2003). *A Toolkit for Evaluation of Public R&D Investment*. Washington, DC: National Institute for Standards and Technology.

Runka, John and John Young. (1987). "A Venture Capital Model of the Development Process for New Ventures." *Journal of Business Venturing*. (2), PP. 167-184.

Sahlman, William. (1997). "How to Write a Great Business Plan." *Harvard Business Review*. July-August. pp. 98-108

Saxenian, AnnaLee. (1994) *Regional Advantage: Culture and Competition in Silicon Valley and Route 128:* Boston: Harvard University Press

Shepherd, Dean, Richard Ettenson and Andrew Crouch. (2000). "New Venture Strategy and Profit Reliability." *Journal of Business Venturing.* (15): 449-467

Shrivastava, P., and I. I Mitroff, , 1984. *Enhancing Organizational Research Utilization: The Role of Decision makers' Assumptions*. *Academy of Management Review*, 9: 18-26.

Shuman, Jeffrey and David Rottenberg. (1999). "Loser Chic". *Business Start-Ups*. February 1999.

Silicon Valley Network (2003). *Index of Silicon Valley*. San Jose, CA: Joint Venture Silicon Valley Network.

Smilor, Ramond, George Kozmetsky and David Gibson. (1988). *Creating the Technopolis: Linking Technology Commercialization and Economic Development.* Cambridge, MA: Ballinger.

Sohl, Jeffrey. (1999). "The Early-Stage Equity Market in the USA." *Capital Venture*. Vol. 1, No. 2, pp. 101-120.

Suppe, Frederick. (1997). "Afterward – 1997". In Suppe, Frederick (Editor). *The Structure of Scientific Theories*. Urbana. University of Illinois Press.

Texas Workforce Commission Website. (2003).http://www.twc.state.tx.us/mi/lfs/area/msa/austinmsahome.html

The Economist. (1997). "Survey of Silicon Valley". March 29. London: The Economist

Tidd, Joe, John Bessant and Keith Pavitt. (1997). *Managing Innovation: Integrating Technological, Market and Organizational Change*. New York: John Wiley & Sons

Timmons, Jeffery. (1994). *New Venture Creation. Entrepreneurship for the 21st Century*. Chicago: Irwin.

U. S. Bureau of Labor Statistics Website. (2003). http://www.bls.gov/data/

U. S. Census Bureau. (2003). http://quickfacts.census.gov/qfd/meta/long_metro.htm.

Vaughan, Liwen. (2003). *Statistical Methods for the Information Professional*. Meford, New Jery: Information Today.

Van de Ven, Andrew. (2000). *Professional Science for a Professional School: Action Science and Normal Science*, chapter 19 in Beer, M. and N. Nohria (Eds.) *Breaking the Code of Change*. Boston: Harvard Business School Press, pp. 393-413.

Van Osnabrugge, Mark and Robert Robinson. (2000). *Angel Investing.* San Francisco: Jossey-Bass.

Venture Economics. (2003). *Venture Funding*. March 31, 2003. www.ventureeconomics.com

Yin, Robert. (1994). *Case Study Research: Design and Methods*. Thousand Oaks: Sage Publications.

Vita

Darius Mahdjoubi has been a Texas resident since 1999, Canadian citizen since 1994 and Iranian national since 1951. He received his B. S. and M. S. degrees in mechanical engineering, from the Engineering College of Tehran University, in 1974 and 1976. Between 1977 and 1986 he worked as a process engineer, project engineer and project manager in a wide range of industrial projects in Iran. Through this process he became interested in the role and impacts of technology on enterprise and regional development. Parallel with his day job, he independently studied the process of developing technological capabilities, as a foundation for further enterprise and economic development.

Between 1986 and 1991, he worked as an industrial consultant and was active in developing technology strategies—as a basis for practical business plans—for a group of industrial projects. He also took part in developing the first national technology strategy for Iran. *Organizing Engineering Services Firms in Developing Countries*, a document of about 120 pages, is a result of this period of intellectual activity.

In 1991 he immigrated to Canada to establish *Industrial Consultancy Technology Center*. Between 1994 and 1997 he was active in developing a regional innovation strategy for Etobicoke, a suburb of Toronto, Canada. The Federal Department of Human Resources Development Canada – HRDC financially supported this project. *The Mapping of Innovation*, a document of about 150 pages, is an outcome of the project.

In 1999 he met Dr. George Kozmetsky, who suggested an interdisciplinary Ph.D. study on knowledge and innovation, which would lead to the development of *The Atlas of Innovation* as an extension of *The Mapping of Innovation*. The present dissertation is a result of this effort.

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