Building Indigenous Companies: Private/Public Infrastructures for Economic Growth and Diversification

By: **George Kozmetsky and Raymond W. Smilor**

Date: May 1986

Abstract:

This monograph brings together selected articles and IC² Institute research on the topic of regional economic development through the growth of locally founded (or "indigenous") companies, in contrast to development relying primarily on industrial relocation. It provides a framework for understanding and implementing new approaches to economic growth and diversification at the community and regional levels. Talent, technology, capital and know-how are all required to build successful ventures. There must also be institutional foundations that support the entrepreneurial process through innovative infrastructures. These infrastructures include educational institutions, public and private sector entities, financial institutions and business networks. In addition, newer institutional relationships are necessary to link effectively business, government and academia.

Keywords: economic development; regional development; entrepreneurship

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BUILDING INDIGENOUS COMPANIES:

PRIVATE/PUBLIC INFRASTRUCTURES

FOR ECONOMIC GROWTH AND DIVERSIFICATION

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Preface

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The monograph provides a framework for understanding and implementing new approaches to economic growth and diversification at the community and regional levels. Talent, technology, capital and know-how are all required to build successful ventures. There must also be institutional foundations that support the entrepreneurial process through innovative infrastructures. These infrastructures include educational institutions, public and private sector entities, financial institutions and business networks. In addition, newer institutional relationships are necessary to link effectively business, government and academia.

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CHAPTER 1

INSTITUTIONAL DEVELOPMENTS FOR COMMUNITY/REGIONAL ECONOMIC GROWTH & DIVERSIFICATION THROUGH TECHNOLOGY: HIGHLIGHTS

By

George Kozmetsky

I. Technology since the Indusrial Revolution has been a basic motor for economic growth and wealth generation.

   A. Jobs development In U.S. since 1974 has been unique. Nothing like it has happened in any other country. Specifically:

      1. Over 24 million jobs were created.

      2. Small business establishments (less than 50 employees) generated 62.4% of the net increase in new employment.

      3. Fortune 500 companies in the manufacturing and service sectors lost more than 5 million jobs.

   B. By 1983, the U.S. economy was transformed into an information economy; i.e., information industries constituted 51.5% of the GNP.

      1. An information economy consists of <u>education, research & development, media & communications, information services</u> (legal, engineering, architecutral, accounting and auditing, computer & data processing, medical, financial services, insurance, real estate, wholesale, and governmental services), and <u>information technology manufacturing</u> (robotics, CAD/CAM, numerical controls,

printing, computer equipment & software, radio & television, telephone & telegraph, electronic components, instruments for measuring, photographic equipment, medical instruments & supplies, and athletic equipment).

2. More than high technology is involved in an information economy. The largest sectors in rank order are health & medical services, banking & credit, insurance, education, telephone & telegraph, research & development, and advertising.

3 Information technology manufacturing's largest industrial sectors in rank order are computers & software, electronic components, radio & television, photographic equipment, and telephone & telegraph.

II. Lack of economic growth results in:

A. Decay and depressive situations - lack of dynamism.

B. High unemployment, especially among youths, minorities, and displaced employees.

C. Deficits for all governmental entitites.

D. Pressures for protectionism.

E. Loss of leadership and preeminence - technological backwardness.

III. Prerequisities for Success

A. An on-going scientific-technical base.

1. Technology oriented institutional complexes.

2. Education and training of scientists, engineers, managers, business specialists, and technicians.

3. Changing scope of higher education for technological and economic leadership.

4. Not all innovations are technology driven; other drivers are demographics, markets and domestic/international crises.

5. Smaller firms create more overall jobs in innovation centers.

B. Private/Public infrastructure basic institutional building blocks.

1. Research and Development Performers (See Chart B)

2. Financing Technology Based Firms (See Table 4 - 6, 7, 8 & 9 & Chart C.)

   a. Traditional Venture Capital Sources

   b. Emerging Venture Capital Sources

   c. Special Sources

3. Technology Venturing -- Newer Institutional Developments

   a. For scientific and economic preeminence

      (1) NSF Centers for Scientific & Engineering Excellence

      (2) Government/Business/University Collaborations

      (3) Industrial R&D Joint Ventures and Consortia

      (4) NSF/University/Industry Cooperative Research Centers

   b. To develop emerging industries

(1) Academic/Business Relationships

(2) Industrial R&D Consortia

c. To create small and take-off companies

(1) Incubators

(2) Small Business Innovation Research Centers

(3) State Venture Capital Funds

C. Governmental actions that facilitate and stimulate technological developments for economic growth.

1. Encourage and support R&D for comprehensive security.

2. Planning, financing and managing government-sponsored large scale programs.

3. Provide incentives for technological entrepreneurship and remove barriers to innovation.

4. Facilitate and generate technological transfer and use through:

   a. Environment for fostering innovation and industrial investment.

   b. Promotion of university-industry relationships and exchanges.

D. Transformational environment for growth.

1. Focus on benefits for individual firms and corporations as well as the general welfare.

2. Need for flexibility and adaptability to deal with rapid and external technological changes.

3. Need for institutional arrangements to deal with economic growth or stagnation.

4. Need for systematic body of ideology that deals with human life or culture, and is comprised of a set of integrated assertions and aims that constitute a social political program.

IV. Challenges for Texas

A. How do we establish State of Texas Science & Technology Policies that encompass our own unique technologies that are more than following the five or six high technologies that all other states and developed nations are following?

B. Why is it that Texas does not have a major Federal R&D Laboratory?

C. What does it take for Texas to attract outside venture capital and other financing second to California to build indigenous companies headquartered in Texas that become the new Fortune 500 in the next 20 years?

D. How do we diffuse technology developed in our flagship and lightning-rod institutions to all our communities so that we maintain the viability of current firms as well as provide for diversification and growth in newer indigenous firms?

E. How can we increase Texas' share of Federal R&D so that we are at least the third-ranked state?

F. How can Texas technology be used to transform our economy so that it is more export driven?

V. Priorities for Texas

A. Texas should establish its own State Venture Capital Funds for funding Texas's start-up companies. Statutes should be changed so our public pension funds and other state endowment funds can be prudently invested in venture capital partnership.

B. Steps should be taken to identify and to extend those technologies that will permit us to maintain our energy technology leadership in the world. Furthermore, these should be extended to diversify the use of oil and gas from fuel purpose to higher value-added products that give Texas a worldwide edge and market.

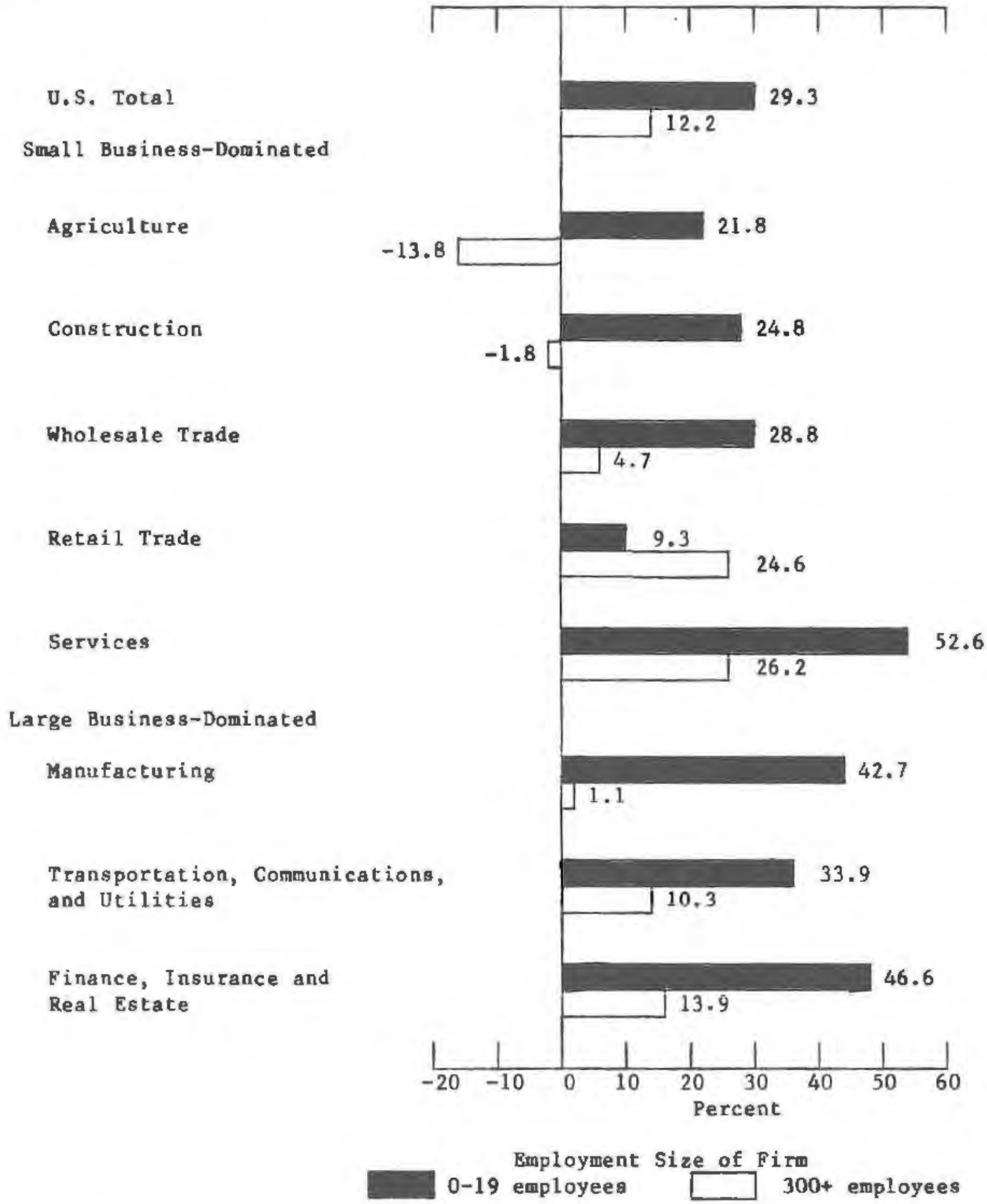
C. We should take the necessary steps that increase both the federal govenment and industry research base in Texas.

D. Texas should actively seek to establish a major Federal Research Laboratory preferably within the current capabilities and longer-term goals of our flagship universities and other lightning-rod institutions.

E. Institutions in Texas must act in a cohesive and collaborative way to advance focused technology developments and to promote a positive economy.

CHART A

GROWTH COMPARISON OF SMALLEST AND LARGEST FIRMS ON INDUSTRY DIVISION 1976-1983



NOTE: The U.S. Small Business Administration, Office of Advocacy defines an industry division as small business-dominated when 60 percent or more of the division's sales or employment is found in businesses with fewer than 300 employees. By this criterion, the agriculture, construction, wholesale trade, retail trade, and service divisions are classified as small business-dominated.

Source: U.S. Small Business Administration, Office of Advocacy, Small Business Data Base, unpublished data.

TABLE 1

Revenue Estimates of the U.S. Information Economy
Selected Dates and Character of Output 1958, 1970, 1983
(In Billions of Current Dollars)

Character of Output	Machlup[1] Knowledge Production (1958)	Harvard[2] Informational Resources (1970)	IC[2] [3] Information Industries (1983)
Education	$ 60.2	$ 72.1	$218.7
Research & Development	11.0	26.6	87.0
Media & Communications	38.4	133.4	244.8
Information Services	18.0	213.0	967.5
Information Machines Information Technology Manufacturing	8.9	Not reported	169.3
TOTAL	$ 136.4	$ 445.1	$1687.3
DNP	475.6	976.0	3304.8
Percent of GNP	28.7	45.6	51.1

Sources: [1] Machlup, F., "The Production and Distribution of Knowledge in the U.S.," 1962 pp 354-357.

[2] Harvard University "A Perspective on Informational Resources: The Scope of The Program," 1973-74 p. 2.

[3] IC[2] Institute University of Texas at Austin, unpublished survey 1985.

Table 2

REVENUE ESTIMATES OF U.S. INFORMATION ECONOMY
By Service Industries
(in billions of $)

	Machlup[1/] (1958)	Harvard[2/] (1970)	IC^2[3/] (1973)
Legal	$ 3.0		
Engineering & Architectural	2.0	$ 8.5	$ 31.5
Accounting & Auditing	1.1		
Medical (excluding Surgical)	2.1		355.4
Financial Services (banks, security brokers)	.6	101.7	295.9
Insurance Agents	2.2	92.6	222.5
Real Estate Agents	*		
Wholesale Agents	*		
Miscellaneous Business Services (including Consulting)	1.7	3.2	25.0
Government--Federal, State, Local	4.0	5.1	11.8
Computers & Dataprocessing Service	*	1.9	25.4
TOTAL	$136.4	$213.0	$967.5

*No Data Available

1/ Fritz Machlup, The Production and Distribution of Knowledge in the U.S. (Princeton University Press, 1962), pp. 354-357.

2/ Harvard University, "A Perspective on Information Resources: The Scope of the Program," 1973-74, p.2.

3/ IC^2 Institute, The University of Texas at Austin, unpublished survey, 1985.

Table 3

REVENUE ESTIMATES OF U.S. INFORMATION ECONOMY
By Information Technology Manufacturing
(in billions of $)

	Machlup[1/] (1958)	Harvard[2/] (1970)	IC^2[3/] (1973)
Printing Machinery	$ .4	*	$ 2.1
Musical Instruments	.2	*	*
Motion Picture Apparatus	.1	*	*
Telephone & Telegraph Equipment	1.2	*	13.4
Signaling Devices	.2	*	*
Measuring & Controlling Instruments	5.0	*	7.2
Typewriters	.3	*	*
Electronic Components	*	*	38.7
Other Office Machines & Parts	1.2	*	*
Photographic Equipment	*	*	17.2
Medical Instruments & Supplies	*	*	5.5
Athletic Equipment	*	*	1.4
Computer Equipment & Software	.3	*	44.0
Radio & TV Equipment	*	*	37.9
Numerical Controls	*	*	.2
CAD/CAM	*	*	1.5
Robots	*	*	.2
TOTAL	$ 8.9	-0-	$169.3

*No Data Available

1/ Machlup, *op. cit.*

2/ Harvard, "A Perspective on Information Resources," *loc. cit.*

3/ IC^2, *op. cit.*

Chart B

Federal Obligations for R&D - By Performer and Agencies 1983 (In Billions of Dollars)

By Performers

1.	Industrial Firms	$17.1	45.4%
2.	Universities and Colleges	4.8	12.9
3.	Federal Labs	10.2	27.1
4.	Federal Labs Administered By Universities and Colleges	2.3	5.9
5.	Federal Labs Administered By Industrial Firms	1.4	3.7
6.	Federal Labs Administered By Other Non-Profit Institutions	.6	1.5
7.	Non-Profit Institutions	1.1	3.0
8.	State and Local Government	.2	.5
	Total	$37.6	100.0%

By Agencies

1.	Department of Defense	$22.9	61.0%
2.	Department of Energy	4.5	12,0
3.	Department of Health and Human Services	4.3	11.5
4.	NASA	2.6	7.0
5.	NSF	1.1	2.8
6.	Department of Agriculture	.8	2.2
7.	Department of Interior	.4	1.0
8.	Department of Transportation	.3	.9
9.	Department of Commerce	.3	.9
10.	EPA	.2	.6
	Total	$37.6	100.0%

CHART C

OVERVIEW FOSTERING AND MANAGING GROWTH AND DIVERSIFICATION

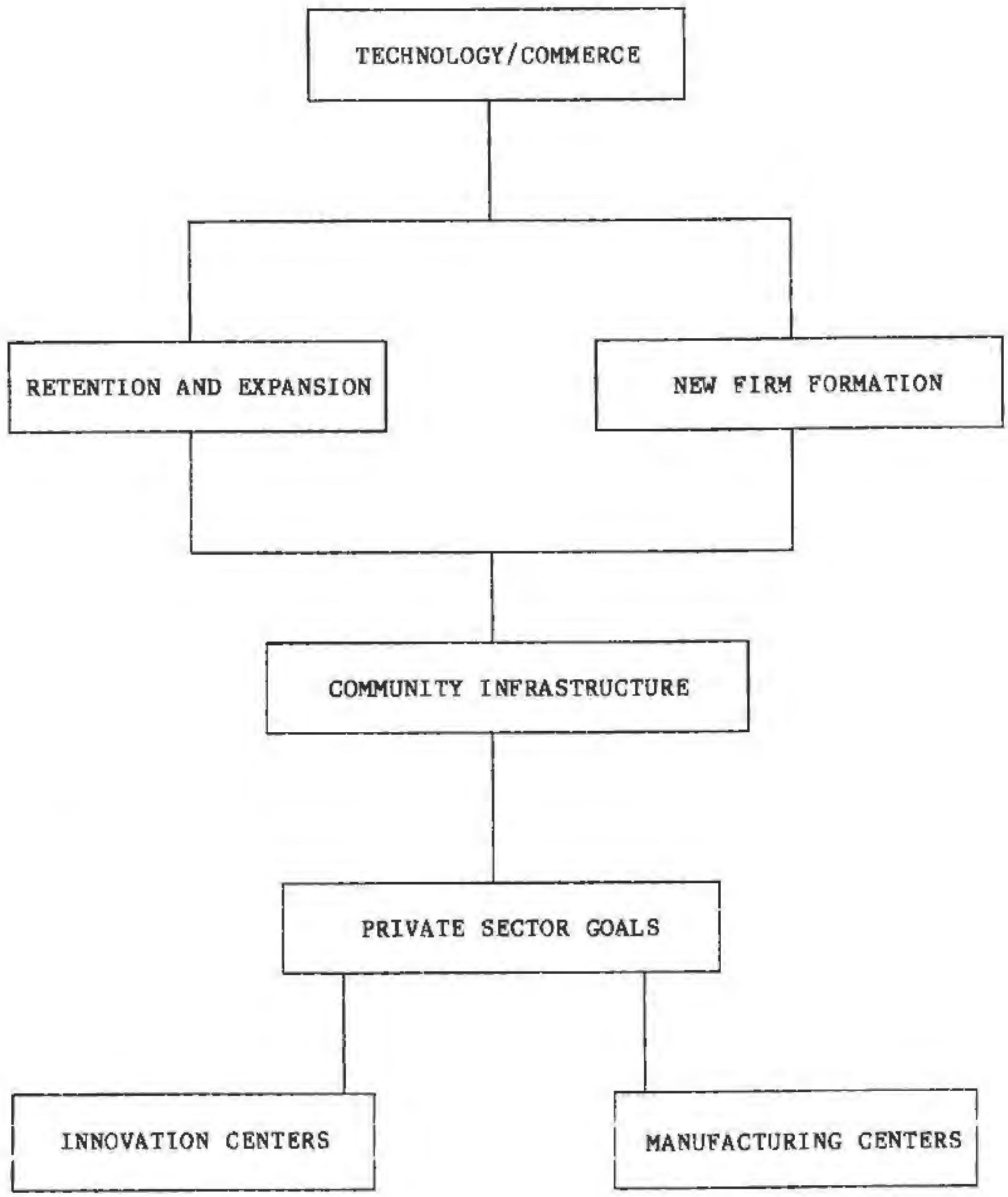


CHART D

FRAMEWORK FOR COMMUNITY/REGIONAL ECONOMIC GROWTH AND DIVERSIFICATION THROUGH TECHNOLOGY

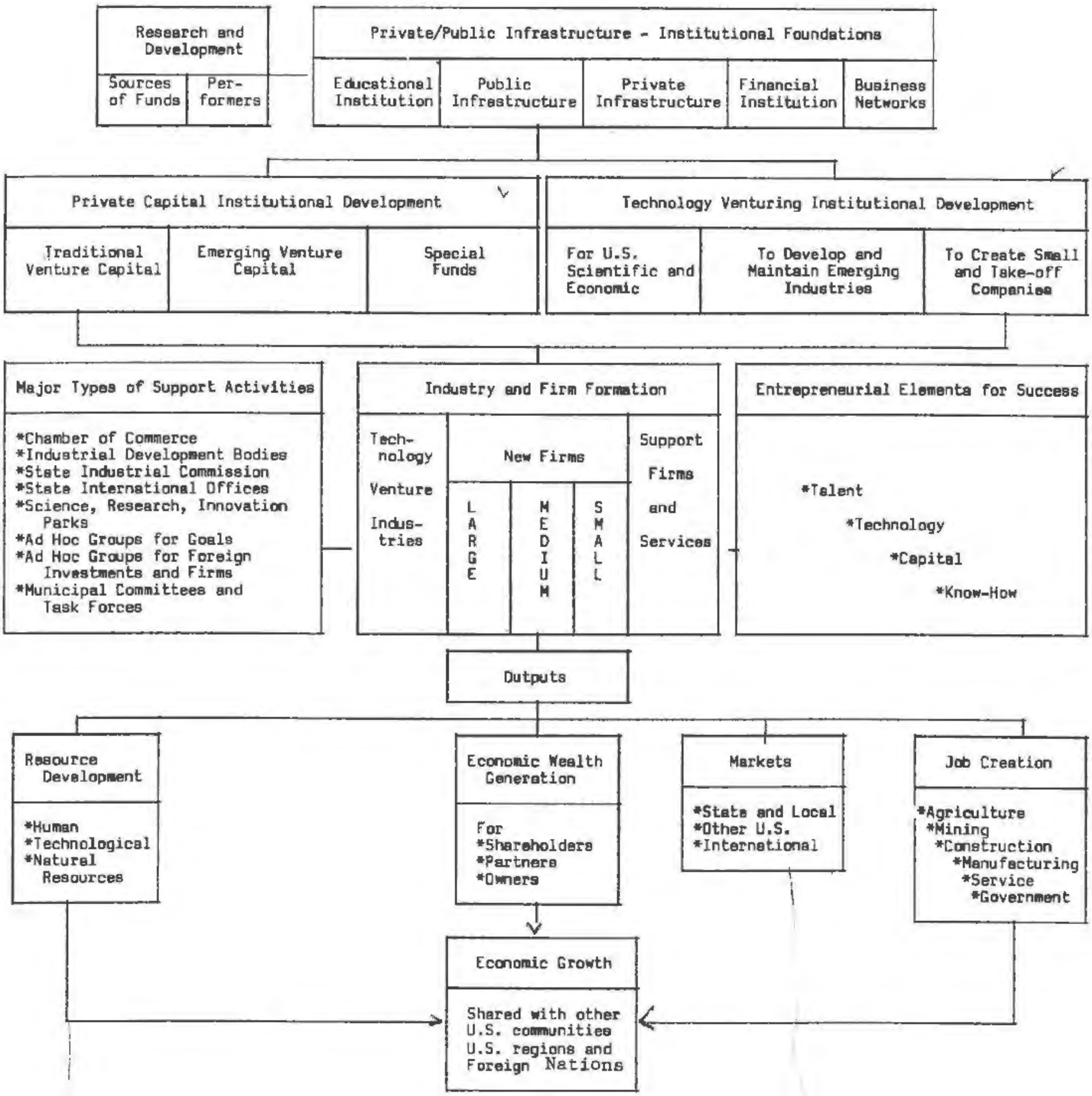


CHART E

PRIVATE/PUBLIC INFRASTRUCTURE FOR COMMUNITY/REGIONAL ECONOMIC GROWTH THROUGH TECHNOLOGY

PRIVATE/PUBLIC INFRASTRUCTURE -				
Educational Base	Public Infrastructure	Private Infrastructure	Traditional Financial Institution	Business Networks
*Elementary *Secondary *Vocational *Higher Education *Continuing Education	*Utilities *Transportation *Water *Security *Waste Desposal *Quality of Life and Environmental Factors *Government Labs *Other	*Service Clubs Trade Associations *Venture Capital *Services and Consulting Legal Accounting Financial Marketing Othering *Support Institutions Fabrication Parts and Supplies *Media Info Technology *Affordable Housing	*Commercial Banks *S&Ls *Investment Banking *Others	*Professional *Ad Hoc Associations *Informal Contacts *Mentors

CHART F

FRAMEWORK FOR COMMUNITY/REGIONAL ECONOMIC GROWTH THROUGH TECHNOLOGY

Private/Public Infrastructure - Institutional Foundations				
Educational Institution	Public Infrastructure	Private Infrastructure	Financial Institution	Business Networks

Private Capital Institutional Development

Types / Institutional Forms	Traditional Venture Capital	Emerging Venture Capital	Special Funds
1. Private Partnership	X		
2. Corporate Financial Firms	X		
3. Corporate Industrial Firms	X		
4. Small Business Investment Companies	X		
5. International Venture Capital Companies		X	
6. Business Development Firms		X	
7. R&D Limited Partnerships		X	
8. Leverage Buy Outs			X
9. Mergers and Acquisitions			X

Technology Venturing Institutional Development

Purpose / Newer Forms	For U.S. Scientific & Economic Preeminence	To Develop and Maintain Emerging Industry	To Create Small and Take-off Companies
1. Industrial R&D Consortia	X	X	
2. Academic & Business Collaborations	X		
3. University/Industry Research & Engineering Centers of Excellence	X		
4. University Intellectual Property Commercialization		X	X
5. Academic/Business/Government Collaboration		X	
6. Incubators			X
7. Small Business Innovation Research Programs			X
8. State Venture Capital Funds			X

Table 4

VENTURE CAPITAL DISBURSEMENTS BY STATE
1983 and 1984

State	1984	1983
California	44%	43%
Massachusetts	14	12
Texas	8	5
TOTAL	66%	64%

Table 5

PERCENT OF DOLLAR AMOUNT INVESTED BY STAGE

STAGE OF INVESTMENT	1984	1983	1982	1981
Seed	3%	2%	2%	2%
Startup	13	12	15	22
Other Early Stage	18	21	22	18
Total Early Stage	34%	35%	39%	40%
Second Stage	35	32	30	28
Later Stage	18	20	21	15
Total Expansion	54%	50%	51%	44%
Other (LBOs, etc.)	10%	13%	10%	14%

Table 6

VENTURE CAPITAL DISBURSEMENTS
By Industry

INDUSTRY	Percent of Companies Financed	Percent of Funds Invested
Computer Hardware and Systems	23	32
Other Electronics	12	13
Telephone and Data Communications	11	12
Software and Services	15	11
Medical/Health Care Related	11	8
Consumer Related	6	6
Commercial Communications	3	4
Industrial Products and Machinery	4	3
Industrial Automation	4	2
Genetic Engineering	3	2
Energy Related	2	2
Other	6	5
TOTAL	100%	100%

Source: Venture Economics Inc., 1984

Table 7

SOURCES OF CAPITAL FOR VENTURE CAPITAL POOLS
1980-1983

(Commitments to Independent Private Firms Only)

Investors	1984	1983	1982	1981	1980
Pension Funds	34%	31%	33%	23%	30%
Individuals and Families	15	21	21	23	16
Insurance Companies	13	12	14	15	13
Foreign Investors	18	16	13	10	8
Corporations	14	12	12	17	19
Endowments and Foundations	6	8	7	12	14

Table 8

DISTRIBUTION OF CAPITAL
AMONG VENTURE CAPITAL INDUSTRY SEGMENTS

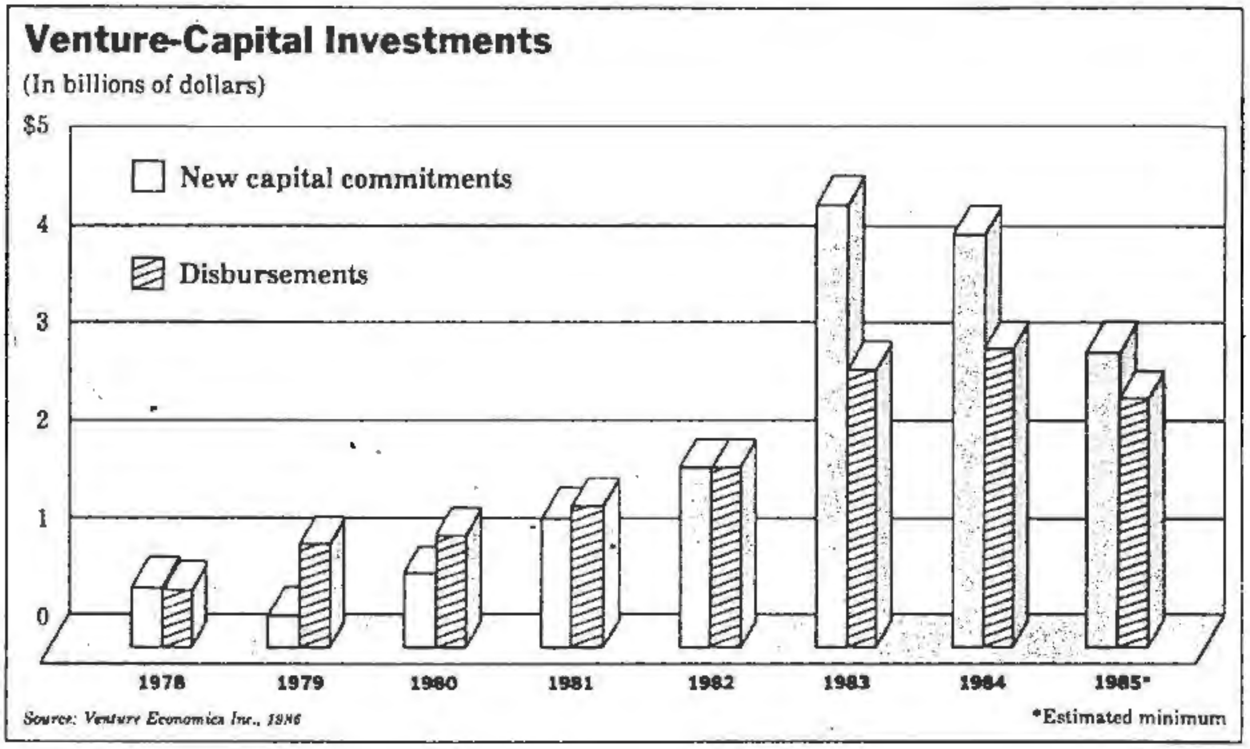
INVESTMENT VEHICLE	Millions of Dollars 1977	1984	Percent Increase
Independent Partner-	$ 950	$12,177	1,182
Corporate Financial	913	1,981	116
Corporate Industrial	258	1,423	430
SBICs and Other	390	727	86
TOTALS	$2,521	$16,308	546%

Table 9

DISTRIBUTION OF CAPITAL RESOURCES BY LEADING STATES
(millions of dollars)

STATE	1977	Percent	1983	Percent	1984	Percent
California	$ 524	21	$3,656	30	$ 5,295	32
New York	718	28	2,559	21	3,262	20
Mass.	334	13	1,549	13	2,054	13
Illinois	225	10	715	6	863	5
Conn.	89	4	683	6	794	5
Texas	83	3	473	4	775	5
Totals	$1,973	79	$9,635	80	$13,044	80

CHART G

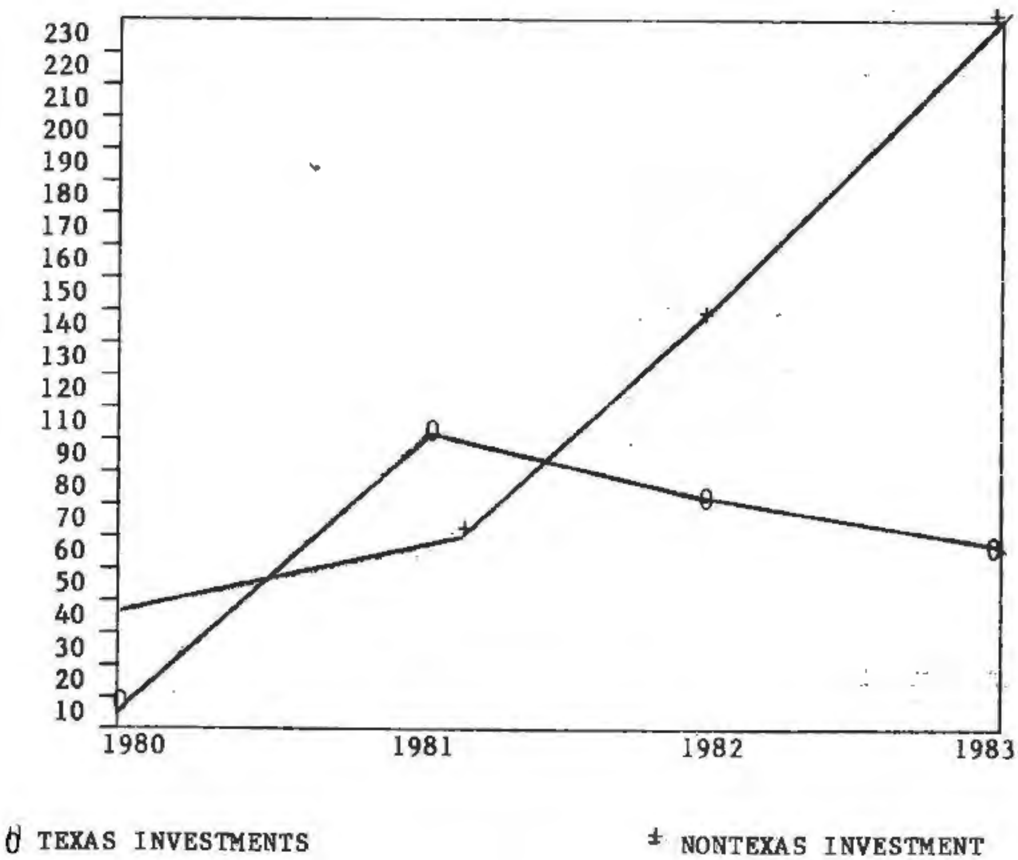


Venture-Capital Investments
(In billions of dollars)
$5
4
3
2
1
0
New capital commitments
Disbursements
1978
1979
1980
1981
1982
1983
1984
1985*
Source: Venture Economics Inc., 1986
*Estimated minimum

CHART H

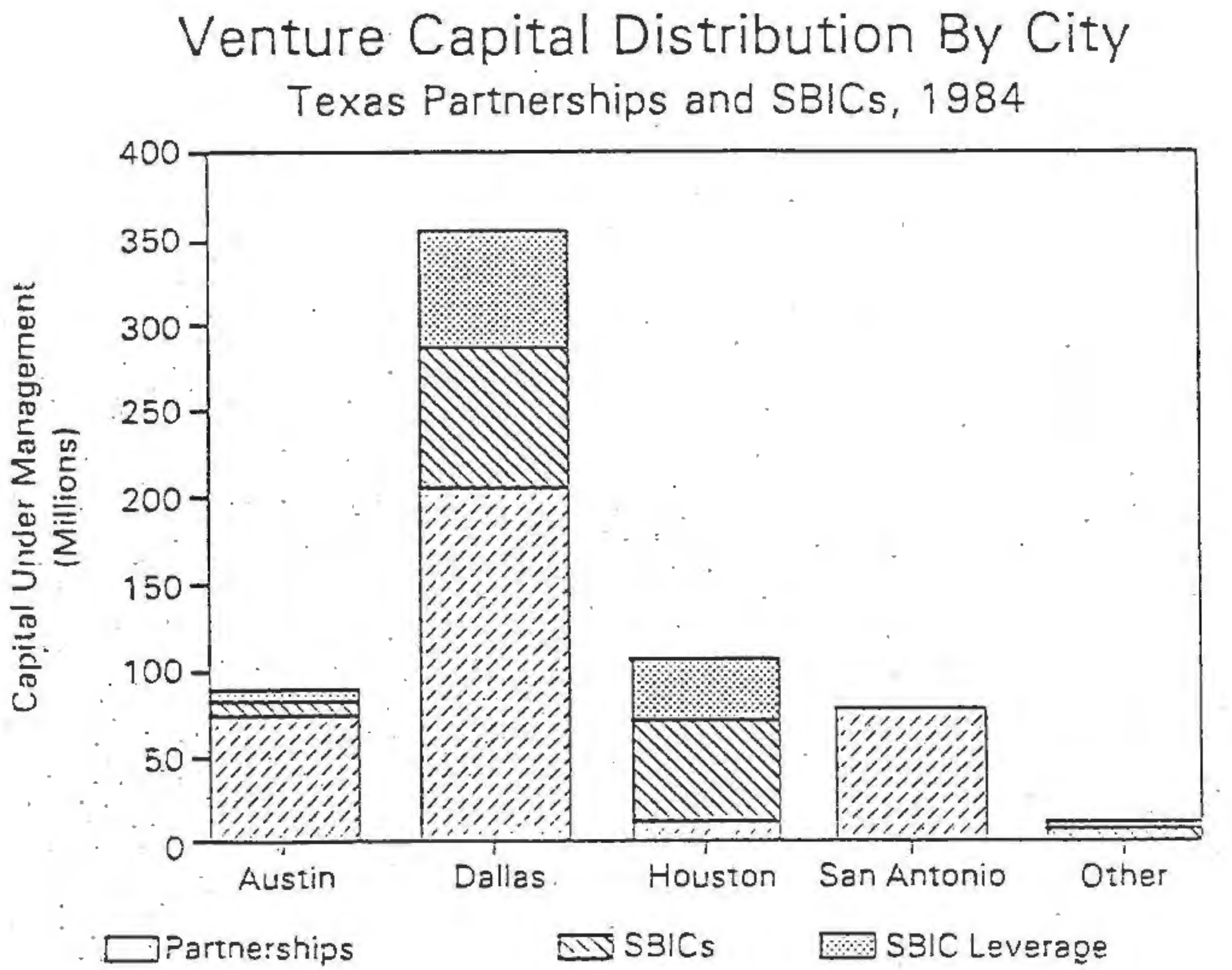
TEXAS BASED VENTURE CAPITAL INVESTMENT

GEOGRAPHIC DISTRIBUTION 1980 - 1985



Source: Thompson, David T., "Venture Capital and Financing," unpublished speech, "Technology Venturing: American Innovation and Risk-Taking," February 7, 1984

CHART I

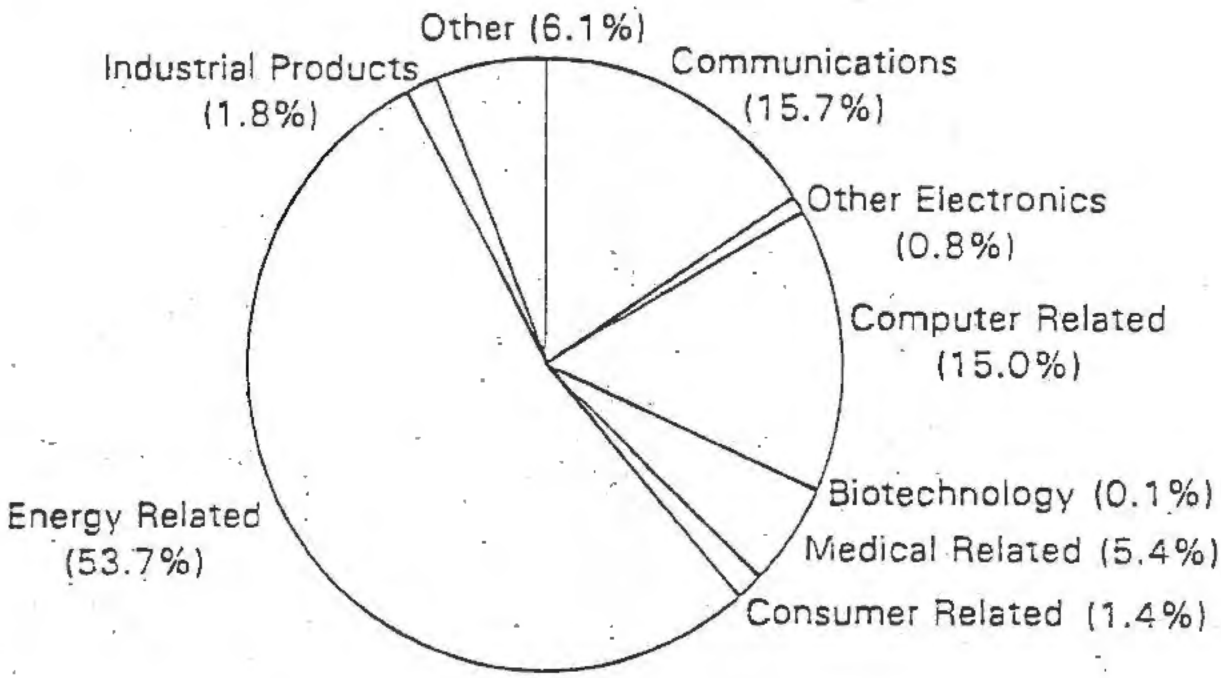


Source: Data Base, The IC[2] Institute, The University of Texas at Austin.

CHART J

Texas Venture Capital Investments

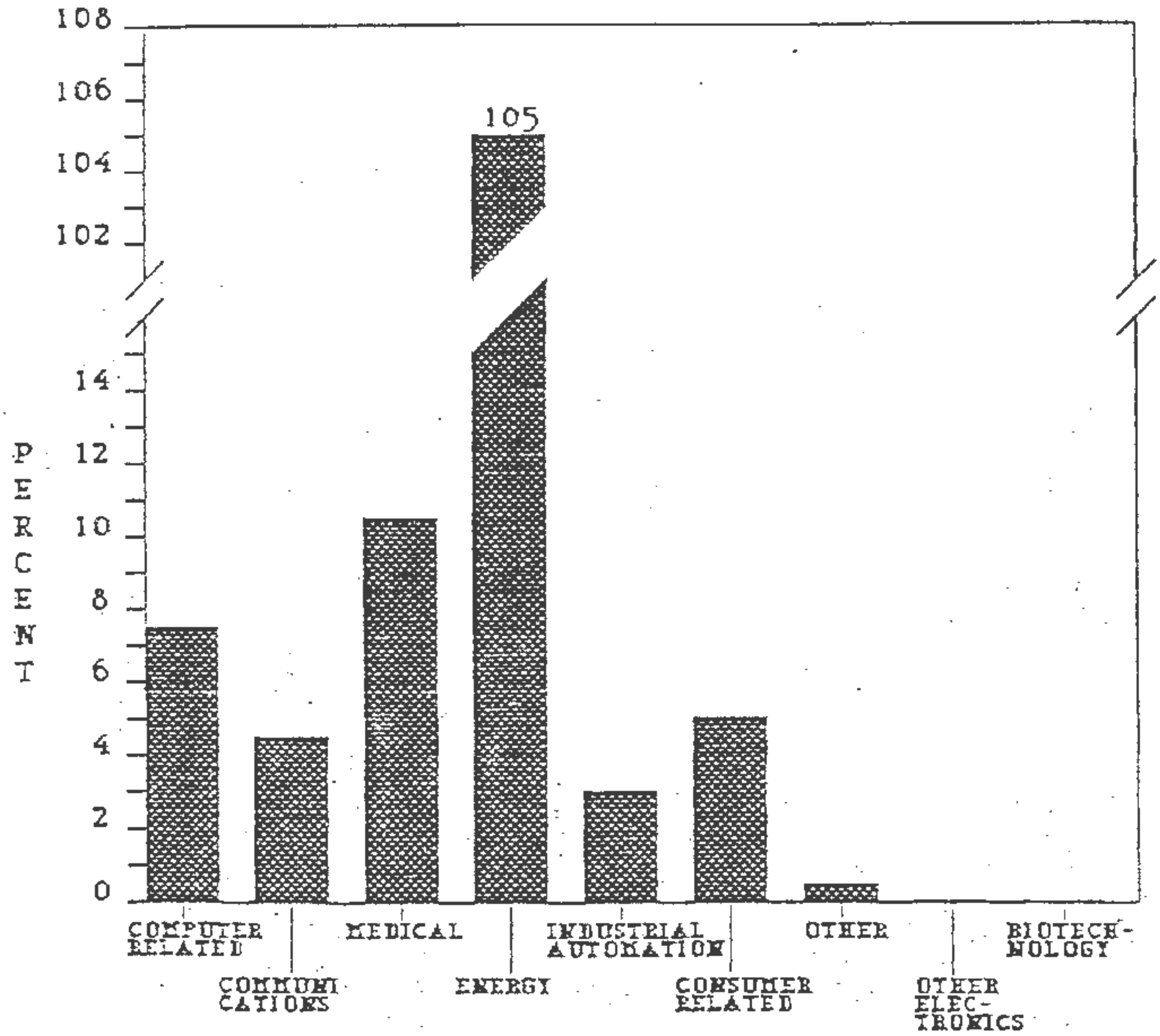
By Texas Based Firms, 1980 to 1983



Source: Thompson, David T., "Venture Capital and Financing," unpublished speech, "Technology Venturing: American Innovation and Risk Taking," February 7, 1984.

CHART K

TEXAS VENTURE CAPITAL INVESTMENT AS A PERCENT OF CALIFORNIA VENTURE INVESTMENT



TEXAS INVESTMENT BY TECHNOLOGY, 1983

CHAPTER 2

THE CONTEMPORARY INFORMATION ECONOMY

By

George Kozmetsky

Introduction

The nature of our contemporary information economy is difficult to describe. It cannot be put into simple statistical form or presented within a generally accepted framework of industries in terms of size and structure, growth, employment, investments in R&D, and other areas of concern. It involves far more than this. The information technology that has evolved over the last two decades restructured our nation's economy in at least four significant ways:

1. It has contributed to the growth of a strong overall economy.

2. It has given rise to its own technologies which in turn have created new complexes of manufacturing and service industries and which have been diffused to other manufacturing and service industries in the private and public sectors. Thus the contemporary information economy involves both technology making and technology taking.

3. It has contributed significantly to national security.

4. It has stimulated the growth of robust, creative and innovative basic science and research and development.

The contemporary information economy is fundamentally different from even a decade ago in two key respects. First, the current structure and nature of our economy is undergoing dramatic and accelerating change. Science and technology are transforming the very nature of American society. Second, a new economy is emerging as a result of revolutionary changes in the ways information is collected, stored, processed, communicated, presented, and diffused. The old economy emphasized cheap and abundant natural resources, borrowings over savings, growth over efficiency, and quantity over quality. The new economy is reversing these trends. International competition is taking the form of a worldwide scientific, technological and economic race for preeminence.

The ramifications of this emerging information economy perhaps is best summarized by Peter Drucker in Innovation and Entrepreneurship when he wrote:

> In the two decades 1965 to 1985, the number of Americans over sixteen (thereby counted as being in the work force under the conventions of American statistics) grew by two-fifths, from 129 to 180 million. But the number of Americans in paid jobs grew in the same period by one-half, from 71 to 106 million. The labor force growth was fastest in the second decade of that period, the decade from 1974 to 1984, when total jobs in the American economy grew by a full 24 million.
>
> In no other peacetime period has the United States created as many new jobs, whether measured in percentages or in absolute num-

bers. And yet the ten years that began with the "oil shock" in the late fall of 1973 were years of extreme turbulence, of "energy crises," of the near-collapse of the "smokestack" industries, and of two sizable recessions.

The American development is unique. Nothing like it has happened yet in any other country. Western Europe during the period 1970 to 1984 actually lost jobs, 3 to 4 million of them. . . . Even Japan did far less well in job creation than the United States. During the twelve years from 1970 through 1982, jobs in Japan grew by a mere 10 percent, that is, at less than half the U.S. rate.[1]

During the past two decades or so, over 35 to 40 million new jobs have been created. At the same time, manufacturing and services employment in the Fortune 500 companies decreased by more than 5 million. The period between 1976 and 1982 saw employment growth in the U.S. substantially created by the establishment of new small firms and their subsequent growth through expansion. During this period, small business establishments generated 62.4% of the net employment increases. Chart A shows a comparison by industry, the employment growth between large and small firms. It shows that large firms employment growth rates only exceeded that of small businesses in retail trade. Those industries that are generally considered to be primarily part of the information economy, that is, services and finance, insurance and real estate, had the largest small firm growth rate.

The information economy, in my opinion, has been substantially due to rapidly increasing R&D expenditures. As Chart B shows, R&D expenditures between 1968 and 1985 increased on a constant dollar by 46% in the decade of the 1960s; by 23% in the decade of the 1970s; and by 35% in the 1980-1985 time period. These expenditures, while being performed, are drivers to the economy. Subsequently R&D expenditures become a technology resource to be used in the marketplace. As resources, their diffusion benefits many industries in terms of new products and services, increased productivity, and reduction of prices. Their diffusion also have an impact on demand and investment in the user industry. In the process, they can cause distortion in the industrial structures.

An industrial restructuring has taken place. Currently, this restructuring is being discussed in terms of smokestack and high technology industries rather than as the outcome of a long period of R&D in information technology and its subsequent diffusion which has resulted in the information economy. Table 1 shows the employment projections between 1979-1987 for selected high technology and smokestack industries. Smokestack industries are not expected to recover more than one-half of their loss of employment before 1987. On the other hand, the high technology industries employment in 1987 is expected to increase by over 17% over the 1979 employment. However, the increase is not across the board as permanent losses are expected in the plastic materials and synthetic rubber industry. The highest increase is in computing and office equipment, electronic components, and communication equipment industries. All clearly contribute to an information economy.

This study clearly sets forth some hidden problem on the regionalization of the information economy employment. The loci of this industry as measured by high technology are predominantly in the mid-Atlantic and Pacific regions. (See Chart C) High technology samples in the Department of Commerce study include those industries characterized by rapid technological change and a high proportion of engineers and scientists to total employment. The geographic distribution of employment under an information economy can become a significant concern of greater proportions than high technology versus smokestack industries.

<u>Concepts, Definitions and Character</u>

A discussion of a contemporary information economy requires a careful delineation of concepts and definitions. Sometime early in the 1970s, a number of scholars were commissioned to examine the future impacts of information processing.[2] They came to the realization that information processing could not be discussed unless it was in the framework of information technology. In addition, they determined that a nation enters an information society when it devotes more than 50% of its gross national products to the data collection, data input, knowledge and information storage, knowledge and information processing, communications and presentation and dissemination of information.

The percentage of the GNP that is generated by information technology can provide a benchmark as well as means to help measure, analyze and evaluate the state of the contemporary information economy.

To the best of my knowledge, there have been very few studies that tried to measure the revenues generated from information technology industries and to relate them to the gross national product. Table 2 is a summary of three studies found in the literature. Although results are not comparable statistically. Each used separate definitions and selected segments of the industry related to the information economy. For example, the Harvard informational resources omitted any manufacturing revenues for informational machines. This was not the case in the Machlup and the IC^2 Institute studies. The Harvard study also omitted health care services while those of Machlup and IC^2 did. What the data shows is that prior to 1970 education and media and communication were the dominant (i.e., over 50% of the reported amounts) information sectors. By 1970, information services grew the fastest and with media and communication became the dominant information sector in the economy. By 1983, information services alone became the dominant sector.

What Table 2 clearly sets forth is that by 1983, it is possible to define that our contemporary information economy society is based predominantly on the character of its outputs as education, research and development, media and communications, information services, and information technology manufacturing.

The 1985 U.S. Industrial Outlook data for 350 industries show that the dimensions of the contemporary information economy can be understood in terms of four major segments related to information technology.

* Information technology is a body of knowledge. It is what we know about the generation of knowledge as well as the collection, measurement, storage, manipulation, transmission, and use of data and information.

* Information technology includes the hardware for information generation, flow, organization, and use.

* Information technology includes software.

* Information technology includes behavioral, organizational and social methods and practices.

Let us now turn to the technologies themselves that are driving our contemporary information economy. The core information technologies have been delineated functionally by the Office of Technology Assessment (OTA) in Tables 3[3].

Table 4 presents typical application areas with representative information technologies. These tables illustrate how information technologies may transform various industries and services.[4]

Commercializing these technologies in a new economy is a major challenge. Commercialization is the process by which results of research and development are transformed into products and services for sale in the marketplace. Some of the transformation involves new to the world products, new product lines to the firm, additions to existing product lines, improvements/revisions to existing products, repositioning products and cost reductions. Information technology in my definition includes the technologies of what some writers have referred to as technologies for the Fourth Industrial Revolution. The first three industrial revolutions can be characterized as follows:

* The First Industrial Revolution was based on technologies for manufacturing textiles, making iron from coke, and supplying power from Watt's steam engine.

* The Second Industrial Revolution was based on the railroads and steelmaking.

* The Third Industrial Revolution was based on electricity, batch chemicals, and the internal combustion engine.

When transformed to commercial products, these technologies provided security, economic prosperity, wealth, and national and international prestige.

Technologies for the Fourth Industrial Revolution include microelectronics, biotechnology, lasers, artificial intelligence and robotics, synthetic materials, waste technologies, and communications. These and other innovations in the next few decades will lead to markets for advanced materials, special application designs, photosynthesis, supercold technology, industrial and scientific instrumentation, robots, and automated batch and process production. All of these Fourth Industrial Revolution technologies should lead to long-term investments in newer plants and equipment, increased productivity, and a stronger U.S. international trade posture. The commercialization of defense R&D can play a pivotal role in the transition to the Fourth Industrial Revolution.

In fact, two major streams of technology development -- communications and computers -- are fusing to change the nature of information and to restructure the economy. This fusion can lead to growth industries in the information economy.

<u>Implications</u>

Given the nature of emerging technologies, the implications of the contemporary information economy can be viewed

1. investments in R&D;
2. through financing of newer technologies;
3. through newer institutional developments; and
4. by global competition for economic and scientific preeminence.

<u>Background</u> Prior to 1979, the prevalent attitude for economic growth was a "go it alone" philosophy that was reflected in a variety of ways. The emphasis was on industrial relocation rather than on building indigenous companies; separation of institutional rela-

tionships, especially between universities and corporations; adversarial roles between government and business; and reactive rather than proactive policies both nationally and industrially to international competition. A short six years ago, technology and its impacts were more threats than opportunities with which to build a future. Total annual venture capital was less than the current one-day's loss of Amtrak operations. Entrepreneurship was ignored as a force or driver. Technology transfer and diffusion were subjects for research and not a mandate for commercialization of research and development.

It was generally assumed that scientific research would in one way or another transfer into developments or technologies and subsequently be commercialized. For much of this period, little attention was paid to how science was transformed into technology which was subsequently transferred for specific commercialization purposes and then diffused throughout all industries.

The general paradigm was that basic research innovations would be utilized for applied research and developments and that their manufacture would naturally follow. Diffusion to other uses and industries would occur when R&D results were both economical and better understood in general. The utilization of technology as a resource was perceived as an individual institution's responsibility. Economic developments flowed from this process because of American ingenuity and our entrepreneurial spirit. It was expected that all regions of the U.S. would in time enjoy the benefits of this paradigm in which new innovations from research were followed naturally by timely developments, commercialization, and diffusion.

Since 1979, some fundamental transformations have taken place in American society as a result of becoming a contemporary information technologies. These transformations include

1. new patterns of behavior have emerged which are embedded with and in changing values;

2. shifts in centers of economic and political power bases;

3. creation of new knowledge with vast economic ramifications; and

4. renewed emphasis on improving education from elementary school through graduate education, encouraging collaborative efforts between universities and corporations, establishing and encouraging research parks, helping fund start-up and subsequent growth of new businesses, helping to transfer technological innovations, and encouraging productivity enhancements.

<u>Investments in R&D</u>

R&D is a critical component of an information economy. In many respects, it is a primary driver to innovation. It is essential to the development of new industries, the expansion of markets, and the viability of current industries. Without R&D, the information economy is in jeopardy.

As we have seen earlier, R&D characterizes the information economy. Investments on a current dollar basis have been increasing as a whole, and it is likely that they will continue to grow in the near term.

R&D investments are made primarily by the federal government and by industry. The federal government has begun to make major changes in its R&D focus. They are decreasing the R&D funding for energy and environment. This change will have a minimal impact in the case of information technology generation since the federal government is increasing its R&D expenditures for DOD and for general science, space and technology.

The annual increases are substantial. The DOD R&D budget will go from $23.1 billion in 1984 to an estimated $42 billion in 1988. The DOD R&D budgets will continue to make substantial contributions to information technologies. They will have an impact not only to the defense markets but also through diffusion in the non-defense markets. The Strategic Defense Initiatives Program (SDI) is an R&D program of unprecedented historic significance. Its five-year estimate for R&D of $29-30 billion can become a major catalyst for the commercialization of emerging technologies and know-how. The SDI R&D will have a great impact on the core information technologies and on information technology manufacturing including newer and non-silicon electronic components, expert systems, automation, robotics, supercomputing, optical devices, lasers, advanced materials and alloys, and medical and health products.

The SDI Program has already established a special organization with an estimated $100 million budget to develop collaborative efforts to commercialize SDI R&D. The NASA Space Station Program estimated at more than $8 billion will also generate a series of technologies that will be commercialized. The space station program can contribute to the information economy through developments in automation and robotics, artificial intelligence, telecommunications, development of servicing satellites in space, and automated laboratories services for research.

Industrial sector investments in R&D have also been increasing especially since 1978. As Table 5 shows (OTA, p. 317, table 52), the information technology industry is increasing its R&D expenditures at about two times that of the composite industry. Sales revenues for the information technology industry increased by 60% between 1978 and 1982 while the composite industry revenue increased by 40%. Table 6 shows that five information technology industries made up over 2/3 of the sales revenues; namely, computers, drugs (ethical, proprietary, medical and hospital supplies), chemicals, aerospace, and electronics. More significantly, only 27 companies incurred over 50% of the R&D expenditures in all the above five industries.

The revenue and employment characteristics of these 27 information technology companies are shown in Table 7. Between 1981 and 1983, their collective employment increased by approximately 5,000 persons. This raises an important question concerning shifts in the employment structure of the information technology industry and their impact on the economy in general. Table 8 shows that small businesses of under 500 employees play a significant role in the information technology sector. In the computer services sector, small business accounts for 69% of the industries sales as well as 67% of the employment. Small business in electronic components accounts for 34% of the employment and 33% of the sales. Small firms are also active in office computers, consumer electronics, and communication equipment.

We can now turn to the financing of newer technologies.

Financing Newer Technologies

The financing of newer technologies other than from internally generated funds or through government grants and contracts is the subject of this section. Traditionally, this topic would be covered as venture capital funding. However, since 1978, there have been other financial mechanisms such as limited partnerships and, more recently, leverage buyouts and mergers and acquisitions.

Venture Capital -- Venture capital for information technology firms has been one of the primary methods of financing small/growth companies. The financing of firms in the information technology industry has been the dominant focus of the venture capital industry between 1981-1984. Venture capitalists have disbursed over 2/3 of their funds to the segment of the information economy as shown in

Table 9. Over half of the funds provided through venture capital are for later stages of financing rather than the early stages. The dominant sources of traditional venture capital have been insurance companies, pension funds, individuals, and families.

Three other sources of funds have come into being:

1. About 23 states have established venture capital pools. About 12 states have made it possible to provide venture capital for early stages of growth. Some states have taken measures to permit up to 5% of their public pension funds to be invested in venture capital firms. A few other states have arranged for commercial banks, insurance companies, utilities, manufacturers, and individuals to receive as much as 36% tax credit against their state taxes.

2. Over 150 large companies have established their own formal programs to make direct venture investments in other firms.

3. Foreign venture financial institutions are investing in U.S. venture capital firms as well as directly into U.S. companies through wholly owned ventures.

The significance of venture capital to the information economy cannot be underestimated. Approximately $4 billion a year are invested in emerging companies each year. This is a relatively small amount. However, because the investment is in highly selected companies (approximately 1:100), because venture capialists are expert at leveraging resources to invest in growth companies, and because they invest about 70% of these funds in informational technologies, these funds have a multiplying impact on the information economy.

R&D Limited Partnerships -- These funds are used to help finance start-up companies and newer developments in mature companies. Recorded funds for R&D Limited Partnerships between 1978 and August 1984 amount to approximately $2.4 billion. They, too, have had a direct impact on the information technology industry. Over 58% of these funds have been invested in this industry.

The expansion of investments in R&D and the infusion of new venture funds has accelerated the diffusion of information technologies into the economy.

LBO's and Mergers and Acquisitions -- Venture capitalists have invested between 10 and 14% in leverage buy outs (LBO's). The current merger and acquisitions trend encompasses the information technology industries. Table 10 shows that there is significant activity in mergers and acquisitions in the information technology industry. It is too early to evaluate what impact these transactions will have on the information economy and the structure of the industry. Some industries like communications are consolidating for larger scale operations and economies of scale. The service industries associated with information technology can be merging to prepare for near-term advances like networking to provide a wider array of additional services. On the other hand, some of the merger and acquisitions can be simply due to the fact that the original entrepreneurial managers wish to sell out or have exceeded their managerial capacities, in which case their companies become viable candidates for merger and acquisition.

New Institutional Developments

A new paradigm for economic development has emerged to meet the needs of an information economy. It accelerates the commercialization of science and technology through newer institutional developments. These newer institutional developments include behavioral, organizational, and social methods and practices. They complement and extend more traditional institutional relationships and rules. The newer institutional developments are providing a set of coherent relationships among key institutions focusing on national pride, academic excellence, economic growth, technological diversification, and geographical diffusion.

The drivers for these newer institutional developments are:

1. emerging information technologies;

2. a desire to foster more basic research;

3. shortages of adequately trained scientists and engineers as well as information specialists;

4. difficulty in keeping up to date with developments;

5. gap in new technology transfer especially when it requires pulling together pure research from different disciplines;

6. a need to fill the gap for diffusion of technology for developing useful commercial products and services by individual companies;

7. a determination to diffuse R&D activities across wider geographic areas.

As a result of these drivers, at least eight forms of institutional development are creating newer infrastructures in the U.S. information economy. They are:

1. industrial R&D joint ventures and consortia
2. academic/business collaboration
3. government/university/industry collaboration
4. incubators
5. industry/university research and engineering centers of excellence
6. small business innovation research programs
7. state venture capital funds
8. commercialization of university intellectual property.

These newer institutional developments have some common elements:

1. There are generally collaborative efforts. In this sense, they are more than partnerships. partnerships generally mean working together and going along together. What is seen in

these new arrangements is that each institution has managed to maintain its own independence while providing on a timely and coherent basis for its own net improvements.

2. The total funds involved are generally small when compared to federally sponsored R&D programs and projects.

3. Leveraging and institutional coupling are other common characteristics. For example, colleges and universities are encouraged to establish centers of excellence with either federal or state government offering annual funding for three to five years provided their funds are matched to some pre-set ratio or more by individual business firms. The government portion is generally under $500,000 per annum.

4. Collaborating institutions are encouraged to utilize existing facilities and to share laboratory equipment.

5. The rights of patents and copyrights have become a key resource for future funding for some of the institutions involved.

As a result of these newer institutional development activities, technopolises are beginning to emerge in many states. These technopolises are bringing together in dynamic and interactive ways, state government, local government, private corporations, universities, non-profit foundations, and other organizations. They are developing corridors and triangles between key cities or research universities.

Centers of excellence are appearing within these corridors and triangles. They have begun to lay out science and research parks; they have begun to target emerging science and technologies for long-term industrial growth and vitality. Leadership networks are forming between previously isolated institutions. The process establishes a newer economic infrastructure to support entrepreneurship, encourage innovation, and accelerate technology transfer and diffusion.

It is still too early to tell how well each of these collaborative institutional developments are doing. It is not clear that they have provided a strong working infrastructure network that leads to balanced competition and cooperation that yields a steady stream of both commercially successful innovations and domestically based manufacturing operations. What is evident is that these developments have created enthusiasm and a following.

Global Competition for Scientific and Economic Preeminence

The contemporary information economy is influenced by intense global competition for scientific and economic preeminence. Scientific achievements not only may have an impact on a nation's economy but also contribute to a nation's pride and heritage. The most critical problem within a hypercompetitive global environment deals with the process of converting scientific advances to technological resources. Only through timely commercialization can these resources be transformed into economically salable products and services that meet global market demands. A nation that has the fastest gallium arsenide chip in the development laboratory is not necessarily assured of economic preeminance in the chip marketplace. The U.S. learned that lesson from the Japanese competition for the 64k RAM chips. The ability to manufacture continually a quality product at lowest cost while meeting timely delivery dates is an important economic consideration in maintaining preeminence in the marketplace. Within this competitive arena, large investments maybe required at every state of commercialization from basic research to final delivery. As a result, new financial mechanisms, often associated with innovative institutional developments, are being established. If successful, they will help maintain our scientific and economic preeminence in selected areas such as CAD/CAM, software, advanced computer architecture, chip packaging, chip automation, advanced chip materials, small device structures and interconnections.

The development of supercomputers provides a telling example of new financial mechanisms through creative institutional developments to maintain preeminence in an information economy. Table 11 shows that over the next ten years, federal government financed R&D, manufacturers' funding, and capital venture support in conjunction with new institutional developments for cooperative R&D could result in more than $8 billion of investment support. These are substantially more than what the Japanese have announced for their entry into the supercomputer race. This may well provide the U.S. with scientific preeminence but may not result in economic preeminence.

Competitive pressures in a global economy are likely to lead to new kinds of joint ventures that make alliances to expand markets and share technologies. Consequently, new structures are being formulated that will further alter the contemporary information economy. Strategic relationships will result in new ties between large and small companies, between companies across industries and between companies in different countries. It is becoming clearer that no one organization by itself can succeed. New ties, based on needs for better data collection, more effective analysis, more direct communication, clearer understanding of knowledge, more rapid diffusion of results and advances in computer and communciation technologies, will change the direction of inter-corporate strategy and organizational relationships. It will become increasingly important to build the required infrastructures for information technology leveraging with highly visible accountability and unprecedented openness in operations and assessment of key milestone results. Unless the U.S. deals with critical changes in economic development, the risks are more than losing a company or industry. Loss of economic and scientific preeminence could result in losing a substantial part of the markets in the information economy.

Conclusions

The nature of the contemporary information economy is difficult to describe in terms of simple statistics or presented within a generally accepted framework of industries. It is possible to delineate the character of the output of the industries primarily involved with information technology. These outputs are education, research and developmetn, media and communications, information services, and information technology manufacturing.

As shown in Table 2, the U.S. information economy sector in 1983 provided over 51% of the gross national product. What has been unique about the information economy has been its ability to create and develop unprecedented employment while getting employment and inflation under control. At the same time, the economy has also been capable of providing capital to both the public sectors while incurring unprecedented public deficits and private sector debts. We are beginning to see that technology is more of a driver than capital.

The contemporary information economy is ready for take-off. This is the most critical period in the development of a rapidly changing economy. It marks the movement into an entirely new and expanding level of activities. This take-off period consequently require creativity and innovation as well as an entrepreneurial attitude in giant, medium, and small organizations and in both the public and private sectors.

FOOTNOTES

[1]Drucker, Peter F. Innovation and Entrepreneurship. New York: Harper & Row, Publishers, 1985, p. 1.

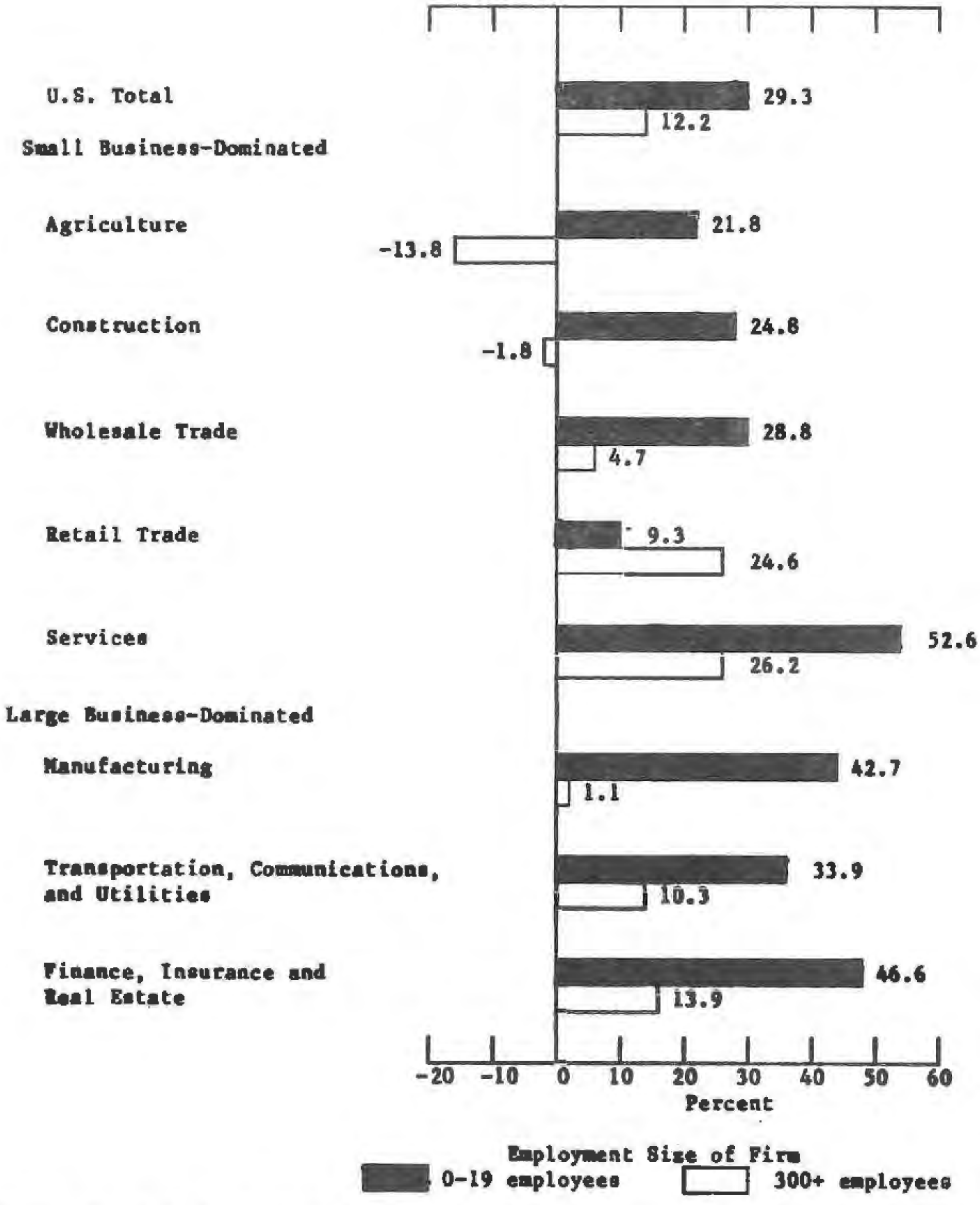
[2]Information Technology. The Conference Board, New York, 1972.

[3]Information Technology and R&D: Critical Trends and Issues. Washington, D.C.: U.S. Congress, Office of Technology Assessment, DTA-CIT-268, February 1985, pp. 308-9.

[4]Ibid,. p. 307.

CHART A

GROWTH COMPARISON OF SMALLEST AND LARGEST FIRMS ON INDUSTRY DIVISION 1976-1983



NOTE: The U.S. Small Business Administration, Office of Advocacy defines an industry division as small business-dominated when 60 percent or more of the division's sales or employment is found in businesses with fewer than 300 employees. By this criterion, the agriculture, construction, wholesale trade, retail trade, and service divisions are classified as small business-dominated.

Source: U.S. Small Business Administration, Office of Advocacy, Small Business Data Base, unpublished data.

CHART B

TOTAL R&D EXPENDTURES, 1960-85,
IN CURRENT DOLLARS AND CONSTANT
DOLLARS (1972=100%)

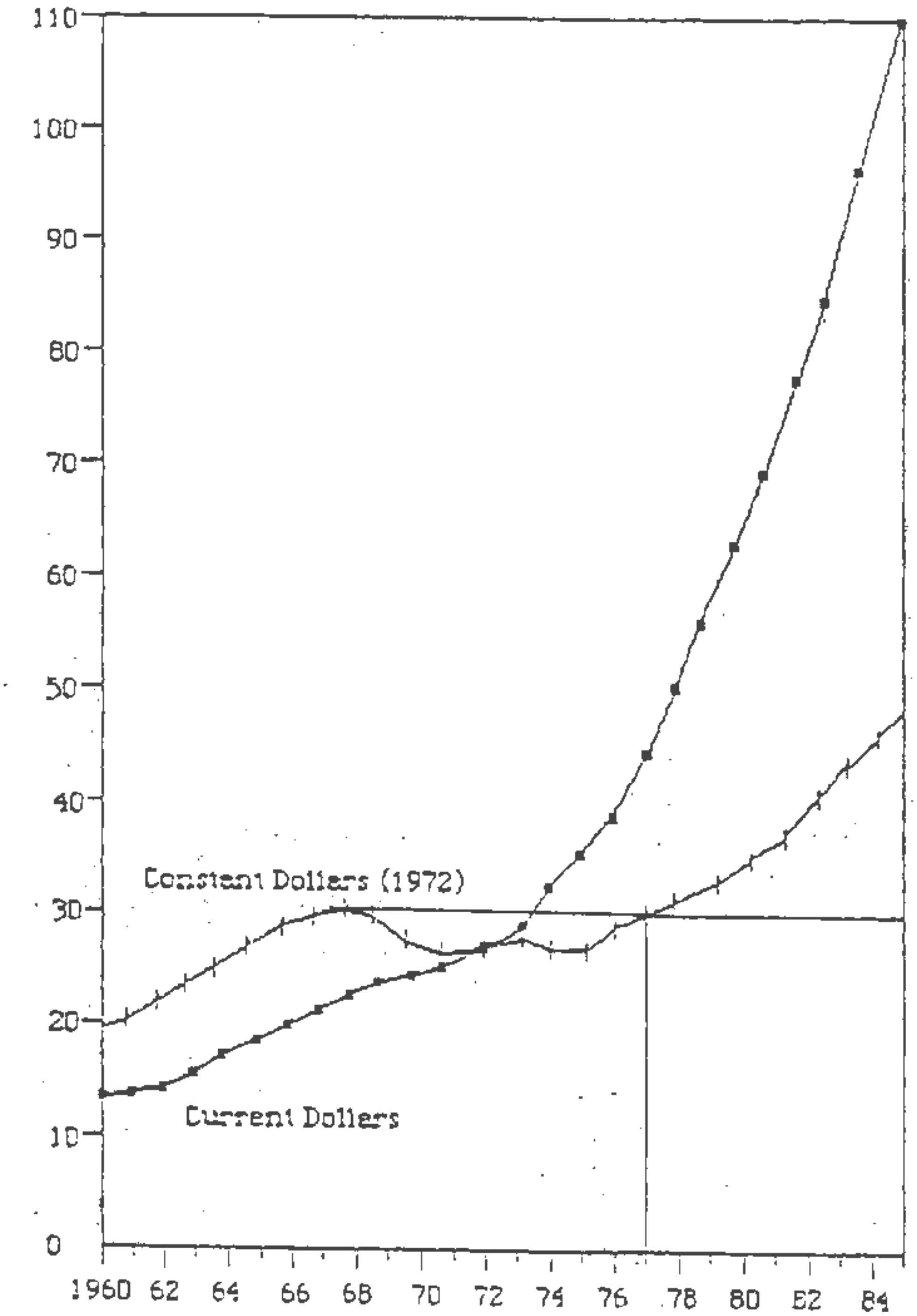


Table 1

Employment Projections for Selected High Technology and Smokestack Industries

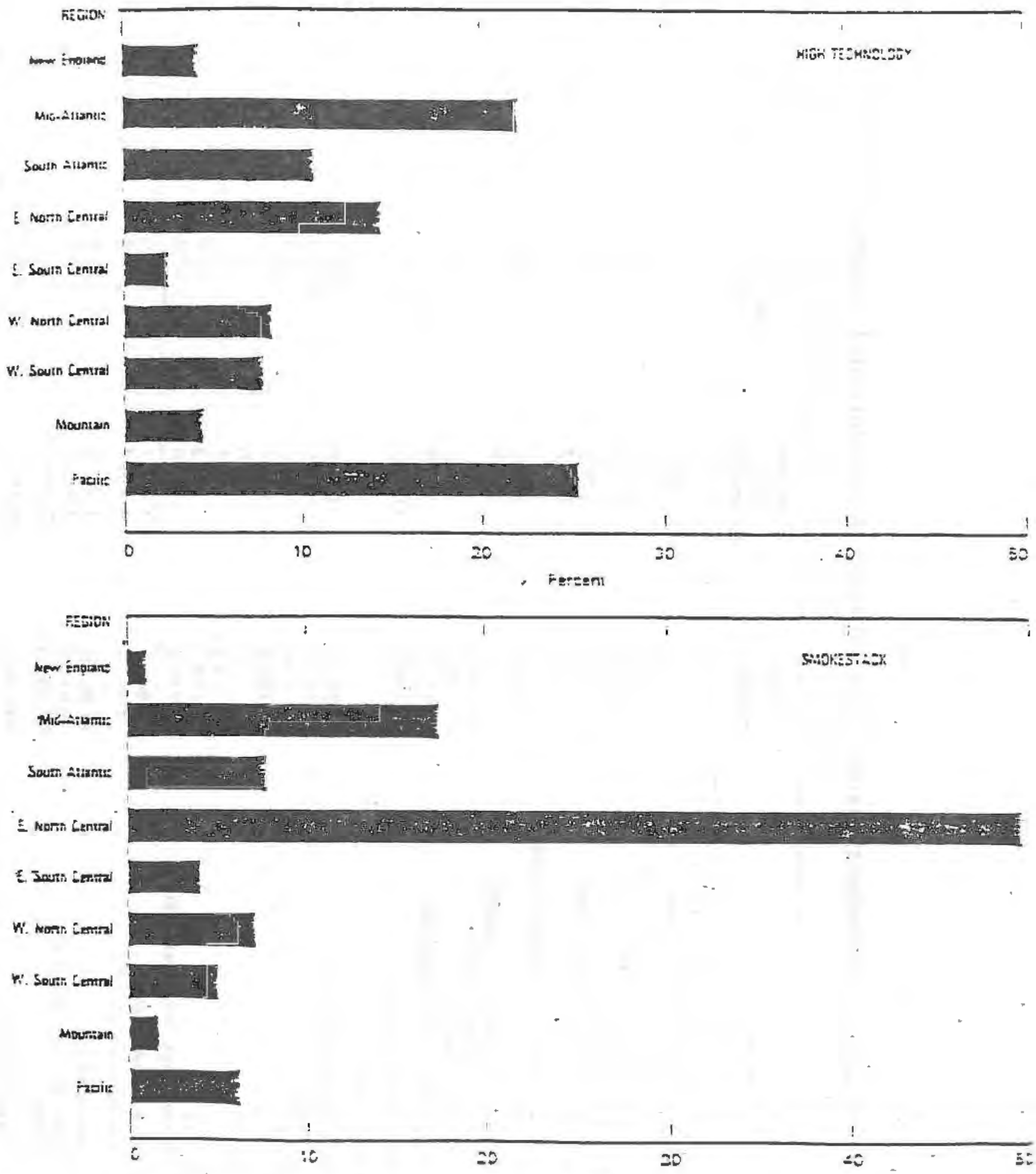
(thousands)

Industry groups	1979 employment	Projected 1983 employment	1979-83 Employment change	Projected 1987 employment	1979-87 Employment change
High Technology Industries					
Plastics materials and synthetic rubber	72.4	69.6	-2.8	69.3	-3.1
Drugs	163.1	170.5	7.4	180.0	16.9
Computing and office equipment	321.0	395.0	74.0	500.0	179.0
Communication equipment	551.7	609.4	57.7	675.6	123.9
Electronic components and accessories	468.0	518.0	50.0	563.0	95.0
Aerospace	682.1	695.2	13.1	731.2	49.1
Engineering, scientific, measuring & controlling instruments	265.9	259.0	6.9	272.0	6.1
Medical & dental instruments & supplies (incl. x-ray apparatus & tubes)	160.5	183.9	23.4	223.3	62.9
Optical instruments and supplies	39.8	45.7	5.9	47.6	7.8
Photographic equipment and supplies	114.0	109.0	5.0	114.0	0.0
High technology employment	2,338.5	3,055.3	216.8	3,376.0	537.5
Smokestack Industries					
Motor vehicles and equipment	892.6	654.0	-238.6	708.0	-184.6
Steel mill products	535.0	330.0	205.0	400.0	-135.0
Primary copper	11.9	9.6	-2.3	9.6	-2.3
Aluminum	159.9	140.2	19.7	160.5	0.5
Primary lead	2.9	2.6	-0.3	2.7	-0.2
Primary zinc	5.1	3.4	-1.7	2.9	-2.2
Farm machinery	140.3	96.3	-44.0	119.2	-21.1
Machine tools (incl. jigs, dies, fixtures)	218.0	165.0	-53.0	225.0	7.0
Smokestack employment	1,965.7	1,401.1	-564.6	1,527.9	-337.8
Total selected industries	4,804.2	4,456.4	-347.8	5,003.9	199.7
Total manufacturing	21,063.0*	18,587.0*	-2,476.0		
Total mining and construction	5,611.0*	4,947.0*	-664.0		
Total service	62,952.0*	66,298.0*	3,346.0		
Total nonagricultural	89,626.0*	89,832.0*	206.0		

* [illegible] adjusted annual data as reported in June 1979 and June 1983. Source: Bureau of Industrial Economics.

Chart C

Distribution of High Technology and Smokestack Employment Among Regions, 1979



Source: Bureau of Industrial Economics.

TABLE 1

Revenue Estimates of the U.S. Information Economy
Selected Dates and Character of Output 1958, 1970, 1983
(In Billions of Current Dollars)

Character of Output	Machlup[1] Knowledge Production (1958)	Harvard[2] Informational Resources (1970)	IC2 [3] Information Industries (1983)
Education	$ 60.2	$ 72.1	$218.7
Research & Development	11.0	26.6	87.0
Media & Communications	38.4	133.4	244.8
Information Services	18.0	213.0	967.5
Information Machines Information Technology Manufacturing	8.9	Not reported	169.3
TOTAL	$ 136.4	$ 445.1	$1687.3
DNP	475.6	976.0	3304.8
Percent of GNP	28.7	45.6	51.1

Sources: [1] Machlup, F., "The Production and Distribution of Knowledge in the U.S.," 1962 pp 354-357.

[2] Harvard University "A Perspective on Informational Resources: The Scope of The Program," 1973-74 p. 2.

[3] IC^2 Institute University of Texas at Austin, unpublished survey 1985.

Table 3

FUNCTIONS OF INFORMATION TECHNOLOGY

1. DATA COLLECTION. Examples of automated data collection systems range from large-scale satellite remote-sensing systems such as weather sat lites to medical applications such as CAT-scans and electrocardiogram

2. DATA INPUT. Input devices include the familiar keyboard, optical character readers, video cameras, and so on. They are the means by wh data are inserted and stored, communicated, or processed.

3. INFORMATION STORAGE. The storage media associated with the informatic industry are the electronic-based devices which store data in a form which can be read by a computer. They include film, magnetic tape, floppy and hard disks, semiconductor memories, and so on. The ability to store increasingly vast amounts of data has been essential to the information technology revolution.

4. INFORMATION PROCESSING. Information processing is the primary functio of a computer. The information stored by a computer can be numeric (used for computations), symbolic (rules of logic used for application such as "expert" systems), or image (pictorial representations used in applications such as remote mapping). The stored information -- in wha ever form -- is manipulated, or processed, in response to specific instructions (usually encoded in the software). The increasing speed of information processing has been another essential factor in the information technology revolution.

5. COMMUNICATIONS. Electronic communications utilize a variety of media -- the air waves (for broadcast radio and television), coaxial cable, paired copper wire (used, among other things, for traditional telephony), digital radio, optical fibers, and communications satellites. Communications systems play a major role in broadening the use of other facets of information technology and make possible distributed computing, remote delivery of services, and electronic navigation systems, among many other applications.

6. INFORMATION PRESENTATION. Once the information has been sent, it must be "presented" if it is to be useful. This can be accomplished through a variety of output devices. The most common display technology is the cathode ray tube or video display terminal. Hard-copy output devices include the most commonly used impact printers as well as those using non-impact technologies such as ink-jet and xerography. There are also audio systems that permit the computer to "speak" -- exemplified by the automobiles that admonish you to fasten your seat belts.

SOURCE: Information Technology R&D: Critical Trends and Issues, U.S. Congress Office of Technology Assessment, OTA-CIT 268, February 1985, pp.308-9.

Table 4

Functions, Applications, and Technologies[a]

Function	Typical application area[a]	Representative information technology
Data collection	Weather prediction	Radar, infra-red object detection equipment, radiometers
	Medical diagnosis	CAT scanners, ultrasonic cameras
Data input	Word processing	Keyboards, touch-screens
	Factory automation	Voice recognizers (particularly for quality control)
	Mail sorting	Optical character readers
Storage	Archives	Magnetic bubble devices, magnetic tape
	Accounting systems	Floppy disks
	Scientific computation	Wafer-scale semiconductors (still in research phase), very high-speed magnetic cores
	Ecological mapping	Charge-coupled semiconductor devices, video disks
	Libraries	Hard disks
Information processing	Social Security payments	General purpose "mainframe" computers, COBOL programs
	Traffic control	Minicomputers
	Distributed inventory control	Multi-user super-micros, application software packages
	Medical diagnoses	"Expert" systems
	Engineering design	Spreadsheet application packages, microcomputers
	Scientific computation	Supercomputers: multiple instruction-multiple data (MIMD) processors, vector processors, data driven processors, FORTRAN programs
	Ecological mapping	Array processors, associative processors
	Factory automation	Robotics, artificial intelligence
Communications	Office systems	Local area networks, private branch exchanges (PBX), editor applications packages
	Teleconferencing	Communications satellites, fiber optics
	Rescue vehicle dispatch	Cellular mobile radios
	International financial transactions	Transport protocols, data encryption, Integrated Services Digital Networks (ISDN)
Data output and presentation	Word processing	Personal computers, printers (impact, ink jet, xerographic)
	Management information	Cathode ray tubes, computer graphics
	Pedestrian traffic control	Voice synthesizers

[a] This list is not exhaustive; any given technology may also be used for some of the other applications mentioned.

Comparison of the U.S. Information Technology Industry with Composite Industry Performance, 1978-82

	1978	1979	1980	1981	1982	Percent change	
Sales (millions of dollars)	1,065,291	1,277,764	1,421,551	1,586,510	1,520,313	40	Composite
	131,872	149,783	174,449	193,921	218,862	66	Infotech
Profits (millions of dollars)	59,578	72,505	73,493	81,757	63,365	6.4	Composite
	12,780	13,821	15,474	16,056	17,436	36.4	Infotech
Profits/sales (percent)	5.5	5.7	5.2	5.1	4.2		Composite
	9.7	9.2	8.9	8.3	7.9		Infotech
Employees (thousands)	15,133	15,542	15,498	15,045	13,959	−7.8	Composite
	2,952	3,099	3,226	3,252	3,301	11.8	Infotech
R&D (millions of dollars)	20,610	24,674	28,984	33,285	37,179	81	Composite
	4,961	5,885	7,221	8,531	10,473	111	Infotech
R&D $/sales (percent)	1.9	1.9	2.0	2.1	2.5		Composite
	3.8	3.9	4.1	4.4	4.8		Infotech
R&D $/profits (percent)	34.6	34.0	39.4	40.7	59.0		Composite
	38.8	42.6	46.7	53.1	60.1		Infotech
R&D $/employee	1,362	1,588	1,870	2,212	2,667		Composite
	1,680	1,899	2,238	2,623	3,173		Infotech
R&D expenditures per employee Infotech/Composite (percent) ...	123	120	121	119	120		

Business Week "Scoreboard" Numbers Notes:

A. This is a sample of R&D spending in information technology by U.S. corporations. It is based on total R&D expenditures for those companies that are publicly held, have annual revenues over $35 million, and R&D expenses of $1 million or 1 percent of revenue. Only that spending by companies whose primary business is information technology (electronics, computers, office equipment, computer services and peripherals, semiconductors, and telecommunications) is included.

B. Sales, R&D spending, and R&D spending per employee figures have been adjusted to reflect the numbers from Western Electric and other AT&T subsidiaries that are not included in the "Scoreboard" numbers. This adjustment involves:

1. addition of revenues received from Western Electric to the total operating revenues figures in the AT&T Annual Reports for the years covered.
2. use of the total AT&T spending figures for R&D which include spending by Western Electric and other AT&T subsidiaries as provided in *Business Week* for the years 1980-82 and as estimated from a chart in the 1983 AT&T Annual Report for the years 1978 and 1979.
3. use of total AT&T employment figures provided in *Forbes* each May for the years 1978-82.

C. Employment numbers for all sectors have been calculated from the R&D spending per employee and the R&D spending figures provided in *Business Week* and may reflect rounding errors.

SOURCE: Data obtained, or calculated from *Business Week*, Scoreboard, June 30, 1983; the U.S. Commerce Department; *Forbes*, May 1979 through 1983; 10K forms filed by AT&T and Western Electric Corp.

Selected Company Research & Development Expenses

Major Industries Accounting for Largest Percent of High Tech Industry Research & Development Expenses (In millions of dollars)

CS Industry Group	1983–84	1982–83	1981–82
Information Processing-Computers	$ 6,091.8	$ 5,370.1	$ 4,217.7
Drugs— Ethical, Proprietary, Medical & Hospital Supplies	3,453.5	2,995.3	2,479.2
Chemicals	3,370.7	3,056.4	2,546.0
Aerospace	2,589.4	2,509.4	2,360.4
Electronics	1,905.4	1,574.8	1,368.0
TOTAL	$17,370.8	$15,206.0	$12,971.3
Percent of All High Tech Industries	69%	68%	68%

Companies Accounting for Largest Percent of Industry Research & Development Expenses

	1983–84	1982–83	1981–82
Information Processing-Computers			
IBM	$ 2,514.0	$ 2,053.0	$ 1,512.0
Digital Equipment	630.7	472.4	3,49.8
Hewlett-Packard	552.0	493.0	424.0
Sperry	410.4	397.1	397.6
TOTAL	$ 4,147.1	$ 3,415.5	$ 2,783.4
Percent of Industry	69%	57%	56%
Drugs-Ethical, Proprietary, Medical & Hospital Supplies			
Johnson & Johnson	$ 405.1	$ 363.2	$ 282.9
Merck	356.0	320.2	274.2
Lilly (Eli)	293.6	267.4	234.5
Smith Kline Beckman	264.7	244.8	163.9
Upjohn	229.2	195.8	171.6
Pfizer	227.2	197.2	176.9
Bristol-Myers	185.3	161.0	144.0
Abbott Labs	184.5	137.0	113.7
TOTAL	$ 2,451.5	$ 2,150.9	$ 1,786.5
Percent of Industry	71%	71%	72%
Chemicals			
DuPont	$ 966.0	$ 879.0	$ 631.0
Dow Chemical	492.0	460.0	404.0
Monsanto	290.0	256.0	220.6
TOTAL	$ 1,748.0	$ 1,595.0	$ 1,255.6
Percent of Industry	52%	52%	49%
Aerospace			
Boeing	$ 429.0	$ 691.0	$ 844.1
McDonnell-Douglas	301.2	254.1	215.7
Lockheed	284.0	127.0	100.0
Northrop	266.0	312.9	152.2
General Dynamics	156.0	139.2	135.9
TOTAL	$ 1,436.2	$ 1,524.2	$ 1,487.9
Percent of Industry	55%	61%	63%

Table 6 (continued)

Companies Accounting for Largest Percent of
Industry Research & Development Expenses
(con't)

C6

<u>Electronics</u>			
Motorola	$ 336.0	$ 278.0	$ 229.0
Raytheon	247.7	195.9	166.1
RCA	216.0	195.4	193.5
AMP	133.0	112.0	111.0
Harris	105.1	90.6	92.8
North American Philips	86.6	74.4	52.1
Zenith Electronics	66.5	63.8	57.7
TOTAL	$ 1,190.9	$ 1,010.1	$ 902.2
Percent of Industry	63%	64%	66%
Total of 27 Companies	$10,974.3	$ 9,695.7	$ 8,215.6
Percent of Total High Tech Industry	43%	43%	43%

Source: <u>Business Week</u>, March 22, 1985, p. 165-194.
<u>Compiled by IC² Institute, The University of Texas at Austin.</u>

Table 7

Selected Company Research & Development Expenses

Major Corporations Accounting for Largest Percent of Research and Development Expenses by High Technology Industry Sales and Employment

1981–1984

C8

Company	Sales ($ Millions) 1983–84	1982–83	1981–82	Total Employment 1983	1982	1981
IBM	$ 40,180.0	$ 34,364.0	$ 29,070.0	369,545	364,796	354,936
Digital Equipment	4,271.9	3,880.8	3,198.1	73,000	67,100	63,000
Hewlett-Packard	4,710.0	4,254.0	3,578.0	72,000.	68,000	64,000
Sperry	5,076.0	5,571.4	5,427.2	77,493	88,720	92,476
Johnson & Johnson	5,972.9	5,760.9	5,399.0	77,400	79,700	77,100
Merck	3,246.1	3,063.0	2,929.5	32,600	32,000	32,400
Lilly	3,033.7	2,962.7	2,773.2	29,200	29,300	28,600
Smith Kline Beckman	3,152.4[2]	2,968.7	1,985.3	31,317	35,831	22,914
Upjohn	1,986.1	1,828.7	1,898.3	21,410	21,190	21,410
Pfizer	3,750.0	3,453.6	3,249.7	40,700	40,000	41,500
Bristol-Myers	3,917.0	3,599.9	3,496.7	36,500	34,900	35,700
Abbott Labs	2,927.9	2,602.4	2,342.5	34,328	32,145	31,502
DuPont	35,378.0	33,331.0	22,810.0	159,231	165,013	177,235
Dow Chemical	10,951.0	10,618.0	11,873.0	54,500	32,145[4]	53,800
Monsanto	6,299.0	6,325.0	6,947.1	50,889	52,199	57,391
Boeing	11,129.0	9,035.0	9,788.2	84,600[3]	95,700[3]	105,300[3]
McDonnell-Douglas	8,111.0	7,331.3	7,384.9	74,466	72,451	74,264
Lockheed	6,490.3	5,613.0	6,372.7[2]	71,800	70,200	71,300
Northrop	3,260.6	2,472.9	1,990.7	37,200	35,500	31,400
General Dynamics	7,146.3	6,352.6	5,063.4	92,600	85,085	81,000
Motorola	4,328.0	3,785.8	3,335.9	88,800	78,800	76,300
Raytheon	5,937.3	5,513.4	5,636.2	76,100	72,000	76,500
RCA	8,977.3	8,016.0	7798.6	110,500	109,000	119,000
AMP	1,515.5	1,243.4	1,234.3	21,300	19,750	19,650
Harris	1,718.1	1,719.0	1,551.5	22,200	26,400	25,800
North American Philips	3,799.8	3,168.1	3,278.3	56,500	45,823	49,021
Zenith Electronics	1,361.3	1,239.2	1,275.2	30,000	24,000	28,000
TOTAL	$198,626.5	$180,073.8	$161,683.7	1,926,179	1,877,748	1,921,499

Source: Fortune, May 3, 1982, May 2, 1983, April 30, 1984.
Compiled by IC[2] Institute, The University of Texas at Austin.

[1]These companies' sponsored R&D expenditures is 43% of all high tech industry R&D expenses.
[2]Includes sales from discontinued operations.
[3]Average for the year.
[4]Source: Moody's Industrial Manual.

Table 8

Percentage of Total Industry Sales and Employment by Size of Small Businesses

	Companies with under 100 employees		Companies with under 500 employees	
	Sales	Employment	Sales	Employment
Office computing machines and computer auxiliary equipment	2.6	2.6	6.0	6.3
Consumer electronics	5.4	5.9	9.3	10.4
Communications equipment	4.7	5.2	9.9	10.8
Electronic components	18.3	17.2	32.7	33.7
Computer services	51.2	47.7	68.6	67.1

SOURCE: Small Business Administration, 1981.

TABLE 9

Venture Capital Disbursements by

Information Technology Industry

1981-84

% of Dollars Invested

Communications	11	10	12	14
Computer Related	30	43	37	38
Electronic	12	13	10	12
Genetic Engineering	7	3	3	3
Medical/Health	6	7	10	11
TOTAL	66	77	72	78

TABLE 10

Information Technology Industry Acquisitions and Mergers

1983 and 1984

	1983		1984	
	Value $B	No. of Deeds	Value $B	No. of Deeds
Communications	$ 2.2	98	$ 5.2	114
Electrical & Electronic Mach	1.6	130	3.0	159
Computer & Data Processing	0.3	91	3.5	118
Business Services	0.7	95	2.9	148
Credit Firms & Holding Cos.	2.3	101	3.6	82
Insurance & Ins. Holding Cos.	3.2	81	4.4	180
Banks & Bank Holding Cos.	4.7	209	5.8	232
TOTAL	$15.0	805	$28.4	1,033
Grand Total	$51.9	2,339	$124.0	2,946
Percentage	35%	29%	43%	29%

Source: Mergers and Acquisition Almanac and Index 1984 & 85.

TABLE 11

Estimated Direct and Indirect Support
For Supercomuter Developments
Next Ten Years
(In millions of dollars)

1. Federal Agencies	
A. DOD – Strategic Computing Survivability Program	$ 1,000
– Strategic Defense Initiatives, Robotics and Artificial Intelligence	1,200
B. NSF – Supercomputer University Centers	200
– Communication Network	5
C. DOE	200
D. NASA – Space Station, Automation, Robotics and Artificial Intelligence	600
E. NIH – Medical Information Systems, Biotechnology Knowledge Bases	100
F. Other	45
	$ 3,500
2. Supercomputer Companies	
A. Primary Manufacturers	1,500
B. Secondary Firms and New Start-Ups	1,000
	$ 2,500
3. Cooperative R&D	
A. MCC – Consortium	1,000
B. Semiconductor Research Corporation	100
C. Stanford University Center for Integrated Systems	300
D. Massachusetts Microelectronic Center	100
E. California Microelectronics Innovation & Computer Science Program	100
F. Minnesota Microelectronics & Information Science Center	100
G. North Carolina – Microelectronic Center	100
H. Florida State Supercomputer Computations Research Institute	100
I. NSF University Supercomputers Centers – Matches	300
J. Washington-VLSI Technology Consortium	15
K. Indiana Computer Integrated Design, Manufacturing & Automation Center	20
L. Other	50
	$ 2,285
TOTAL	$ 8,135

CHAPTER 3

SECURING THE FUTURE THROUGH TECHNOLOGY VENTURING

by

George Kozmetsky

Introduction

Technology venturing as a newer form of economic development is vital to our nation's future. In today's hypercompetitive, protectionist-seeking global environment, technology venturing provides a newer approach to making and securing the U.S. future.

Technology from an institutional development perspective is a societal driver. It is a resource to be used for economic growth and diversification. Venturing, from an institutional development point of view, involves a large and diverse number of institutions. Their multiplicity of programs, projects, regulations, policies, and other activities must be interlocked to successfully start firms, create jobs, educate and train sufficiently skilled and knowledgeable personnel, provide adequate capital, meet the communities' requirements, and at the same time adjust to changing societal values and needs. Today, each state, community, region, and industry is in a different stage of development regarding the technology venturing process.

Technology venturing as a newer means of economic development is highly unstructured. How our nation goes about structuring the public and private infrastructures for successful technology venturing will go a long way toward making and securing our nation's, states', and individual futures. America's strength has always been its ability to be scientifically creative, technologically adept, managerially innovative, and entrepreneurially daring. Technology venturing links science, technology, and management with an entrepreneurial spirit to accelerate the commercialization process and thus promote economic growth and diversification.

Prior to 1979, there was little evidence of technology venturing for economic developments. The prevalent attitude was a "go it alone" philosophy that was reflected in a variety of ways. The emphasis was on industrial relocation rather than on building indigenous companies; separation of institutional relationships, especially between universities and corporations; adversarial roles between government and business; and reactive rather than proactive policies both nationally and industrially to international competition. We, at times, seemed to believe that the rules of the game were set in concrete rather than subject to the dynamics of an ever-changing global environment and and to an economy that was coupled to changing values.

A short six years ago, technology and its impacts were more threats than opportunities with which to build a future. Six years ago, total annual venture capital was less than the current one-day's loss of Amtrak operations. Entrepreneurship was ignored as a force or driver. Technology transfer and diffusion were subjects for research and not a mandate for commercialization of research and development. Six years ago, there was little doubt about U.S. leadership in high technology, particularly in terms of electronics and its industrial and scientific markets. There was no question but that "hi tech" was a major contributors to the nation's trade balances. Six years ago, the loss of earnings, layoffs and production curtailments were not part of management's major concerns in high tech firms.

For much of the period from the 1950s to the 1980s, it was generally assumed that scientific research would in one way or another transfer into developments or technologies and subsequently be commercialized. For much of this period, little attention was paid to how science was transformed into technology which was subsequently transferred for specific commercialization purposes and then diffused throughout all industries, regionally as well as for international trade. The general paradigm was that basic research innovations would be utilized for applied research and developments and that their manufacture would naturally follow. Diffusion to other uses and industries would occur when R&D results were both economical and better understood in general. The utilization of technology as a resource was perceived as an individual institution's responsibility. Economic developments flowed from this process because of American ingenuity and our entrepreneurial spirit. Targeting may have been a Japanese national policy in this period; but in the U.S., market opportunities at home and abroad seemed sufficient for economic growth and diversification. It was expected that all regions of the U.S. would in time enjoy the benefits of this paradigm in which new innovations from research were followed naturally by timely developments, commercialization, and diffusion.

Changing Realities

By the end of the 1970s, however, changing global realities forced us to consider serious questions about our traditional paradigm. These new realities revolved around shortages in materials and supplies, energy crises, loss of competitive advantages in U.S. basic industry, increasing unfavorable trade balances, high regional unemployment, strengthening of the dollar, and shifting investment patterns within the public and private sectors.

Since 1979, some fundamental transformations have taken place in American society. Among these are:

1. New patterns of behavior have emerged which are embedded with and in changing values.

2. The population growth has shifted from the Northeast, North Atlantic, and Midwest to what has been called the "Sunbelt States." This has resulted in rise of newer economic and political power bases yet to be fully comprehended.

3. Basic industry and high tech manufacturing employment has been stabilized at 8% of the work force.

4. States have become more concerned with jobs and diversification through sponsoring R&D at universities and com-

panies, improving education from elementary school through graduate education, encouraging collaborative efforts between universities and corporations, establishing and encouraging research parks, helping fund start-up and subsequent growth of new businesses, particularly technology-based firms, helping transfer technological innovations, and encouraging productivity enhancements in older industries that make up their economic bases.

These transformations lead to the realization of a need to reexamine the public and private infrastructures of our regions, states, industries, and academic institutions because of the transformations that have taken place. The need for better information and analysis is abundantly clear. The hope for a quick fix to our problems through national income policies or monetary policies was recognized as not sufficient.

One way of helping to identify these structures is to review the resource allocations to science and technology. It is important to see where and how the future is being made and what institutional developments are involved. Let us start with understanding what is actually going on in terms of the generally held paradigm of how research is transferred into commercially viable products and services.

The remainder of this paper is in two parts:

1. Present Status of Traditional R&D Sources and Performers and the Commercialization Process.

2. Technology Venture -- New Institutional Developments for the Commercialization Process.

Part I -- Present Status

The data available for Part I are:

A. Federal R&D Obligations by Source and Performers

B. Selected Company Sponsored R&D by Industry

C. Traditional Venture Capital

D. Emerging Venture Capital Sources

E. Special Funds for Financial & Organizational Restructure

A. <u>The Sources and Performers of R&D</u>

Up until 1980, the Federal government and its agencies -- primarily the Department of Defense (DOD) -- were the major sources of R&D funds. Starting in 1980, the industry sector displaced the Federal government as the largest source of funds. In 1985, the industry sector provided $54.0 billion in contrast to $51.5 billion by the Federal government. On the other hand, the major performers of R&D continue to be the industry sector.

A closer analysis of the available data discloses that important transformations are taking place in terms of sources and performers of R&D. The more important transformations for structuring the future are:

1. The industry sector, between 1968-1977, decreased its R&D expenditures on a constant 1972 dollar basis. As you may

recall, this was the period when industry made heavy capital investments in environment, safety and health, and energy conservation. In 1980, industry started to increase its rate of R&D growth by 3-4% annually. NSF forecasts that this rate will continue through the rest of the 1980 decade. This is an important shift in the allocation of R&D resources. It points to the fact that there will be a measurable increase in innovation, particularly applied research, development, and commercialization.

2. The industry sector R&D growth also indicates that there is a growing need for talent to sustain forthcoming innovations. The talent needs can turn out to be more than just a simple shortages of university and college science and engineering graduates. Experienced scientific and engineering talent will be in short supply, as well as marketing, financial, and managerial talent.

3. The loci where industrial research and development growth will take place is shifting. The government sector as a source while relatively less than industry is still growing in absolute terms. This indicates that there will be newer centers of research that reflect the particular industries' R&D growth. In other words, not all the industry sector R&D growth will be in Silicon Valley or Route 128. I will have more to say on this later.

4. Basic research at present is showing a transformation. The Federal government is still the major source (i.e., 68%) and universities and colleges and government labs are still the significant performers. There is, however, a shift in research expertise. There is at present a discernable shift from engineering to physical sciences, math, computer sciences, social sciences and psychology.

5. Applied research and developments by the Federal government are in a process of transformation. DOD is moving into deployment and servicing of its major new weapon systems while it increases its applied research and development through the Strategic Defense Initiative. NASA is shifting from the shuttle to a working space station; DOE is increasing its direct support of national defense efforts while decreasing its research in alternative energy sources. Biological sciences and health programs are being continued. There is a general deemphasis in environment and ecological research and socio-economic impact research. In summary, we are seeing the emergence of a number of very large scale programs by DOD, DOE, and NASA which are long term, meaning, over ten years, and with major resource commitments. The spin-off opportunities -- lasers, computers, artificial intelligence, new materials, etc. -- will be major transforming factors even if they are not of the same magnitude as chips and digital computers. They are still going to affect our lives -- socially, and culturally.

6. Another transformation is that we will be having both industry sector and government sector R&D expenditure growth. This has impacts on institutional developments, particularly in how the industry, government, and academic institutions are relating to one another. It can and will have a major impact in the areas in which the U.S. can make its global future, in terms of world trade. These sectoral growths can be more than just simply building defense and space industries with other industries being suppliers as in the past. Newer pressures and challenges from strategic and tactical points of view will have an impact on every level of company activities. Over the long term, the newer growth patterns will have impacts on current governments (national, state, and local), revenues, infrastructures, and other services.

Let us look at the present regional distribution of Federal R&D obligation funds by dominant states; i.e., where over 50% of the funds are spent. The performers have been categorized into six clusters:

1. Federal Intramural;
2. Industrial Firms;
3. Federal Funded Research Centers, By Administration by
    a. Industrial Firms
    b. Universities and Colleges
    c. Non-Profit Institutions;

4. Universities and Colleges;

5. Other Non-Profit Institutions; and

6. State and Local Governments.

For purposes of this paper, we can omit Category 6 as it has less than 1/2% of all Federal obligations.

California leads all of the other dominant states in every category of performers except one. That is Federal Intramural. The lead state in that category is Maryland. California's preeminence gives it a unique balance of performers and, in many respects, it has become a strong example of transformational leadership. More specifically, of the $8.4 billion of Federal obligations spent in California, Industrial Firms expended 61%, Federal Intramural 1.4%, Universities and Colleges expended 19%, and Non-Profit Institutions spend 6%.

When we look at the second tier dominant states, we see that they individually have significant reduction in total expenditures compared to California. More specifically, the expenditures by states are: in Maryland, $3.4 billion; in New York, $2.5 billion; and in Virginia, $2.3 billion. Their balance of performers are also different as shown in Table 1. Federal R&D obligations performers in Maryland were primarily Federal Intramural in 1983. They expended over 60% of the funds. About 1/3 of Virginia performers are also Federal Intramural performers. California, New York, and Virginia have over 60% of the performers in the Industrial Firms.

Table 2 shows which government agencies are the major sources for their dominant states. It is evident that DOD dominates Federal R&D obligations. It is also evident that Maryland has over 23% of the Federal R&D obligations for Health & Human Services. Each of the dominant states were and are able to have a broad spectrum of theirinstitutional R&D performers compete successfully for federal funds. At present, each has developed a large base of technology as well as R&D talent. California, in particular, has better managed than most other states to develop a very active and innovative industry-academic-federal government laboratory base for the commercialization of science and technology.

B. Selected Company Sponsored R&D by Industry

The present transformation of R&D through major resource allocations from Federal funding to industry funding has occurred only since 1980. At present, the dominant industries by R&D expenses are comprised of companies generally thought of as part of what is loosely defined as high technology industries. The data shows that those companies with annual sales of more than $35 million and with R&D spending of at least $1 million or 1% of sales, accounted for over $40 billion of R&D expenses in the 1983-84 time frame. (See Table 3.) The companies' R&D expenses are comparable to the $37.6 billion of Federal R&D obligations for fiscal year 1983.

Chart A shows that for the 1983-84 period, High Tech Industry had 63% of total R&D expenses; Basic Industry had 26%; Other Manufacturing had 10%; and Mining & Metals and Construction--Building Materials had the balance. High technology industries R&D expenses averaged over 5% of sales revenues during 1983-84. This was more than 2-1/2 times the R&D expenses to sales percentage for basic manufacturing industries.

What is important is not the percentage or other specific standards but that all industries have been increasing their R&D expenses over the 1981-1984 time frame. This is a positive indication that the U.S. private sector is in a period of high innovation. We are all aware that R&D expenses do not generally bring immediate sales. By the time innovations are developed and tested for costs, quality, and market, the commercialization process requires at least a five-year period. We can, therefore, expect a stream of innovations from U.S. industries unless some unforeseen contingencies develop that drastically reduce R&D expenses.

A dominance analysis of industry category and the individual firms can disclose the dispersion and depth of R&D innovations. Two industries out of eleven that comprise the basic manufacturing industry categories dominate in terms of R&D expenses. These are the Automobile and Fuel industries. Four companies dominate these industries; General Motors in the Automotive industry, and Exxon, Chevron, and Mobil in the Fuel industry.

Of the 13 industries that comprise the high technology manufacturing industries, three are dominant. These are the Information Processing/Computers, Pharmaceutical, and Chemicals industries. These three industries are dominated by eleven companies. IBM and Digital Equipment dominate the Information Process/Computer industry. In the Pharmaceutical industry, six companies are dominant; namely, Johnson & Johnson, Merck, Lilly (Eli), SmithKline Beckman, Upjohn, and Pfizer. The Chemical industry is dominated by three firms: DuPont, Dow Chemical, and Monsanto. These five dominant industries will be important in making the U.S. global future. These firms have not only made significant expenditures for R&D in their industry, but they are also recognized leaders as manufacturers and world-wide marketers. As Table 4 shows, these firms have not added to their overall employment between 1981 and 1983.

C. Traditional Venture Capital

The U.S. is undergoing an explosive period of innovation. This environment can be best captured by an analysis of the traditional venture capital process. The traditional capital venture industry consists of private independent partnerships, corporate financial firms, corporate industrial firms, and small business investment companies. This industry can help provide a benchmark as to what technologies are fueling innovation as well as which states are involved in innovative institutional transformations.

The transformation of the venture capital industry started about 1980 if one considers as an arbitrary benchmark $1 billion or more a year of investments. Prior to 1980, the traditional venture capital industry invested less than $1 billion a year.

Let us place the traditional venture capital industry into perspective for it has become an important industry to make and secure the U.S. future. Its present attributes are:

1. It has become distinct from other investment communities in the past eight years. It raised approximately $12.7 billion between 1977-1984. In 1984, it raised $3.2 billion for investment.

2. The traditional venture capital industry in terms of number of firms has grown 89% in the past six years. In terms of professionals engaged in the process, it has grown at 150% in the past six years. This industry reflects the growth in innovation in the U.S.

3. Traditional venture capital pools have been formed outside the New York financial centers. The major traditional venture capital center is in California with 30% of all venture capital funds in 1983.

4. The primary source of investors in these pools are pension funds and wealthy individuals.

5. The fastest growing source of investors in the traditional venture capital pools are foreign investors including foreign capital venture firms. In 1984, foreign investors provided 18% of the total traditional capital venture commitments or $575 million.

6. Venture capital firms are widely dispersed geographically -- almost every state has its own traditional venture capital firms.

Let us now analyze which technologies are dominant as reflected by traditional venture capital investments. In 1983, when $2.8 billion was disbursed, the dominant technologies were computer related (46%) and communications (13%). These investments were made in 1,002 firms. The majority of investments were made in California and Massachusetts.

What is significant is that traditional venture capital is attracted to centers of technological excellence -- they go to where the excitement is. What is interesting is that these areas of dominance are directly related to developments in industrial and university & college performers. In other words, the investments are not necessarily made in the same states from which the pools of capital are formed.

D. Emerging Venture Capital Sources

This category includes business development corporations and R&D partnerships. Both of these sources did not really take off until after 1981.

Business Development Corporations (BDCs) seem to be having a short life. Publicly held BDCs were the result of the Small Business Act of 1980. Until then, BDCs were private companies with less than

100 shareholders because of the Holding Company Act of 1940. They have become less important in new business growth since the passage of the Deficit Reduction Act of 1984 which taxed their distribution to shareholders as ordinary gains.

As Table 5 shows, R&D Limited Partnerships between 1978 and August 1984 have raised at least $2.4 billion. During 1984, there was a decline in the number of partnerships but an increase in the total amount of funds per partnership. Indeed, R&D Limited Partnerships seem to be experiencing their own transformation from specifically designated projects to professionally managed blind and broadly designated pools. The dominant technologies around which R&D Limited Partnerships were formed are computer hardware, medical products, genetic engineering, and other electronics. These investments are at an earlier stage of innovation than the traditional venture capital industry. These investments also provide a window on emerging technologies and their specific commercialization.

E. Special Funds for Financial and Organizational Restructure

Up to now, a common general characteristic of capital sources for innovation has been the desire for capital gains. This is also the characteristic of special funds. These special funds consist of leveraged buy outs (LBOs) and acquisitions and mergers.

Both the traditional venture capital industry and emerging specialty funds are interested in having their investments become part of LBO and acquisition and merger activities. Many of their investees are also interested in becoming such candidates. Not all start-ups necessarily stay small or become middle or large size companies that engage in global trade. Many innovators who build companies deliberately plan to "sell out." We are seeing dominant companies invest in the equity of independent growth companies; e.g., IBM, AT&T, GM, Ford, GE, Chevron, etc.

There has been a dramatic transformation in 1984 in the magnitude of leverage buy-outs. In 1984, LBOs were four times the amount in 1983. There were over $18 billion of LBOs. Traditional venture capital firms invested over 12% of their 1984 funds in LBOs. LBO investment in principle makes it possible to secure capital gains in less time than investments in starts-up or mezzanine stages of growth companies.

The explosive amount invested for acquisitions and mergers signals another major transformation. Today's acquisitions and mergers are, in many respects, different from past periods. In the past, they represented either vertical or horizontal mergers for manufacturing or market control or for financial purposes; e.g., conglomerates. Today's mergers and acquisitions are more for capital gains, increasing managerial effectiveness, or providing investment opportunities that lead to increased liquidity. Many of today's acquisitions and mergers focus on innovations in terms of managerial effectiveness and telescoping the time to successfully commercialize innovations because of the accelerated life cycles of newer products, processes, and services.

By any measure, acquisitions and mergers have transformed the allocation of capital. Mergers and acquisitions in 1984 were over $105 billion, compared to $47 billion in 1983. In terms of dollar activity, the dominant industries were mining, oil & gas extraction, petroleum refining, retail trade, food & allied products, and banks & bank-holding companies. In terms of numbers of transactions, bank and bank-holding companies, and machinery (except electrical and electrical & electronic machinery) were the most active industries. Foreign buyers were involved with 182 acquisitions out of a total of 2,946.

The dominant regions in which acquisitions and mergers take place are the Middle Atlantic, Midwest, and Pacific. The dominant states are California, New York, Texas, Illinois, Florida, Pennsylvania, and New Jersey.

Let us look at where the innovative developments are taking place. For these purposes, the major drivers are Federal R&D obligations, traditional venture capital, and selected company R&D expenses. The dominant states by ranking are shown in Table 6.

At present, there are 17 states and the District of Columbia that meet the innovative criteria. Four states are ranked in the top 10 within each category; namely, California, New York, New Jersey, and Massachusetts. These certainly are the first tier states. The second tier or those in at least two of the categories' top 10 would include two states: Maryland and Texas.

There are active developments taking place in restructuring firms and industries in terms of acquisitions and mergers. The dominant states, in rank order, are California, New York, Texas, Illinois, Florida, Pennsylvania, and New Jersey.

While a transformation is taking place, in terms of innovation, it has become evident that the present traditional paradigm that science and technology naturally evolve into commercialization that makes and secures a nation's future is inadequate. It does not adequately (1) provide employment opportunities; (2) mitigate layoffs; (3) maintain a strong global competitive position; (4) make economic security; and (5) present growth opportunities across the board. Furthermore, the mechanism of allocating resources needs to focus more on flexibility and adaptability than on efficiency and effectiveness.

The traditional paradigm is undergoing transformation. Emerging institutional developments are leading to a newer paradigm of commercialization of science and technology within a compressed time frame and a broader base of opportunities; i.e., technology venturing. What our conference has shown is that there is a need for infrastructure reviews to assure that there are no gaps in providing the talent, capital, technology and know-how for innovation to become diffused to all states. In this regard, there must be available not only excellent schools, transportation, utilities, water, natural resources, quality of life, but also a vibrant capital environment that provides appropriate institutional segments, savings, in-state markets, business-to-business markets, a regional economic focus, basic research centers supported by Federal and state R&D funds, outstanding industrial laboratories, better educated including Ph.D.'s and excellently trained workers with advanced skills. There must also be entrepreneurs who are encouraged by the local communities, universities and colleges, and the larger companies.

Part II -- Technology Venturing -- New Institutional Developments

Technology venturing is a collaborative means for economic growth. Newer institutional developments are providing a set of coherent relationships among key institutions involved with economic growth and technological diversification. These institutional developments fill in previous gaps in the traditional venture capital and economic development process.

The drivers for these newer institutional developments are: (1) increasing foreign competition; (2) shortages of highly trained scientists and engineers; (3) difficulty in keeping up to date with developments; (4) gap in new technology transfer especially when it requires pulling together basic research from different disciplines; (5) a need to fill the gap for diffusion of technology for developing useful commercial products and services by individual companies; (6) a desire to foster more basic research in universities; and (7) a determination to diffuse R&D activities across wider geographic areas.

At least eight newer institutional developments have been identified. They are:

* industrial R&D joint ventures and consortia
* academic/business collaboration
* government/university/industry collaboration
* incubators
* industry/university research and engineering centers of excellence
* small business innovation research programs
* state venture capital funds
* commercialization of university intellectual property

These newer institutional developments have some very common elements:

1. There are generally collaborative efforts. In this sense, they are more than partnerships. Partnerships generally mean working together and going along together. What is seen in these technology venturing arrangements is that each institution has managed to maintain its own independence while providing on a timely and coherent basis for net improvements to the local, state, and national economies.

2. The total funds involved are generally small when compared to the more traditional institutional efforts. For example, very few states provide as much as $20 million for seed funding for entrepreneurial endeavors. Corporations entering into

cooperative technology ventures individually contribute annually in the low millions of dollars per year. Universities' cooperative efforts generally are funded with small amounts per year. For example, in the largest biotechnology cooperative agreements we know of between Harvard University and Hoechst amounted to $70 million over a ten-year period. Others are much more modestly funded.

3. Leveraging and institutional coupling are other common characteristics. For example, universities are encouraged to establish centers of excellence with either Federal government or state government offering small annual fundings for 3 to 5 years provided their funds are matched to some pre-set ratio or more by individual business firms. The matching funds are an incentive to provide couplings that are both necessary for commercialization and for reducing the time for commercialization and diffusion.

4. Another common characteristic is that collaborating institutions are encouraged to utilize existing facilities and to share laboratory equipment.

5. The rights to patents and copyrights have become a newer resource for future funding for some of the institutions involved. The Federal government has given the rights to basic research breakthroughs funded under Federal R&D obligations to the performing universities and colleges. This

gives them the incentive to convert such technological resources for commercialization through the market place and to provide their own flow of future research funds through fees, royalties and other financial forms.

Throughout America, each of the states is moving to aid the growth of high technology and to foster technological commercialization. They, rather than the federal government, have taken a leadership role through policy development organizations, economic growth initiatives, and corporate-university partnerships. Since 1980, over 150 programs or initiatives have been developed by states for high technology and economic development. For most states, the major source of R&O funds is still the federal government. There is a direct correlation between those states receiving the largest federal obligations for R&D and those taking the lead to initiate technology venturing developments.

As a result of these activities, technopolises are beginning to emerge in many states. These technopolises are bringing together in dynamic and interactive ways, state government, local government, private corporations, universities, non-profit foundations, and other organizations. They are developing corridors and triangles between key cities or research universities. Centers of excellence are appearing within these corridors and triangles. they have begun to lay out science and research parks; they have begun to target emerging science and technologies for long-term industrial growth and vitality.

Leadership networks are forming between previously isolated institutions. The development of such technopolises is not accidental. They can have a catalytic impact and cause reactions far beyond their immediate location within the state. Very often these impacts are national and international in scope.

What is clear from this conference is that these state initiatives along with the industry cooperatives and the Federal government's Small Business Innovation Research Programs and NSF's Center of Excellence in Science & Engineering have really been focused on covering the gaps in the traditional paradigm of commercializing science and technology. These newer institutional developments for economic growth and diversification are: (1) encouraging emerging industries; (2) providing seed capital for early and start-up entrepreneurial endeavors; and (3) assuring U.S. economic preeminence.

1. To develop emerging industries. Institutional relationships involved here are academic and industrial collaborations and industrial R&D consortia. Because the basic research is carried out in the universities and colleges, getting collaborative efforts between academia and industry can accelerate the commercialization of basic research into emerging industries.

Since 1981, there have been a series of private corporation joint research efforts. The pioneering institutions, such as Semiconductor Research Corporation (SRC), Council for Chemical Research (CCR), Center for Advanced Television Studies (CATS), and Microelectronic and

Computer Technology Corporation (MCC) are favored by the current Administration and Congress. The obstacle to such consortia in the past has been ambiguous legal status under the antitrust laws that would entail the risk of huge penalties. The passage of the Cooperative Research & Development Act in October 1984 has done much to alleviate the legal concerns. One result of the passage of this act is likely to be a proliferation of large-scale R&D consortia. Already there are a number of consortia being considered. Among them are:

* Military Software Productivity Consortium - TRW, Lockheed, Boeing, Rockwell and seven other defense contractors are considering new ways to produce computer programs and other software techniques for military applications.

* Fiber optics - Battelle is trying to put together a 20-company consortium to develop components to tie together fiber optic networks, high-speed communication systems. Allied Corporation, 3-M and AMP, Inc., have already joined.

* Other consortia are being considered for the energy, steel, machine tools, airframe, and auto engines industries.

Biotechnology is an example of an important, emerging industry. No U.S. R&D consortium, however, has emerged to compete with the recently formed $100 million, seven-year Japanese consortium in this area. Most U.S. biotechnology research is being conducted by individual firms or by establishing university-corporate relations. Some of the more recent start-up biotechnology companies have had as equity shareholders other major firms in energy, drugs and agriculture.

Newer institutional structures are emerging in the "megabuilding business." These structures include other domestic and foreign support and process companies as well as domestic and foreign governments. Innovative financing is required that pulls together banks, institutional investors, government financial export credit agencies, and international development organizations, such as the World Bank and IMF. In addition, megabuilding institutions are required to make their own investments in the projects, carry on basic, generic and engineering research, as well as keep up with technological advances in new materials, products and processes. Their marketing strategy includes more than competitive winning of contracts. It involves the ability to do longer-range planning and forecasting of markets as well as to generate new businesses based on commercial-size demonstration plants.

2. To create seed capital for small and take-off companies. Some forms of institutional development such as incubators, SBIR programs and state venture capital funds are providing seed capital for small and take-off companies. They are also pushing regional and local economic diversification through entrepreneurial activities.

A number of states are now developing special initiatives, such as tax incentives, enterprise zones, research and industrial parks, and direct financial assistance in the form of low-interest bank loans and loan guarantees to meet the start-up capital needs of new technology firms.

One area of concentrated interest is state support and implementation of private venture capital sources for small technology firms. Given the high risk and generally long-term pay-back time of typical venture capital investments, firms with less than $500,000 "start-up needs" are not attractive investment targets for the private market.

A fine example of state involvement in this area is the Massachusetts Technology Development Corporation. Operating both as a public agency and non-profit corporation since 1979, the MTDC has invested $3.4 million of its own funds into 20 individual firms. More dramatically, it has used these investments to leverage more than $22 million in private sector money to these same companies.

A creative approach was taken in 1982 by the Michigan Legislature which permitted the use of Michigan State Retirement Funds to be used as a venture capital base for equity investment in Michigan high technology firms. The estimated value of these venture funds is $350 million.

Incubators are another promising tool being employed to provide a suitable environment for "hatching" new spinoff applications of high technology ventures. These are funded by both public and private sources. There are over 100 incubators across the country. The great majority have sprung up in the last 18 months. To the seed fund programs and incubators, a number of states have also established training and support programs for entrepreneurial development, feeling that this is one of the most critical areas in promoting technology commercialization.

3. _To provide for U.S. economic preeminence._ A number of institutional developments are seeking to ensure U.S. economic preeminence. These focus on the creation of NSF centers of research and engineering excellence, government/business/university collaborative arrangements in technological areas, industrial R&D joint ventures and consortia, and NSF's sponsorship of Industry/University Cooperative Research Centers (IUCR). These are intended to provide a broad-based research program that is too large for any one company to undertake alone. Most of these centers are for multidisciplinary research programs to meet industry's research needs. To date, 20 such centers have been established with 10 more in the planning stage. Twenty states are involved. Massachusetts leads with four. Those states that have three centers are North Carolina, Pennsylvania, and Ohio. New Jersey, Georgia, and Texas have two centers each. The science areas range from ice research, computerized chemical engineering, biological process technology, ceramics, hydrogen technology, steel processing, polymers, and biotechnology. The 20 university centers now in operation involve 250 faculty members, 300 graduate students, and 30 postdoctoral students. There are 150 industrial members who have invested $25 million since 1972, with $10 million of that total coming in 1984.

There are four supercomputer/university consortia which are funded by NSF as well as the Florida State University Supercomputer Computation Research Institute. There are also various universities that have formed consortia for undertaking scientific research that requires that scientific resources of more than one university.

Much remains to be done in the new frontier of technology venturing. There is little question but that these newer institutional developments have their own momentum. How effective they will be is yet to be assessed. We know we are educating a newer group of entrepreneurs. We know we have initiated newer means and methods of allocating and using resources to meet the challenges of a hypercompetitive, protectionist-seeking marketplace.

There are still a number of critical issues that must be addressed if technology venturing is to fulfill its promise:

1. What will be the impacts of new tax simplification regulations?

2. How will changes in the buying practices of DOD affect economic growth and technological diversification?

3. How will changes in the peer review process for basic research affect long-term regional economic trends?

4. What will be the impact of fundamental changes in intellectual property on the commercialization process and on the nature of higher education?

5. How can entrepreneurial abilities be developed and enhanced over the long run? Is it possible to accelerate the learning and experiential processes?

6. How can we encourage more domestic manufacturing for small and medium-sized firms? Should flexible full-scale manufacturing demonstration laboratories be publicly or privately sponsored?

These newer collaborative institutional efforts are not short-term phenomena. There are several reasons why the institutional developments under technology venturing are expected to be active over the long term:

1. The emerging U.S. industrial structure is knowledge intensive, which makes it easier for people with innovative technologies or business to commercialize their ideas.

2. There is a growing acceptance to finance patents as well as sound business plans.

3. Government, academia and business are continuing to push all areas of technological development.

4. University graduates are more prone to identify with start-up entities and to be more entrepreneurial.

5. The surpluses of human, physical and financial resources are making it easier for entrepreneurs to get started.

For these reasons, technology venturing, by transforming institutional relationships, will be critical in making and securing the future of the United States.

TABLE 1

Percent Distribution of Federal Obligations for R&D
By Dominant States and By Performer

Fiscal Year 1983

State	Total Obligations[1]	Total %	Federal Intramural	Industrial Firms*	Universities & Colleges*	Other Non-Profit	State & Local Govt's
First Tier							
California	$8.4	100	14	61	19	6	**
Second Tier							
Maryland	3.4	100	63	24	12	2	**
New York	2.5	100	3	65	27	4	1
Virginia	2.3	100	32	61	4	3	**

*Includes Federal Funded R&D Centers administered by indicated performer sector.

**Less than ½ of 1%.

[1]Billions of dollars.

Table 2

Percent Distribution of Federal Obligations for R&D
By Dominant States and By Agency

Fiscal Year 1983

State	Total Obligations[1]	Agencies %				
		DOD	DOE	NASA	Department of Health and Human Services	All Other
First Tier						
California	$8.4	19	11	29	11	40
Second Tier						
Maryland	3.4	8	1	10	23	58
New York	2.5	7	7	1	11	74
Virginia	2.3	9	1	6	1	83
Agency % of Total Federal Obligations		61	12	7	12	8
Total Federal Obligations[1]	$37.6	22.9	4.5	2.6	4.3	3.3

[1] In billions of dollars.

Table 3

Major Industries and Their Firms Accounting For Largest Percent of R&D Expenses for 1983-84 (In Billions)

	Firm R&D Expenses	Industry R&D Expenses
Dominant Basic Manufacturing Industries		
Automotive -- Cars and Trucks		$4.9
General Motors	$2.6	
Fuel		2.2
Exxon	.7	
Chevron	.3	
Mobil	.2	
Dominant High Technology Industries		
Information Processing--Computers		6.1
IBM	2.5	
Digital Equipment	.6	
Drugs--Ethical, Proprietary, Medical and Hospital Supplies		3.5
Johnson & Johnson	.4	
Merck	.4	
Lilly (Eli)	.3	
SmithKline Beckman	.3	
Upjohn	.2	
Pfizer	.2	
Chemicals		3.4
DuPont	1.0	
Dow Chemical	.5	
Monsanto	.3	

Chart A
Percentage of Research and Development Expenses by Industry Categories 1983 to 1984

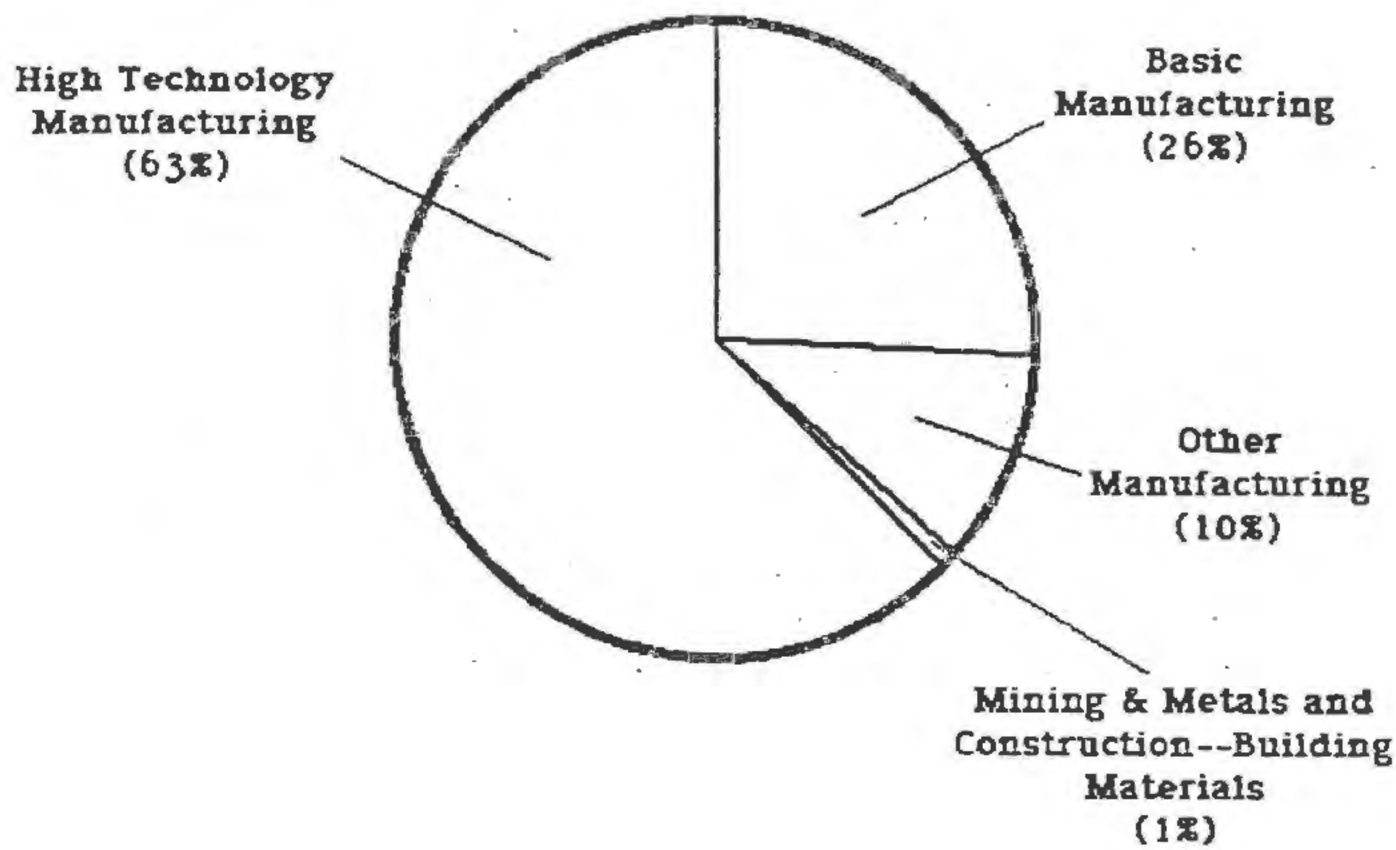


Table 4

Industry Category and Dominant Firms Accounting for Largest Percent of R&D Expenses in Employment for 1981 and 1983 (In Thousands)

Firms	Employment		Change
	1981	1983	
Basic Manufacturing Industry			
General Motors	741	691	-50
Exxon	180	156	-24
Chevron	43	40	- 3
Mobil	206	178	-28
High Technology Manufacturing			
IBM	355	370	+15
Digital Equipment	53	73	+20
Johnson & Johnson	77	77	--
Merck	32	33	+ 1
Lilly (Eli)	29	29	--
SmithKline Beckman	23	31	+ 8
Upjohn	21	21	--
Pfizer	42	41	- 1
TOTAL	1,802	1,740	-63

Table 5

Research and Development Limited Partnership
Formation and Capitalization
1978-1984

Year	Partnerships Funded	Capitalization**
1984*	27	$623
1983	81	806
1982	72	709
1981	22	205
1978-80	6	22

*Through August 1984

**In millions

Table 6

Innovative State Rankings

State	Dominant Federal R&D Obligations[1]	Dominant Selected Company R&D Expenses[2]	Traditional Venture Capital[3]
California	1	3	1
New York	3	1	2
New Jersey	8	3	10
Massachusetts	4	5	3
Maryland	2		6
Texas	7		8
Illinois			5
Virginia	5		
Florida	9		
New Mexico	6		
District of Columbia	10		
Michigan		2	
Pennsylvania		5	
Connecticut			4
Colorado			7
Minnesota			9
Delaware		5	
Ohio		5	

[1]For fiscal year 1983.

[2]1983-84

[3]1984

CHAPTER 4

BUILDING INDIGENOUS COMPANIES: THE TECHNOLOGY VENTURING APPROACH

By

Raymond W. Smilor

The United States is in the midst of a great entrepreneurial era. Cities and regions across the country are finding creative and innovative wyas to build indigenous companies. These responses comprise a new approach to assisting the economic renaissance of an area known as technology venturing.

Technology venturing is an entrepreneurial process by which individuals and institutions -- universities, federal, state and local government, and the private and non-profit sectors -- take and share risk in integrating and commercializing scientific research, new technologies and business opportunities. Technology venturing often links public sector initiatives and private sector investments to spur economic growth and technological diversification. Eight interactive stimulants are generating the technology venturing process.[1]

Imaginative collaborative relationships between universities and corporations. Universities and corporations are building stronger and more extensive ties to commercialize science and technology. Appendix 1 shows selected university/corporation programs. It indicates the scope of business firms, the diversity of research activities, the substantial amounts of funding and the range of academic institutions involved in developing collaborative ties. These programs seek to speed the technology transfer process. They also provide an important window on emerging technology opportunities for business development.

Pioneering programs and linkages between government, business and universities. The Federal government has taken the lead in providing for new applied research and development programs. The National Science Foundation, for example, has initiated a landmark efforts in supercomputers while NASA is advancing space commercialization. NSF has established supercomputer research centers at four major universities -- Princeton University, University of California at San Diego, Cornell University and University of Illinois. NASA is in the process of establishing space commercialization centers at six other geographically dispersed universities. The centers maintain critical links with business and reflect a new role for the university in economic development.

Innovative private joint efforts for scientific advances. The Cooperative Research Act, which was passed by the U.S. Congress in October 1984, sanctioned and encouraged private consortia for research and development. These consortia reflect both a recognition of the realities of a truly international marketplace and a realization of financial, scientific and human requirements for advanced research and development. The Microelectronics and Computer Technology Corporation in Austin, Texas, is a consortium of twenty-one companies in the computer industry. The Semiconductor Research Corporation in Research

Triangle Park, North Carolina brings together 33 companies in the semiconductor industry. The Advanced Television Research Center in Boston, Massachusetts, includes each of the major television networks. These examples of R&D consortiums are remarkable because they signal new types of collaborative ventures among intensely competitive firms.

A blossoming venture capital industry. Venture capital is growing rapidly in the United States. Over $3 billion was committed to venture capital pools in 1984 and over $2 billion was dispersed to ventured backed companies. Two-thirds to three-fourths of these dispursements went to technology-based companies.[2]

Creative institutional arrangements between the public, private and non-profit sectors. Foundations are playing an increasing important role in economic development. Through endowments to universities, support of consortium efforts and involvement in research centers, they are finding ways to help diversify regional and state economies.

Imaginative local community initiatives for economic growth and social development. Local governmental entities, chambers of commerce and city research groups and task forces are pushing economic diversification. They are finding new ways to link efforts and build community consensus. The Project '90 effort in San Antonio, Texas is a prime example of effective community initiatives and leadership. By pulling together business, government, academic and community constituencies, Project '90 addressed key city issues, developed 177 action initiatives and charted a new strategic direction for San Antonio.[3]

Leading-edge state government growth initiatives fostering high technology. States governments are taking a leadership role in diversifying regional economies through technology diversification. They are initiating programs for high technology development, technology education, vocational training and technical assistance. They are establishing seed capital funds. They are also setting up task forces to address special issues and respond to important business location and relocation projects.[4]

Selected federal government programs. In a number of ways, the federal government is acting as a stimulant to new business development. One of the most successful programs has been the Small Business Innovation Research program (SBIR), through the Small Business Administration. Twelve federal government agencies have been mandated by Congress to set aside a percentage of their budgets to award to small businesses for technology development. The program operates on a competitive and phased process. From 1983 to 1988, the period covered by the current legislation, is is estimated that the SBIR program will fund over $1 billion in new monies to small businesses for R&D work.

These stimulants are having a dramatic impact on the entrepreneurial process.

The Entrepreneurial Process[5]

Economic development is based on four critical factors:

1. talent--people
2. technology--ideas
3. capital--resources
4. know-how--knowledge

Entrepreneurial talent results from the drive, tenacity, dedication, and hard work of special types of individuals--people who make things happen. Entrepreneurs are individuals who recognize opportunities. Where there is a pool of such talented entrepreneurial people, there is the opportunity for growth, diversification, and new business development. There are a variety of sources for entrepreneurs: universities, corporations, research labs, communities, the public sector and inventors of all sorts. Events that trigger their entrepreneurial push may include dissatisfaction with current employment, recognition of an opportunity, an urge to try a new venture, changes in public policy or simply a desire to push an innovative idea.

But talent without ideas is like seed without water. The second critical component in the entrepreneurial process concerns the ability to generate ideas that have real potential within a reasonable time. The burst of creativity and innovation in emerging technological industries holds tremendous promise for economic development and technology business growth. When talent is linked with technology, that is when people recognize and then push viable ideas, then the entrepreneurial process is underway.

Every dynamic process needs to be fueled. The fuel for the entrepreneurial process is capital. Capital is the catalyst in the entrepreneurial chain reaction. It is the life blood of emerging and expanding enterprises. It is the *sine qua non* in business of a new product, an innovative service, or a brilliant idea. It provides the financial resource through which the ideas of the entrepreneur can be realized.

Given talent, technology and capital, one other element is indispensible to making the entrepreneurial process successful. Know-how is the ability to leverage business or scientific knowledge in linking talent, technology and capital in emerging and expanding enterprises. It is the ability to find and apply expertise in a variety of areas that can make the difference between success and failure. This expertise may involve management, marketing, finance, accounting, production and manufacturing, as well as legal, scientific and engineering help.

Hypercompetition

The business climate is fierce both domestically and internationally. The competition is between countries, states and communities, as well as between large and small firms and among industries. The environment in which yet to be born born and emerging firms must operate is particularly unforgiving. The ability to introduce new technologies or services to the marketplace poses several unique competitive problems.

To help companies meet the challenge of a hypercompetitive environment and to maximize the contributions of the small business and technology business growth sectors to American society, the promotion of new business growth has become an important facet of economic policy at the federal, state and local levels. Building indigenous companies has become an essential element in regional economic development.

Industrial relocation, long the central focus of regional economic development, tends to be a zero-sum game--one region or location benefits only at the expense of another. Indigenous company growth may be a more beneficial and necessary long term economic development strategy for several reasons. First, it harnesses local entrepreneurial talent. Second, it builds companies which in turn creates jobs and thus adds economic value to a region and community. Third, this strategy keeps home-grown talent--a scarce resource--within the community. Fourth, it encourages economic diversification and technological innovation by creating a climate that rewards productivity and innovation.

Communities must operate in a hypercompetitive environment. Appendix 2, "Hypercompetition: America's 50 High-Tech Highways," provides a telling perspective on the intense competition for economic development and technological diversification. There may be as many as 20,000 cities, states and countries competing for less than 1,000 relocations of high-tech firms. Consequently, cities and regions are focusing on building indigenous companies. They are trying to create a "Golden Triangle," "Satellite Ally," "Electronics Belt," "Robot Ally," "Tech Island," and "Silicon Bayou," all of which are attempting to link universities, government entities and private corporations in new approaches to economic development.

To compete in this kind of environment, communities must stress factors that enhance quality <u>for</u> life. <u>For</u> implies a more proactive approach to insuring the quality of an economic region. It conveys a recognition of the economic importance of qualitative factors. Some of these are:

- Quality of schools
- Quality of parks and playgrounds
- Outdoor recreational opportunities
- Variety of entertaining activities
- Cultural events
- Relaxing ambience of community
- Community safety
- Community cleanliness
- Ease of transportation with the city
- Accessibility of airport
- Housing costs
- Availability of jobs for spouses
- As a place to raise children
- As a place to live
- Climate
- Air quality

By stressing these factors, communities can develop a linkage among key institutions to build a viable public/private infrastructure, a strong financial environment, a vibrant entrepreneurial spirit, and a commitment and dedication to risk-taking.

Entrepreneuship Stimulants

A variety of social and economic factors are stimulating entrepreneurial activity and thus generating more robust economic development. These factors include an increasing focus on capital formation, changing institutional relationships, supportive government programs, a reassessment of intellectual property, and new approaches to innovation.

A growing pool of capital dedicated to the entrepreneurial process is being created in the United States today. Much of the attention concerning this pool has been focused on venture capital--a dynamic and creative process by which capital investments in mid-growth enterprises are made, managed and developed. Venture capital is generally available only to firms with a proven track record. Venture capitalists rarely provide seed capital--that is, capital used to prove a concept, to build a prototype, or to permit an entrepreneur to start a new firm. Consequently, there needs to be mechanisms for entrepreneurs to reach a point where they may be in a position to tap the resources of the venture capital industry.

A second stimulator concerns the commercializaiton of technology through new institutional developments. The ability to transform scientific and technical developments into profitable business opportunities is at the heart of the commercialization process. There area set of social institutions that are important sources of research and development--government, industry, and non-profit institutions. There are other institutions which directly perform research and developmetn activities--government laboratories, industry, universities and colleges, and other non-profit institutions. These institutions are looking for innovative ways to collaborate, to promote entrepreneurial activity, and to diffuse technology while they reap the rewards of their intellectual property assets. Each of these institutions holds potential entrepreneurs who are considering ways to comemrcialize their ideas.

A third stimulant to the entrepreneurial process is the proactive role of federal, state and local governments. The federal government is actively seeking to fund and support technological efforts which have the potential for commercialization.

Fourth, universities, federal laboratories, industry and research consortia are undertaking a major reassessment of policies and approaches to intellectual property due to hypercompetition. This is particularly important to many emerging high technology companies. Since entrepreneurs are springing from each of these institutions to take their ideas and innovations to the marketplace, it is becoming more important to reassess questions concerning patents, licenses, royalties and general ownership of scientific and technological developments. Given the growing collaborative relationships that are developing between business, government, and academia, and given their more direct attempts to transfer technology to the marketplace, there is likely to be increasing numbers of entrepreneurs seeking the opportunity to commercialize their ideas and innovations.

A fifth stimulant to new business development is the removal of barriers to innovation through the establishment of an environment favorable to entrepreneurial activity. The removal of barriers has been accomplished on a variety of levels, including the federal, state, and local governments and by industry. On the national level, the federal government has encouraged the transfer of technology from federal laboratories and has encouraged research consortia formation by modifying antitrust laws. Many state governments have repealed tax laws which are considered disadvantageous to technology-oriented firms, have enacted special education laws to help keep and attract highly qualified personnel to local employment, and have endeavored generally to create an environment conductive to entrepreneurship. Many corporations, recognizing that entrepreneurship increases productivity, have established flexible corporate cultures to accommodate <u>intra</u>preneurial activity. Some have even established venture capital pools and incubator units to invest in entrepreneurially oriented employees.

New Business Incubator

Successful entrepreneurship takes a wide variety of talents. However, it is rare to find a potential entrepreneur who combines the technical expertise necessary for technological innovation with the business acumen necessary for successful product commercialization. One concept which has developed in the last five years to facilitate the development of entrepreneurial creativity and education is the incubator unit.

Incubator units are designed to assist entrepreneurs in developing their business skills in an environment that simultaneously stimulates creativity. Although incubators vary in scope of assistance provided, there are some generic components to the incubator concept. An incubator provides low cost office and/or laboratory space, administrative services, access to library and computer facilities, skilled consultants, an inexpensive work force in the form of graduate and undergraduate students, and special contacts with bankers, venture capitalists, technologists and government officials. In this environment, an aspiring entrepreneur is free to be technologically creative since his energies can be devoted to product development and not to the rigors of obtaining financing or managing an organization. All the while, the entreprneeur is associated with other entrepreneurs facing similar difficulties, this providing an association which should, it is hoped, stimulate the entrepreneur's drive for success and help solve problems. (See Figure 1).

An incubator is not only an organization, but also a physical unit. Incubators start as a single building or group of buildings where the participating entrepreneurs can be housed and where, due to physical proximity, they will spontaneously interact. In the building, there may be space for a number of different entrepreneurs. The institution sponsoring the incubator will provide secretarial support, duplicating services, accounting services, technical editing help, computer equipment, conference space, health and other benefit packages, and access to university facilities and expertise for a nominal fee.

The advantages of being on or near a university campus are numerous: library facilities, exposure to state-of-the-art technical thinking and equipment, undergraduates that form a pool of cheap and technically skilled labor, a creative environment, and potential employment as a lecturer. Companies within the incubator profit from the technical resources of the university in a variety of ways. These companies benefit from the best available talent when they need it without having to carry that high-priced talent on their payroll. And these companies receive the stimulus and catalytic effect associated with working along side outstanding professionals from outside their organization.

Organizationally, incubators differ from one another due to their varying priorities. Priorities are different because of the funding that supports the incubator unit. Funding sources for these units include federal, state, and local governments, communities, universities, private individuals and foundations, and corporations. Incubators can be associated with any of these funding sources to varying degrees, and therefore, have similar goals but different priorities. The general goals of incubators are to develop firms, often technically based, and stimulate entrepreneurship. Incubators may seek to develop jobs, create investment opportunities for college endowments, expand a tax base for local government, enhance the image of college technical programs, speed transfer of technological innovation from the academic and research worlds to industry, fill a perceived gap in venture capital financing by improving the quality of locally-based entrepreneurial talent, and build a core of indigenous companies.

The Entrepreneurial Network

Entrepreneurship is a dynamic process. As such it necessarily requires links to relationships not only among and between individuals but also among and between a variety of institutions. The stronger, more complex and more diverse the web of relationships, the more the entrepreneur is likely to have access to opportunities, the greater his chance of solving problems expeditiously, and ultimately the greater the chance of success for a new venture.

The entrepreneurial network, as depicted in Figure 2, illustrates some of the potential links and relationships that can promote and sustain new ventures in an economic area. A university provides business and research centers, continuing business education (especially in management and marketing skills) and potentially a base for research and development which also helps develop entrepreneurs. Major firms provide key credibility to emerging companies as customers, and are sources of spin-off opportunities. Emerging firms provide a tier of peer support, find critical help in incubators and establish important links with and through suppliers and customers. Professional support comes through networks to accounts, lawyers, and financiers. State and local government provide incentives, direct aid, and access to contracts while responding to the creative pressures of emerging business interest groups. Other support networks take a variety of forms: key individuals, consultants, workshops and business education programs, social and civic groups, and collective efforts to improve quality for life factors.

Through networking, communities can advance economic development and technological diversification by providing a broader and richer range of opportunities to entrepreneurs.

Trends in Economic Development

There are seven major trends affecting the direction of economic development:[6]

1. Technology as a resource
2. Hypercompetition in domestic and international markets
3. The role of invention
4. Government as stimulator
5. Entre/Intra-preneurial development
6. Innovative capital formation
7. Collaborative relationships

Technology is more than a thing, a gadget, or even a process. It is a self-generating resource that is not consumed in the process of use. Consequently, it is an important form of economic wealth.

Hypercompetition is forcing a reassessment of our individual and collective responses to the marketplace. Fierce domestic and international competition for scientific, technological and economic preeminence is forcing communities and regions to leverage all their resources--human, technological and financial--to compete effectively for vibrant and diversified economies.

The United States is experiencing an unprecedented burst of invention. Myraid technological advances are occurring with incredible speed and frequency. The ability to commercialize these inventions will have direct and immediate economic consequences.

Federal, state and local governments are trying to find positive yet non-interventionist approaches to encouraging entrepreneurship and technological diversification. They seek to create jobs, provide benefits to the small business sector and push technology. The creation of an environment that promotes entrepreneurial activity has become a more important focal point in government policy development.

People with raw energy and a productivity for risk-taking built the United States. They are continuing to build it today--in new ways, with new approaches. These entre- and intra-preneurs are breaking tradition and providing a dynamic source of creative and innovative enterprises.

Innovative capital formation is providing the catalyst for the entrepreneurial process. Mechanisms for providing seed capital as well as an expanding venture capital industry are helping to build new ventures. It is essential for the entrepreneurial process to succeed to continue to support and expand the formation of capital and its innovative utilization in new business development.

Finally, creative collaborative relationships are being formed between business, government and academia. These ties are forging new opportunities for commercialization and are accelerating the technology transfer process.

Conclusion

Progress in economic development and technological diversification does not happen accidentally or haphazardly. In a hypercompetitive environment, the economic renaissance of an area depends on a city's or region's ability to address critical needs. To sustain the momentum of positive economic growth, communities must establish programs for investment in a viable public/private infrastructure. This includes not only meeting requirements for infrastructure needs such as roads, water and utilities and services but also providing for educational needs and diversified cultural amenities.

A vibrant financial environment is essential to continued economic development. This includes a sophisticated banking community that understands the unique problems and needs of emerging companies, especially technologically based companies, and an expanding venture capital industry that can address the requirements of high-risk ventures. Only in this way can an area insure diversified opportunities for entrepreneurs.

A pool of capable people keeps economic development on track. A community, therefore, has to find ways to insure a locally trained workforce with a minimum reliance on imported services. As needs are supplied locally, there are more opportunities for entrepreneurs, including opportunities for minorities. A workforce with the know-how appropriate to community needs is essential for economic renaissance.

Technology venturing provides strategic direction for the economic renaissance of an area. It requires new relationships between business, government and academia. It creates new institutional links. By responding to a rapidly changing environment, it engenders a dynamic entrepreneurial spirit.

ENDNOTES

[1]George Kozmetsky, "Technology Venturing: The New American Resonseto the Changing Environment," in Eugene B. Konecci and Robert L. Kuhn, eds., Technology Venturing, New York: Praeger Special Studies, 1985.

2For further information on venture capital see George Kozmetsky, Michael D. Gill, Jr. and Raymond W. Smilor, Financing and Managing Fast Growth Companies: The Venture Captial Process, Lexington, MA: Lexington Publishing Company, 1985.

[3]Target '90, Office of the Mayor, San Antonio, Texas, 1984.

[4]Technology and Growth: State Initiatives in Technological Innovation, Draft Final Report of the Task Force on Technological Innovation, Committee on Transportation, Commerce and Technology, the National Governor's Association, July 1983.

[5]The following presentation on the Entrepreneurial Process, Hypercompetition, Entrepreneurship Stimulants and Trends in Economic development are extracted from Raymond W. Smilor and Michael D. Gill, Jr., The New Business Incubator: Linking Talent, Technology, Capital and Know-How, Lexington, MA: Lexington Publishing Company, 1986.

[6]These trends have emerged from the research program and conference activities of the IC^2 Institute, The University of Texas at Austin.

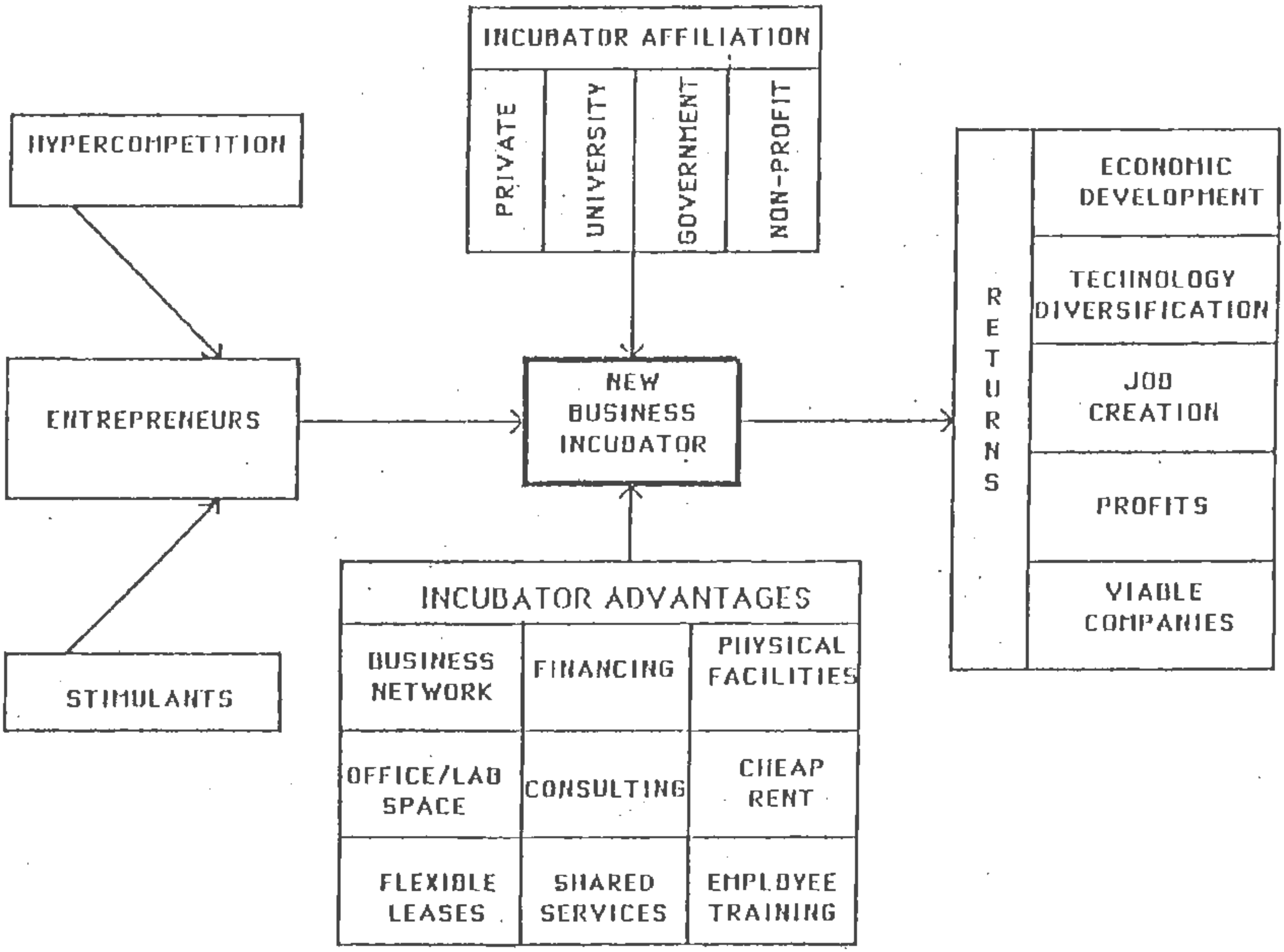
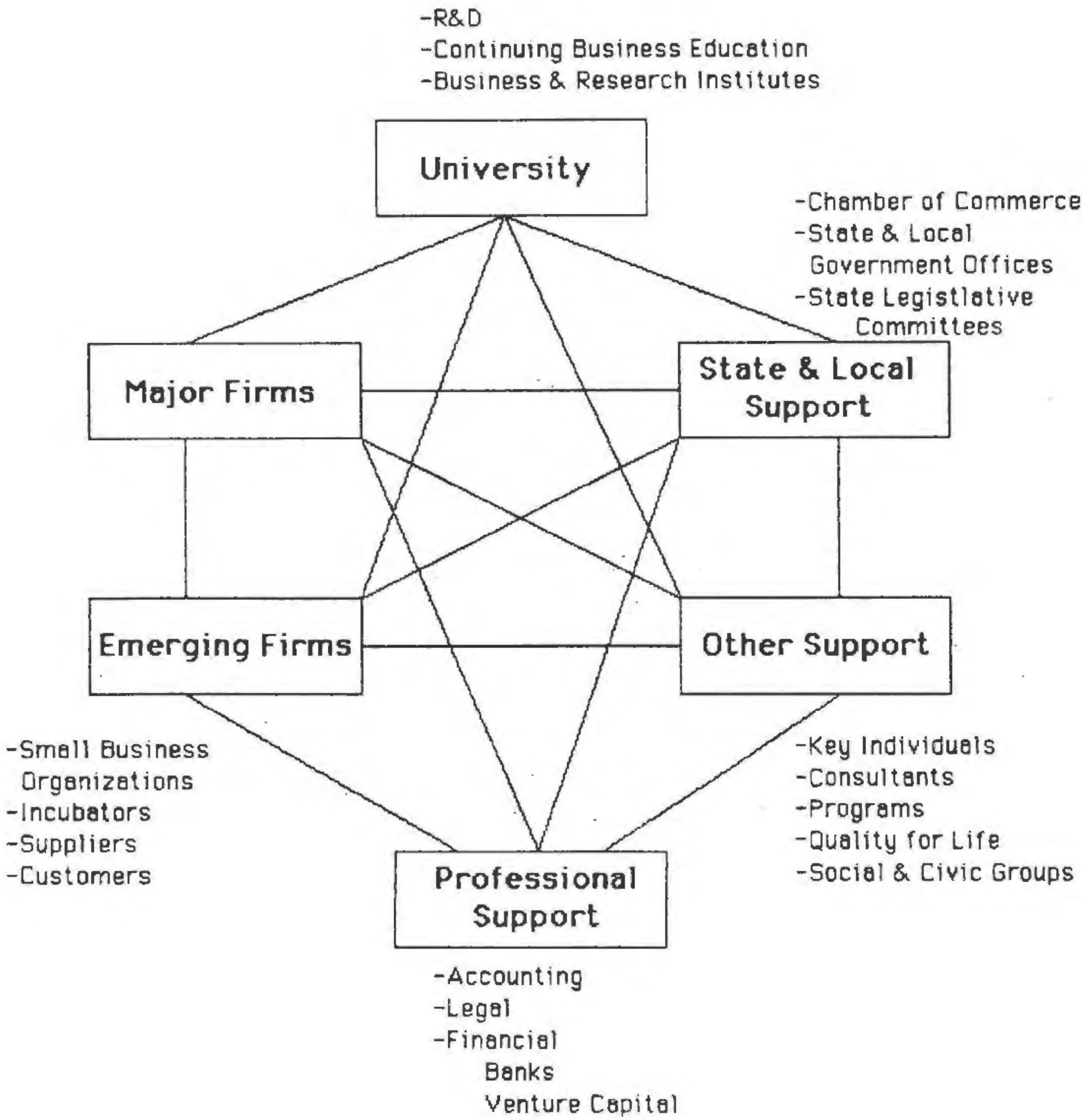


Figure 1

Source: Reprinted with permission from Raymond W. Smilor and Michael D. Gill, Jr., The New Business Incubator: Linking Talent, Technology, Capital and Know-How, Lexington, MA: Lexington Publishing Company, 1986.

Figure 2

The Entrepreneurial Network



Source: The Author

Appendix 1

Selected University/Corporation Programs

Business Firm	Activity	Funding	Academic Institution
Monsanto Company	Biomedical-proteins and peptides regulate cellular functions - 30% basic, 70% applied to human diseases	$23.5 million; 5-year renewable	Washington University St. Louis, Missouri
Monsanto Company	Will sponsor Basic Research in Plant Molecular Biology structure and regulation of plant genes	$4 million; [illegible]-year	Rockefeller University
IBM	Develop manufacturing engineering courses. 1981 IBM grants totaled $17 million	$50 million; $10 million cash, $40 million equipment	Five universities share $10 million cash (to be announced). Twenty universities receive the equipment. Includes UT Austin
Green Cross Corp. (OSAKA)	Mass producing monoclonal antibodies by all fusion techniques to combat cancer	$ unknown, 2 year contract signed	University of California
American Cyanamide-Lederle Labs	Pathway to generate chemical mediators causing allergic reactions to develop drugs to block released mediators.	$2.5 million; 5-year grant	John Hopkins School of Medicine
W. R. Grace Company	Research in Microbiology	$6-8 million; 5-year grant	Massachusetts Institute of Technology

Selected University/Corporation Programs

Business Firm	Activity	Funding	Academic Institution
Apple Computer to Xerox (26 Companies)	Microelectronic innovations; 31 high tech research projects	$2.2 million in cash and equipment	University of California Microelectronic Innovations and Computer Research Opportunities Program - 6 U.C. campuses
IBM	Robotics and use of computers and assembly lines	$1 million grant	University of Pennsylvania School of Engineering and Applied Science
NSF and Coalition of some 30 Industrial Companies	Establish the University/Industry Cooperative Center for Robotics	$ unknown	Site - University of Rhode Island
Celanese Corp.	Specific Basic Biotechnology research	$1.1 million; 3-year term	Yale University
Bristol-Meyers Company	Developing anti-cancer drugs - company option to license cancer chemotherapy drugs discovered by participating Yale faculty	$3 million; 5-year cooperation agreement	Yale University
Gould Inc.	Gould Lab computer service facility	$500,000 over next 5 years	Brown University
IBM	NYU Robotics Center, math, geometric molding and software	Major contribution from IBM and equipment value unknown	New York University

Selected University/Corporation Programs

Business Firm	Activity	Funding	Academic Institution
NSF grant plus - Carolina Power and Lights, Digital Equipment, Exxon, General Telephone & Electronic, IBM, ITT, Western Union and Western Electric	North Carolina State's University/Industry Cooperative Research Center for Communications and Signal Processing. Basic and applied research.	NSF - $650,000; 5-year grant Industrial sponsors - $50,000 each for first 5 years	North Carolina University
Hoechst	Biotechnology research	$70 million over 10-year period	Massachusetts General Hospital and Harvard University
Dupont	Genetic engineering	$6 million over 5 years	Harvard Medical School
Monsanto	Tumor angiogenesis factor	$23 million over 12 years	Harvard University
Engenics (consists of Bendix, General Foods, Koppers, Mean, MacLaren, and Elf Technologies)	Industrial microbiology	$1 million; 4-years	University of California at Berkeley and Stanford
Syntex & Hewlett-Packard	Biotechnology	$600,000 per year for 3 years	Stanford University
Exxon	Combustion research	$7-8 million; 10 years	MIT
Westinghouse	Robotics	$1.2 million per year	Carnegie-Mellon
Industry Participants	Industry scientists work for a year at CalTech and gets view of ongoing research and shares expertise with faculty and staff	$100,000 each	CalTech

Selected University/Corporation Programs

Business Firm	Activity	Funding	Academic Institution
IBM, General Electric and Norton	Research funds and equipment for a Center for Integrated Structures	So far: $1.25 million from GE for 3 years; Norton Co. donated building; and IBM provided a $2.75 million electron beam lithograph system	Rensselaer Polytechnic
<u>Consortium</u> Caterpillar Tractor Co. Cummins Engine Co. John Deer Co. United Technologies Research Center	Engine research includes diesel engines and fuel	$ unknown	MIT-Sloan Automotive Labs
MCC - Microelectronics and Computer Technology Corporation	MCC in Austin - Programs Long Range 1) cost effective interconnection of computers using VLSI chips + $1 million + circuit elements 2) 8-10 year adv. computer architecture study 3) breakthroughs in CAD/CAM systems 4) Quantum improvement in procedures and tools centered on expert and knowledge-based system	MCC budget after start-up $50 to $100 million per year	University of Texas System at Austin and Texas A & M University

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America's 50 High-Tech Highways

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
California	Santa Clara County "Silicon Valley"	Stanford, Fairchild Camera & Instr., Hewlett-Packard, Apple Computer, Intel, National Semiconductor	California Dept. of Economics and Business Development - Sacramento	x		
	Orange County	University of Calif.-Irvine, Calif. State-Fullerton, Long Beach State Univ., North American Aviation, Ford Aeroneutronics, Baker International, Xerox, Cannon	Economic Development Corporation of Orange County:Irvine		x	
	Sacramento	University of Calif.-Davis, Calif. State Univ. at Davis, Hewlett-Packard, Signetics, Intel, Teledyne, Shugart	Sacramento Commerce and Trade Organization: Sacramento		x	
	San Diego "Golden Triangle"	Univ. of Calif.-San Diego, San Diego State Univ., Scripps Institute of Oceanography, General Dynamics, Rohr Industries	San Diego Economic Development Corp.: San Diego		x	

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
Maryland	Montomergy County "Satellite Alley"	COMSAT, Fairchild, Litton, IBM, NASA, NSA, National Institute of Health	Maryland Industrial Development Board: Annapolis		x	
	Prince George County	Univ. of Maryland-College Park, Litton, NASA, OAO, Martin Marietta	Prince George Economic Development Corp.: Landover		x	
Massa-chusetts	Route 128: Boston	MIT, Harvard, Boston U., Tufts, Northeastern, DEC, Wang, Honeywell, GE, GTE, RCA, Raytheon	Mass. Department of Commerce and Develop.: Boston	x		
Florida	Orlando area: "Electronics Belt"	Pratt & Whitney, GE, IBM, Westinghouse, Honeywell, Harris Corp., Martin Marietta, Western Electric	Florida Division of Economic Development, Florida Dept. of Commerce: Tallahassee		x	
	Dade, Broward, Palm Beach Counties "Silicon Beach"	University of Miami	Florida Division of Economic Development, Florida Dept. of Commerce: Tallahassee		x	
	Gainsville to Orlando: "Robot Alley"	Univ. of Florida-Gainsville, IBM, GE, Westinghouse	Florida Division of Economic Development, Florida Dept. of Commerce: Tallahassee			x

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
New York	Long Island: "Tech Island"	SUNY-Stonybrook, Polytechnic Institute of NY, Grumman Aerospace, Brookhaven Natl. Labs, Cold Springs Harbor Labs, Harris Corp.	NY State Science & Technology Foundation: Albany		x	
	Syracuse	Syracuse University, Carrier, GE, Research Corporation of Syracuse, Niagra Scientific	NY State Science & Technology Foundation: Albany			x
Texas	Austin and San Antonio	UT-Austin, UT-San Antonio, Motorola, Lockheed, Tandem	Texas Industrial Comm.: Austin		x	
	Dallas-Ft. Worth: I-20	UT-Dallas, Univ. of Dallas, Texas Instruments, E-Systems, Sunrise Systems, Nuclear Medicine Labs	Texas Industrial Comm.: Austin		x	
	Houston: I-610 and I-45 to Woodlands	Texas A&M, Rice, Univ. of Houston, Texas Medical Center, Litton, Shamrock, Visidyne, Switch Data, NASA, oil companies	Texas Industrial Comm.: Austin		x	

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
New Mexico	Rio Grande Research Corridor	NM Tech, Univ. of NM, NM State Univ., Intel, Motorola, Signetics, GTE, GE, Western Electric, Kirkland AFB, Los Alamos Labs, Sandia Labs, Sperry Rand	New Mexico Economic Development Division: Santa Fe			x
Virginia	Fairfax Co.: I-95 and Washington	George Mason Univ., ATT Long Lines, GTE, McDonnell Douglas, Westinghouse	Fairfax County Economic Development Authority: Vienna		x	
Ohio	Cleveland	Lewis Research Center (NASA), Defense Contract Administration, Case Western Reserve Univ., Picker Intl., Johnson & Johnson, TRW, Bendix	Dept. of Economic Dev., city of Cleveland: Cleveland		x	
	Columbus	Ohio State Univ., Western Electric, Bell Labs, Rockwell Intl., Battelle Memorial Research Institute	State Dept. of Development: Columbus		x	
	Cincinatti	Univ. of Cincinatti, GE, Cincinatti Milicron, Structural Dynamic Research Corp.,	Cincinatti Chamber of Commerce			x

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
Ohio (cont.)	Dayton	Univ. of Dayton, Wright State Univ., NCR, Mead, Wright-Patterson AFB, Air Force Institute of Technology, Monsanto Research, Bendix, Grumman	Dayton Development Council			x
Pennsyl-vania	Philadelphia Route 202	Univ. of Penn. (Wharton), Drexel Univ., Univ. City Science Center, IBM, Commodore	Technology Council, Chamber of Commerce: Philadelphia		x	
	Pittsburgh	Alcoa, Pittsburgh Plate Glass, US Steel, Westinghouse, Gulf, Univ. of Pittsburgh, Carnegie-Mellon	Commonwealth of Penn., Dept. of Commerce: Harrisburg		x	
Washing-ton	Seattle-Bellevue I-5 corridor	Univ. of Washington, Boeing, Eldec Corp., John Fluke Co., Squibb, Weyerhauser	Dept. of Commerce & Economic Development: Olympia		x	

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
Tennes-see	Knoxville-Oak Ridge	Univ. of Tennessee, Oak Ridge Natl. Labs, Boeing, Goodyear Aerospace, Westinghouse, Magnavox	Tennessee Technical Foundation: Knoxville			x
New Jersey	Princeton	Princeton Univ., RCA, Grumman Aerospace, American Cyanamid, Exxon, Mobile	New Jersey Dept. of Commerce & Economic Development: Trenton		x	
Colorado	Colorado Springs	Univ. of Colorado-Colorado Springs, Rolm, TRW, Ford Aerospace, Honeywell	Division of Commercial Development, State of Colorado: Denver		x	
	Denver-Boulder	Univ. of Colorado-Boulder, Colorado State Univ., DEC, NCR, Hewlett-Packard	Division of Commercial Development, State of Colorado: Denver		x	
Illinois	Chicago	Northwestern Univ., Univ. of Illinois, Illinois Institute of Technology, Univ. of Chicago, Bell Labs, Western Electric, Amoco, Abbott Labs, Searle, Gould, Northrup, Fermi Labs, Argonne Natl. Labs	Illinois Department of Commerce: Chicago		x	

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
Alabama	Huntsville	Univ. of Alabama-Huntsville, Redstone Arsenal, Intergraph Inc., Army Corps of Engineers, Army Missle Command, Lockheed, Rockwell, Boeing	Development Division of Chamber of Commerce: Huntsville		x	
Arizona	Phoenix-Tempe	Arizona State Univ., Motorola, Sperry Rand, ITT, Intel, Goodyear, Honeywell, IBM	Arizona Office of Economic Planning and Development		x	
	Tucson	IBM, Hughes Aircraft, Anaconda Copper, National Semiconductor, Univ. of Arizona-Tucson	Tucson Economic Development Corp.: Tucson		x	
Michigan	Ann Arbor	Univ. of Michigan, Ford, GM, Chrysler, Bendix	Office of Economic Development, Dept. of Commerce: Lansing			x
Louisiana	Lafayette "Silicon Bayou"	Univ. of SW Louisiana, Regional Vocational Technical School, Celeron, Shell, Texaco, NASA, Exxon	Lafayette Harbor Terminal & Industrial Development District: Lafayette		x	

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Developing High-Tech Centers	Emerging High-Tech Centers
Minnesota	Minneapolis-St. Paul	Univ. of Minnesota, 3M, Control Data, Honeywell, Cray Research	Minnesota High Tech Council: Minneapolis		x	
Utah	Salt Lake City	Univ. of Utah, Eaton, UNIVAC Aerospace, US Steel, Kennecott Copper	Utah Economic Development Division: Salt Lake City		x	
North Carolina	Raleigh-Durham-Chapel Hill "Research Triangle"	NC State, Univ. of NC, Duke, IBM, Environmental Protection Agency, Becton, Dickenson, GE Semiconductor, Burroughs, Data General, Northern Telecom	NC Department of Commerce Industrial Development Division: Raleigh	x		
Georgia	Atlanta	Georgia Tech, Rockwell, Scientific Atlanta	Office of the Governor: Atlanta		x	
Rhode Island	Newport, Portsmouth, Middletown: Aquidneck Island	Naval War College, Brown Univ., Univ. of RI, Raytheon Submarine Div., US Navy Underwater Systems Center, Gould, Goodyear	RI Dept. of Economic Development: Providence			x

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Devel-oping High-Tech Centers	Emer-ging High-Tech Centers
Indiana	Indianapolis	Purdue, Indiana Univ., GM, Eli Lilly, Renault, Intl. Harvester, Naval Avionics Center	Office of the Mayor: Indianapolis		x	
Wisconsin	Madison	Univ. of Wisc.-Madison, Univ. of Madison Hospital, GE Medical Sys., Ohio Medical Labs, Nicolet Instruments, Cray Research	Wisconsin Department of Development: Madison			x
Oregon	Tualatin Valley: "Sunset Corridor" west of Portland	Tektronix, Intel	Business and Community Development Dept., State of Oregon: Salem		x	
	Wilmette Valley: I-5 Portland to Eugene	Oregon State Univ., Hewlett-Packard, Spectra Physics	Business and Community Development Dept., State of Oregon: Salem		x	
	Bend-Richmond	Bend Research	Economic Development Department: Salem			x
South Carolina	Columbia	Monsanto, GE, Sony, United Technologies, NCR, DEC	State Development Board of SC: Columbia			x

State	Area	Participants: Universities, Govt. Entities, Base Companies	Government Agency	Mature High-Tech Centers	Developing High-Tech Centers	Emerging High-Tech Centers
Oklahoma	entire state	Western Electric, GM, oil companies, Univ. of Okla.-Norman, Okla. State Univ., Tinker AFB	State Office of Economic Development: Oklahoma City			x
New Hampshire	Salem-Manchester-Nashua: "Golden Triangle"	Univ. of NH, Lowell Univ., DEC, Bedford Computer, Sanders Assoc., Kollsman Instruments, Computer-Vision, Data General	NH Office of Industrial Development: Concord		x	
Arkansas	Little Rock to Pine Bluff: Technology Corridor	Univ. of Arkansas-Pine Bluff & Little Rock, Little Rock Medical Center, BEI Electronics, Pine Bluff Arsenal, Natl. Center for Toxicological Research	Arkansas Industrial Development Commission: Little Rock			x
Maine	Portland	Univ. of Southern Maine, Data General, DEC, Fairchild Semiconductor, Sprague Electric	Maine State Development Office: Augusta			x
Vermont	Burlington	Univ. of Vermont, GE, IBM, DEC, McDonnell Douglas, Bendix	State of Vermont Economic Development Dept.: Montpelier			x

Source: *Venture*, Sept 83

CHAPTER 5

CRITICAL SUCCESS FACTORS FOR NEW BUSINESS INCUBATORS

By

Raymond W. Smilor

A new business incubator is a facility designed to assist the development of new firms. By providing a variety of services and support to start-up and emerging companies, the incubator seeks to link effectively talent, technology, capital and know-how to leverage entrepreneurial talent and accelerate the development of new companies.

The word "incubate" takes on fascinating connotations when applied to new business development. To incubate is to maintain under prescribed and controlled conditions favorable for hatching or developing. It also means to cause to develop or to give form and substance to something. In this context, an incubator is an apparatus for the maintenance of controlled conditions for cultivation.

To incubate fledging companies implies an ability or desire to maintain prescribed and controlled conditions favorable to the development of new firms. A new business incubator, thus, seeks to give form and substance, i.e. structure and credibility, to start-up or emerging ventures by maintaining controlled conditions to assist in the cultivation of new companies. The "controlled conditions" include four types of services and support: secretarial support, administrative assistance, facilities support and business expertise, including management, marketing, accounting and finance.

Growth of Incubators

The new business incubator is attracting widespread attention in the United States and in many other countries, including France, Germany, Sweden, England, Japan and China. It goes under a variety of names including "innovation center," "enterprise center," and "business and technology center."

Data on new business incubators in America was collected by means of a mail survey. The survey was conducted in July and August 1985. Traditional mail survey research techniques and procedures were employed when collecting the data, including follow-up telephone calls and questionnaires to initial nonrespondents. The original population consisted of 117 incubators that included all the operating or planned incubators in the United States at that time. (There are approximately 150 incubators in the United States today.) Responses were received from 50 incubators. This represents an effective response rate of 43%.

The number of incubators in the United States has grown rapidly in recent years. 89% of the incubators responding to the national survey have been opened since 1983. And 34% were opened in 1985 alone. These incubators are widely geographically dispersed in the United States. They have developed in 28 states and in every region of the country.

The concept has generated great enthusiasm. An economic development publication called it "the most potent economic development tool to be introduced in this decade."[1] It has also caused skepticism. A February 1985 article in Venture magazine wondered if tenant companies, those firms occupying space in the incubator, might not be giving up far more than they are getting by being in an incubator.[2]

Two Broad Strategies

As the concept began to evolve in the late 1970's and the early 1980's, two broad strategies emerged. One approach was to renovate older or vacant buildings such as school buildings, factories or warehouses, and lease space at relatively inexpensive rates. The strategy focused more on providing entrepreneurs with access to space than on building companies, i.e. expanding the operations, personnel and markets for tenant firms. Success was defined in terms of leased space and in terms of the entrepreneur's ability to meet monthly expenses.

The second strategy was a more conscious attempt to build companies, that is, to leverage resources to help companies grow. With this strategy, some incubators sought an equity position in tenant companies. While providing space was still important, the focus was on developing firms. Success was defined in terms of tenant company expansion and its ability to stand eventually on its own.

As the incubator concept has developed, there has been an increasing emphasis on the second strategy -- helping companies to grow. And incubators have been experimenting with a variety of tactics to link talent, technology, capital and know-how.

To appreciate business incubator development, it is important to realize that the idea is relatively new. It is still an experiment. As with all experiments, there is a great deal of testing taking place.

Diversity of Incubator Models

The testing is reflected in the diversity of incubator organizational models. There are university-related incubators such as the one at Rensselaer Polytechnic Institute in Troy, New York, and the Georgia Advanced Technology Center at the Georgia Institute of Technology in Atlanta, Georgia. There are private incubators such as the Utah Innovation Center in Salt Lake City, Utah, and the Rubicon Group in Austin, Texas. There are corporate/franchise incubators operated by Control Data Corporation in Minneapolis, Minnesota, and by Technology Centers International in Montgomeryville, Pennsylvania. And there are community supported incubators such as the Fulton-Carroll Center in Chicago, Illinois and the Los Alamos Innovation Center in Los Alamos, New Mexico, which is indirectly associated with the national laboratory there.[3]

As incubators have emerged across the country, a few key studies have begun to shed light on the concept.[4] To understand how the incubator concept works in practice, it is necessary to consider a range of factors critical to their success.

New business incubators are diverse in their purposes, organizational structures, operating policies, and institutional affiliations. Nevertheless, a number of critical success factors for incubator management are pertinent to the development and operation of an incubator. Through a national survey, on-site review and extensive discussions with those involved in incubation development, ten factors emerged as important in the incubation experience:

- On-site business expertise
- Access to financing and capitalization
- In-kind financial support
- Community support
- Entrepreneurial network
- Entrepreneurial education
- Perception of success
- Selection process for tenants
- Tie to a university
- Concise program milestones with clear policies and procedures.

Not all successful incubators necessarily incorporate each of these factors. But there does seem to be a direct correlation between successful incubator development and the extent to which each of these factors is consciously implemented by most of the incubator managements. The more extensively these factors are incorporated into the incubator, the greater the chance of success for the tenant companies and the incubator of which they are a part.

1. On-Site Business Expertise

Emerging companies require business expertise. Very often they will have the talent, ideas and even capital to launch a new venture. But they most often lack in various degrees the business know-how to transform these assets into viable business enterprises.

The importance of this expertise was reinforced in the national survey. The consulting services considered most important to provide to tenant companies, in order of importance, included business planning, marketing, accounting and management. When important and most important evaluations are combined, management and marketing support rank highest. (See Chart 1).

The marketing function is essential in both differentiating the products of the company and establishing the credibility of the firm in a highly competitive environment. Marketing is especially difficult in technologically innovative companies, particularly when they are addressing new needs and markets. Marketing must deal with several problems unique to technologically-based companies:

- o technological obsolescense;
- o hesitation to buy early-generation technologies;
- o the uncertainty of selecting the right initial market for a new technology where there is the potential for multiple applications across a variety of industries;
- o the need to educate potential users; and
- o difficulties in forecasting market demand for innovative

products for which users may have little or no frame of reference.

Management determines how emerging companies will respond to changes in the marketplace and especially how effectively they will deal with growth. Managing human, financial and technological resources demand skills that very often need to be learned by enterpreneurs and then honed through experience.

Business planning requires that emerging companies look past their first product. They need to anticipate new products and chart the general direction and future needs of the company. Planning may include not only the growth of the firm but also its eventual acquisition by a larger company.

The accounting function in start-up ventures is a key part of the control and oversight mechanism for the firm. It is particularly important to tenant companies in terms of coming to grips with cash flow.

Regardless of what form incubators take, they can provide on-site business expertise in a variety of ways. The know-how that is internally available in incubators may be leveraged into tenant companies through:

- o an incubator director or president who brings experience and professional management and marketing savvy to the incubator;

- a board of directors that encompasses a range and mix of of expertise that can be passed on to tenant companies;
- an advisory council made up of key professionals to whom the tenant companies have access; and
- a consultant network which can provide services, often on a favorable fee basis.

2. Access to Financing and Capitalization

Capital is the life blood of emerging companies. Consequently, access to working capital financing and equity and debt capitalization comprised the second tier of consulting services considered most important to tenant companies. In order of priority, this access included evaluation of financial options, access to loans and grants, loan packaging and introduction to venture capital institutions and venture capitalists. (See Chart 1)

Given the range and complexity of financing alternatives in today's marketplace, companies need assistance in understanding the alternatives and in determining which may be best for them. The ability to perceive and appreciate what start-up entrepreneurs give up and what they get through any particular financial option is important in launching and developing a new venture. Commercial banking, investment banking, Small Business Administration support, Research and Development Limited partnerships and private investors, to name a few alternatives, all present different advantages and disadvantages which need to be identified and evaluated. This process involves not only understanding the technical and financial dimensions of an alternative but also recognizing the attitudes, perspectives and concerns -- the mind set -- of those providing funds to the venture. This is particularly true as a company considers trading equity for control.

Many emerging companies finance their early development through personal loans and government grants. A number of incubators try to provide access to individuals, institutions and agencies that provide loans and grants. Access here implies the ability to "get to the right person" and to move more expediously. Sources of loans and grants not only include traditional funding mechanisms like banks but also newer mechanisms such as the Federal Small Business Innovation Research program and key individuals or "angels" in the community.

Most entrepreneurs who start companies are not very experienced in dealing with banks and other lending institutions. The ability to package a loan or an application for a grant, therefore, is an important service that can be provided to tenant companies.

Finally, most incubators think it is important to provide tenant companies with introductions to the venture capital industry. This is especially important after a company has developed for a time in the incubator. Few venture capital firms are interested in start-up companies, and most do not make seed capital investments. Because start-up companies require a great deal of help, have a higher chance of failure, take up a lot of time of the venture capital staff, and have little management or marketing experience, most venture capital firms prefer to make investments in more developed enterprises.[5]

Some venture capital firms do set aside a small amount of their venture pool, perhaps 3% to 10%, to make selected seed capital investments. And some funds devoted to seed capital are being developed. But most venture capitalists prefer to wait until a company has a tract record, proven management and demonstrated market competence before making an investment. Consequently, an incubator can provide an important link to the venture capital community by focusing early attention on tenant companies, by making introductions as the company proves itself in the marketplace, and especially by educating the entrepreneur to the venture capital process and the mind-set of the venture capitalist.

Incubators can be a source of and provide access to seed capital, which is the hardest type of funding to generate. The national survey showed that a variety of community related sources provide financial assistance to incubators which pass on some of those resources to tenant companies. (See Chart 2) In addition, some state and federal government financial support is being directed to new business incubators.

3. In-Kind Financial Support

A type of seed capital financing that incubators provide to tenant companies concerns financial assistance through in-kind service support. These in-kind services include secretarial, administration and facilities support. The most important secretarial services to tenant companies, in order of importance, are photocopying, receptionist, word processing and general typing. (See Chart 3) The key administrative services are equipment rental, mailing, accounting help, and contract administration. (See Chart 4) The most important shared facilities services are other (janitorial, parking, etc.), security, computers, loading dock and conference room. (See Chart 5)

By assisting with secretarial, administrative and facilities services, incubators help provide a range of basic but much-needed services that start-up companies require but may often neglect, ignore or cannot afford.

Tenant companies pay the cost of these services in a variety of ways. The incubator may provide a relatively low or subsidized rent to the tenant companies. It may charge a competitive rent but tie access to services into the rental agreement. It may provide these services for an equity share in the company. Or the tenant company may be charged only on an as-used basis, which helps keep its own costs down. As part of the arrangement, most incubators provide extremely flexible lease terms.

4. Community Support

Community support plays an important role in sustaining incubator development. Most incubators in some way reflect a community's effort to diversity its economy, create jobs and leverage entrepreneurial talent for a more viable long term economy. (See Chart 6) Part of the process, however, involves recognizing that companies take time to develop. Economies do not change overnight. And an incubator should be only one tool in a broader economic development plan.

The national survey showed that there is indeed some evidence that incubators contribute to the process of building indigenous companies. That is, they can keep home grown talent at home and develop companies that in turn help generate jobs for the community. Since the incubator concept is relatively new, not many companies have actually graduated or left the incubators. However, of the thirty companies that were found to have graduated from incubators in the national survey, 20% remained in the same neighborhood as the incubator, 60% in the same city and 20% in the same state. No doubt, some companies will be lured or opt to move to other states in the future. But early indications are that incubators may be a viable economic development tool.

Because of this, incubators do gain the financial, moral, and/or public relations support of communities. This support may come from private individuals, city government, private industrial councils, county government, universities and chambers of commerce. This support is also crucial in leveraging additional assistance from professionals and others in the community who may be able to provide business expertise to the tenant companies. When the incubator is perceived as a reflection of community goals and as a potential asset to economic development and diversification, then it is able to a degree to rise above self-interest and thus garner more broad-based support.

5. Entrepreneurial Network

Entrepreneurship is a dynamic process. As such it necessarily requires links or relationships not only among and between individuals but also among and between a variety of institutions. The stronger, more complex and more diverse the web of relationships, the more the entrepreneur is likely to have access to opportunities, the greater his chance of solving problems expeditiously, and ultimately the greater the chance of success for a new venture.[6]

An entrepreneurial network can provide links and relationships that can promote and sustain new ventures in an incubator. A university provides business and research centers, continuing business education (especially in management and marketing skills) and potentially a base for research and development which also helps develop entrepreneurs. Major firms provide key credibility to emerging companies as customers, and are sources of spin-off opportunities. Emerging firms provide a tier of peer support, find critical help in peer organizations and establish important links with and through suppliers and customers. Professional support comes through networks to accountants, lawyers, and financiers. State and local government provide incentives, direct aid, and access to contracts while responding to the creative pressures of emerging business interest groups. Other support networks take a variety of forms: key individuals, consultants, workshops, business education programs, and social and civic groups.

Incubators thus try to advance tenant company development by providing the interface for a broader and richer range of networking opportunities to entrepreneurs.

6. Entrepreneurial Education

If tenant companies are to grow they must eventually stand on their own. At some point, they must cut the umbilical card to the incubator. But this is not easy to do.

One persistent problem that most incubators encounter is the reluctance of tenant companies to move out on their own. The protected environment of the incubators is hard to leave. The expectations of tenant companies for continued support, the reinforcement of peers, the ability to tap business expertise and the general comfort of working in an environment that one knows, all can make the process of graduation from the incubator a difficult one.

To deal with this problem, many incubators are addressing the need for entrepreneurial education. Entrepreneurial education helps prepare the entrepreneur to do business outside the incubator. It seeks to develop the skills -- to instill some of the necessary know-how -- in entrepreneurs so that they extend their own abilities in running a company.

Training and education in incubators may be a formal and structured program of both theoretical and how-to topics, or it may be an informal process of interaction, discussion and exchange. Programs may be developed in-house, related to continuing education efforts in a university, or provided by consultants, academics and experienced practitioners. Training and education activities may address a variety of topics: estate planning, tax advise, business planning, product development, marketing techniques, management skills, competitive contract bidding, grant application and accounting practices.

Part of the education process also occurs through peer interaction. The opportunity to meet and talk with other entrepreneurs who have experienced and solved similar problems or faced similar business situations is a valuable learning experience that the incubators can help facilitate.

7. Perception of Success

An important intangible element plays a role in incubator development. Incubators need to create a perception of success. This perception can help establish the incubator as a resource for the community. It can also help position the tenant companies in the market.

If the incubator is perceived as successful, then it can attract resources more easily, get stronger start-up ventures to seek admission and help tenant companies build credibility.

There are a variety of ways to establish a perception of success:

- o a new and/or attractive facility;
- o affiliation with key institutions, both public and private,

in the area;

- o an experienced (i.e. "successful") incubator manager;
- o a key board of directors;
- o a noted advisory council;
- o a group of promising start-up companies; and
- o successful graduated firms.

Essentially by inference (who is associated with the incubator), by reference (what others say about the incubator and its tenants), and ultimately by evidence (what the incubator actually produces), a perception of success can be established that serves both the incubator and the tenant companies.

8. Selection Process for Tenants

If an incubator seeks to build companies, then it must have a selection process through which it evaluates, recommends and selects tenant firms. By what criteria will it admit companies into the incubator? How will the incubator judge success? When and under what circumstances will it "pull the plug" on tenant companies? What, if any, exit policy exists, and how does this apply to the selection of incoming firms?

The criteria for tenant selection are important and may vary with the mission and objectives of the incubator. Incubators favor high technology and light manufacturing firms. (See Chart 7) Criteria for tenant company selection includes the ability to create jobs, pay operating expenses, present a written business plan, have a unique opportunity, be a start-up company, be locally owned, have fast-growth potential, and be high technology related. (See Chart 8)

Unless there is some set of criteria by which to determine tenant company selection, there is no frame of reference for judging whether a company is on or off track and no way to decide whether and to what degree it may need additional resources.

Most incubators have established some process by which firms are reviewed and approved for admission into the facility. Usually the incubator manager or a selection committee is involved in the review process. In some cases, the board of directors becomes involved. Admission into the incubator often requires a decision by the board or by the incubator manager. In some cases, a selection committee may be involved.

There are exceptions to all selection criteria. But, importantly, the clearer and the more developed the set of selection criteria, the greater the likelihood of admitting companies that can be successful.

9. Tie to a University

Most incubators have established ties to a university. In the national survey, over 80% of the incubators had some kind of affiliation with a university. These ties have developed because the relationship has proven to be mutually beneficial.

These ties can be formal or informal. The incubator may actually be a part of the university or a particular college. In this case, the facility may be on campus, and the incubator may be subject to the rules and regulations of the university system.

Through an informal affiliation, the incubator may be on campus but operate as an independent entity that leases space from the university.

In addition, incubators have developed other types of ties to a university which includes having former university professors as managers or advisors, or having university faculty entrepreneurs in the tenant companies.

Incubators affiliated with a university are also physically close to the university. Among the survey respondents , 39% are 5-10 minutes by car from the university; 27% are within walking distance; 18% are 10-60 minutes by car from the university; and 15% are actually on a university campus.

While incubators benefit from the direct and indirect support of the university, there are also advantages to a university arising from its relationship to an incubator. The incubator provides a mechanism to commercialize university research. It helps a university partly fulfill an emerging obligation of directly contributing to economic development. It also provides an opportunity for university faculty and graduate students to do research.

10. Concise Program Milestones with Clear Policies and Procedures

Whether and how rapidly companies develop in an incubator is partly dependent on the "chemistry" between those managing the incubator and the entrepreneurs in the tenant companies. Tenant companies need to know what will be expected of them, what the incubator will provide, how they will be evaluated, and what the day-to-day procedures and general operating policies of the incubator will be. These issues become all the more important for tenant companies in those incubators that take an equity position in the incoming firms.

All emerging companies experience problems and uncertainties. To help minimize the difficulties, it is incumbant upon incubator management to communicate and entrepreneurs to understand the program milestones by which tenant company performance will be measured as well as the incubator's policies and procedures for dealing with tenant company development.

The relationship between the incubator and the tenant company can be a sensitive one, especially if the expectations of each are different or if there is confusion over what each contributes to and what each gets from the association.

Consequently, the more concise the program milestones and the clearer the policies and procedures, the greater the likelihood that expectations on both sides will be met, that misunderstandings will be minimized, and that each side will benefit from the relationship.

Conclusion

The incubator idea is still new and experimental. Consequently some incubators will fail; others will be modified; and still newer variations on the concept are likely to emerge. Yet some key findings are already emerging. New business incubators do seem to help provide an infrastructure condusive to the development of start-up and emerging companies. They do provide a practical mechanism for risk-taking and risk-sharing in the early and most uncertain stages of entrepreneurial ventures. They do promote cross-institutional net-working. And there is a correlation between incubators and indigenous company development.

Those planning incubators must realize that the incubator is not a panacea for economic woes. It is only one tool or mechanism in a broader economic development strategy. It can contribute to economic diversification, but the process takes time. Results do not appear overnight. Consequently, it is important to have realistic expec-tations and to understand the work involved in developing a viable incubator.

Incubator managers and directors must continually find ways to implement critical success factors in incubator operations. The more that these factors are incorporated in the incubator, the greater the chance of success for tenant companies. Building companies requires not only resources but also an understanding of the entrepreneurial process. By integrating the two, those running incubators will have more effective operations.

Entrepreneurs will have to be mindful of their own interests and more fully understand the incubation process. Being in an incubator requires no less work and dedication than not being in one. Each entrepreneur must ultimately be responsible for his or her own company. Consequently, the entrepreneur must ask questions and evaluate options. He must be aware of what he gives up and what he gets through an association with an incubator, especially one that takes equity in the firm as part of the arrangement. The match can be effective if the "chemistry" is right and if each side knows what is involved in the association.

New business incubators will continue to increase in the United States and in many other countries because they provide an alternative for economic development, an opportunity for diversification and more choices for entrepreneurs.

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6. For a discussion of the relationship between networks and entrepreneurial development, see Howard Aldrich and Catherine Zimmer, "Entrepreneurship Through Social Networks," in Donald L. Sexton and Raymond W. Smilor, eds., The Art and Science of Entrepreneurship, (Cambridge, MA; Ballinger Publishing Company, 1986), p. 3-23.

CHART 1

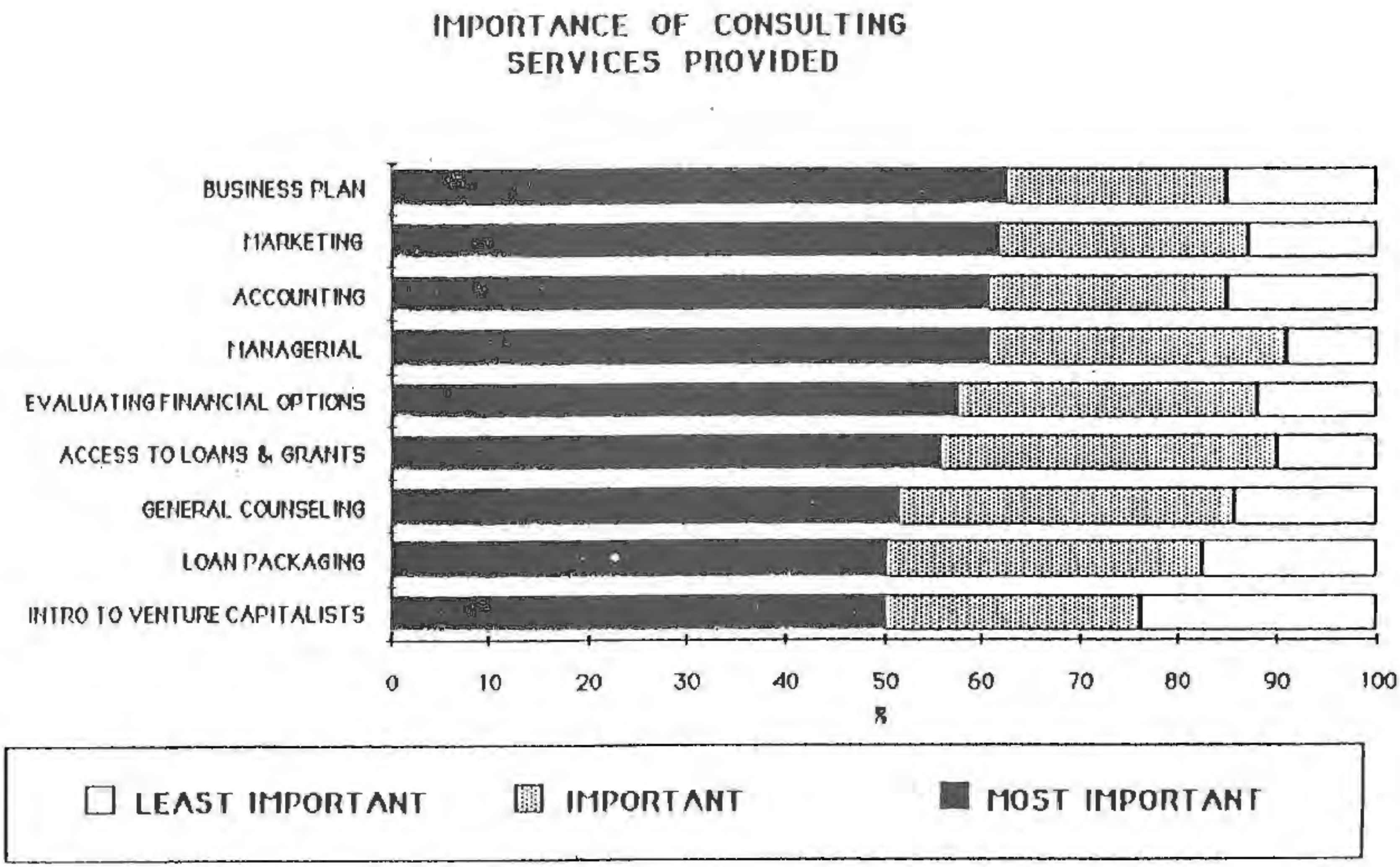
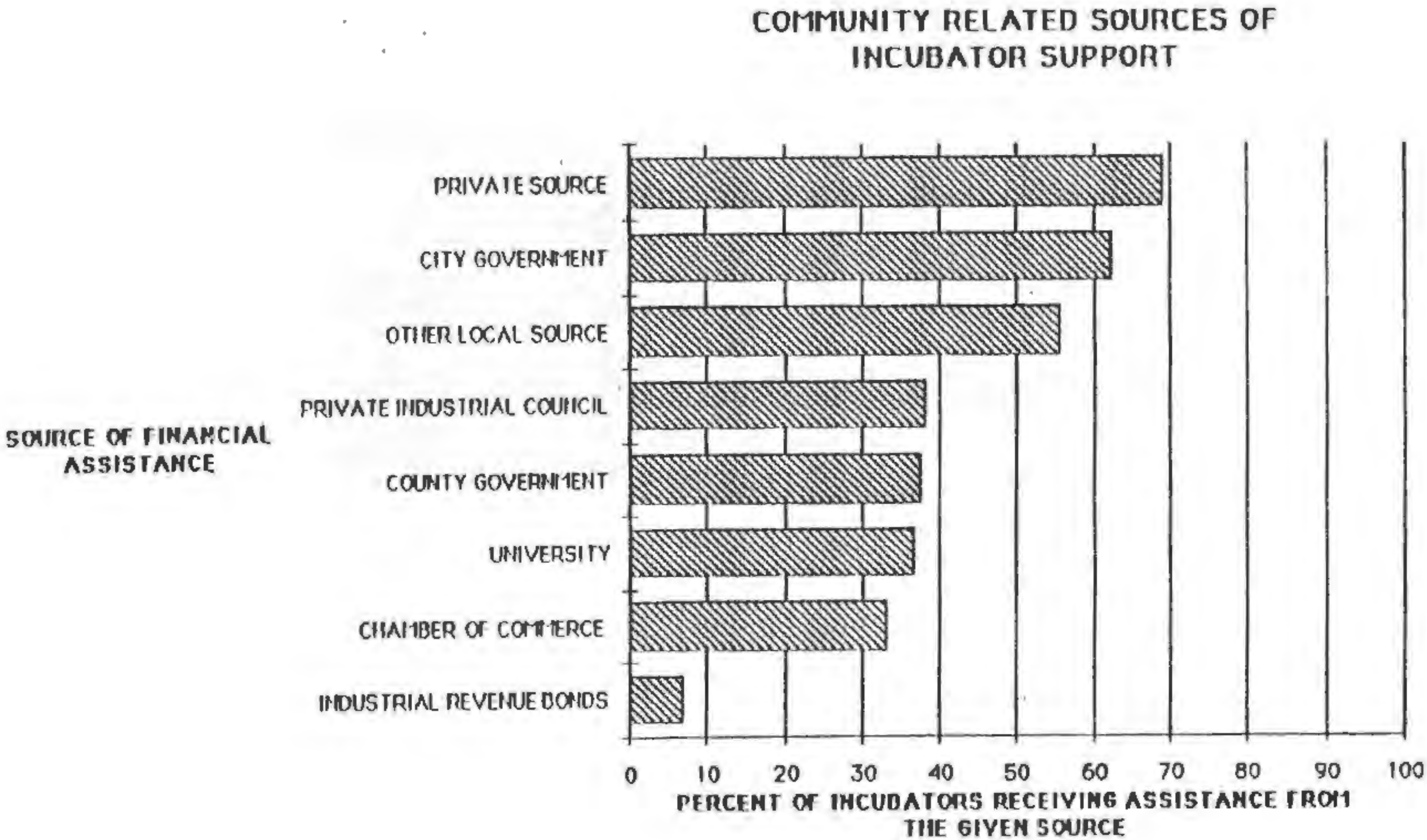

IMPORTANCE OF CONSULTING
SERVICES PROVIDED
BUSINESS PLAN
MARKETING
ACCOUNTING
MANAGERIAL
EVALUATING FINANCIAL OPTIONS
ACCESS TO LOANS & GRANTS
GENERAL COUNSELING
LOAN PACKAGING
INTRO TO VENTURE CAPITALISTS
0 10 20 30 40 50 60 70 80 90 100
%
LEAST IMPORTANT
IMPORTANT
MOST IMPORTANT

CHART 2



COMMUNITY RELATED SOURCES OF INCUBATOR SUPPORT
SOURCE OF FINANCIAL ASSISTANCE
PRIVATE SOURCE
CITY GOVERNMENT
OTHER LOCAL SOURCE
PRIVATE INDUSTRIAL COUNCIL
COUNTY GOVERNMENT
UNIVERSITY
CHAMBER OF COMMERCE
INDUSTRIAL REVENUE BONDS
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF INCUBATORS RECEIVING ASSISTANCE FROM THE GIVEN SOURCE

CHART 3

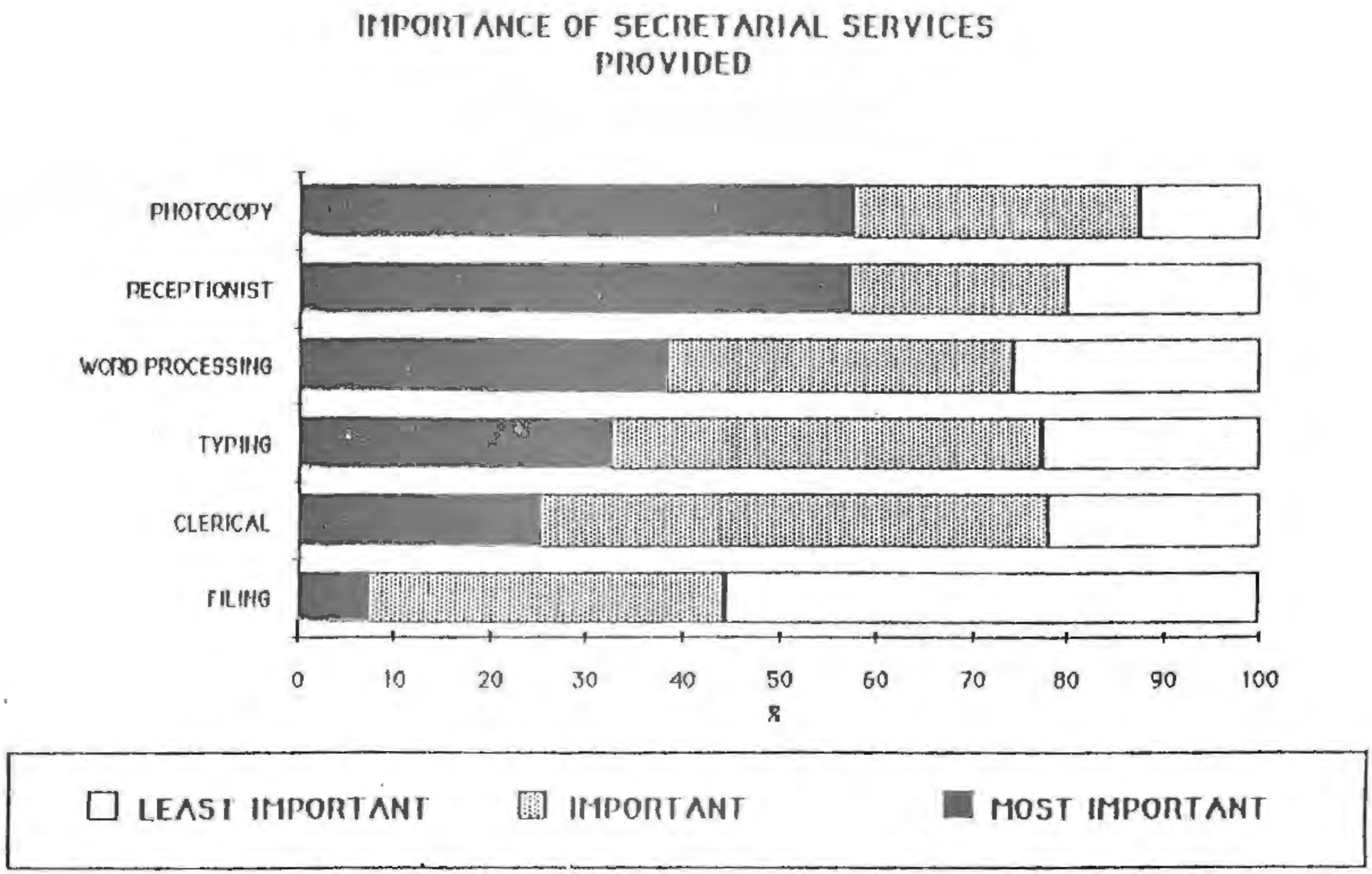

IMPORTANCE OF SECRETARIAL SERVICES
PROVIDED
PHOTOCOPY
RECEPTIONIST
WORD PROCESSING
TYPING
CLERICAL
FILING
0
10
20
30
40
50
60
70
80
90
100
%
LEAST IMPORTANT
IMPORTANT
MOST IMPORTANT

CHART 4

IMPORTANCE OF ADMINISTRATIVE
SERVICES PROVIDED

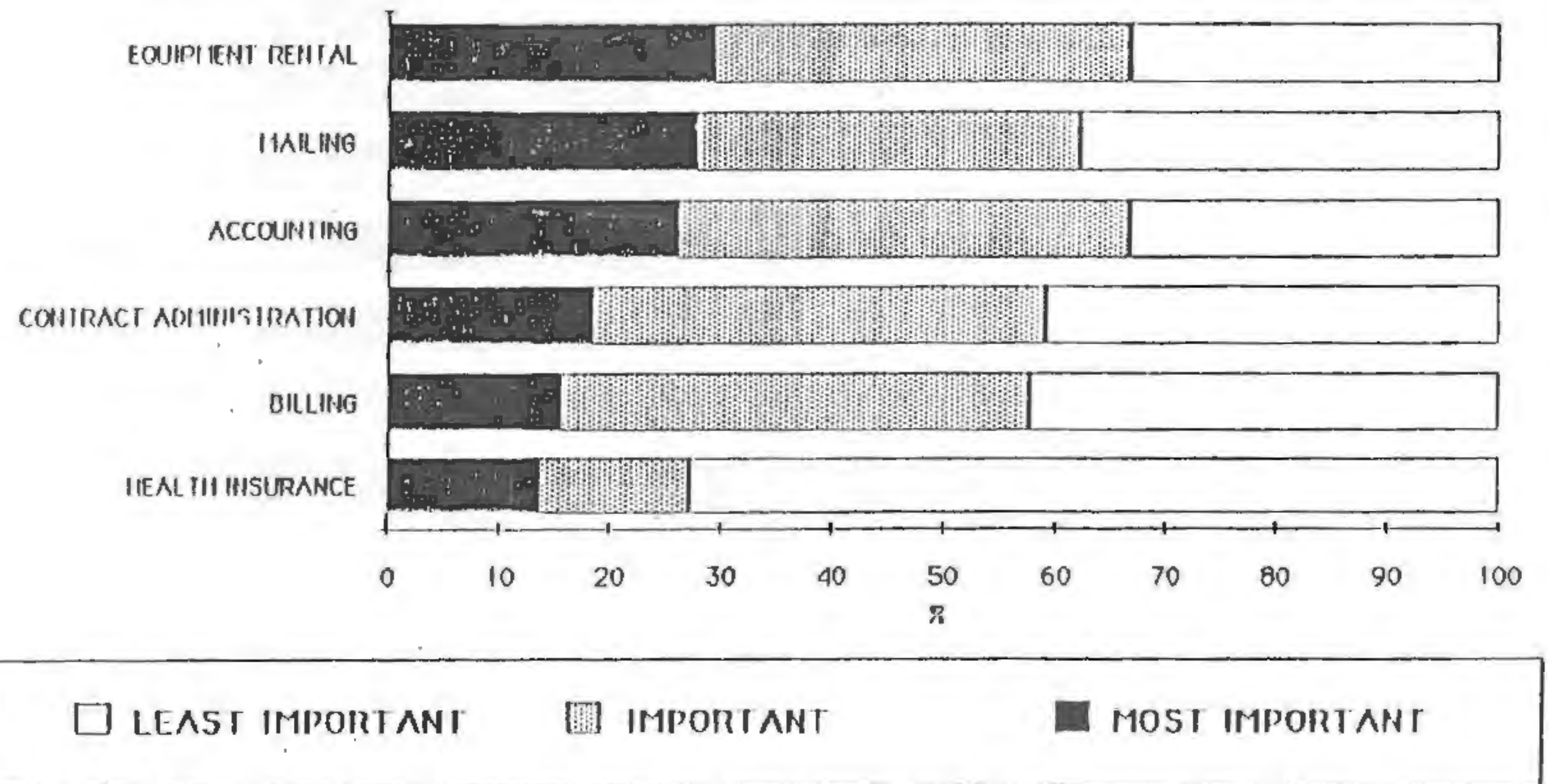


CHART 5

IMPORTANCE OF SHARED FACILITIES PROVIDED

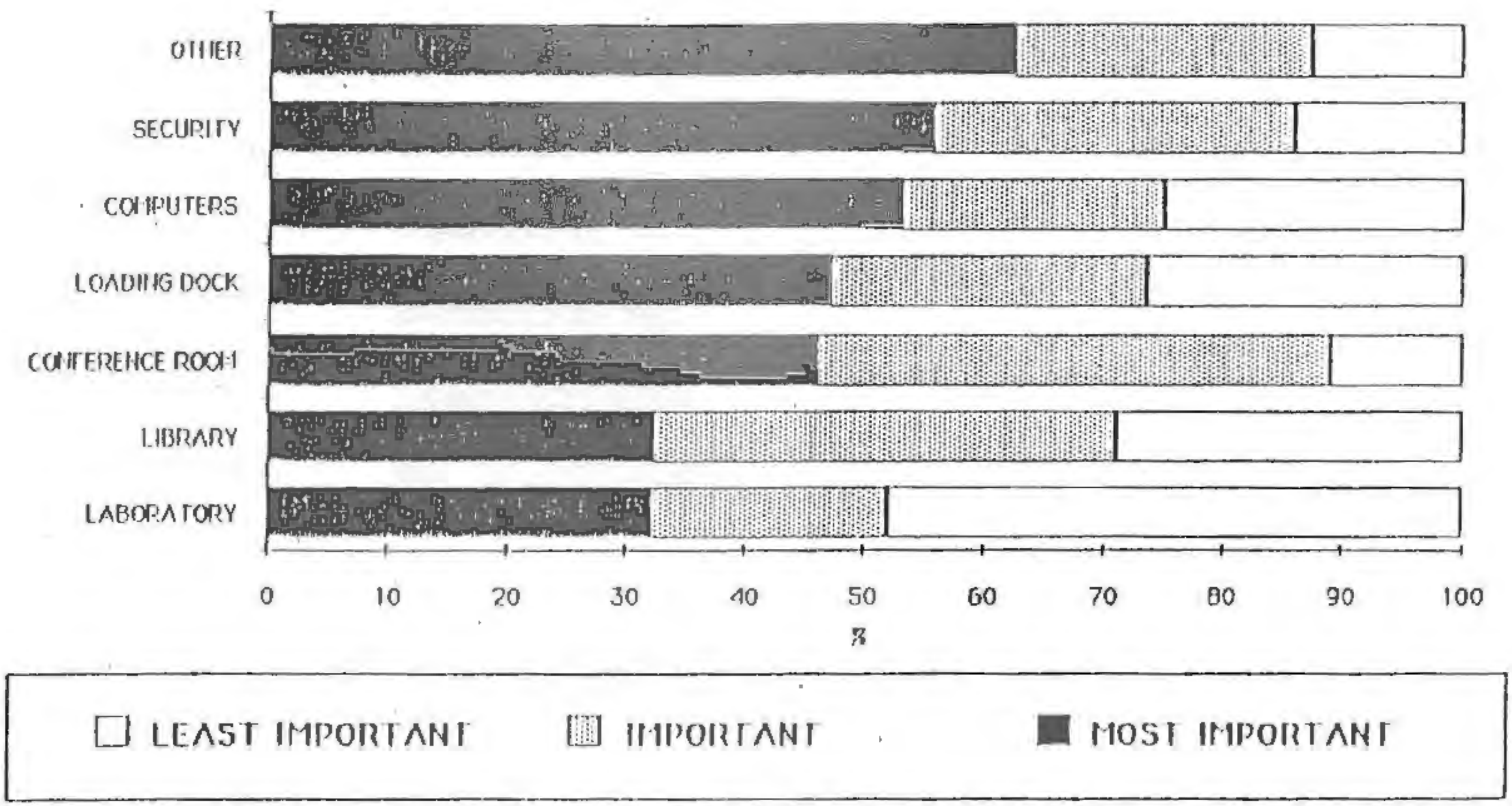


CHART 6

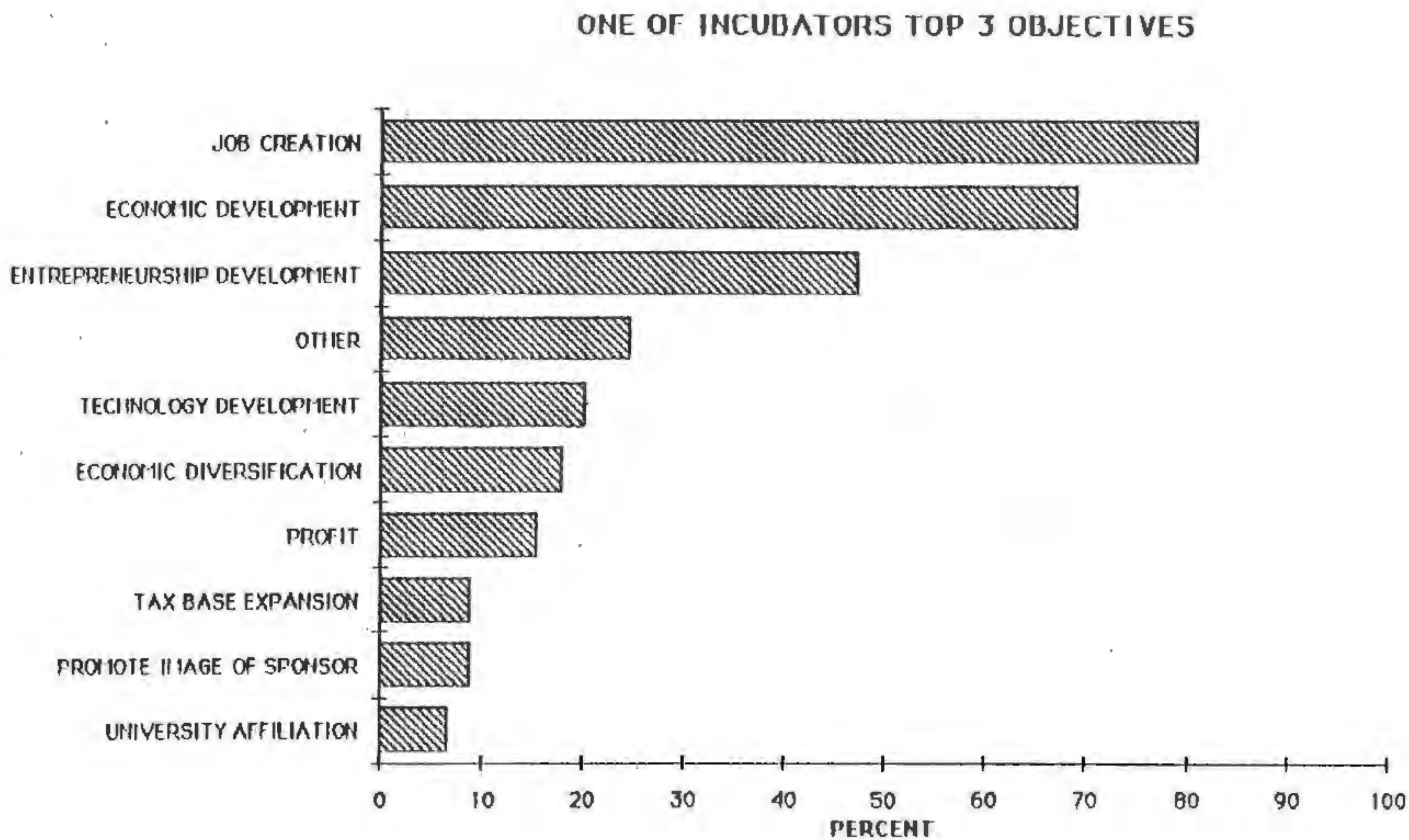

ONE OF INCUBATORS TOP 3 OBJECTIVES
JOB CREATION
ECONOMIC DEVELOPMENT
ENTREPRENEURSHIP DEVELOPMENT
OTHER
TECHNOLOGY DEVELOPMENT
ECONOMIC DIVERSIFICATION
PROFIT
TAX BASE EXPANSION
PROMOTE IMAGE OF SPONSOR
UNIVERSITY AFFILIATION
0 10 20 30 40 50 60 70 80 90 100
PERCENT

CHART 7

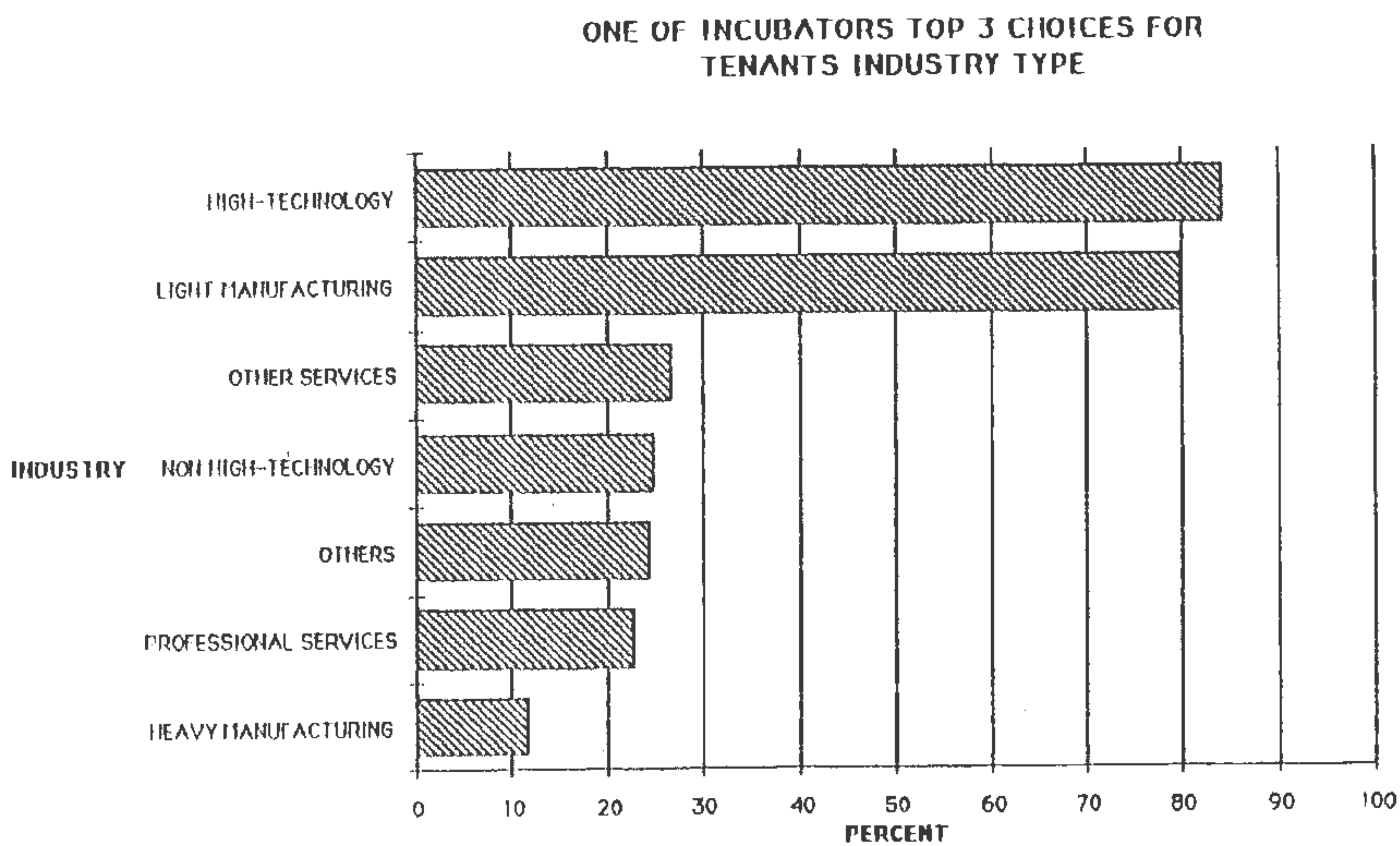
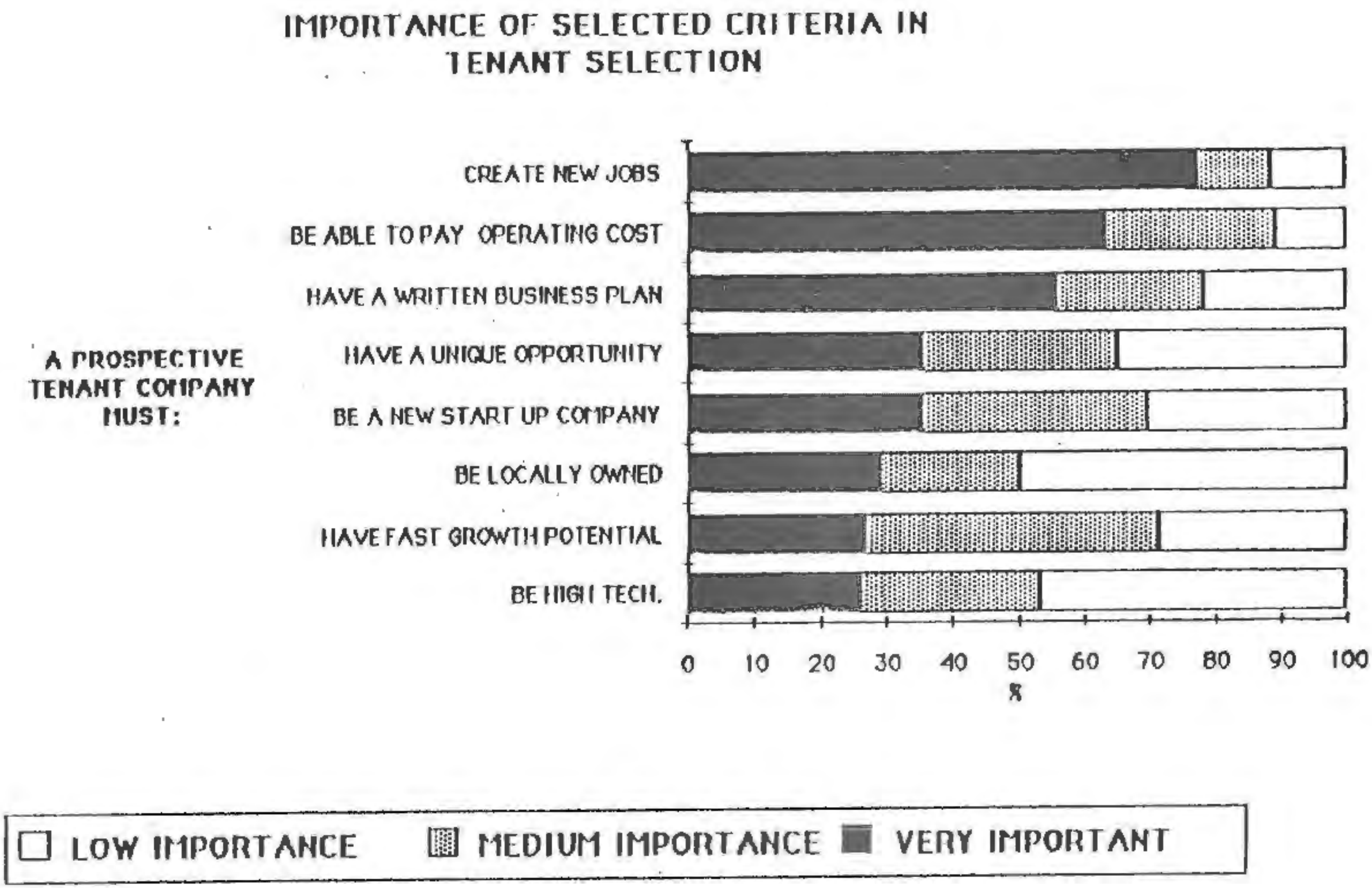

ONE OF INCUBATORS TOP 3 CHOICES FOR
TENANTS INDUSTRY TYPE
INDUSTRY
HIGH-TECHNOLOGY
LIGHT MANUFACTURING
OTHER SERVICES
NON HIGH-TECHNOLOGY
OTHERS
PROFESSIONAL SERVICES
HEAVY MANUFACTURING
0
10
20
30
40
50
60
70
80
90
100
PERCENT

CHART 8



IMPORTANCE OF SELECTED CRITERIA IN TENANT SELECTION
A PROSPECTIVE TENANT COMPANY MUST:
CREATE NEW JOBS
BE ABLE TO PAY OPERATING COST
HAVE A WRITTEN BUSINESS PLAN
HAVE A UNIQUE OPPORTUNITY
BE A NEW START UP COMPANY
BE LOCALLY OWNED
HAVE FAST GROWTH POTENTIAL
BE HIGH TECH.
0 10 20 30 40 50 60 70 80 90 100
%
LOW IMPORTANCE
MEDIUM IMPORTANCE
VERY IMPORTANT

CHAPTER 6

"HIGH" TECHNOLOGY IN TEXAS: THE CURRENT STATE OF AFFAIRS

By

George Kozmetsky

The current state of affairs of Texas technology plainly and simply is in transformation. The depressed conditions of today's oil and agricultural economies are the primary drivers for this transformation. In many respects, they can become more positive drivers than building "high technology," corridors, and research and science parks. Texans, as a whole, are beginning to realize that high technology is not the panacea for solving unemployment and creating tomorrow's newer economic wealth. On the other hand, Texans are ready to take a hard and sober look at all technology for their state's economic growth and diversification.

There is general recognition that the "oil shocks" of the 1970's and early 1980's resulted in higher prices for our oil and gas industry that masked production levels. These good times let us put off the more timely transformation of our state's economy with the necessary public and private infrastructure.

For purposes of this presentation, I would like to look at the state of high technology in Texas from three perspectives:

First, how have our key institutions responded to high technology?

Second, what are the impacts of hypercompetition on the State's technology development?

Third, what are the near-term prospects for Texas's technological future?

Institutional Responses

During the past five years, many Texans thought that a quick fix to the economy would come about hopefully through high technology efforts. High technology has provided our state the necessary momentum to transform our economy and provide hope for a stronger future. There is no question but that during the past five years high technology industries--such as computers, telecommunications, semiconductors, aerospace, biotechnology, and others--increased the employment opportunities and number of firms in high technology in the four major Texas SMSAs. Between 1979 and 1984, Austin had an increase of about 35 firms; Dallas-Fort Worth had an increase of about 25 firms; El Paso had an increase of 10 firms; Houston had an increase of about 55 firms; and San Antonio had an increase of about six firms. These firms were found in over 12 industries.

Occupational Composition

The occupational composition of the Texas high technology manufacturing industries was similar to those of the petrochemical industry. They provided jobs for professional specialities such as managers, scientists, engineers, and technicians. However, they provided fewer jobs for production workers than the non-high technology firms. Hi tech firms provided more jobs for women than the petrochemical industry. High technology jobs are proportionately higher in the managerial, professional, and technician levels than in petrochemicals. They also made up half of the production workforce. Minorities made up 20% of the high technology and petrochemical industries' production workforce. These workers are by and large younger than those in standard manufacturing by about three years in the professional and managerial levels.

Both high technology and petrochemical workforces contain twice as many workers with college degrees and three times as many workers with postgraduate studies than in standard manufacturing. High technology has at least 20% of its workforce with a college degree and another 25% with some post-secondary education. This is in sharp contrast to standard manufacturing industries, two-thirds of whose workforce generally have only high school diplomas.

The dominant annual income in high technology was between $5,000-15,000 while it was $5,000-25,000 for the petrochemical industry. The lower high technology wage patterns reflect the concentration of less-educated women in the lower-wage occupations. On the other hand, they received higher wages than their counterparts in the standard manufacturing industries while less than those in the petrochemical industries.

High technology firms in Texas are relatively small firms. They are new, non-unionized, and have extensive research and development activities. In terms of their relative manufacturing employment, Austin has 44% of such employment in high technology; Dallas-Fort Worth, 28%; San Antonio, 17%; El Paso, 15%; and Houston, 2%.

<u>Venture Capital</u>

These past five years have seen the rise of the venture capital industry in Texas. Prior to that, private investors and bank SBICs were our primary sources of venture capital.

Dallas has emerged as the primary venture capital center in Texas, with a $286 million venture capital pool. Of this total, $205 million is controlled by eight venture capital partnerships. In Houston, SBICs control $64 million of venture money; but, with two exceptions, these SBICs are small by venture capital standards. Venture capital partnerships in Houston are also small and control only $7.5 million. San Antonio has $86 million of venture capital, $74.5 million of which is managed by Southwest Venture Partnerships, the oldest venture capital firm in the state. Austin has $82 million of venture capital, $66 million of which was raised by three venture capital partnerships in 1984. There is an additional $62 million controlled by ten other SBICs across the state.

The fact that these funds are located in Texas does not mean that all their investments are made in the state. Over the 1980 to 1983 period, Texas venture capital organizations placed only 36% of their investment dollars in-state, with the remainder spread around the nation. Of 61 selected Texas investments by Texas-based venture capitalists, 38% went to oil and gas-related businesses, while 30% went to fund high technology endeavors, including communications, biotechnology, semiconductor, and computer-related firms.

Investments in Texas firms by venture capitalists nationwide followed similar patterns. From 1980 to 1983, 54 percent of disbursements by all venture capitalists to Texas firms were to energy-related companies. Texas firms whose products fall into either the computer-related, communications, other electronics, or biotechnology categories received only 31% of disbursements. The IC2 Institute database shows that among 21 giant venture capital firms' investments in Texas, 67% of the companies backed were energy-related, and 75% of the money invested went to these firms. While the sample of the giant venture capital firms' investments is not sufficiently large to be conclusive, it has proved to be a valuable leading indicator of venture capital investments in the past.

Investments of individual Texas venture capital firms by technology and SMSAs are as follows:

* Dallas' $266.9 million of venture capital investments by technology and number of firms were 9 in computer-related; 5 in medical; 9 in telecommunications; 6 in manufacturing; 7 in oil and gas-related; 5 in semiconductors; 3 in broadcasting; 3 in food service; and 4 in others.

* Houston's $55.8 of venture capital investments by technology and firms were 5 in computer-related; 4 in robotics; 5 medical; 3 telecommunications; 4 in manufacturing; 9 in oil and gas-related; 3 broadcasting; 1 in food service; and 5 in others.

* Austin's $77.35 million of venture capital investments by technology and number of firms were 3 in computer-related; 1 medical; 3 telecommunications; 1 manufacturing; 1 oil and gas-related; 1 broadcasting; and 2 in others.

* San Antonio's $76.0 million of venture capital investment by technology and firms were 1 in computer-related; 1 in medical; 1 in telecommunications; 1 manufacturing; and 1 in biotechnology.

An additional source of funds to broaden these investment trends are out-of-state venture capital firms that are being attracted to Texas. For example, in 1983 and 1984, seven out-of-state partnerships have opened offices in Dallas: Citicorp Venture Capital of New York; Investments Orange Nassau of Boston and the Netherlands; Golder Thomas and Company and Woodland Capital of Chicago; Intercapco of Cleveland; Business Resource Investors, and Doughery, Jones & Wilder, both of California.

<u>High-Tech Firms Move to Texas</u>

High technology R&D in Texas got a high boost from the successful location of Microelectronics & Computer Technology Corporation (MCC) in Austin, Texas. Some firms like 3M are transferring substantial R&D activities into Austin. Other high technology firms have moved their operations into Dallas-Fort Worth.

A number of high technology companies headquartered in other states also moved to Texas. They were primarily in semiconductors, telecommunications, and biotechnology. These firms generally moved their manufacturing operations into Texas. In the 1980 to 1985 period, Texas was in many respects one of the major high technology manufacturing centers in the U.S. for very large-scale integrated chips. These included the 64K rams which have become a major Japanese export to the U.S.

In 1984, it became evident that the U.S. was losing some of its position in high technology. In fact, seven out of nine high technology areas' imports were higher than exports. The one that has had a particularly significant impact on Texas is the semiconductor field. For one of the few times in over 30 years, significant cut-backs and layoffs were felt in the high technology industries including those in Texas.

Science and Technology Policy

The 1983 to 1985 period brought about the initiation of our state science's and technology policies for economic growth and job creation. There were a series of factors that contributed to this other than technology; namely, population structure and a decline in agricultural and petrochemical mainstay industries. An important stimulus for high technology in Texas was the projected defense build up through 1987 by the Reagan Administration. In terms of 1979 dollars, this build-up was more than $8.5 billion of output. Between 1983 and 1987, the defense expenditures could result in a net increase of over 70,000 high technology jobs. In addition, aerospace companies such as Lockheed, North American Rockwell, and others were establishing operations in Texas. The Defense R&D budgets were growing at a faster rate than we had seen for some time. Today, many of the major national research universities' faculty members in the Northeast and California were not accepting funds from the largest R&D program in history -- namely, the Strategic Defense Initiative. This provided a rare opportunity for Texas.

In 1983, Governor Mark White began to emphasize technology for economic development. The technology focus was on high technology firms like MCC. Moreover, he initiated collaborative efforts between the two flagship universities (The University of Texas System and the Texas A & M University System), the communities across Texas, and the private sector. In many respects, this was a landmark achievement in terms of newer institutional arrangements for high technology for economic growth.

The 1983, 1984, and 1985 legislative actions can be summarized as follows:

* Appropriated funds for the Institute for Ventures in New Technology (INVENT) at Texas A & M University and the

Advanced Robotics Research Institute at The University of Texas at Arlington.

* Authorized the creation of the Senate Committee on Business, Education and Technology.

* The Committee proposed the following legislations:

  1. Encouragement of closer collaboration between universities and industry.
  2. Increased organized research funding.
  3. Flexible policies dealing with intellectual property.
  4. Improved methods of project solicitation funding.

* The Science & Technology Council was formed with staffing in the Governor's Office.

* The Texas Educational System for secondary education reform was passed with emphasis on advances for technical training.

* A House Science & Technology Committee was formed.

* The Senate and House Committees in the 1985 session introduced over 30 bills to consider technology legislation. Over 14 bills were passed. An important bill was the Texas Advanced Technology Research Program with $35 million for organized research to be competitively allocated by the Coordinating Board of Texas Colleges & Universities.

* The 1985 Legislature mandated that the Coordinating Board hold hearings on the future of higher education and to prepare proposals especially on technology policy for future legislation.

Community Initiatives

During the 1980-1985 period, a number of communities began to take independent initiatives to encourage high technology. The communities' activities were very extensive and broadly based in Texas. They included Houston, Dallas, Fort Worth, San Antonio, Austin, and El Paso. Also other communities, such as Beaumont, Port Arthur, Orange, Corpus Christi, Galveston, Kingsville, Laredo, Victoria, Midland-Odessa, Tyler-Kilgore-Marshall-Longview, and numerous others. The larger cities got most of the media attention. These communities established various mechanisms and task forces for high technology growth and economic development and diversification. They brought together the business community, academic institutions, service organizations, and local and state government officials and agencies to help develop significant building blocks for a high technology infrastructure. These included the establishment of incubators, institutes and centers, and corridors. They gathered together leadership from all groups in the communities, including minorities and unions, conducted symposia and conferences, and visited other states or foreign nations to view high technology programs for potential spin-offs. There was not only a lot of high technology action but also successful accomplishment in terms of attracting firms, venture capital, and encouraging the building of indigenous new high technology firms.

The action of state government and communities has been largely through independent initiatives. As a result, progress is not uniformly recognized by regions of the state or by smaller communities. On the other hand, there is a degree of acceptance about the role of technology in the transformation of the Texas economy. In my opinion, this includes the following areas of consensus:

1. Research spawns new industries and jobs.

2. An educated and well-trained workforce is necessary for stable economic growth.

3. Universities are the appropriate institutions for scientific research activities.

4. It is important to stimulate the formation of entrepreneurial firms as well as attracting out-of-state companies.

5. State government should provide science & technology policies as well as resources for economic growth and the required incentives and removal of regulatory barriers to incorporate technologies for maintaining the viability of Texas industries and to encourage new home-grown firms.

The notion that high technology is not the answer to all of Texas's problem is becoming clear to even the most ardent supporters of high technology. There is now the beginning of a more focused and perhaps more realistic view of the use of all technologies to transform Texas's resources -- oil and gas, minerals, agriculture, its location pertinent to Mexico, Central and South America, its coast line, etc. We are in the process of developing these resources into a sound economic foundation for stable economic growth that will meet the needs of the future demographic mix of population, and at the same time play an important leadership role in modernizing American economics for the twenty-first century. In other words, we are becoming aware that high technology is neither the economic savior nor the over-emphasized answer to all problems. It is a catalyst and an important integral part of a much larger system of innovation that most of us cannot directly or explicitly link.

Higher Education: THe University of Texas System

The higher education community is an important and integral part of technology in Texas. A significant number of advances and developments for Texas higher education and technology have developed during the past five years. For purposes of today's talk, I shall confine myself to the University of Texas System. The UT System Board of Regents, the Chancellor's Offices, and institutional heads have accepted in principle and practice the belief that they have a responsibility to accept leadership for economic development through science and technology. In my opinion, this is a major breakthrough in higher education. Few other universities across the country have yet to accept this challenge.

The University of Texas System institutions have taken a number of initiatives for transforming and diffusing their advances in science and technology. These include increasing the scope of basic scientific research, competing more vigorously for appropriate Federal, state, and private research grants, strengthening their graduate curricula in the sciences, engineering, and management as well as the liberal arts and education , and supporting a growing human resources need for transforming the Texas economy. There are a number of specific steps underway:

1. Expanding engineering facilities, programs and enrollments at both The University of Texas at Arlington and The University of Texas at Dallas. This is an investment of over $50 million for facilities and test equipment.

2. All component institutions have been allocated building funds from the Permanent University Funds in accordance with their five-year strategic plans.

3. There have been a number of institutions and centers established at each component university to enlarge and enhance academic research and teaching.

4. A very large number of innovative collaborative research arrangements have been undertaken with private sector firms by both the academic universities as well as the medical and health service components.

5. Institutes, centers, and foundations are being established throughout Texas for technology venturing, which is a collaborative means for utilizing science and technology for economic development. These include:

* The Advanced Robotics Research Institute at The University of Texas at Arlington which will be located in Fort Worth.

* Establishment of non-state funded biotechnology endowment funds for research and commercialization at The University of Texas Health Science Center at Dallas. This effort was greatly encouraged by the Dallas Mayor's Task Force for Technology.

* Center for Energy and Economic Diversification at The University of Texas of the Permian Basin.

* Institute for Biotechnology at The University of Texas Health Science Center at San Antonio.

* A number of ongoing start-up activities including a Center for Technology Venturing at The University of Texas at Tyler and The University of Texas Health Center at Tyler. The University of Texas System Cancer Center, M.D. Anderson Hospital and Tumor Institute, and The University of Texas Health Science Center at Houston are working on centers and special non-state funded

endowments for research and commercialization. The University of Texas at El Paso has completed plans for establishing an Institute of Flexible Manufacturing and New Materials.

6. Establishment of the University of Texas System Center for High Performance Computing.

7. There have been a series of economic development and technology diversification workshops held at Beaumont, Port Arthur, Corpus Christi, Dallas, El Paso, Houston, the Permian Basin, San Antonio, and Tyler-Kilgore-Marshall-Longview. These efforts have been unique because they dynamically link the university, state government, and the local community in an innovative process of applying science and technology to economic development.

Current State of High Technology

Let us now turn to the current state of high technology in Texas.

In my travels to various communities in Texas, I have sensed a strong sense of perplexity when it comes to high technology. In many respects, it matches the frustrations of $15/bbl oil and the hard times faced by our farmers. Who would have thought five years ago that high technology manufacturers would be facing layoffs and asking Congress for protection? Who was prepared for the very rapid and wide swings in demands for high technology products such as home-game and personal computers?

Today's economic crises in energy, agriculture, and high technology in Texas have become the drivers for transforming our economy. They have served to let us look at the realities of what exists and provided the emotional spur to make positive changes. We are now asking ourselves hard questions and seeking alternatives that bring about the requisite changes. There is now general recognition that we have to ask the public and private sectors, "What is best for Texas?" Today's state of technology in Texas is faced with challenges:

1. How do we establish State of Texas Science & Technology Policies that encompass our own unique technologies that are more than following the five or six high technologies that all other states and developed nations are following?

2. Why is it that Texas does not have a major Federal R&D Laboratory?

3. What does it take for Texas to attract outside venture capital and other financing second to California to build indigenous companies headquartered in Texas that become the new Fortune 500 in the next 20 years?

4. How do we diffuse technology developed in our flagship and lightning-rod institutions to all our communities so that we maintain the viability of current firms as well as provide for diversification and growth in newer indigenous firms?

5. How can we increase Texas' share of Federal R&D so that we are at least the third-ranked state?

6. How can Texas technology be used to transform our economy so that it is more export driven?

As you can see, I am far from discouraged. As a state, we have exceeded any reasonable expectation in the past five years to develop a technology base. There are few states that can match us. We have not waited wishfully for things to take a turn for change nor have we relied on federal government relief as some of the "rust belt states." We have taken things into our own hands. Texans have committed themselves to raise the educational quality of all its children. We have attracted newer areas of research and outstanding technological firms to join with our Texas firms to place their roots in our economic soil. Most are rooted here to stay and others are following. Our major institutions of higher learning have positioned themselves to maintain as well as accelerate the education of the required human resources. Moreover, we have developed and expanded their scientific and research capabilities. The Nobel Prize won by Drs. Michael Brown and Joseph Goldstein are only the first of others to follow that will bring scientific preeminence to Texas. Our Permanent University Fund and the generous private support of Texans to higher education have placed us in a unique position to determine much of our own destiny. Texas institutions can play the major role in the next decade in U.S. higher education. What California's higher education did in the 1960s, '70s, and '80s we can do in the 1990s and 2000. Only we can stop ourselves from attaining that goal.

The near-term prospects for Texas' technological future is one of getting our priorities in order and enhancing the collaborative efforts of the private sector, academia, and state and local governments to achieve the goals of building a unique Texas technology that results in innovation centers as well as world-class manufacturing centers.

Priorities for High Technology Development

In my opinion, there are a number of priorities that we should consider:

First, Texas should establish its own State Venture Capital Funds for funding Texas's start-up companies. Statutes should be changed so our public pension funds and other state endowment funds can be prudently invested in venture capital partnerships.

Second, steps should be taken to identify and to extend those technologies that will permit us to maintain our energy technology leadership in the world. Furthermore, these should be extended to diversify the use of oil and gas from fuel purpose to higher value-added products that give Texas a worldwide edge and market.

Third, we should take the necessary steps that increase both the federal government and industry research base in Texas.

Fourth, Texas should actively seek to establish a major Federal Research Laboratory preferably within the current capabilities and longer-term goals of our flagship universities and other lightning-rod institutions.

Fifth, institutions in Texas must act in a cohesive and collaborative way to advance focused technology developments and to promote a positive economy.

I would like to end on a note of caution. The current economic situation and the state of the fiscal budget make it imperative that we realistically establish and balance our state's budgets. The concern I have is that the momentum and quality of our state universities cannot be placed in jeopardy at this time of transformation. Texas and its industries are short of graduate students in the sciences, engineering, and management as well as world-class faculty.

As Texans, we can do much to help shape the American response to foreign technological competition. Texas has retained its frontier and "can do" attitude. We can take the national leadership in what has always been America's strength; namely, our ability to be scientifically creative, technologically adept, managerially innovative, and entrepreneurially daring.

APPENDIX

APPENDIX A

SCIENCE TECHNOLOGY AND ECONOMIC DEVELOPMENT IN TEXAS

STATE PROGRAM DESCRIPTIONS

1986 POLICY RESEARCH PROJECT

CONDUCTED BY

THE LBJ SCHOOL OF PUBLIC AFFAIRS

THE UNIVERSITY OF TEXAS AT AUSTIN

Under the supervision of

Dr. Jurgen Schmandt

MINNESOTA

Governor's Office/Science and Technology

GOAL: To provide a clearinghouse for inquiries concerning science and technology development programs in Minnesota.

To institutionalize the link between the Governor and private sector technology developers.

- Established in 1983
- 1986 Budget $500,000 (100% State)

Microelectronics and Information Sciences Center

GOAL: To further cooperative research between private corporations and the University of Minnesota's Institute of Technology.

- Established in 1981
- 1985-1987 Budget $7.3 million (100% State)

Minnesota Educational Computing Corporation (MECC)

GOAL: To produce high-quality educational courseware and software for K-12 grades to distribute throughout Minnesota, the nation, and the world.

- Established in 1973
- 1985 Budget $7.2 million
- Became state-owned corporation in 1973

Minnesota Wellspring

GOAL: To bring together business, labor, academia, government, and agricultural interests to create economic development strategies for all Minnesota.

- Established in 1981
- 1985 Budget $210,000 (100% State)

High Technology and Industry Council

GOAL: To promote economic development by coordinating activities of government, industry, and education to meet needs of high-technology industry.

- Established in 1983
- 1985 Budget $4.6 million

  Venture Capital Fund ($1.5 million)
  Research and Applications Program ($1.6 million)
  Centers of Electronic Emphasis ($1.3 million)

Florida Engineering Education Delivery System (FEEDS)

GOAL: To produce more engineers in Florida by serving those not in commuting distance of Florida universities by offering evening videotaped classes.

- Established in 1983
- 1985 Budget $1.4 million (100% State)

Special University Funding for Engineering and Science Programs

GOAL: To produce more engineers for industry.

To enhance the quality of the programs by upgrading equipment.

- Established in 1981
- 1981-1986 Budget $54 million (100% State)

Industry Services Training Program (ISTP)

GOAL: To provide training to meet employment needs of industry.

- Established in 1978

- 1985 Budget $1.2 million (100% State)

Postsecondary Programs of Excellence in Math, Science, and Computer Education

GOAL: To better educate faculty and students in math, science, and computer education.

- Established in 1983

- 1985 Budget $2 million (100% State)

NORTH CAROLINA

Research Triangle Institute

GOAL: To perform contract research for industry and government clients.

- Established in 1958
- 1985 Budget: $52 million (80% Federal; 10% Private; 10% State and Foreign)

North Carolina Board of Science and Technology

GOAL: To encourage and support the use of scientific, engineering, and technological resources in the interests of the state.

- Established in 1964/ Reorganized 1979
- 1984 Budget $1.7 million (100% State)

Customized Job Training

GOAL: To attract outside businesses to North Carolina by guaranteeing trained personnel.

To provide training and new skills to displaced North Carolina workers.

- Established in 1960
- 1985 Budget $5.5 million (100% State)

Technological Development Authority

GOAL: To encourage increased employment in North Carolina by helping in-state businesses start and grow.

- Established in 1983

- 1985 Budget $1.1 million (100% State)

  Innovation Research Fund ($500,000)
  Incubator Facilities Program ($600,000)

North Carolina School of Science and Mathematics

GOAL: To provide excellence in North Carolina science and mathematics secondary education.

- Established in 1980

- 1985 Budget $5 million (90% State; 10% Private)

Massachusetts Technology Development Corporation (MTDC)

GOAL: To provide an additional capital resource for Massachusetts' technology-based enterprises and entrepreneurs.

To make loans and equity investments to promote job creation and economic growth in technology areas.

- Established in 1978
- 1986 Budget $948,000

Massachusetts Capital Resource Corporation

GOAL: To provide an additional capital resource for Massachusetts businesses.

- Established 1977
- 1977-1987 Budget $100 million (100% Private Funding)

Bay State Skills Corporation

GOAL: To award grants to educational or training institutes which provide training programs sensitive to the needs of industry.

- Established in 1981
- 1986 Budget $4 million (100% State)

Centers of Excellence Program

GOAL: To provide Massachusetts with state-of-the-art research and training facilities in emerging technologies.

- Established in 1985
- 1986 Budget $50 million (100% State)

PENNSYLVANIA

The MILRITE Council--Make Industry and Labor Right in Today's Economy

GOAL: To utilize business and labor expertise in formulating solutions to economic infrastructure problems being faced by the state.

- Established in 1978
- 1986 Budget $211,000

Seed Capital Venture Funds

GOAL: To serve as a catalyst to the establishment of private venture capital funds focusing on the needs of newly established advanced technology companies.

- Established in 1984
- 1986 Budget $3 million (25% State; 75% Private)

The Ben Franklin Partnership's Advanced Technology Centers

GOAL: To promote through matching grants university and industry cooperation in research, training, and entrepreneurial services.

- Established in 1983
- 1986 Budget $102.2 million (20% State; 53% Private; 27% Federal and Other)

Pennsylvania Technology Assistance Program (PENNTAP)

GOAL: To disseminate existing technical, scientific, and engineering information to small businesses and local governments.

- Established in 1965
- 1986 Budget $1.2 million

NEW YORK

New York State Science and Technology Foundation

GOAL: To coordinate and implement the state's science and technology programs.

- Established in 1963/ Revitalized in 1981
- 1984-1986 Budget $9.7 million (for all programs and Foundation)

Centers for Advanced Technology

GOAL: To improve relations and collaboration between academia and industry.

- Established in 1981
- 1986 Budget $7 million (100% State)

Corporation for Innovation Development

GOAL: To foster the formation of new, technology-based ventures with a significant potential for creating jobs and to leverage private investment funds.

- Established in 1982
- 1986 Budget $2.2 million (73% State; 27% Federal)

Regional Technology Development Organizations

GOAL: To foster regional relationships to increase development in technology-based sectors of the region's economy.

- Established in 1981
- 1985 Budget $325,000 (100% State)

Productivity Development Program

GOAL: To increase firms' competitiveness for job retention.

- Established in 1983
- 1985 Budget $150,000

New York State Small Business Innovation Research (SBIR) Program

GOAL: To encourage the start-up and growth of small R&D businesses.

- Established in 1984
- 1985 Budget $400,000 (100% State)

Research and Development Grants Program

GOAL: To encourage university-industry cooperation and to stimulate the process of technology-transfer.

- Established in 1981
- 1986 Budget $750,000 (100% State)

APPENDIX B

STATE LEGISLATIVE REPORT

STATE VENTURE CAPITAL INITIATIVES

by

Greg Bettger

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STATE VENTURE CAPITAL INITIATIVES

BACKGROUND

To the uninitiated, state economic development might be characterized by the recent madcap rush to land the General Motor's Saturn plant. Although the economic and political importance of obtaining such a plant is great, state economic development initiatives today encompass much more than "plant chasing," which dominated state economic development policies in the 1960s and 1970s.

Three major trends have at once enlarged and shifted the focus of state strategies. The first is a diminishing federal presence in economic development. Over the past two decades, the federal government played a significant role, especially in urban economic redevelopment. Reductions in federal aid over the last few years, however, have forced states to search out alternatives to federally sponsored economic development programs.

The second trend is the movement away from plant chasing, which is usually characterized by offering tax and other incentives, the Saturn plant notwithstanding. From the late 1950s until the end of the 1970s, state economic development usually meant "industrial development," and this translated into luring manufacturing plants from other states or trying to land new facilities of expanding companies. Accumulated evidence suggests that these attempts to promote development have not been very successful.

The third trend has been the increasing acceptance by state policymakers of a "home-grown" economic development strategy. Most economic development experts now agree that state policies that attempt to retain, strengthen and expand existing businesses and nurture the start-up and growth of new firms are the best strategies to create jobs, diversify a state's economy and increase tax revenues. Studies such as the one performed by David Birch of the Massachusetts Institute of Technology in 1979 recognized that 50 to 80 percent of new jobs are created by small businesses.(1) Most states now emphasize an entrepreneurial strategy, although they also have continued industrial recruitment.

Even as the effects of the 1981-82 recession fade, states have intensified efforts to foster economic development because of the uneven nature of the recovery and the lessons of the recession. State initiatives aimed at promoting the growth of new firms include: designing business incubators to nurture small start-up businesses; fostering partnerships among state government, universities and the private sector to speed up the transfer of new ideas to the marketplace; and promoting the export of goods and services.

State-sponsored venture capital programs, adopted in one form or another by a growing number of states, are one of the most innovative and potentially important trends in this new arena of economic development. This State Legislative Report will review the arguments for and against state involvement in creating sources of venture capital, survey the types of programs adopted by states and results to date, and then discuss the future of such initiatives on state agendas.

THE CASE FOR STATE-SUPPORTED VENTURE CAPITAL

More than 30 states have instituted some type of venture capital program since the mid-1970s, with most having been adopted in the past few years. States have provided financial assistance to businesses for years, but involvement with venture capital, as the term suggests, is riskier than past efforts. State policymakers are attracted to venture capital programs by the potential economic benefits--more jobs, diversification of a state's economic base and more tax revenues--of "seeding" small, high-growth firms that do not have access to other public or private funding.

But why should states become involved in venture capital when the private sector has already provided more than $16 billion? One reason is that funding gaps exist in the private venture capital market. According to Roubina Khoylian, director of research at Venture Economics, Inc., 70 percent of all venture capital is concentrated in California, Massachusetts, New York and Texas. Even though the absolute amount of venture capital available is growing nationwide, it appears that most funds still gravitate to familiar entrepreneurial hotbeds like California's Silicon Valley and Massachusetts' Route 128. State-sponsored venture capital efforts provide a source of risk capital and, in some instances, may assist in the growth of private venture capital markets in states where there is little venture capital activity.

The Maine Capital Corporation is a good example of how a state-backed venture capital program can help attract private venture capital to a state. As a privately run Small Business Investment Company (SBIC), the corporation was capitalized with $1 million in state funds. Since 1980 when it was launched, the corporation has made numerous investments in Maine businesses. In addition, by co-investing in over $16 million worth of private financing and by helping firms find other investors, the corporation is a catalyst in attracting private funds to the state.

Studies have found no consistent correlation between the amount of venture capital managed by a state and the amount of private investment.(2) In Maine's case, however, the state-sponsored venture capital program has provided a significant sum of capital that was previously unavailable to firms within the state's borders.

In addition, there are other reasons why new businesses in need of venture capital have trouble raising the money. In March 1985, the Wall Street Journal pointed out that it has become more difficult for young businesses to obtain venture capital. Although venture capital funds flowed freely in 1983, much of it now is being used to keep struggling firms afloat that were first funded during the boom days. Consequently, many small firms face great difficulties in obtaining venture capital. Or, if the money is available, the businesses have to surrender "a large chunk of their equity, reorganize or even merge their firms."(3)

By providing capital in the early stages of a new firm's life, the states can assist the growth of businesses that venture capitalists might overlook because of their tendency to invest in a latter phase of a new firm's development. The case of Sky Computers offers an example of how a state venture capital program can play an important role. The small Massachusetts-based company which makes plug-in computer boards for scientists and engineers desperately needed capital four years ago.

The Massachusetts Technology Development Corporation (MTDC), an independent public agency created by the state legislature, invested in the company after private venture capitalists refused. Today, due to the efforts of MTDC and other investors attracted to the firm by MTDC's commitment, Sky Computers employs 85 people and ships $10 million worth of products per year.

WHAT IS STATE-SPONSORED VENTURE CAPITAL?

Definitions of venture capital are generally a function of the particular stage at which the money is injected into a private business, and these stages are difficult to distinguish. One analyst has identified at least six stages of business development, beginning with seed and start-up.(4)

Common definitions of venture capital are limited in nature for the purposes of state policymakers. For example, one definition states that venture capital is defined as "early-stage financing of young, relatively small, rapidly growing companies or companies with rapid growth potential."(5) A different source defines venture capital as "equity financing in a high-risk company with hopes of extraordinary financial return."(6)

These definitions, however, do not account for the breadth of public assistance given to firms in different stages of growth and with various products in different phases of development. Furthermore, to facilitate economic development, states provide a wide range of financial assistance to businesses, including grants and debt financing. This assistance is not usually considered venture capital. Consequently, the following definition of state-sponsored venture capital is proposed for the purposes of state policymakers:

Definition: A state venture capital program, directly or indirectly, increases the amount of equity or risk capital (including "seed" capital and other subordinated long-term capital) available to private firms and helps create an entrepreneurial climate.

While this definition is broad enough to cover the various state initiatives, it is also refined enough to distinguish such initiatives from other definitions of venture capital. State programs differ as to the types of businesses or products in which they become involved.

State-sponsored venture capital initiatives generally target small, high-growth, technology-based businesses. For example, the Massachusetts Technology Development Corporation provides funds for start-up and early stage technology-based companies. But the New York Business Venture

Partnership, which was capitalized with state pension funds, will also consider firms that are not in commonly considered growth industries if they show promise. Furthermore, rather than targeting high growth industries, the Alaska Resources Corporation (then called the Alaska Renewable Resources Corporation) invested in 1980 in fishing and timber industries in an effort to help those sectors through economic hard times (the corporation encountered problems, which are discussed later).

In addition, although state initiatives usually target firms during their early stages, that is not always the case. The Iowa Product Development Corporation prefers seed financing in businesses that are at least at the advanced, prototype stage of a new product. The Indiana Corporation for Innovation Development invests in both technical and nontechnical firms at different stages in the development process. The Michigan Department of Treasury, which is allowed to invest a percentage of the state's public pension funds in venture capital projects, prefers joint ventures with other organized venture capital funds in later-stage investments.

In the role of venture capitalist, states usually expect some form of return for providing the capital. The return, normally long-term in nature and generally not receivable for five to 10 years, may be in the form of royalty payments or dividend and capital appreciation of equity instruments.

CATEGORIES OF STATE INITIATIVES

Most analysts of state venture capital programs study only quasi-public corporations created by legislatures, but this narrow focus clouds a thorough understanding of state initiatives. The sources of state venture capital funding and the way that the dollars are dispersed vary as much as the businesses that receive the funds.

States have used three basic approaches for providing venture capital:

- o Creating state-chartered quasi-public and private venture capital funds;
- o Allowing public pension funds to make venture capital investments;
- o Providing tax incentives to encourage private investment in venture capital funds or to encourage private venture capital investment directly in specified types of companies.

Each of these approaches varies in the degree that the state is involved in the capitalization and operational funding of the programs and in directing the investment decisions. The state-chartered venture capital funds exhibit the greatest amount of state involvement while the tax incentive approach represents the least. In each instance, however, these initiatives are designed to increase the amount of venture capital available to private firms and to improve their access to the funds.

State-Chartered Entities: This approach, which usually directly involves the state, is the most common. By summer 1985, 20 states operated

24 such programs. As a quasi-public or private entity, the agency is permitted to take an equity position that most states cannot assume directly because of state constitutional prohibitions. For example, the New Mexico constitution prohibits the state from lending its credit or making a donation to any person, association or public or private corporation. By establishing the Energy Research and Development Institute, however, the state can provide seed capital to energy-related companies for the research and development phase of a product.

Initiatives in this category differ greatly in the ways in which they are capitalized and administered. Many of the programs were established through direct state appropriations. For example, the Indiana Corporation for Science and Technology received a $20 million state general fund appropriation to be used for the development of prototype products. An additional $20 million was appropriated for the current biennium. Some programs have also attracted funds from other sources to enhance their operations. The Massachusetts Technology Development Corporation, for instance, received funds from the Economic Development Administration of the U.S. Department of Commerce as well as the Commonwealth of Massachusetts. Some states have not provided direct appropriations, but instead have allowed a tax incentive to corporate and individual investors who invest in a newly created, properly operated venture capital fund. Such a measure helped Indiana's Corporation for Innovation Development raise initial capitalization of $10 million.

The administration of state-chartered venture capital programs is equally diverse. The mix of public influence and private expertise on investment boards is of paramount importance. At one extreme, the Massachusetts Community Development Finance Corporation is representative of programs that have boards consisting of government and other public- and private-sector individuals appointed by the governor. At the other extreme, the Iowa Venture Capital Fund, Limited Partnership, while conceived by the state, is capitalized by private investors. Investment decisions are made by a private venture capital firm, InvestAmerica Venture Group, Inc.

Since most state-chartered programs risk significant sums of public money, the debate probably will continue to center on who should make investment decisions. Most boards resemble the Massachusetts model, although in the case of Indiana's Corporation for Innovation Development, all decisions are made by a seven-person board composed solely of business executives.

These boards generally make equity or equity-type investments. However, the Massachusetts Technology Development Corporation provides a combination of equity and debt. Furthermore, the Alaska Resources Corporation has been involved in both equity and debt financing, as well as providing some grants. One of the more innovative financing methods is the royalty agreement, which is used in Connecticut, Iowa, New Mexico and Ohio. The Connecticut Product Development Corporation, created in 1972, does not take an equity position in its clients' operations, nor does the investment appear as an outstanding debt on the company's balance sheet. The corporation's participation is an investment in the product itself--not the company. Under the agreement, the firm pays a royalty of 5 percent of the sales of the product to the Product Development Corporation as the return on the corporation's investment, although this percentage may drop after a few years of the firm's operation. If the product is a success, the corporation recovers its investment; if the product or company fails, the investment is lost, except for rights to the development, including patents.

In addition to providing much-needed funding, many state venture capitalists offer valuable management assistance as well. New York's Corporation for Innovation Development Program provides a range of technical assistance services to its clients. In Maine, a staff member of the Maine Capital Corporation often works directly with the company management and usually sits in on meetings of the board of directors, at least in the initial stages. The Indiana Corporation for Innovation Development does not seek active involvement in the management of the companies in which it invests, but nonetheless expects an open line of communication with the company's management and, in most cases, requires a seat on the board.

Public Pension Fund Investments: Another approach to promote venture capital is to tap the vast resources of public pension funds. In most states these funds, whose assets run into the billions of dollars, are invested by fund managers who seek to generate an acceptable return to provide retirement income for public employees. Public pension funds, usually subject to state laws that attempt to keep the funds fiduciarily sound, have generally been managed in a conservative manner.

These investments are generally made under the prudent investor rule, which provides broad authority for the investment of public pension funds. A trustee may make investments which would be selected by an investor of prudence, diligence and intelligence in the management of his or her own affairs, giving due consideration to the safety of principal and income.(7)

In recent years, some state policymakers have advocated using part of these funds to promote economic development. Since the funds provide a promising capital pool and their liabilities are long-term in nature, several states have initiated legislation allowing public pension fund investments in venture capital projects. By mid-1985, seven states--Colorado, Illinois, Michigan, New York, Ohio, Oregon and Washington--had made significant investments with such funds. Several other states were studying similar legislation--Iowa, for example, enacted a bill in its 1985 legislative session--or were about ready to make specific investments.

Most of the seven states undertake only passive investments in the form of limited partnerships with other venture capital funds. For instance, the Oregon Investment Council, which consists of the state treasurer and others appointed by the governor, can commit up to 5 percent of the pension funds it manages to venture capital. Other state programs, such as the Colorado Public Employees Retirement Association, are given full discretionary investment authority under a specific state statute. In addition to participating in limited partnerships, Michigan and Ohio also make direct investments in particular businesses. Michigan has been a leader in initiatives in public pension fund usage. In 1982, Public Act 55 created the Venture Capital Division of the state Department of Treasury. The act specifies that the Treasury Department, custodian of five separate retirement systems, may invest up to five percent of the systems' assets in qualified small businesses or venture capital firms on an equity, debt or warrant basis.

The Michigan Venture Capital Division looks for businesses with above average potential for growth, especially technology-based firms and companies with unique products. To date, the division has invested more than $126 million, and its portfolio includes 25 high growth firms and 12 venture capital funds. The investments created or retained 2,700 jobs for Michigan residents, according to the division.

Despite the apparent success of the Michigan effort and that of other state pension funds in venture capital finance, questions remain about the appropriateness of investing the retirement funds of public employees to further economic development. Paul Rice, administrator of the Michigan Venture Capital Division, stresses that "our ultimate goal must still remain one of achieving a return for our retirees, and not investing only for the sake of some state social or economic goal."

Others believe that prudent financial standards for pension funds must necessarily be lowered to accomplish economic development objectives. A report by the Southern Growth Policies Board concludes that the expertise to identify and evaluate venture capital opportunities is not ordinarily found within the structure of a state pension fund program. The report states that "the professionally managed venture capital limited partnership is the most reasonable model for public pension involvement in this type of investment."(8)

Although these arguments should certainly not be overlooked, they appear to be offset by evidence to the contrary. The Michigan program provides a successful example of a state pension fund which makes direct venture capital investments, yet adheres to prudent financial standards.

Tax Incentives to Attract Private Funds: Under this approach, a state plays the most passive role of the three categories of state-sponsored venture capital assistance. The state provides tax incentives for private investors to place their money in existing venture capital funds or in qualified businesses.

The legislation normally specifies the general business targets and how a private venture capital fund qualifies for the tax incentive. Private capital firms may apply for investment authority and the subsequent tax break. (This approach should not be confused with the use of a tax incentive granted to private investors to capitalize a venture capital fund, such as the Indiana Corporation for Innovation Development.)

In 1983, the Montana Legislature passed the Montana Capital Companies Act, which grants investors in qualified capital companies a 25 percent tax credit--up to $25,000--on personal or corporate income tax liability. The available Montana tax credits are limited to $2 million through 1987 and are allocated to capital companies in the order that they become qualified. The companies must apply to the Montana Economic Development Board to be certified as qualified investors and must comply with the state law that limits their investments to small businesses engaged in specific activities, including manufacturing, natural resources, agriculture and tourism. By August 1985, five companies had been certified.

Meanwhile, Louisiana, under the Capital Companies Tax Credit Program, expects to induce private venture capitalists to invest $20 million yearly in Louisiana businesses.

Many see using tax incentives to attract private venture capital to a state as a demonstration of cooperation between the public and private sectors not readily visible in some of the other initiatives. The state plays a catalytic role by giving broad directions to the investment firms, but the investment decisions are left to the firms. Because interest in state-sponsored venture capital has risen only within the past few years and because most states operate under constitutional bans against direct state investment, it appears that this approach may grow in importance.

CAUTIOUS OPTIMISM PERVADES STATE EFFORTS

Although considerable interest in state-sponsored venture capital is apparent, concern over state attempts to use such policies as quick cures for economic woes remains. Venture Capital Journal suggests that "expectations for rapid economic development, for reduced unemployment and for the growth of new industries can only be met by venture capital support to industry over the long term."(9)

In addition, John P. Frazier, Jr., president of Connecticut's Product Development Corporation, which began investing in 1975, cautions that "any state official who plans to construct a venture capital operation should be prepared for a lengthy development and payback period in the operation's existence." To this day, the corporation is still receiving returns to repay initial investments, which created new jobs early in its operation.

At the outset, a policymaker must first closely study the role and scope of private venture capital and the problems and capital needs faced by businesses before deciding what type of program, if any, to propose. Each state must understand its own capital market structure before considering the adoption of another state's methods. Pathbreaking efforts such as Connecticut's Product Development Corporation, Massachusetts' Technology Development Corporation and Michigan's Venture Capital Division should be examined, but not necessarily duplicated.

Finally, it is important to remember the views of those who maintain that public-private sector cooperation may be the most effective method to enhance the venture capital process. As such, some programs have been instituted in which the state's role in venture capital formation rests more on an informational basis. In addition to providing debt financing to businesses, the Pennsylvania Milrite Council, an independent state economic development agency created to address the state's economic problems, has undertaken an extensive venture capital formation survey to determine the needs of businesses in the state. The Georgia Advanced Technology Development Center provides, among other things, detailed information and research reports about statewide resources and technical capabilities to qualified firms.

Meanwhile, Florida offers another example of how a state can provide the informational link needed to bring together private venture capitalists and businesses. As an effort begun in 1983 to improve the climate for new business startups, the Florida Entrepreneurial Network, among other activities, seeks to improve the flow of information to investors and entrepreneurs and to help the formation of local pools of venture capital.

Thus, given the variety of issues surrounding the development of a state venture capital initiative, a state legislator considering such a proposal should ask the following questions about his or her state:

- What are the state's economic development goals? Does public lending accomplish such public purposes as economic and technological diversification and institutional change?
- How does a venture capital program fit into this plan, whether it is a "grand strategy" or a collection of separate programs?
- Are there capital market imperfections? What are they? Can the state effectively intervene and complement or stimulate the workings of the financial markets and institutions?
- Is there a shortage of private venture capital in the state and, if so, why?
- What mechanisms exist for generating a pool of venture capital? Should the state compete with the private sector?
- What would be the costs and benefits of instituting a state-sponsored venture capital initiative?

CONCLUSION

Most of the state venture capital programs have been successful in broadening the state's economy through job creation and product development. As mentioned, the Michigan Venture Capital Division has had considerable success with its operation. The Massachusetts Community Development Finance Corporation has created or retained about 2,000 jobs since 1979 with $8 million in investments in its Venture Capital Program.

In addition, products backed by the Connecticut Product Development Corporation, either in development or in the market, have been directly responsible for generating more than 800 full-time jobs. For the last five years, its operating expenses have been covered by its investment returns. According to the corporation's president, John P. Frazier, Jr., the use of royalties to cover operating expenses has been a "measure of our success." Frazier noted, however, that the corporation is not yet self-sustaining in terms of funding new projects. Depending on royalty paybacks, the corporation doesn't expect to establish a revolving fund for at least several years to fund projects, Frazier said.

On the other hand, the Alaska Resources Corporation's decision to try to save weak, existing fishing and timber companies cost the corporation $4.5 million. According to Belden H. Daniels, president of the Counsel for

Community Development and a consultant to many states on economic development policy, "The Alaska Resources Corporation got into trouble by allowing politics to get into the way of sound investment decisions."(10) The Alaska Legislature has voted to phase out the operation by 1988. Most states target firms with the potential for high growth with their venture capital programs, however, instead of attempting to save so-called "sunset" industries.

Since most state venture capital programs are only a few years old, it is apparent that this new state experiment is still in its infancy. It is clear, however, that states are unwilling to remain passive in the ever-changing national and international economic climate. At the very least, state-sponsored venture capital initiatives help portray particular states as pro-business, a tag that many states have actively sought since the 1981-82 recession. In the world of state legislative policy and debate, such a perception is not inconsequential.

Some states have also included venture capital initiatives as part of comprehensive economic development strategies. Ohio's Thomas Alva Edison Program, Pennsylvania's Ben Franklin Partnership, and New York's Science and Technology Foundation are examples of sweeping initiatives that include venture capital programs as well as business incubators, advanced technology centers and other efforts to promote new business development and modernize older industries.

In light of the diminishing federal presence in economic development at the state level, the new state initiatives in such areas as venture capital should not be surprising. Instead of allowing diminished federal aid and hostile, uncertain economic tides to frustrate their economic fortunes, many states have taken the initiative to shape their future.

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STATE-CHARTERED VENTURE CAPITAL FUNDS

Appendix A

STATE	NAME	YEAR	FUNDING SOURCES	GOVERNING OVERSIGHT
ALASKA	Resources Corporation Wayne Littleton, (907) 279-5602	1978	State appropriation of $40M from permanent fund.	Three member board appointed by governor.
ARKANSAS	Science & Technology Authority Jim Benham, (501) 371-3554	1985	$1.8M from investment fund of Authority.	Guidelines not set.
CONNECTICUT	Product Development Corp., Burton Jonap, (203) 566-2920	1972	$17M in state appropriations, may become self-sustaining.	Non-profit, directors appointed by governor.
FLORIDA	High Technology Innovation Research & Dev. Fund. House Appropriations, (904) 488-6204	1985	$1.6M from general revenue.	Board: treasurer, comptroller, and 7 members of private sector appointed by governor.
ILLINOIS	Illinois Venture Fund Frontenac Venture Co. Rodney Goldstein, (312) 368-0047	1984	$2M state appropriation. $5M from Frontenac, and $5M from other institutional investors.	Private firm, Frontenac, responsible for investments.
INDIANA	Corporation for Innovation Development Marion C. Dietrich, (317) 635-7325	1981	No appropriation. State provided 30% tax credit; investors providing $10M capitalization.	Private, for profit. Board composed of private individuals.

STATE	NAME	YEAR	FUNDING SOURCES	GOVERNING OVERSIGHT
INDIANA	Corporation for Science and Technology John Hague, (317) 635-3058	1982	$20M state appropriation from general fund every two years.	Private, non-profit. Board composed of individuals from public & private sector.
IOWA	Product Development Corp., Doug Getter, (515) 281-3925	1983	$1.2M in state funds; also, lottery will provide more capital.	Board selected by governor and confirmed by Senate.
IOWA	Venture Capital Fund, L.P. InvestAmerica Venture Group. David Schroder, (319) 363-8249	1983	State provided leadership to start fund capitalized by private individuals and corporations. Funding nearing $12M.	Limited partnership. Managed by private firm, InvestAmerica.
KANSAS	Venture Capital, Inc. Development Credit Corp. George Doak, (913) 235-3437	1978	Owned by Kansas Development Credit Corp. & banks. Capitalized at $1M.	Private, for-profit SBIC. Enables operation to borrow $3M from SBA.
LOUISIANA	Small Business Equity Corp. Jean Armstrong, (504) 342-5361	1980	$2M state appropriation in 1982.	Board appointed by governor.
MAINE	Capital Corporation David Coit, (207) 772-1001	1980	State provided 50% tax credit to investors. $1M original capitalization.	Private, for-profit SBIC. Additional capital available from SBA.
MARYLAND	Equity Participation Investment. Stanley Tucker, (301) 659-4270	1985	Appropriation from existing fund. Additional funding expected in January 1986.	Maryland Small Business Development Financing Authority, no formal guidelines yet.

STATE	NAME	YEAR	FUNDING SOURCES	GOVERNING OVERSIGHT
MASSACHUSETTS	Community Development Finance Corp. Judith Cranna, (617) 742-0366	1980	Investments made from $10M fund provided by state.	Non-profit, independently operated. Board consists of three government officers and six appointees of governor.
MASSACHUSETTS	Technology Development Corp. John Hodgman, (617) 723-4920	1979	$4M from state, plus initial funding from U.S. Economic Development Administration.	Board consists of government officials, two academic sector, six from private. All appointed by governor.
NEW MEXICO	Business Development Corp. Keith Dotson, (505) 843-6517	1985	State Appropriation of $2M as well as $5M credit capacity with state & financial institutions.	Private, for-profit.
NEW MEXICO	Energy, Research & Development Institute Larry Icerman, (505) 827-5886	1981	$3.5M per year from state funds. Royalty program to reduce need for further appropriations.	State agency.
NEW YORK	Corporation for Innovation Development Program, Science & Technology Foundation Barbara Murphy, (518) 474-4349	1982	$4.2M in state and federal funds. Foundation program of over $20M annually for incubators, advanced tech centers, venture capital, etc.	Decision made by Foundation Board of Directors, composed of commissioners of health, education & commerce and private sector individuals.
OHIO	Thomas Alva Edison Program. Chris Coburn, (614) 466-3086	1983	State appropriation of $34.8M for Edison program including R&D capital.	Dept. of Development. Advice also provided by Industrial Technology & Enterprise Advisory Board, a bipartisan, independent body.

STATE	NAME	YEAR	FUNDING SOURCES	GOVERNING OVERSIGHT
OREGON	Resource & Technology Development Corp. Joseph Cortright, (503) 378-8811	1985	$10M state appropriation from state lottery.	Non-profit, public corporation. Board represented by governor and 10 directors chosen by him from various sectors.
PENNSYLVANIA	Ben Franklin Partnership Seed Capital Fund Program. Roger Tellefsen, (717) 787-4147	1983	$3M set aside from $190M industrial revenue bond financial program.	Four regional privately-managed funds.
UTAH	Technology Finance Corp. Grant Cannon, (801) 583-8832	1983	$3.2M program revenue base. Approx. $1M for venture capital program.	Board appointed by governor. Venture Capital Program operated independently by Utah Technology Venture Fund I.
WISCONSIN	Community Capital, Inc. Wisconsin Community Development Finance Authority. Louis Fortis, (608) 266-0590	1982	$250,000 in state approp. $2.6M from private sector ($2.5M from contributions, $100,000 attracted through 75% state tax credit.)	Community Capital created by Authority, but independent operation. Work together in assistance programs. Capital's board of directors elected by shareholders.
WYOMING	Industrial Development Corp. Larry McDonald, (307) 234-5351	1979	$1M initial capital. Also many institutional stockholders.	Investment decisions made by privately-managed board. Created Capital Corporation, a private SBIC (funding available from SBA).

STATE-CHARTERED VENTURE CAPITAL FUNDS

STATE	TARGETS	INVESTMENT TYPES	ACTIVITY
AK	Rehabilitation & enhancement of renewable resources & tourism industry.	49% equity in firm, also some debt and grants.	Most of appropriation committed, operation phase-out by 1988.
AR	Technology-based companies in idea or early stages.	Seed capital.	Not yet in operation.
CT	Innovative products, defense companies wishing to diversify.	Product investment with royalty agreement.	Over 60 products, $14.2 M.
FL	R&D activities of new and existing small, high-tech firms.	Equity agreements.	Not yet in operation.
IL	Prefers technology-based startups.	Equity in form of common stock or convertible securities.	No projects completed.
IN	Technically-oriented, growth firms at various stages.	Equity or equity-type Investments with CID taking significant management role.	12 projects, $4.5M.

STATE	TARGETS	INVESTMENT TYPES	ACTIVITY
IN	Technology-based research leading to products that will enhance Indiana economy.	R&D contract capital, some grants.	46 projects, $24M.
IA	New innovative product development that will enhance Iowa job creation.	Product investment with royalty agreement; prudent investor deals only.	7 projects, $995,000.
IA	Start-ups, later stage. First 18 mos. all investments in Iowa. After that, up to 1/3 capital can be invested out of state.	Equity agreements, significant management role sought.	Formally announced in in August 1985.
KS	Start-ups and a variety of Kansas firms.	Debt, debt with equity options, and straight equity.	Limited equity activity.
LA	Small growth firms and minority-owned businesses.	Lend via intermediaries (SBICs, MESBICs, & CDCs) on matching basis, which then finance firms through equity and debt.	2 projects, $275,000, only limited equity activity.
ME	Developing, new companies, or mature, leveraged buyouts. No specific industry target.	Equity and equity-type financing; role sought on firms' board of directors.	9 projects, $950,000.
MD	Minority (race and sex) franchise businesses.	Temporary equity & start-up capital.	Operational in Oct. 1985.

STATE	TARGETS	INVESTMENT TYPES	ACTIVITY
MA	Viable small businesses sponsored by community development corporations.	Equity, usually shared with CDCs, as well as some debt.	32 projects, $8.5M.
MA	Early-stage, technology-based firms.	Combination of equity & debt. All investments on co-venture basis.	2 projects, $6.1M.
NM	Early-stage firms, start-ups on limited basis.	Collateralized debt; equity also available.	No projects completed.
NM	Innovators in energy-related services and products.	R&D seed capital on 2% royalty basis.	16 projects, $2.7M.
NY	Foster innovative, technology-based, new ventures that will stimulate state economy.	Debt, equity, or both. 3:1 private match. Technical assistance also given.	23 projects, $2.25M.
OH	Cooperative R&D projects directed at innovative products/processes.	R&D capital with royalty agreement as well as some grants.	39 deals, $4.2M.

STATE	TARGETS	INVESTMENT TYPES	ACTIVITY
OR	Innovation in existing industry & development of new industries.	Seed capital, as well as some grants; legislation broad in this manner. R&D grants, technical information clearinghouse.	Not yet in operation.
PA	New businesses during earliest stages including firms in small business incubators.	Equity financing, look for private match.	1 project, $400,000.
UT	New & emerging technology-based companies.	Equity position; some management role sought.	No projects completed.
WI	Firms connected with community development corporations. Create jobs for chronically unemployed.	Equity and debt.	2 projects, $125,000.
WY	Diversified manufacturing firms with growth potential and viable management team.	Equity and debt.	About 25% of over $12.7M committed to venture capital.

TAX INCENTIVES AND PUBLIC PENSION FUND INVESTMENTS TO PROMOTE VENTURE CAPITAL IN THE STATES

Appendix B

STATE	PROGRAM NAME	YEAR	TI	PP
CO	Public Employees Retirement Assoc. Norman Jaskol (303) 832-9550	1973		o
IA	Iowa Public Employees Retirement System, Dennis Jacobs (515) 281-5800	1985		o
IL	Illinois State Investment Board and other funds, Bob Harmon (312) 793-5710	1982		o
LA	Capital Companies Tax Credit State Development Office Neil Meyers (504) 342-5364	1984	o	
MI	Michigan Venture Capital Division Department of Treasury, Paul Rice (517) 373-4330	1982		o
MS	Chapter 459, House Bill No. 640 Department of Economic Development Greg Hinkebein (601) 359-3437	1985	o	
MT	Capital Companies Act Economic Development Board Dale Harris (406) 444-2090	1983	o	
NY	State Business Venture Partnership Rothschild, Douglas Luke (212) 757-6000	1984		o
ND	Senate Bill No. 2281 Economic Development Commission Marvin Dutt (701) 224-2810	1985	o	
OH	PERS, State Teachers Retirement System and other funds, PERS-- Marina Milenkovski (614) 466-2085 TRS--Dan Szente (614) 227-4090	1981		o

STATE	PROGRAM NAME	YEAR	TI	PP
OR	Oregon Investment Division Department of Treasury Jim George (503) 378-4111	1983		o
WA	State Investment Board David Weig (206) 753-6810	1981		o

DESCRIPTION OF ACTIVITY

CO Approximately $10M invested in past six years. PERA has invested $5.4M as a limited partner under prudent man rule. Board of public and private individuals given discretionary investment authority under state statute.

IA Statute amended for "prudent person" investments; will allow 2%-3% of system's assets to be committed to venture capital and leveraged-buyout funds.

IL State Investment Board manages three funds. Has committed $11M in limited partnerships. Other funds include state teachers and Chicago Municipal Employees Funds.

LA Act allows certified capital companies to receive up to 35% tax credit. Company must have at least 60% of its investments in Louisiana. Certain small and medium-sized businesses targeted. Expected to attract $20M per year.

MI Legislation creating the division allows it to invest up to 5% of the "State Retirement Systems" assets in small businesses or venture capital firms. Makes direct and passive investments. Emphasis on high growth, high tech firms. Over $126M committed.

MS Act allows designation of qualified Mississippi capital companies to provide capital for creation or expansion of certain businesses. Private investors granted 25% tax credit up to $20,000 per year.

MT Act allows designation of qualified Montana capital companies to provide capital to certain types of small businesses. Private investors granted 25% tax credit up to $25,000.

NY State law allows 5% of public pension funds to be invested in venture capital. Partnership capitalized at $60M with state employees retirement fund and teacher's retirement system as limited partners. Investment decisions made by private firm. Approximately $10M committed.

ND Act authorizes incentives for private venture capital companies to provide capital to state businesses. Provides 25% tax credit for investors.

OH Two funds provide direct and passive investments. Direct investments are permitted under Ohio Revised Code provided that firm has one-half of its assets or employees in state. Teachers system has committed $20M to both types. PERS has committed $64M in direct investments.

OR Investment Council, which includes state treasurer and appointees of governor, can invest 5% of the Oregon pension funds for which it is responsible in equity and other venture capital. Approximately $70M committed in limited partnerships under prudent man rule.

WA Composed of government officials and appointees of governor. Investments in limited partnerships under prudent man rule. Also participates in leveraged buy-outs. Approximately $115M committed to venture capital.

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NOTE: Charts were constructed with information from Hollis and Ioannou sources as well as from a comprehensive NCSL survey of state programs (effective October 1985).

APPENDIX C

COOPERATIVE RESEARCH DEVELOPMENT AGREEMENT FILINGS

ADIRONDACK LAKES SURVEY CORPORATION

Parties:
New York State Department of Environmental Conservation; Empire State Electric Energy Research Corporation (ESEERCO).

Objectives:
To improve the environmental status of certain waters located in the Adirondack Mountains by evaluating fish communities and water chemistry and by providing a collaborative mechanism between public and private entities.

AGRIGENETICS CORPORATION

Parties:
Agrigenetics Research Associates, Ltd.

Objectives:
To develop effective techniques for identifying, manipulating and transferring agronomically valuable genetic traits through cell and tissue culture and recombinant DNA technology.

APPLIED INFORMATION TECHNOLOGIES CORP

Parties:
American Chemical Society; Batelle Memorial Institute; CompuServe Incorporated; Mead Data Central, Inc.; OnLine Computer Library Center, Inc.

Objectives:
To engage in advanced longterm research and development activities in the following general areas of information technology:

1. Artificial Intelligence
2. Telecommuncations
3. Microelectronics
4. Information processing
5. Software engineering
6. Systems engineering

BELL COMMUNICATIONS RESEARCH, INC.

Parties:
Ameritech Services, Inc.; Bell Atlantic Management Services, Inc.; BellSouth Services, Inc.; NYNEX Service Co.; Pacific Bell;

Southwestern Bell Telephone Co.; The Mountain States Telephone and Telegraph Co.; Northwestern Bell Telephone Co.; Pacific Northwest Bell Telephone Co.

Objectives:
To maintain high quality and technologically up-to-date network capabilities to support the provision of exchange and exchange accss telecommunications services.

BELL COMMUNICATIONS RESEARCH INC. AND U.S. DEPARTMENT OF THE ARMY

Parties:
Bellcore; U.S. Department of the Army

Objectives:
To increase the subminiaturization of semiconductor devices which can be used for very high speed switching applications and in the area of optical signal processing devices. This research is directed at potential applications to telecommunication exchange services and telecommunications exchange access services.

BELL COMMUNICATIONS RESEARCH INC. AND AVANTEK, INC.

Parties:
Bellcore; Avantek, Inc.

Objectives:
To understand the applicatins for telecommunication exchange services and telecommunication exchange access services of high speed integrated circuits and to demonstrate feasibility of research concepts by experimental prototypes of such circuits.

BELL COMMUNICATIONS RESEARCH INC. AND RACAL DATA COMMUNICATIONS, INC.

Parties:
Bellcore; Racal Data Communications, Inc.

Objectives:
To explore new technologies for end-to-end and intra exchange digital connectivity, new technologies in image conferencing systems, or other areas of related research that are directed to telecommunications applications.

BELL COMMUNICATIONS RESEARCH, INC. AND HONEYWELL, INC.

Parties:
Bellcore; Honeywell, Inc.

Objectives:

To conduct research and development in the area of advanced gallium arsenide integrated circuits.

BETHLEHEM STEEL CO. AND UNITED STATES STEEL CORPORATION

Parties:

Bethlehem Steel Corp.; United States Steel Corp.

Objectives:

To conduct research activities directed to the continuous casting of thin sections of steel and to license any resulting inventions or data.

CENTER FOR ADVANCED TELEVISION STUDIES (CATS)

Parties:

ABC, Inc.; Ampex Corp.; CBS, Inc.; Harris Corp.; Home Box Office, Inc.; NBC, Inc.; Public Broadcasting Service; RCA Corp.; Tektronix Corp.; 3M Co.

Objectives:

To define the ideal television transmission system and identify the technological and economic tradeoffs that must be made in developing and implementing such a system.

CHAR-TECH

Parties:

Kean Manufacturing Corp; Fabristeel Products Inc.

Objectives:

To design, refine, engineer, develop and test techniques for producing self-piercing metal fasterners.

COMPUTER AIDED MANUFACTURING-INTERNATIONAL

Parties:

U.S.Industrial: 3M Co.; Applicon; B.F. Goodrich Co.; Bendix Corp.; Camax Systems, Inc.; Caterpillar Tractor Co.; Computervision Corp.; Cray Research, Inc.; Cummins Engine Co.; Daisy Systems Corp.; Deere & Co; Denelcor, Inc.; Digital Equipment Corp.; Douglas Aircraft Co.; E.I. Du Pont de Nemours & Co.; Eastman Kodak Co.; Eaton Corp; Evans & Sutherland Computer Corp.; Ford Motor Co.; General Dynamics; General Electric Co.; General Motors Corp.; Grumman Aerospace Corp.; Hughes Aircraft Co.; Lawrence Livermore National Lab; Lockheed; Los Alamos National Lab; LTV Aerospace & Defense Co.; Martin Marietta Energy Systems; McDonnell Aircraft Co.; McDonnell Douglas Automation Co.; Morton Thiokol, Inc.; Northrop Aircraft Corp.; Optical Gaging Products, Inc.; Raytheon Co.; Scientific Calculations, Inc.; SEI Information Technology; Warner & Swasey Co.; United Technologies Corp.; USAF; Valid Logic Systems, Inc.; Westinghouse Electric Corp.;

European Industrial: ADEPA (France); Adolf Waldrich Coburg GmbH & Co. (West Germany); Aerospatiale (France); Asea AB (Sweden); British Aerospace; Construcciones Aeronauticas, S.A. (Spain); Calma (UK); Daimler-Benz AG (West Germany); Deutsche Forschungs und Versuchsanstalt fur Luft und Raumfahrt e.V.(West Germany); Electronic Control Systems S.p.A(Italy); Elsag (Italy); Fiat S.p.A (Italy); Finmeccanica Alfa Romeo (Italy); Hewlett Packard GmbH(Federal Republic of Germany); Ingersoll Engineers (England); International Computers, Ltd. (UK); Istel Ltd. (UK); ITT IITE AMT Center (Belgium); IVF (Sweden); Jaguar Cars Ltd.(UK); Lucas Group Services Ltd (England); Vandelli S.p.A. (Italy); Matra-Datavision, Inc. (France); Messerschmitt-Bolkow-Blohm GmbH (West Germany); Nuovo Pignone S.p.A. (Italy); Philips International B.V. (The Netherlands); Prime Computer CAD/CAM Ltd (UK); Racal-Redac Ltd. (England); Renault (France); Saag-Scania (Sweden); Sandvik AB Coromant (Sweden); Short Brother Ltd. (Northern Ireland); Siemans AG (West Germany); STC Telecommunications, Ltd. (UK); The Plessey Co. PLC (England); Thomson Informatique Services-CSF (France); TNO Metaalinstituut (The Netherlands); Valmet Procons OY, Ltd. (Finland); Volkswagenwerk AG (West Germany); VTT (Finland).

Japanese Industrial: Computer Services Corp.; Daikin Industries Ltd.; Fujitsu; Hitachi; Japan Information Services; Kawasaki Heavy Industries; Matsubishi Electric Corp.; Nachi Fjuikoshi Corp.; NEC Corp.; Nippon Telegraph and Telephone; Nippon Univac Kaisha, Ltd.; Oki Electric Industry Co.; Omron Tateishi ELectronics Co.; Sanyo Electric Co.; Shoko Co., Toshisha Corp.

Educational: Members include 20 U.S. universities, 14 European universities and 3 Japanese universities.

Objectives:

To sponsor joint research and development in the use of computer systems and software to improve the productivity of the industry.

DEET JOINT RESEARCH VENTURE

Parties:

Airosol Company, Inc.; Bayer AG; Chemical Specialities Manufacturers Association, Inc.; Fuller Brush Company; Lehn & Fink Products Group, Sterling Drug, Inc.; McLaughoin Gormley King Co.; Miles Laboratories, Inc.; Mohawk Laboratories, Inc.; Mowatt Sporting Goods; "Ole Time" Woodsman, Division Pete Rickard, Inc.; Plough, Inc.; S.C. Johnson and Son,Inc.; Speer Products, Inc.; Virginia Chemicals, a division of Celanese Corp.; Wisconsin Pharmacal, and division of Badget Pharmacal, Inc.

Objectives:

To sponsor and conduct resaearch on the pesticide ingredient

N,N-Diethyl-metatoluamide and related isomers (more ocmmonly referred to as "DEET") and to submit the results of the research to the EPA.

EATON CORPORATION, MEDIUM RANGE TRUCK TRANSMISSION COOPERATIVE PROJECT

Parties:
Eaton Corp., Eaton, Ltd., Fiat Veicoli Industrialia, S.p.A.

Objectives:
To design and develop medium range manual change gear synchronized truck transimissions.

EMPIRE STATE ELECTRIC ENERGY REEARCH CORPORATION (ESEERCO)

Parties:
Central Hudson Gas & Electric Corp.; Consolidated Edison Co. of New York; Long Island Lighting Co.; New York State ELectric and Gas Corp.; Niagara Mohawk Power Corp.; Orange and Rockland Utilites, Inc.; Rochester Gas and Electric Corp.

Objectives:
To in engage advanced, long-term research and development in the following general areas of energy technology: Fossil Fuel Research, Nuclear Power Research, Electrical Systems and Equipment, and Environmental Research.

EXXON PRODUCTION RESEARCH CO. AND HALLIBURTON SERVICES

Parties:
Exxon Production Research Co.; Halliburton Services.

Objectives:
To collect data for improving well cementing practices.

GEOTHERMAL DRILLING ORGANIZATION

Parties:
California Energy Company; Chevron Resources Co.; Republic Geothermal, Inc.; Steam Research Corp.; Union Geothermal Division; Foamair, Divison of Pool Co.; Dresser Industries; Geothermal Resources Int., Inc.; MCR Geothermal Corporation; Mono Power Company; Sandia National Laboratories; Eastman Whipstock; NL Industries; Pajarito Enterprises; H&H Oil Tool Co., Inc.; Dailey Directional Services.

Objectives:
To encourage technological improvements that may reduce the cost of drilling and maintaining geothermal wells. The first set

of projects include the research and testing of such projects as:
1. An acoustic borehole televiewer capable of functioning at high temperture and pressure.
2. Eleastomeric blowout preventer seals and drill pipe protectors that can withstand the high temperatures and corrosive environment in a geothermal well.
3. Rotating head seals that function as blowout preventers.

INTEL CORPORATION/XICOR CORPORATION

Parties:
Intel Corporation; Xicor Corporation

Objectives:
To engage in the joint development of EEPROM devices.

INTERNATIONAL PARTNERS IN GLASS RESEARCH

Parties:
ACI Ventures, Inc.; Bayerische Flaschen-glashuettensereke; Brockway Research Inc.; Emhart Glass Research, Inc.; Portion Research, Inc.; Rockware Glass Limited; Yamamura Glass Co.

Objectives:
To develop glass containers that will be stronger and lighter than those currently used by members of the glass container industry.

KAISER ALUMINUM & CHEMICAL CORPORATION AND REYNOLDS METALS

Parties:
Kaiser Aluminum & Chemical Corp., Reynolds Metals Co.

Objectives:
To research and develop suitable ingot metallurgy and manufacturing processes for the manufacture of commercially acceptable aluminum-lithium alloy products from ingots, and appropriate aluminum-lithium recycling technology.

MERRELL DOW PHARMACEUTICALS, INC. AND HOFFMANN-LA ROCHE,INC

Parties:
Merrell Dow Pharmaceuticals; Hoffmann-La Roche.

Objectives:
To evaluate the effect of concomitant administration of DFMO and interferon for the treatment of metastatic malignant melanoma.

MICROELECTRONICS AND COMPUTER TECHNOLOGY CORPORATION

Parties:

Advanced Micro Devices, Inc.; Allied Corp.;Bellcore; BMC Industries Inc.; The Boeing Co.; Control Data Corp.; Digital Equipment Corp.; Eastman Kodak Co.; Gould Inc.; Harris Corporation; Martin Marietta Corp.; 3M Co.; Mostek Corp.; Motorola, Inc.; National Semicoductor Corp.; NCR Corp.; RCA Corp.; Rockwell Corp.; Sperry Corp.

Objectives:

To engage in advanced, long-term research and development activities in the following general areas of microelectronics and computer technology: Advanced Computer Architectures, Packaging/Interconnect, Software Technology, VLSI/CAD.

MOTOR VEHICLES MANUFACTURERS ASSOCIATION OF THE U.S. (MVMA)

The MVMA submitted 15 filings in February 1985.

Parties:

Each filing may include: Motor Vehicles Manufacturers Association of the U.S.; American Petroleum Institute; Coordinating Research Council;AM General Corporation, LTV Aerospace and Defense Company; American Motors Corp.; Chrysler Corp.; Ford Motor Co.; General Motors Corp.;Internaitonal Harvester Co.; M.A.N. Truck and Bus Corp.; PACCAR Inc.; Volkswagen of America; Volvo North America Corp.;Cummins Engine Co.; John Deere

Objectives:

The objectives of each filing vary, but are most often concerned with developing methods for measuring and analyzing exhaust emmissions, testing gasoline and diesel fuels, and conducting and analyzing accident/braking tests.

NAHB RESEARCH FOUNDATION--SMART HOUSE PROJECT

Parties:

AMP Incorporated; Apple Computer, Inc.; Bell Communications Research Inc.; Bell Northern Research Ltd.; Brand-Rex Company; Broan Mfg. Co., Inc.; Burndy Corporation; Carrier Corporation; Dukane Corporation; E.I. duPont de Nemours & Company; Electrice Power Research Institute; Emerson Electric Co.; General Electric Co.; Gas Research Institute; Honeywell, Inc.; Landis & Gyr Metering Inc.; NAHB Research Foundation; North Americn Philips Consumer Electronics Corp.; Robertshaw Controls Company; schlage Lock Company; Scott Instruments Company; Scovill Inc.; siemens-Allis, Inc.; SLATER ELECTRIC, INC.; Sola Basic Industries, Inc.; Square D Company; Systems Control,Inc.; Whirlpool Corporation; The Wiremold Company.

Objectives:
To develop a coordinated home control and energy distribution system containing integral telecommunications and advanced safety features by designing and developing a set of compatible products including integrated power and signal cabling to tie home electrical products into a single power and communications network.

NORTON/TRW CERAMICS

Parties:
Norton Company; TRW Inc (TRW Structural Ceramics, Inc.)

Objectives:
To conduct basic research and development programs directed to the development of ceramic products, ceramic/ceramic composite products, and ceramic coatings for metallic and ceramic products.

ONCOGON LIMITED PARTNERSHIP

Parties:
Wallingford Research, Inc.; Cancer Research, Inc.; Sygenic Co.

Objectives:
To engage in research and development of commercial products for the diagnosis or treatment of human cancer.

PETROLEUM ENVIRONMENTAL RESEARCH FORUM

Parties:
Amoco Oil Co.; Atlantic Richfield Co.; Champlin Petroleum Co.; Chevron Research Co.; Conoco Inc.; Exxon Research and Engineering Co.; Koch Refining Co.; Mobil Research and Development Corp.; Murphy Oil USA.; Occidental Petroleum Corp.; Pennzoil Co.; Shell Development Co.; Standard Oil Company of Ohio; Sun Company Inc.; Tenneco Inc.; Texaco Refining and Marketing Inc.; Union Oil Co.

Objectives:
To provide a forum for the collection, exchange, and analysis of research information relating to the development of technology for environmental pollution control and waste treatment for the U.S. Petroleum Industry.

PLASTICS RECYCLING FOUNDATION, INC.

Parties:
Allegheny Leeter-Eater Division; Bev-Pak; Brockway, Inc.; Coca-Cola Bottling Co.; Conair,Inc.; Continental Plastic

Containers; Eastman Chemical Products, Inc.; E.I. duPont de Nemours & Co.; Hoover Universal Inc.; Nelmor Co.; Owens Illinois Inc.; Pepsi Cola Co.; Rohm and Haas Co.; The Seven-Up Co.; The Society of the Plastics Indsutry, Inc.; Sundor Brands; Union Carbide Corp.; U.S. Industrial Chemicals Co.; Van Dorn Plastic Machinery Co.

Objectives:
To sponsor research into improved recycling of all plastic materials and disseminate recycling technology.

PORTLAND CEMENT ASSOCIATION

Parties:
Aetna Cement Corp.; Alaska Basic Industries; Arkansas Cement Corp.; Ash Grove Cement Company; Atlantic Cement Company; Blue Circle Inc.; CalMat Co.; Capitol Aggregates, Inc.; Cianbro Corporation; Davenport Cement Co.; General Portland Inc.; Genstar Cement Co.; Gifford-Hill & CO.; Ideal Basic Industries; Independent Cement Corp; Lehigh Portland Cement Co.; Lone Star Industries; The Monarch Cement Co; Moore McCormack Cement Inc.; Northwestern States Portland Cement Co.; Rinker Portland Cement Corp; Rochester Portland Cement Co.; St. Mary's Peerless Cement Co.; St. Mary's Wisconsin Cement Co.; The South Dakota Cement Plant; Southwestern Portland Cement Co.; Canada Cement Lafarge Ltd.; Ciment Quebec Inc.; Federal White Cement Ltd.; Genstar Cement Ltd.; Lke Ontario Cement Ltd.; North Star Cement Ltd.; St. Lawrence Cement Inc.; St. Mary's Cement Ltd.

Objectives:
To improve and extend the uses of cement and concrete.

PUMP RESEARCH AND DEVELOPMENT COMMITTEE(PRADCO)

Parties:
Borg-Warner Industrial Products, Inc.; Ingersoll-Rand Co.; Dresser Industries; Transamerica Deleval Inc.

Objectives:
To conduct general research ito the reliability and efficiency of centrifugal pumps.

PYRETHRIN JOINT RESEARCH VENTURE

Parties:
Chemical Specialties Manufacturers Association; Fairfield American Corporation; McLaughlin Gormley King Co.; Office of Pyrethrum of Rwanda; Penick-BIO-UCLAF Corporation; Prentiss Drug and Chemical Corp.; Pyrethrum Board of Kenya; S.C. Johnson and Son, Inc.; Tanganyika Pyrethrum Board.

Objectives:

To sponsor and conduct toxicological research on the pesticide ingredient PYRETHRIN and to submit the results of the research to the EPA.

SEMICONDUCTOR RESEARCH CORPORATION

Parties:

Advanced Micro Devices Inc.; AT&T Technologies Inc.; Burroughts Corp.; Control Data Corp.; Digital Equipment Corp.; E.I. duPont de Nimours Co.; Eastman Kodak Co.; Eaton Corp.; E-Systems, Inc.; GCA Corp.; General Electric Corp.; General Motors Corp.; Goodyear Aerospace Corp.; GTE Labs, Inc.; Harris Corp.; Hewlett Packard Co.; Honeywell, Inc.; IBM Corp.; Intel Corp.; LSI Logic Corp.; Monolithic Memories, Inc.; Monsanto Co.; Motorola Inc.; National Semiconductor Corp.; Perkin-Elmer Corp.; RCA Corp.; Rockwell Corp.; Semiconductor Equipment and Materials Institute, Inc.; Silicon Systems Inc.; Sperry Corp.; Texas Instruments,Inc.; Union Carbide Corp.; Varian Associates, Inc.; Westinghouse Electric Corp.; Xerox Corp.

Objectives:

To sponsor and conduct research supportive of the semiconductor industry and directed toward increasing knowledge of semiconductor materials and related scientific and engineering subjects that are required for the useful application of semiconductors.

SOFTWARE PRODUCTIVITY CONSORTIUM

Parties:

Allied Corporation; The Boeing Co.; E-Systems Inc.; Ford Aerospace and Communications Corp; General Dynamics Corp; Grummann Aerospace Corp; GTE Government Systems Corp; Lockheed Missiles and Space Co.; McDonnell Douglas Corp; Northrop Corp; Rockwell International; Science Applications International Corp; TRW Inc.; United Technologies Corp; Vitro Corp.

Objectives:

To explore the possible nature and structure for a joint venture to conduct research and development in the area of advanced technology relating to computer software tools and techniques.

UNINET RESEARCH AND DEVELOPMENT COMPANY

Parties:

Uninet,Inc.; Control Data Corporation.

Objectives:

To provide packet-switching data communications networks designed to meet the reliability, security, diagnostic, and support features needs of users through the 1990's.

UNITED TECHNOLOGIES CORPORATION AND TOSHIBA CORPORATION

Parties:
United Technologies Corp.; Toshiba Corp.

Objectives:
To develop and apply basic techniques, new designs, and manufacturing technologies for the production of fuel cell power plants and fuel cell systems.

WEST VIRGINIA UNIVERSITY/INDUSTRY COOPERATIVE RESEARCH CENTER

Parties:
West Virginia University, Monsanto, E.I. Dupont de Nemours & Company; Standard Oil; Union Carbide.

Objectives:
To conduct reearch and stimulate industrial innovation in, and otherwise to develop, the field of fluidization and fluid particle science.

APPENDIX D

1986 LEGISLATIVE INITIATIVES FOR CALIFORNIA
RELATING TO
TECHNOLOGY AND INDUSTRIAL COMPETITIVENESS

K-12 EDUCATION

Computer Assisted Education - This bill would create the "School Instructional Program" to provide funding for model schools to develop instructional programs which integrate technology. The program would be structured so that learning problems are identified and corrected as early as possible to ensure that students proceed through successful completion of tasks.

TECHNICAL HUMAN RESOURCES

Charitable Contributions - This bill would allow a corporation a deduction for the donation of a service contract on services to an educational organization for research or instructional purposes.

Technical Specialty Centers - This bill would require the California Community Colleges, the California State University, and the University of California, if the Board of Regents so elects to do so, to identify the technical specialties of the various campuses in each segment. Information would be provided to K-12 schools to assist in guidance counseling. The governing bodies of each segment, in cooperation with the California Postsecondary Education Commission, would establish the criteria for selecting campuses to serve as technical specialty centers, and identify the specialized training, equipment, and facilities to be provided at each center.

Translation Centers - This bill would allow Translation Centers to be established on UC campuses where there is sufficient capability and interest to translate research and other documents.

Community Colleges - This bill would create the "Employer Based Training Program," a grant program administered by the Board of Governors of the California Community Colleges, to provide funding for equipment, materials, and other necessary expenses for high demand, industry specific training for the Community College competing for the program.

Software Grants - With the approval of the Regents of the University of California, this bill would require the University of California to provide grants to schools of education, schools of psychology, and computer departments of the University to develop software and a new computer language to facilitate the efficient development of educational software.

RESEARCH AND DEVELOPMENT

Research Bibliography - With the approval of the Regents of the University of California, this bill would establish a computerized systemwide bibliography of the research papers and current research projects of the faculty and graduate students and provide this information to the private sector.

California Research Council - This bill would establish the California Research Council, which would be composed of scientific advisors from

California who have been elected into the National Academy of Sciences, the National Engineering Academy, and the National Academy of Medicine, to develop a research agenda and to award and monitor research for projects to increase the state's industrial competitiveness.

Technology Extension Service - With the approval of the Regents of the University of California, three Technology Extension Services would be established to provide information to businesses or individuals about research in the UC or the National Research Laboratories, assist in technical evaluation of business and product development proposals, and disseminate research findings to industry.

Biotechnology - With the approval of the Regents of the University of California, this bill would establish a program which would encourage joint funding of projects between the University of California and the private sector in the area of biotechnology. A policy committee, composed of faculty members from various campuses and informed private sector representatives, would be established to review and fund project proposals.

INDUSTRIAL PRODUCTIVITY

Center on Manufacturing Competitiveness - With the approval of the Regents of the University of California, this bill would require the establishment of a Center on Manufacturing Competitiveness at a UC campus. Also, an advisory committee would be established to create guidelines for the Center, secure matching federal and private sector funding, and to identify critical research projects with the goal of enhancing the competitiveness of state industry.

TECHNOLOGY AS AN EXPORT PRODUCT

Export Assistance - This resolution would request assistance from chambers of commerce and others to assist the California International trade Commission by identifying small and medium size firms that have export potential. It also would request the state to expand the Export Finance Program to make it accessible to such firms. Finally, the Commission is asked to develop information for exporting firms that identifies many of the nuances of potential foreign markets that must be considered in exporting strategies.

Export Trade - This bill would make exportation the primary focus of the state trade policy. It would require the Governor to seek the advice of the Legislature, the California State World Trade Commission, and representatives of trade association, and business interests in matters related to the state's trade interest. The Governor would be required to support and promote programs and activities which expand export opportunities, including communication to develop federal legislation which affect the state's trade.

Overseas Trade Office - This bill would require the Governor to establish an overseas trade office in Tokyo, Japan by January 1, 1987 to promote California goods, services, and tourism.

INTERNATIONAL TRADE

Industrial Comptitiveness - This bill would create the California Advisory Council on Industrial Competitiveness, composed of eleven governmental and private representatives, to advise the Secretary of Business, Transportation and Housing on matters pertaining to industrial competition. The goal of the Council would be to coordinate state government action in specified areas relating to trade.

International Trade - This bill would require the California State World Trade Commission to develop model cultural exchange programs, to encourage the development of courses of study of trade and specialized languages in schools, and to access the cultural exchange efforts currently taking place.

APPENDIX E

THE TEXAS ALLIANCE FOR THE NEXT ECONOMY

(TEXANE)

TEXANE is a non-profit organization of business leaders whose purpose is to forge a partnership between the public and private sectors that will move this state ahead to the next economy. Its aim is to envision and create a mix of productive activities that will employ Texas people and assure their prosperity in the post oil-and-gas era.

TEXANE expects to work closely with the Texas Economic Development Commission in the design and implementation of mutual goals. It seeks a catalytic role in shaping an economy that will sustain the state well into the next century.

TEXANE will:

work to minimize the disruptive/negative impact and maximize the positive/job creating aspects of the transition to the next economy;

provide input from the private sector for the formulation of state policies which will impact the viability of the next economy;

prime the corporate and political culture in Texas for the enormous changes to come with the next economy;

support programs to train and retrain the Texas work force so that there will exist a highly skilled labor pool capable of capitalizing on the next economy;

stimulate research and development and the commercialization of intellectual talent in Texas;

work aggressively in Washington, D.C. and in the national political arena to ensure that Texas gets its fair share of federal research and development allocations.

TEXANE is under the direction of Harden H. Wiedemann, President, 3626 North Hall Street, Suite 800, 214/528-5630. It's steering committee is made up currently, of: George P. Mitchell, Chairman & President, Mitchell Energy & Development, Houston; George Kozmetsky, Executive Associate for Economic Affairs, The University of Texas System, Austin; Robert Alpert, Founder and Chief Executive Officer, Alpert Investment Corporation, Dallas; Wales H. Madden, Jr., Attorney, Amarillo; Charles Martin Wender, Owner, Charles Martin Wender Real Estate and Investments, San Antonio; and Admiral Bob R. Inman, President and Chief Executive Officer of Microelectronics and Computer Technology Corporation (MCC).

Background

The Texas economy, partially as a reflection of the national and international economies, is undergoing enormous change. The signs are all around us. Like most transitions, the changes are unsettling. Yet the revolutionary technological breakthroughs on the horizon are exhilarating. It is as if the world has been stood on its ear and nothing we can do will stop the drain on our productivity, our markets and our profits. We have entered a new era in world manufacturing. We know its hardball, but the rules seem to have changed. The competition is stiffer, the life cycle of products far shorter and the margins narrower. In addition, the continuing strength of the U.S. dollar has exacerbated the problem by making domestic market penetration by foreign goods easier and by eroding the price competitiveness of U.S. goods in world markets.

The information economy is not necessarily a better one - it is only different. Just as the mass economy has shown and glistened for many years as we always looked ahead to more goods and greater prosperity, the information economy may seem green and lush. However, an economic transition of this magnitude has already left and will continue to leave many people out of work, impoverished, confused and unwilling to change. The temptation at the twilight of an industrial age to turn the clock back is overwhelming because it offers a false hope of quick relief. But, if we do not look ahead to the next economy that is now beginning to emerge and plan for it today, all our economic policies will fail.

Definition and Statement of Purpose

TEXANE is a small group of influential Texas businessmen who will help forge the next economy for our state. Through the creation of a results-oriented business alliance which will work very closely with state government, it is hoped that the disruptive and negative consequences of the current major structural changes in our economy can be minimized - and the positive aspects maximized.

Objectives

TEXANE will:

- work to minimize the disruptive/negative impact and maximize the positive/job creating aspects of the transition to the next economy
- provide business leadership and private sector input for the formulation of state policies which impact the viability of the next economy
- work closely with state agencies, especially the Texas Economic Development Commission, to make our state more competitive and successful in all aspects of economic development
- prime the corporate and political culture in Texas for the enormous changes which are an inherent part of the next economy

- support and catalyze programs aimed at training and retraining the Texas work force so that there exists a highly skilled labor pool cabable of capitalizing on the next economy.

- raise funds and hire a small, highly professional staff to be located in Austin in order to liaison with the TEXANE board and other appropriate groups and individuals and to carry out the day-to-day organizational and administrative activities as well as the program of TEXANE

- serve as the private sector partner for the rapid creation of the type of dynamic, public-private partnerships for economic development that successfully brought MCC to Texas

- stimulate and support increased R&D and commercialization of intellectual property in Texas

- work aggressively in Washington, D.C. and in the national political arena to secure a fairer share of federal research allocations (e.g. for the Strategic Defense Initiative) for Texas

- develop programs and a business network to make Texas' economy more flexible and competitive

- leverage the business relationships of its board members to place Texas in the best possible position for corporate/industrial relocations and expansions

- work to create a business climate in Texas in which companies can grow and prosper

First Priority

Texas is being massively outspent by many other states for economic development. In an era of hypercompetition, this situation cannot be allowed to persist for long periods of time without a severe loss of economic power and prestige for Texas.

The first priority and first major work program to be launched by TEXANE will be the successful recruitment, working closely with TEDC and other appropriate organizations and individuals, of one large corporate headquarters and three small-to-medium expansion operations per year. The type of companies that will be targeted are:

- successful
- growing rapidly
- innovatively managed
- knowledge-based (not necessarily high tech but aggressively applying advanced technologies to existing operations)
- productivity-conscious

The reason for targeting this type of company in addition to the fact that corporations are the single best identifiable revenue generating economic unit, is to capitalize on the creation of the new start-up enterprises that innovative managers of these larger operations leave the corporation to launch.

This recruitment effort will be launched in the Fall of 1985 and will be conducted parallel with ongoing activities and programs of the Texas Advertising & Marketing Council (TAMC).

It is envisioned that the comprehensive advertising and marketing initiative currently being launched by the TAMC will generate a growing number of bona fide prospects for TEXANE to follow-up with a carefully-targeted recruitment effort, working with the TEDC and others.

A small (3-4) highly professional staff will be recruited to carry on the work of this first of several major TEXANE work programs. Other programs geared to the objectives of the organization will be developed as time and resources allow.

Organizational Plans

In the next six months, TEXANE will:

- recruit a core steering committee of top Texas businessmen
- appoint a chairman
- apply for 501(c)(3) or 502(c)(6) not-for-profit, tax exempt status for fundraising purposes
- locate potential office space in Austin
- begin to identify a small, highly professional and capable staff
- develop a detailed, multi-year business plan including all staffing, budgetary and other requirements
- coordinate closely with the Texas Advertising and Marketing Council (TAMC) and the Texas Economic Development Commission (TEDC)
- develop in detail the conceptual plan for the targeted recruitment of successful, growing, innovatively managed, productivity conscious, knowledge-based companies

In the next 6-12 months, TEXANE will:

- fill out its board
- raise sufficient funds to create an endowment which will permanently fund TEXANE's ongoing operations

- lease office space in Austin or establish operations in donated space in Austin
- hire an executive director and support staff
- launch the first phase of the targeted recruitment effort working closely with TAMC
- expand the TEXANE business network
- initiate planning and feasibility studies on other major work programs consistent with TEXANE organizational objectives.

In the next 12-24 months, TEXANE will:

- implement additional work programs
- build the TEXANE network
- explore new and innovative ways to make Texas' economic development efforts more competitive
- explore new and innovative ways to smooth Texas' transition to the next economy
- conduct or contract to have conducted appropriate research studies consistent with organizational objectives

Your involvement and support are appreciated. For further information, contact:

Harden H. Wiedemann
c/o The Wiedemann & Johnson Companies
3626 N. Hall Street, Suite 800
Dallas, Texas 75219
214/528-5630

TEXANE PROJECTS - MARCH, 1986

1. R & D Targeting - working with Art Hansen at A&M, Hans Mark at the U.T System and other interested parties around the state, TEXANE has begun to develop a short, medium and long-term strategy for increasing the amount of federal research and development grant money that comes to Texas. Long-term, we must focus on the excellence of our university and research center faculties and facilities. Short-term, we must learn better how the grant-award game is played in Washington, D.C. Medium-term, we must strategically coordinate our Texas congressional delegation, our State of Texas office in Washington, D.C. and place more qualified Texans on the Science Boards of DOD, NIH, NASA, HHS, etc. Texas' long term manufacturing competitiveness is directly tied to the amount of federal R & D we receive because the federal government is the main source of all research funding (about 70-80% of total). Without substantial ongoing research, we are not innovating. Unless we are innovating, we are not integrating productivity - improving products and processes into our existing manufacturing base.

2. Technical Vocational Training - TEXANE is developing a model for strengthening the technical vocational training system in our state. Voc-tech received no attention during the proceedings of the Perot Commission and the subsequent educational reforms. It has received only brief attention so far by the Higher Education panel chaired by Larry Temple. No single area has greater potential to make or break Texas as we transform our industrial infrastructure and transition to the next economy. Training and retraining will be an entirely new industry in the next economy. There are already severe shortages in the number of middle-level technicians in key technical areas. We cannot overcome this challenge without a carefully coordinated strategy. And yet neither the public (government) nor the private (business) sector is addressing this issue in a comprehensive, serious way. The Job Training Partnership Act (JTPA) is one program that is attempting to make a contribution - but it is too large and diffused to be truly effective. TEXANE is looking at a model that would link our state's community college system with our many technical training institutes (such as the Texas State Technical Institute [TSTI] headquarters in Waco) and tie this in to our State's industrial start-up training program (jointly administered by the Texas Education Agency [TEA] and the Texas Economic Development Commission [TEDC] and currently severely underfunded at $890,000/yr.).

3. Texas Advertising & Marketing Council (TAMC) - an effort has been ongoing under TEXANE auspices, for a year to develop a comprehensive, multi-year advertising and marketing program (in an economic development context) for Texas. This program has now been developed and awaits the necessary funding of $5-10 million. Ads would appear exclusively in the national, Asian and European editions of the Wall Street Journal. Chuck Jarvie (President and CEO, Schenley Industries, Dallas) and Tony Wainwright (President and CEO, Bloom Companies, Dallas) are spearheading this effort.

4. Opening of Paris Office for Texas - working with Management Pilotage, the large French construction conglomerate, TEXANE is exploring the concept of a shared sales and marketing office for the State in Paris.

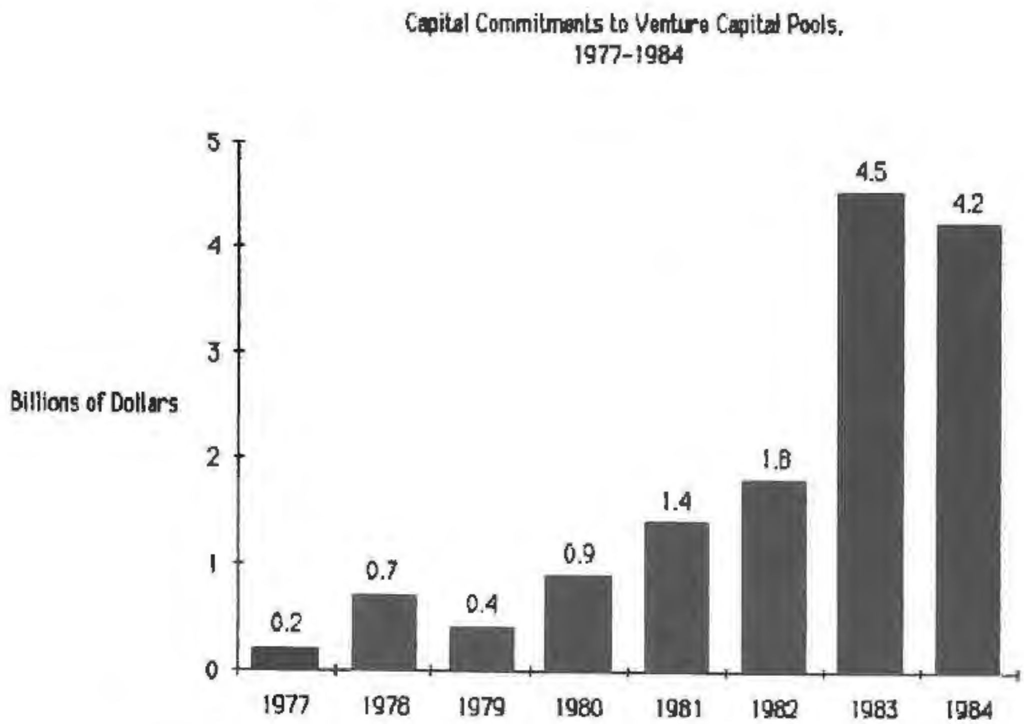
5. Educational publications and seminars - TEXANE sponsored, jointly with the Center for a New Democracy (Washington, D.C.) and Booz-Allen Hamilton (San Francisco, Ca.) a major symposium in January 1986 entitled "Modernizing America." The briefing book for this seminar has been widely requested and distributed within Texas and nationally. TEXANE is now exploring, with the New York based Japan Society, the idea of a late fall 1986 symposium focusing on the issue of Japanese - U.S. technology transfer and licensing. The seminar would be designed to come up with some concrete steps which could be taken to improve communication and information on Japanese technology trends (e.g. microelectronics, optoelectronics, biotechnology, ceramic and new materials, robotics, etc.) in the U.S.

6. We are pursing a number of "wild-card" projects whose development at this stage does not justify a report.

Venture Capital Overview

by Michael D. Gill, Jr.

A) Venture captial is an emerging American response to the changing competitive world environment. Venture capital as an industry has only coalesced into an industry distinct from other investment communities in the past 8 years, as commitments to venture capital pools rose to significant levels:



B) Venture capital pools are increasingly being formed outside of what was once considered the major venture captial center, New York. Since 1977 venture capital's center has been established on the West Coast, primarily in the Northern California area of the Silicon Valley:

DISTRIBUTION OF CAPITAL RESOURCES BY LEADING STATES
(millions of dollars)

STATE	1977	Percent	1983	Percent	1984	Percent
California	524	21%	3,656	30%	$5,296	32%
New York	718	28	2,559	21	3,262	20
Mass.	334	13	1,549	13	2,054	13
Illinois	225	10	715	6	863	5
Conn.	89	4	683	6	794	5
Texas	83	3	473	4	775	5
Total	$1,973	79%	$9,635	80%	$13,044	80%

C) Investors in venture capital pools are driven by expectations of superior rates of return and on income which is taxed as long term capital gains. The mean rate of return for venture capital pools has historically been 25%, and no venture capital partnership with capitalization over $5 million has ever lost money The primary investors in private venture capital pools are pension funds and wealthy individuals, although foreign investors, the fastest growing segment of investors in the venture capital process, in 1984 surpassed wealthy individuals aas the second largest group commiting funds:

SOURCES OF CAPITAL FOR VENTURE CAPITAL POOLS, 1980-1983

(Commitments to Independent Private Firms, Only)

INVESTORS	1984	1983	1982	1981	1980
Pension Funds	34%	31%	33%	23%	30%
Individuals and Families	15	21	21	23	16
Insurance Companies	13	12	14	15	13
Foreign Investors	18	16	13	10	8
Corporations	14	12	12	17	19
Endowments and Foundations	6	8	7	12	14

D) The primary vehicle used in the venture capital industry to manage investment pools is the independent private partnership Corporate sponsored venture capital pools and Small Business Investment Companies have experienced the smallest increase in venture dollars over the last 7 years:

DISTRIBUTION OF CAPITAL AMOUNG VENTURE CAPITAL INDUSTRY SEGMENTS

INVESTMENT VEHICLE	Millions of dollars 1977	1984	PERCENT INCREASE
Independent partnership	$ 950	$12,177	1,182%
Corporate financial	913	1,981	116
Corporate industrial	268	1,423	430
SBICs and other	390	727	86
TOTAL	$2,521	$16,308	546%

E) Geographically speaking, venture capital disbursements to portfolio companies is highly concentrated, with three states receiving nearly two-thirds of all investment capital:

VENTURE CAPITAL DISBURSEMENTS BY STATE, 1983 and 1984

State	1984	1983
California	44%	43%
Massachusetts	14	12
Texas	8	5
Total	66%	64%

F) Venture capital disbursements to portfolio companies vary by stage of maturity of the investee company, but are increasingly concentrated in the expansion stages, rather than the more risky earlier and start-up stages.

PERCENT OF DOLLAR AMOUNT INVESTED BY STAGE

STAGE OF INVESTMENT	1984	1983	1982	1981
seed	3%	2%	2%	2%
startup	13	12	15	22
other early stage	18	21	22	18
total early stage	34%	35%	39%	42%
second stage	36	32	30	28
Later stage	18	20	21	16
total expansion	54%	52%	51%	44%
Other (LBOs, etc.)	12%	13%	10%	14%

G) Venture capital is invested primarily in the emerging technology areas. Of all dollars invested by venture capitalists in the last three years, nearly three quarters is invested in "high technology", and that total is increasing

VENTURE CAPITAL DISBURSEMENTS BY INDUSTRY, 1981-1984

	PERCENT OF DOLLARS INVESTED			
INDUSTRY	1984	1983	1982	1981
Communications	14	12	10	11
Computer related	38	37	43	30
Other Electronics	12	10	13	12
Genetic engineering	3	3	3	7
Medical Health Related	11	10	7	6
TOTALS	78	72	76	66