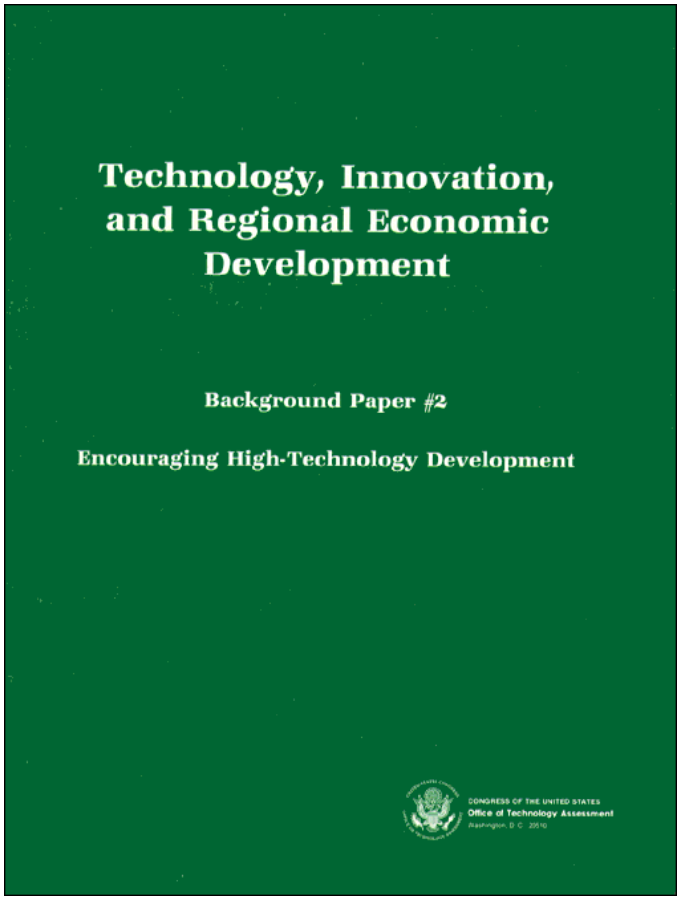
Encouraging High-Technology Development

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Preface

This background paper contains information gathered by OTA during its assessment of *Technology, Innovation, and Regional Economic Development.* The information is being made available at the request of Committees of Congress, State and local officials, and others with an interest in high-technology development programs that are being mounted at the State and local levels. OTA hopes that its timely publication will prove helpful to readers who have an immediate need for more detailed information than will be available in the formal report of this assessment.

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CHAPTER 1

Summary

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Summary

Overview

In the last 10 to 20 years, several regions of the United States have developed strong local economies based on fast-growing "high-technology" industries. Encouraged by these successes, public and private sector groups in other regions are launching initiatives to promote similar high-technology development (HTD) of their own. These initiatives are the subject of this background paper, which presents information gathered by the Office of Technology Assessment (OTA) in its ongoing assessment of *Technology, Innovation, and Regional Economic Development.*

The following chapters focus separately on the roles that are being played by State and local governments, universities, and the private sector in encouraging high-technology industrial development. This organization may be somewhat misleading, however, since State government programs, for example, usually involve the participation of university, local government, and/or private sector groups, just as university and local initiatives often seek to create closer and more productive relationships with private industry. Forging these innovative, cooperative linkages between sectors has in fact been one of the objectives and major accomplishments of these initiatives.

Similarly, Federal Government programs have played at least an indirect role in many of these initiatives. As the various chapters show, some of these efforts were encouraged by Federal pilot studies or planning grants; in others, Federal agencies or officials have provided advice and technical assistance; and in many cases, these initiatives have made innovative use of Federal funds and other development tools. In addition, recent changes in Federal policies and programs may have provided at least part of the stimulus for the increased concern and activity at the State and local levels. However, OTA has not yet completed its investigation of the role and impacts of Federal policies and programs in regional HTD.

State governments are becoming increasingly active in promoting HTD. State officials define HTD in many different ways, but in most cases they consider their high-technology initiatives to be natural extensions of their various economic development strategies. High-technology initiatives are usually based on an analysis of the State's existing industrial base, and are generally undertaken in conjunction with more traditional economic development activities. OTA's investigation suggests that, while general industrial development programs may have a more direct influence on high-technology location decisions, the more recent targeted programs have important indirect effects and can be particularly important to high-technology startups and expansions. Most of these initiatives have been launched in the last 3 years, so it is too soon to tell what their long-term effects will be. Nevertheless, most respondents to an OTA survey—public officials and high-technology executives alike—would favor additional initiatives by both State and Federal governments.

Public universities are often important components in these State initiatives, but public and private universities alike have been playing a significant role in regional economic development for decades—the Stanford Industrial Park dates from the 1940's and North Carolina's Research Triangle Park from the 1950's. Universities train technical workers and expand the base of scientific knowledge; by transferring this talent and knowledge to the private sector, they contribute to the diffusion of innovation and the creation of new firms and industries. The growing economic importance of technological innovation creates a greater need, and new opportunities, for cooperation between universities and industry. Recent studies suggest that, given strong leadership and stable, long-term funding, these initiatives can enhance technological innovation and regional economic development.

Local initiatives also influence the success of State and university initiatives, and in many communities

governments and quasi-public groups are taking an active role in encouraging HTD. These efforts usually address perceived weaknesses in an attempt to develop the resources and characteristics of such models as California's Silicon Valley and Massachusetts' Route 128. Common initiatives include zoning changes and high-technology marketing programs, education and training programs, and partnerships with local universities and business groups. Several highly publicized location decisions, such as the Microelectronics & Computer Technology Corp.'s recent choice of Austin over 50 competitors, suggest that these local efforts can have a positive impact on regional HTD.

OTA's investigation also suggests that private sector participation is an important factor in the success of State and local HTD programs. High-technology industry is the immediate target and ultimate beneficiary of most of these efforts, but in many cases individual firms or business groups have taken the lead. Industry contributes to regional development through site location decisions and business operations. In addition, the private sector works closely with universities to strengthen instruction and provide support for research and entrepreneurship. Foundations and business executives also contribute to regional development through local investment funds and public advocacy programs.

The Allure of High-Technology Development

State and local government leaders are attracted to high-technology industries because of this sector's rapid expansion and its presumed job-creating potential. Some also believe that high-technology industries can be a major force in the revival of distressed regions and cities, especially in the Midwest. In addition, they are assumed to be a key source of the innovative ideas, products, and processes that are essential to modernizing older industries and maintaining U.S. technological and economic competitiveness. Some critics, however, believe that high-technology job projections are unrealistically high or that its potential for reviving distressed areas has been overstated. Others suggest that the successes of California and New England in the 1970's may not provide useful models for the Midwest and other regions in the 1980's. Some of the strongest criticisms of these initiatives come from those who see in the rush to high technology a distinct danger of ignoring policies and programs that could be more beneficial to a State or local economy.

A related issue concerns the appropriateness of government intervention in HTD at any level. Many observers, however, point out that the United States already has an ad hoc industrial policy, and they can point beyond Washington for evidence. In the area of HTD, State and local governments are far more active than the Federal Government. The intense competition for HTD has generated literally hundreds of State and local programs, and in some areas their innovative strategies are undoubtedly making a contribution to public policy. They are encouraged in their efforts because the high-technology sector is expanding rapidly beyond its original strongholds: places that have been unsuitable for high-technology research and product development may be well suited to high-technology production activities. The more immediate result, however, is that the ad hoc national industrial policy and the numerous State, local, and private initiatives may be uncoordinated and overlapping.

As a result, State and local economic development policies are at a crossroads. Their high-technology initiatives may have only a marginal impact on HTD in the short term, and may be a zero-sum game from the national perspective if resources are spent simply to entice a firm to locate in one city or State rather than another. But while some States and cities may still conduct "raids" on their neighbors, they are also beginning to take actions to encourage economic activity that would not have happened without government intervention. This form of competition for HTD promises to have positive net results, because the emphasis is shifting toward strengthening the linkages among the financial, academic, and business communities; promoting entrepreneurship; and improving the overall scientific and technological base of State and local economies.

Common High-Technology Initiatives

The HTD initiatives investigated by OTA are as varied as the locales in which they were launched, but they seem to share three common goals: employment, business development, and economic diversification. In most cases, strategies attempt to achieve these goals either by mobilizing the necessary local resources or by removing barriers to HTD. The emphasis of the resulting initiatives falls into six general categories:

. research, development, and technology transfer;
• human capital;
. entrepreneurship training and assistance;
• financial capital;
• physical capital; and
. information gathering and dissemination.

Research, Development, and Technology Transfer

Perhaps the most fundamental initiatives are those that aim to quicken the flow of innovation itself. Since most basic research is still performed by universities, many of these initiatives focus on improving linkages between universities and industry. Some, like joint research ventures and research consortia, involve formal, long-term collaboration between a university and one or more companies. Others, like research centers and technical extension services, provide technical assistance or perform short-term research for local firms in exchange for fees or other support. In other cases, alumni groups have become active in patenting and commercializing the results of university research.

In all of these cases, the object of the initiative is to make university resources more widely available, to raise the level of formal and informal communication between academic and industrial researchers, and to increase the speed with which research results become available to industry. Recent studies suggest that, given strong leadership and a stable source of funding, such initiatives can contribute to regional economic development by reorienting university research toward the needs of industry, by attracting outside firms to the region, by improving the productivity of existing firms, and by encouraging the creation of new firms.

Human Capital

Other initiatives focus on developing the human capital needed to exploit these innovations. Two important secondary effects of university/industry collaboration are improving science and engineering training and providing continuing education for those already employed by industry, but for many initiatives these are the principal goals. Some universities, for instance, provide student internships in high-technology companies or, in cooperation with State governments and local employers, offer special training or retraining programs for technical workers. Local governments frequently lobby for engineering programs at nearby State colleges or develop special "magnet" high schools or technology-based curricula in their vocational education programs. Several high-technology companies also contribute funds, equipment, or personnel to upgrade science and mathematics instruction in the local public schools. In other cases, local initiatives focus on creating employment opportunities for engineers or technical workers who might otherwise leave the area because of cutbacks at a nearby research installation.

Entrepreneurship Training and Assistance

A special subset of human capital is entrepreneurship, and many initiatives by both universities and private sector groups are designed to provide training, technical and management assistance, and other support needed by those who create new technology-based companies. As many as 400 colleges and universities now offer courses in the creation and management of small businesses, often with financial support from local firms or major corporations as well as State governments. Some of them also conduct seminars and conferences or provide evaluation, consulting, and referral services for local inventors and entrepreneurs. In many cases, they offer this assistance in connection with an innovation center or "incubator" facility dedicated to nurturing new ventures by students and local entrepreneurs.

Financial Capital

Many universities have also begun to invest in technology-based spinoffs, either directly or through seed capital funds and venture capital partnerships. In addition, almost half of the State government initiatives identified by OTA provide some form of financial assistance to high-technology firms. Most of this assistance is indirect, taking the form of tax credits, industrial revenue bonds, or loan guarantees. While many State programs help firms to locate seed or venture capital, very few actually provide risk capital themselves.

Venture capital investing is still dominated by independent firms and corporate subsidiaries, whose investments tend to go where the returns are expected to be greatest. In recent years this has meant that California and Massachusetts have received the most support. Several universities and local governments have tried to attract these investments to their areas by holding venture capital conferences. In addition, several State and local governments, in cooperation with local business groups and foundations, have recently established venture capital funds with explicit geographic requirements. Seed capital, invested at the earlier and riskier stages of a new venture, does tend to stay local, and several initiatives attempt to increase the level of local seed capital investments, often in connection with entrepreneurship services and incubator facilities.

Physical Capital

Local governments often seek to encourage HTD through changes in land use and zoning, as well as the provision of public services and facilities. Incubator facilities, which provide low-cost office and laboratory space for entrepreneurs and struggling firms, are one form that this type of initiative can take. Far more common, however, are research and science parks—parcels of land set aside for research-intensive firms and facilities, with varying tax incentives and eligibility requirements. These parks are usually accompanied by improvements in local utilities, transportation systems, and other infrastructure. Both types of initiative have also been undertaken by universities on sites adjacent to the campus, often in conjunction with entrepreneurship programs or technical centers. This arrangement gives businesses access to student workers and faculty consultants, as well as laboratory, computer, library, and other university resources.

Information Gathering and Dissemination

The first step in almost any State or local high-technology strategy is the creation of a task force or commission, usually with university and private sector participation. Task forces serve to focus local attention and often have a pronounced networking affect. They also perform a valuable service in gathering information about the needs and problems that can be addressed through HTD; the institutional and economic resources that can be brought to bear; and the kinds of actions that might be undertaken. OTA identified several cases in which task force recommendations were the basis for subsequent initiatives, and in some instances the task force itself became a permanent council or foundation charged with implementing and overseeing these activities.

The complement to these activities is information dissemination, usually in the form of government marketing programs aimed at target firms and industries. Business groups also undertake promotional campaigns, usually advocating desired changes in public policy but occasionally aimed at increasing the development efforts of member firms. These business advocacy programs are a valuable means of building consensus and bringing private prestige to bear on public problems, just as public advocacy programs give recognition to the contributions of business groups and individuals.

Factors That Contribute to Success

The initiatives investigated by OTA hold considerable promise for promoting both technological innovation and regional economic development, but they are too recent and too varied to evaluate systematically. Most have been launched in the last 3 to 5 years, and the majority have undergone no formal evaluation or comparative analysis. Some are designed to attract new industry in the short run, while others are building the technological infrastructure for growth in the future. Many involve institutional changes that might take decades to bear fruit.

In fact, since their most important effects maybe indirect, their effectiveness will always be difficult to measure. In some cases, relatively mature initiatives have been very slow to produce any significant results, while more recent programs elsewhere are already considered successful. Furthermore, many of the States and communities investigated by OTA had already experienced a considerable amount of HTD before launching their initiatives, and other regions have experienced a great deal of HTD even without a dedicated initiative.

No single factor explains why some communities and regions have been more successful than others in nurturing and benefiting from HTD. For every locational determinant identified in economic theory or implicit in government practice, examples can be provided of cities that have several or all of the ingredients but have not yet achieved success. A strong research university, skilled labor pool, available financing, the presence of corporate headquarters, transportation, good climate, cultural amenities—all may be desirable or necessary preconditions, but they are not always enough. OTA's investigation suggests that the following additional factors increase the odds of success for State and local HTD initiatives:

- identifying local needs and resources;
- adapting to external constraints;
- linkage with broader development efforts;
- local initiative and partnership; and
- sustained effort, often over a period of decades.

In short, it appears that cooperation and commitment by public and private individuals and organizations provide a necessary catalyst to bring the ingredients together.

Identifying Local Needs and Resources

Different regions have different needs and different resources with which to address them; no single, all-purpose approach or program design will work in all settings. While individual States and communities can learn from the successes of others, therefore, success also requires a detailed knowledge of local conditions and a clear recognition of the local attributes, both strengths and weaknesses, that influence a region's ability to attract or spawn high-technology industry. These analyses are typically conducted by task forces representing government, university, and industry, or by outside consultants.

State governments, for example, appear to be implementing the programs they judge to be most effective in meeting their needs, based on an analysis of the State's existing industrial base, rather than merely copying the activities of other States. Public officials in almost all States also indicate that they have targeted specific high-technology industries for encouragement. States with more recent initiatives have a slightly higher percentage of programs involving capital assistance, reflecting their perception that capital availability is an area of great importance if they are to compete with traditional high-technology leaders, such as Massachusetts and California.

Adapting to External Constraints

What works in one area may not work in another, and there are many factors over which a community has little control, such as climate, terrain, and proximity to existing high-technology centers. Successful States and communities recognize these external constraints and adjust their objectives and strategies accordingly. Those without an existing high-technology base, for example, typically focus their initial marketing efforts on branch plants rather than on research- or technology-intensive establishments.

Over time, as these branch plants create a skilled labor force and technical infrastructure, the communities will be able to attract more sophisticated operations and encourage local spinoffs.

Linkage With Broader Development Efforts

High-technology initiatives that form part of a broader development strategy often appear to produce the most substantial results. Efforts to attract high-technology branch plants, for example, are generally part of a broader effort to strengthen or diversify the local industrial base. Most State officials, in fact, consider their high-technology initiatives to be a logical and perhaps unavoidable extension of more traditional economic development efforts. This attitude apparently is correct—the majority of high-technology executives who stated that their location decisions had been influenced by a State program identified a general economic development or training program, rather than a high-technology initiative. Similarly, most local strategies involve not only incubators and technical centers but also more traditional initiatives to make the community more attractive to technology-based firms, such as infrastructure improvements or the construction of a cultural center.

Local Initiative and Partnership

High-technology development efforts generally will be most successful if they are initiated and implemented locally. Some communities receive substantial help from State governments in developing university resources and complementing the local marketing program; others use funding and a number of development tools made available by the Federal Government. But in most cases, the objectives and strategies are developed locally, and local representatives play a major role in the design and implementation of the initiatives.

In addition, government cooperation or "partnership" with local entrepreneurs and business groups plays an important role in successful programs, since the public and private sectors are far less distinct at the local level. Social and economic conditions affect the willingness of business to participate in these development programs, but more important is the past history of public/private initiatives in the community: a strong history of collaborative efforts provides a foundation of positive experience, as well as building trust and understanding between business, government, and community groups. Stable political climate and local government with an efficient, probusiness image are positive influences, as is the existence of intermediaries, brokers, or organizational mechanisms to bring together public and private leaders.

States and communities that have benefited most from these factors have three characteristics in common:

- an Organizational culture that promotes a common civic perspective and a positive attitude about the region's attributes and prospects;
- an environment that nurtures leaders, both public and private, who combine an established track record for innovation with a broad view of their community's resources and promise; and
- a network of business/civic advocacy organizations that attracts the membership of top officers of major companies and receives from them the commitment of time and effort to work on issues of mutual concern, including cooperation with the public sector.

Sustained Effort

States and communities are not likely to reap immediate benefits from HTD initiatives. Some have been able to strengthen their economies quickly by attracting branch plants of technology-based companies, but few have developed large concentrations of high-technology establishments in a short period of time. Based on the few initiatives that have been in place for a significant period, a minimum of 10 or even 20 years may be a realistic period to develop to the stage where a significant number of local jobs can be credited to products created by local entrepreneurs or research establishments. As a result, success will depend in part on sustained effort and commitment, including stable long-term funding.

CHAPTER 2

State Government Initiatives

CHAPTER 2

State Government Initiatives

Summary

State governments are becoming increasingly active in promoting technological innovation and high-technology development (HTD). OTA's census (published as a background paper in May 1983) identified 153 State government programs with at least some features directed toward HTD. Of these, 38 programs in 22 States were "dedicated" initiatives specifically targeted on the creation, attraction, or retention of high-technology firms. Some of these initiatives date from the 1950's, but most are too recent to evaluate systematically. A survey was conducted in 16 States to gather further information on the design, operation, and effectiveness of these initiatives.

In general, the survey States appear to be implementing the programs they judge to be most effective in meeting their needs, often based on an analysis of the State's existing industrial base, rather than merely copying the activities of other States. In most cases State officials consider their high-technology initiatives to be a natural (and even unavoidable) extension of their various economic development strategies. A high-technology task force was the most common mechanism for identifying needs and formulating policy recommendations, and the Governor's Office was identified as the primary initiator of 58 percent of the programs investigated. The role of the private sector was generally that of advice and consultation, the same role commonly played by university officials. Respondents reported that local governments had no involvement in the establishment of over half of the State programs investigated.

About one-third of the programs in the survey States were classified as "labor and technical assistance" (primarily training programs). States with older initiatives had a slightly higher percentage of "high-technology education" programs, which may reflect their greater university resources. States with more recent initiatives had a slightly higher percentage of "general industrial development" programs with special provisions for high-technology firms, as well as programs involving capital assistance. The latter may reflect their perception that capital availability is an area of great importance if they are to compete with traditional high-technology leaders, such as Massachusetts and California. However, while many State programs help firms to locate seed or venture capital, very few actually provide risk capital themselves.

Most of these initiatives have been launched in the last 3 years, and the vast majority (85 percent) have undergone no formal evaluation. Preliminary analysis of their effectiveness and impact is inconclusive and often contradictory. OTA's investigation suggests that dedicated programs have served relatively few businesses directly, and that high-technology location decisions by existing firms are more likely to be influenced by general economic development programs than by high-technology initiatives. Nevertheless, dedicated initiatives provide a wide range of technical and financial services that are particularly useful to high-technology startups and expansions. Their principal achievement to date may be in terms of institutional rather than technical innovation—i.e., policy development, consensus-building, and the encouragement of cooperative linkages among governments, universities, and industry. Most respondents–State officials and high-technology executives alike—would favor additional initiatives by both State and Federal governments.

Analysis reveals that during the 1975-78 period, high-technology employment grew faster than overall manufacturing employment in all 16 of the survey States. During the 1978-80 period, which includes part of the recent recessionary cycle, survey States that had high-technology programs in place experienced a continued expansion in high-technology employment sufficient to offset what would otherwise have been a decline in overall manufacturing employment. By contrast, survey States that had not launched their programs experienced a decline in high-technology employment that contributed to

their general decline in manufacturing employment. These comparisons do not provide a statistically sound proof of the effectiveness of State HTD programs, but the more favorable experience of these States may have encouraged the other survey States (and many other States not included in the survey) to initiate their own high-technology programs.

Introduction

High-growth, technology-based firms and the industries they compose are becoming the targets of numerous State economic development strategies. In some cases, these strategies involve organizational innovations designed to identify, integrate, and mobilize existing State resources for technological innovation. In many cases the strategies also include the development of government programs specifically designed to stimulate, attract, or retain high-technology industrial development. The impetus for these dedicated programs comes from an increasing awareness of the impact of State and local initiatives on the creation of new businesses. In addition, recent changes in Federal policy have put increasing emphasis on the role and responsibility of the States in controlling the distribution of public funds and in promoting their own economic development and well-being.

The Task Force on Technological Innovation of the National Governors' Association (NGA), with finding from the U.S. Economic Development Administration (EDA), has analyzed many of these new State policies and programs.[1] The NGA study found that most States are actively pursuing short-term efforts to compete for technology-based research and manufacturing firms, and that they are also developing medium- and long-term strategies based on encouraging modernization in traditional industries and creating a favorable environment for entrepreneurship and technological innovation.[2] As a result of these activities, according to the NGA report, both the center of gravity for technological innovation and "the real and effective initiative for economic development and for the provision of jobs is shifting from the Federal Government to the States."[3] The report acknowledges that most of these State initiatives are too new to evaluate, and that "no State has yet devised a fully integrated, comprehensive policy" for promoting HTD; but it asserts that these efforts "already show great promise for meeting pressing national economic needs. "[4]

Researchers at the Urban Institute have testified that these initiatives provide a potential alternative to a Federal industrial policy: State economic development programs, if "reoriented" to serve national interests and integrated into a " 'federalist' industrial policy," might "increase overall economic activity in the Nation rather than simply rearranging the location of a fixed amount of activity." They also noted, however, that "total development expenditures by States maybe smaller than optimal" because they are unable to capture all the benefits of their outlays, and that "less than 1 percent of the allocated resources in 1981 were targeted to specific industries, high-technology firms, R&D activities, small firms, minority firms, or distressed geographic areas. "[5]

OTA conducted a preliminary census of State government initiatives in December 1982 and January 1983.[6] This census identified 153 State programs

[1] Task Force on Technological Innovation, *Technology and Growth: State Initiatives in Technological Innovation* (Washington, D. C.: National Governors' Association, October 1983); see also *State Initiatives in Technological Innovation: Preliminary Report of Survey Findings,* February 1983.

[2] Task Force on Technological Innovation, NGA, **op. cit., pp. 9-10.**

[3] Task Force on Technological Innovation, NGA, **op. cit.,** p. 8.

[4] Task Force on Technological Innovation, NGA, **op. cit., pp. 102,** *104,* and 8.

[5] Larry C. Ledebur and David W. Rasmussen, "Toward a Federalist Industrial Policy: The Role of State Industrial Development Programs," testimony before the Joint Economic Committee of Congress, July 14, 1983; see also "The Role of State Economic Development Programs in National Industry Policy," *Po/icy Studies Journal, vol. 2, No. 4,* May 1983, pp. 750-761. Further discussion of this topic, as well as a comprehensive listing of State economic development programs, can be found in *Directory of Incentives for Business Investment and Development in the United States: A State-by-State Guide* (Washington, D. C.: Urban Institute Press, 1983).

[6] **Census of State Government** *Initiatives for High-Technology Industrial Development* (Washington, D. C.: U.S. Congress, Office of Technology Assessment, OTA-BP-STI-21, May 1983).

with at least some features directed toward HTD (table 1). Only a few of these programs, however, focused specifically on the needs and problems of technology-based businesses. Using the narrower definition of a "dedicated" HTD initiative–chartered and at least partially funded by the State government, and specifically targeted on the creation, attraction, or retention of high-technology firms—OTA identified a total of 38 programs in 22 States. In addition, OTA identified 15 high-technology education (HTE) initiatives, undertaken in conjunction with State universities, designed to equip entrepreneurs with the skills needed to create firms or to help existing firms commercialize emerging technologies. (These 15 programs are only a fraction of the high-technology initiatives that have been launched by U.S. colleges and universities–see ch. 3.)

In order to gather more detailed information on State government initiatives, OTA contracted with the Research Triangle Institute (RTI) to conduct a survey and comparative analysis of high-technology initiatives in 16 States—8 that had implemented dedicated programs before 1981, and 8 that initiated dedicated programs in 1981-82. The sample States selected for the survey were:

Pre-1981 States	*1981-82 States*
California	Indiana
Connecticut	Illinois
Georgia	Michigan
Massachusetts	Minnesota
New York	Missouri
North Carolina	New Mexico
Tennessee	Ohio
Pennsylvania	Rhode Island

A total of 321 interviews were completed during February and March 1983. The distribution of these respondents among the 16 survey States is presented in table 2. RTI gathered information on a total of 68 HTD-related programs in the survey States, but it investigated their impacts and effectiveness only in the pre-1981 States, on the assumption that these initiatives might be old enough to have produced measurable results. The findings of this survey are presented below.

Table I.—State High.Technology Programs by Type[a]

State	HTD	TF	HTE	LTA	CPA	GID
Alabama	—	—	—	—	—	1
Alaska	—	—	—	—	2	—
Arkansas	—	—	—	2	1	—
Arizona	—	—	1	1	1	1
California	1	—	1	1	—	—
Colorado	1	1	—	1	—	1
Connecticut	3	—	—	1	1	1
Delaware	—	—	—	—	—	1
Florida	3	—	1	—	—	3
Georgia	1	—	2	—	—	—
Hawaii	1	—	—	—	—	—
Idaho	—	—	—	2	—	1
Illinois	2	1	—	2	1	—
Indiana	1	—	1	—	—	—
Iowa	—	1	—	—	—	—
Kansas	—	1	—	—	—	1
Kentucky	—	—	—	1	1	1
Louisiana	—	1	—	—		
Maine	—	—	—	—	2	2
Maryland	—	1	—	2	3	—
Massachusetts	1	—	1	1	1	1
Michigan	8	—	—	1	1	—
Minnesota	—	—	1	—	—	1
Mississippi	1	—	—	1	1	1
Missouri	1	—	1	2	2	2
Montana	—	—	—	—	—	1
Nebraska	—	—	—	1	—	1
Nevada	—	—	—	—	—	1
New Hampshire	—	—	—	—	—	1
New Jersey	—	1	—	—	—	—
New Mexico	2	—	1	—	—	—
New York	2	—	—	1	2	—
North Carolina	1	—	2	—	—	1
North Dakota	—	—	—	—		1
Ohio	1	–	–	–	2	1
Oklahoma	—	—	—	—	—	1
Oregon	—	—	—	—	—	1
Pennsylvania	2	—	1	1	1	—
Puerto Rico	—	—	—	2	1	—
Rhode Island	1	—	—	1	1	—
South Carolina	—	1	—	1	—	—
South Dakota	—	—	—	—	—	1
Tennessee	2	—	1	—	—	—
Texas	1	—	—	1	—	2
Utah	—	—	—	—	—	1
Vermont	—	—	—	—	1	—
Virginia	1	1	—	—	—	1
Washington	1	—	1	—	—	—
West Virginia	—	—	—	1	—	1
Wisconsin	—	—	—	—	—	3
Wyoming	—	—	—	—	—	1
Totals	38	9	14	28	27	37

[a]HTD = high-technology development; TF - task force; HTE = high-technology education; LTA = labor/technical assistance; CPA = capital provision/assistance; GID - general industrial development.

SOURCE: Office of Technology Assessment.

Table 2.–Distribution of Survey Respondents by State

States	State policymakers	Program managers	Other participants	High-technology firms	Total
Pre-1981 States:					
California	1	7	2	17	27
Connecticut	1	6	2	27	36
Georgia	2	3	3	22	30
Massachusetts	2	5	4	24	35
New York	1	3	7	18	29
North Carolina	2	3	4	31	40
Pennsylvania	2	4	4	15	25
Tennessee	1	4	5	23	33
Subtotal	12	35	31	177	255
1981-82 States:					
Illinois	1	3	4	0	7
Indiana	1	3	4	0	8
Michigan	1	9	2	0	12
Minnesota	1	2	6	0	9
Missouri	2	6	0	0	8
New Mexico	1	3	2	0	6
Ohio	1	6	4	0	11
Rhode Island	1	2	1	0	**4**
Subtotal	9	34	23	0	66
Total all survey States	21	69	54	177	321

SOURCE: Research Triangle Institute.

Program Design and Operation

State Goals and Strategies

States appear to define HTD in many different ways.[7] States with dedicated initiatives, for example, tend to be those that had a sophisticated research base and considerable high-technology industry even before these programs were established; their objective in part is to strengthen and retain what was already there. However, in States where the economic base consists primarily of ''sunset'' industries, the ''high-technology" strategy tends to emphasize economic diversification and the application of new production technologies untraditional manufacturing sectors. Still other States, notably those that are less highly industrialized, base their strategies on the aggressive pursuit of the production facilities of expanding high-technology firms as part of a broader effort to bolster their industrial base and build the foundation for future development.

These patterns suggest that, for most States, attention to high-technology industrial development is not distinct from economic development ingeneral. They also suggest that in launching their initiatives, the States have given attention both to the special needs of technology-based enterprises and to their own comparative advantage vis-à-vis the basic stages of technological innovation and commercialization. In most cases, State officials consider their high-technology initiatives to be a natural (and even unavoidable) extension of their different economic development strategies.

The overall goals the 16 survey States hope to achieve through their high-technology initiatives fall into three general categories: jobs and income; business development; and economic diversification. State policymakers in 13 of the 16 States were able to identify specific policy goals in each of these categories that guide their high-technology strategies.

- Job and *income goals* focus primarily on creating new jobs and increasing per capita income. States in the industrial Northeast and North

[7] The balance of this chapter is based on the contractor report, *State Initiatives Survey,* prepared for OTA by the Research Triangle Institute, Alvin M. Cruze, principal investigator, May 1983.

Central regions reported a greater emphasis on creating new jobs; Pennsylvania and Michigan, both of which have been hard hit by structural changes in their industrial base, indicated that reducing job losses and unemployment were also major goals. Emphasis on increasing per capita incomes was more common in Sunbelt States.

- *Business development goals* focus on the creation of new ventures and the expansion of existing firms. States in both groups also strive to attract new businesses, but retaining existing business is a more common goal in the pre-1981 States. Pennsylvania and Ohio, on the other hand, report that modernizing existing industry is a major goal.
- *Industrial development goals* in almost every survey State focus on diversifying the industrial base, but several States are also trying to increase the geographical distribution of their industry. Respondents in almost all of the survey States indicated that they had targeted manufacturing or R&D as the key business activity to be encouraged. On the other hand, only three States, all with fairly recent initiatives—Michigan, Missouri, and Ohio–specified the services as business activities of interest. In addition, every survey State except Ohio has targeted specific high-technology industries for encouragement (table 3).

Program Design

High-technology economic development programs appear to be initiated in one of four different ways, each of which may affect the design and operations of the program:

- *To alleviate specific needs identified by State task forces or commissions.* Examples include the Connecticut Product Development Corp. (created in 1972 by legislation growing out of the State's Full Employment Task Force); Georgia's Advanced Technology Development Center (created as a result of a study commissioned by the Governor in 1979 to determine how to promote the growth of high-technology industry); the Bay State Skills Corp. (evolved from a gubernatorial plan to meet Massachusetts' need for more skilled and trained workers); and Tennessee's Technology Corridor Foundation (created as a result of recommendations of the Governor's Technology Corridor Task Force).
- *Through the evolution of traditional economic development organizations,* which have been redirected or strengthened to form the basis of

Table 3.—Targeted High.Technology industries and Business Activities in the Survey States

	Pre-1981 States								1981-82 States								
	CA	CT	GA	MA	NY	NC	PA[a]	TN	IL	IN	MI	MN	MO	NM	OH	RI	Total
Targeted high-technology industries:																	
Space/Avionics	X	—	x	–	–	–	–	–	–	–	–	–	–.x	–	–	–	3
Transportation	—	—	–	–	–	–	–	–	–	–	x	—	—	—	—	—	1
Communications	X	—	x	–	–	x	–	x	–	–	x	–	–	–	–	–	5
Electronics	X	X	–	–	–	–	–	–	–	X	–	–	X	X	–	–	5
Microelectronics	—	X	–	X	–	X	–	–	X	–	–	–	–	–	–	–	4
Robotics	—	—	–	–	–	–	–	–	–	–	X	–	–	–	–	–	
Computer hardware	X	—	X	X	X	X	–	–	X	–	–	–	–	–	–	–	1
Computer software	—	—	x	–	x	–	–	–	x	–	–	–	–	–	–	–	3
Lasers	—	—	x	—	—	—	—	—	—	—	–	—	—	X	—	—	2
Energy	—	—	x	—	—	—	—	x	—	—	–	—	—	—	—	—	2
Biotechnology	—	—	X	X	X	X	–	X	X	–	X	–	–	–	–	–	7
Biomedical	—	X	–	–	X	–	–	–	–	–	X	X	X	X	–	X	
Pharmaceutical	—	X	–	–	X	X	–	–	X	–	–	–	–	–	–	–	1
None targeted	—	—	–	–	–	–	–	–	–	–	–	–	–	–	x	–	I
Targeted business activities:																	
Manufacturing	x		X	—	X	—	X	—	X	—	X	x	—	X	X		10
R&D							X	X	–	X	—	X	—	X	—	—	X	—	X	X	X	8
Services							—	—	—	—	—	—	—	—	X	—	x	—	x	—	3

[a]Pennsylvania has targeted 27 specific industries.

SOURCE: Research Triangle Institute,

a new program. An example of this type of evolutionary design is the Pennsylvania Industrial Development Authority, which has provided low-interest loans to businesses for over 20 years but has recently been directed to set aside 25 percent of its funds for advanced-technology businesses.

- *To alleviate localized problems or needs,* and later expanding to include additional locales. Programs designed for localized impact include Science Park in New Haven, Corm. (designed to attract companies engaged in developing and producing new products, in order to increase the economic vitality of the surrounding area) and the Center for Industrial Cooperation at University of New York at Stony Brook (formed in 1978 to link the resources of the University with the needs of local industry).
- *To take advantage of Federal initiatives and finding.* Examples include the Innovation Development Loan Funds in both California and Connecticut (created to obtain EDA grants, which are then used to provide financial, managerial, and technical assistance to inventors and small high-technology businesses) and the Massachusetts Small Business Development Center (created to obtain U.S. Small Business Administration finding to develop five centers to assist small businesses).

Public/Private Participation

Since economic well-being has been an overriding political issue at the State level in recent years, and since many present Governors campaigned on platforms that included economic revitalization, it is not surprising that they have played an extensive role in initiating and designing high-technology programs. The Governor's Office was identified as the primary initiator of 58 percent of the programs investigated. A high-technology task force or commission appointed by the Governor was the primary mechanism for identifying needs and formulating policy recommendations in each of the survey States except Indiana and Missouri. Programs created in this way bring with them whatever political clout or liability the Governor and his commission possess. This can be relatively advantageous until a change of administration: programs designed to address problems identified by a previous Governor's "special commission" may be viewed more critically by his successor than programs that have evolved more naturally; this appears to be happening at present in California.

The legislature's role is also important, since 75 percent of the programs required enabling legislation, and this body is also the key provider of funding (see below). However, the role of the legislature varied widely among the survey States, from little or no involvement in Indiana and New Mexico to the driving force in Ohio. The State economic development office takes a lead policy role in Connecticut, Massachusetts, North Carolina, Indiana, and Missouri, but a less direct role elsewhere.

Another major factor is the participation and support of local officials and business leaders, but respondents reported that local governments had no direct involvement in the establishment of over half of the programs investigated; local governments generally participated indirectly, through their legislative representatives. The role of the private sector was generally that of advice and consultation (64 percent of the programs), but the private sector also was cited as the primary initiator of 10 percent of the programs and as an important contributor to most programs. University officials also provided extensive advice and consultation (48 percent of the programs), and they were identified as the primary initiator of 16 percent of the programs.

Program Types

Table 4 shows the distribution of programs implemented by the survey States to accomplish the goals outlined above. Analyzing the 68 initiatives by program type reveals little significant difference between the two groups. States with older initiatives had a slightly higher percentage of HTD and HTE programs, perhaps a reflection of their existing high-technology base and greater university resources. States in the 1981-82 States, on the other hand, have a slightly higher percentage of GID programs with special provisions for high-technology firms, a possible reflection of the relative youth of their strategies. They also have a slightly higher percentage of "capital assistance" programs, which may indicate they are designing their initiatives to compete with the traditional high-technology leaders, such as Massachusetts and California, where capital is much

Table 4.–High-Technology Development Programs in the Survey States, by Type

Type[a]	All programs		Programs in pre-1981 States		Programs in 1981-82 States	
	Number	Percent[b]	Number	Percent	Number	Percent
HTD	30	44	16	48	14	40
HTE	14	21	8	24	6	16
LTA	23	34	11	33	12	40
CPA	19	28	8	24	11	31
GID	15	22	6	18	9	26

[a]H T D = high-technology development; HTE = high-technologyeducation; LTA = labor/technical assistance; CPA = capital provision assistance; GID = general industrial development.
[b]Percentages do not sum to 100 because some programs are categorized in more than one program type.

SOURCE' Research Triangle Institute,

easier to obtain from the private sector. Capital provision is also one of the areas in which survey respondents desired more State and Federal Government involvement (see below).

- *High-technology development initiatives* are generally key elements in State strategies because they focus specifically on the creation and expansion of high-technology firms. Six of these 30 programs are task forces, but the others provide financial services, perform research, or disseminate information.
- *Financial assistance programs* represent exactly half of the 68 programs investigated. While only 6 of these 34 programs are specifically targeted on innovation and high-technology industries, several others have specific assistance for high-technology firms. The financial service provided by the highest proportion of these programs is assistance in finding venture capital (12 programs), but many others offer long-term loans or loan guarantees. The majority of financial assistance programs are relatively new, and 7 have not begun to provide services to businesses.
- *Training programs,* one-third of those surveyed, operate either directly or through grants to other organizations. Most of these programs have linkages with Federal programs and 12 have obtained funding from Federal sources. Some States are analyzing the use of customized job training (i.e., specifically tailored to the needs of potential employers) in connection with new Federal efforts under the Job Training Partnership Act of 1982.
- *High-technology education programs* operating from a university and involved in fostering the creation of new high-technology businesses represent 14 of the 68 initiatives in the survey States. One impetus for such programs appears to be the role played by universities in encouraging new business starts, an important factor in California's high-technology development. California has attempted to institutionalize this role through the Microelectronics Innovation and Computer Research Opportunities (MICRO) program, which provides funding for graduate fellowships and faculty research projects, and is supported by matching grants from private industry. The relatively low percentage of HTE programs results in part from the universe of programs that were investigated: strictly university initiatives were not included, despite their number and importance. (These initiatives are described in greater detail in ch. 3.)

Services Provided

The frequency and distribution of the services provided by high-technology programs provides an indication of which actions the States believe to be most necessary, or most effective, in achieving their high-technology goals. If a State's programs provide a large number of financial or training services, for example, it can be assumed that it has identified the availability of risk capital or the skills of its work force as areas for priority attention.

The OTA census found that the services most frequently offered by dedicated HTD or HTE programs involve *information dissemination*— 17 programs link industry and university resources, and 8 others involve promotional activities aimed at *advertising* the State's resources and opportunities for high-technology firms. Almost half of the programs also offer some form of *financial assistance—9* programs assist

entrepreneurs in locating venture capital, another 9 deal with industrial revenue bonds, 8 provide grants for R&D, and 4 provide loans to high-technology firms. Other services commonly offered include: *market development assistance (7* programs); *product development assistance (4* programs); and *assistance in training technical personnel (5* programs). More unique services include helping inventors to acquire patents, providing laboratory or office space for new and growing businesses, and investing public pension funds in high-technology business.

Table 5 shows the frequency and distribution of services provided by the 68 programs investigated in the RTI survey, using the service codes developed for the OTA census. Because these 68 programs include many that were not considered to be "dedicated" for the purposes of the OTA census, the number and types of services they provide show a different pattern than that outlined above. The most commonly provided services involve *labor training,* either linked with a university (26 programs), provided by the State (14 programs), or with technical support from the State (11 programs). Other fre-

Table 5.—Number of Programs Providing Specific Services in Survey States

Service category	All programs	Pre-1981 programs	1981-82 programs
Enterprise zones	3		2
Industrial revenue bonds	6	2	4
Information dissemination	16	10	6
Investment capital	4		1
Investment in survival	0	0	0
Grants	10	7	3
Research	10	6	4
Startup		1	
Development	2	5	3
Training	8	5	3
Labor	7	5	2
Grant for jobs created	1	0	1
Training vouchers	2	0	
Training by State	14	6	8
Technical support by State		7	4
Links with university	11	15	11
Licensing assistance	1	1	0
Loans	5	2	3
Debt	2	2	0
Equity	5	2	3
Subordinated	2	1	1
Stock or royalty rights	3	2	1
Guarantees	2	0	2
Long-term, low-interest	5	2	3
Market development assistance	7	7	0
Office or equipment provision	4	4	0
Physical plant assistance	7	7	0
Patent searches		1	0
Product development assistance	1	7	2
State resources promotion	9	5	4
Task forces and commissions	10	6	4
Tax incentives	5	1	4
Reduction in corporate tax	0	0	0
Abatement of property tax	4	2	2
Freeze on assessed value	2	1	1
Exemption from sales tax	2	1	1
Venture capital	2	1	1
Direct (startup)	3	1	1
Direct (product development)	2	2	0
Bond issue to raise funds	1	0	0
Royalty or stock rights	1	0	1
Assistance in finding	14	9	5

SOURCE: Research Triangle Institute.

frequently offered services are *information dissemination (16* programs) and assistance in finding *venture capital* (14 programs). However, while many programs help firms to locate venture capital, only three State programs are actually designed to provide venture capital. On the other hand, many programs offer other *financial services:* 10 provide some form of grants, 6 help to arrange for industrial revenue bonds, 5 provide loans or loan guarantees, and 5 provide abatements or other tax incentives for high-technology firms.

With few exceptions, specific services were offered by programs in both groups of States. However, all seven of the programs offering market development assistance or incubator space were implemented by pre-1981 States. Further analysis of the distribution of services between the two groups of States reveals interesting but inconclusive patterns. For example, 7 of 9 product development programs and 10 of 16 information dissemination programs are in pre-1981 States, as are 15 of 26 programs that link business with university resources, the latter corresponding to the higher frequency of HTE programs in these States. In the area of financial services, 1981-82 States more frequently offer industrial revenue bonds and tax incentives, while pre-1981 States make greater use of grants and venture capital assistance.

Eligibility

State high-technology initiatives maintain varying eligibility requirements, usually designed to focus their service on the specific needs of a targeted industry group. More recent initiatives are somewhat more targeted or restrictive, but in general there is little difference between the two groups of States with regard to eligibility. Six categories of eligibility emerge from the survey responses and subsequent analysis:

- *General (15* percent). –No provisions in the program design for limiting program services to any group or subgroup industries. For example, the Pennsylvania Technical Assistance Program offers technical information and assistance to all State businesses, particularly in the area of technology transfer.
- *Specific/high-technology* (17 percent).–Provisions in the program design for limiting program services to a set of industries or businesses, generally defined as “high-technology industries. ” An example of this is the High-Technology Equity Loans Program in Michigan.
- *Specific/technological innovation (9* percent).–Provisions in the program design for limiting services to a set of industries or businesses involved in technological innovation. The Illinois Biomedical Research Park, for example, is set up to assist biomedical firms with innovation and development.
- *Specific/targeted industries (25* percent) .–Provisions in the program design limiting services to a subgroup of industries, but not restricted to only high-technology industries. These include programs for small business, such as the Maine New Enterprise Institute, and programs like the Maryland Technology Extension Service, which provides services to any business that meets certain criteria of need.
- *Specific/geographic* (10 percent) .–Provisions in the program design for limiting services to businesses within a specific region of a State. The Metropolitan Center for High-Technology, for example, is targeted on Michigan’s urban areas.

Funding

Program operations are funded from a variety of sources, including direct State appropriations for program operations, bond issues, State educational appropriations, Federal funding, multistate regional finding, private sources, and various combinations of these sources. Approximately 64 percent of the surveyed programs receive 100 percent of their funding from State appropriations, while only 11 percent of the programs receive less than half of their financial support from the State. The remaining funds come from Federal sources (20 percent of the programs) and/or private funding (18 percent). Only one program, Connecticut’s Science Park, reported that it received any finding from the local government.

The amount of funding is, of course, a key element of the operation of any program. For active

programs in which current funding amounts have been established, 9 percent are below $100,000; 21 percent fall in the $100,000 to $500,000 range; and 23 percent are between $500,000 and $1 million. The largest segment (33 percent) fall in the $1 million to $10 million range. Approximately 14 percent of these programs have financial resources greater than $10 million, but many of these larger budget figures represent loan programs, bond issues, or capital projects, rather than strictly operating budgets.

Program Effectiveness and Impacts

Obstacles and Problems

State policymakers identified the recent economic downturn and its effects on the State's revenues and employment as the most significant obstacle to the implementation of their high-technology strategies. Another obstacle identified by State policymakers is one of information: State legislatures find it difficult to get needed information about business activity in their State and in other States, a problem that may sometimes lead to confused State policies. In addition, 8 of the 16 survey States had new Governors in 1983. While most of them have announced no plan to change their States' programs, this may create problems with continuity and momentum. Other obstacles included the State's image or business climate and the lack of consensus and cooperation on HTD, particularly among local groups, labor unions, and the existing business community.

Program managers, however, identified the program's coordinating function (and the cooperative activities it has fostered) as its major strength (46 percent of respondents). Another major strength was the funding level and general resource base available to the program (34 percent). At the same time, the major weakness identified most often by program personnel was *inadequate* funding and other resources (22 percent). However, the majority of program managers reported no problems. Other participants involved in program design and operation, on the other hand, identified numerous problems—52 of 54 respondents cited the coordination of program activities and the difficulty of obtaining the cooperation of the participants as problems.

Program Evaluations

Only 9 of the 68 programs had been evaluated at the time of the survey, 3 (all pre-1981) through external evaluation and 6 programs (4 pre-1981 and 2 1981-82) through internal evaluation. The vast majority of programs (85 percent) had undergone no formal evaluation of their effectiveness, and many respondents stated that it was too early to assess program impact adequately. In fact, less than three-fourths of the 68 programs were currently in operation: 21 percent were in the planning stages and have obtained first finding, but approximately 7 percent of the programs either were waiting for funding or passage of enabling legislation, or had their operations suspended due to loss of funding, changes in administration, or changes in overall high-technology strategy.

Several program managers, however, were able to furnish baseline data on the number of businesses that had been provided with program services. These data suggest that training programs tend to serve more firms in the 1981-82 States, while financial assistance programs provide services to a greater number of businesses in the pre-1981 States. In general, the available data suggest that the programs for which data were available had provided services to relatively few businesses: over 80 percent had served fewer than 100 firms, and 60 percent had served fewer than 50 clients. The responses of high-technology firms (see below) also suggest that these programs generally have not had a direct impact on a large percentage of the businesses in the pre-1981 States. This may be understandable, however, given the indirect nature of the services provided by many programs and the short history of the majority of them.

Impact on High-Technology Businesses

High-technology firms were surveyed only in the 8 survey States whose initiatives were in operation before 1981, on the assumption that these programs were more likely to have had a measurable impact

on the high-technology business community. Of the 177 businesses contacted, 99 were potential clients for program services—29 were startups, 46 had expanded, and 24 had relocated since 1980. Of these 99 firms, 56 had received services from the State government, most frequently financial assistance, educational and training assistance, and locational and business information. Thirty-four of these 54 firms said that this assistance influenced their location decisions, and 18 said that it was a critical or important factor. When they were asked to name the State program involved, the overwhelming majority of firms named traditional economic development mechanisms such as industrial revenue bonds, business recruitment, and general training programs, rather than the dedicated high-technology programs identified by the OTA census.

In response to an open-ended question about the factors that influenced their decision to locate in a particular State, many of the 99 high-technology firms said they had done so because their founders lived there (22 firms) or because it was close to their existing operations (22). Other important factors included the availability of trained manpower (17), access to the firm's markets (12), local transportation resources (12), and quality of life or climate (10). However, many firms cited general State support (13), along with tax rates (4), financial incentives (4), and training programs (3). Other important locational factors included proximity to university facilities (8) and general high-technology climate (8), as well as the overall business climate (5) and the availability of suitable sites (5) and venture capital (3). It is in these latter areas where the indirect influence of State high-technology initiatives may have their greatest long-term impact, by making more resources available to high-technology firms and improving the general climate for HTD.

Additional Initiatives Desired

Survey respondents were also asked whether the State government should undertake any additional initiatives for HTD. The desire for additional initiatives provides some measure of the effectiveness of existing programs, although an inconclusive measure. That is, respondents might desire additional programs either because current programs are ineffective, or because they have been effective and additional initiatives would increase their impacts. While 51 percent of program managers rated their programs excellent or very good, for example, 77 percent of them would nonetheless desire additional initiatives by their State government.

Table 6 presents the responses of program managers, other participants, and high-technology firms. Two-thirds of all survey respondents desire some additional State initiative, as do a majority of each respondent group: 87 percent of other participants, 77 percent of program managers, and 59 percent of high-technology firms. Regarding the type of additional State initiatives desired, education and training programs and financial assistance programs were mentioned most often (each by 30 percent of respondents), followed by general high-technology assistance programs (26 percent) and additional R&D

Table 6.—Additional High-Technology Initiatives Desired

Response	Program personnel		Other participants		High-technology[a] businesses		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Additional State government initiatives desired?								
Yes	36	77	41	87	98	59	175	67
No	6	13	6	13	47	28	59	23
Don't know	5	10	0	0	21	13	26	10
Totals	47	100	47	100	166	100	260	100
Additional Federal Government initiatives desired?								
Yes	***36***	***62***	***28***	***58***	***85***	51	149	
No	15	26	18	38	59	35	92	34
Don't know	7	12	2	4	23	14	32	11
Totals	58	100	48	100	167	100	273	100

[a]Businesses were contacted only in the eight pre-1981 States

SOURCE: Research Triangle Institute.

programs (10 percent). However, business respondents rated training slightly higher, and financial assistance somewhat lower, than did program managers. On the other hand, startups and expansions since 1980 cited financial assistance (general support, industrial revenue bonds, venture capital assistance, and R&D or expansion funding) more often than training or education programs.

When respondents were asked if they would also desire additional high-technology initiatives by the Federal Government, more than half responded that they would, including a majority of each respondent group (table 6). Support was universally weaker for Federal initiatives than for additional State programs, but analysis reveals a greater desire for additional Federal initiatives in States with more recent programs. Support for additional Federal initiatives among high-technology business respondents ranged from 89 percent in California (16 of 17 firms) to only 14 percent in North Carolina (4 of 31 firms).

When respondents who felt additional Federal initiatives were desirable were asked to identify them, they again mentioned education and training programs most frequently, followed by R&D programs and financial assistance. Many respondents suggested that Federal finding for training and education programs, passed directly to the States, would be the most effective means of Federal involvement. Others wanted an increase in direct research funding by the Federal Government or funding to States for R&D initiatives at the State level. Some respondents also mentioned the need for general assistance to high-technology firms or for changes in Federal industrial and trade policies. Thirteen business respondents felt that the Federal Government should increase high-technology defense spending.

Employment Impacts in the Survey States

Given the inconclusive nature of these subjective evaluations, RTI also gathered secondary data on high-technology employment patterns in the survey States (table 7). Collectively, these 16 States account for over half of the manufacturing employment and two-thirds of the high-technology jobs in the United States. They added approximately 352,000 jobs in the high-technology sector over the 1975-80 period, and their overall manufacturing employment increased by approximately 1.3 million in the same period. These figures, however, should be placed in context: total nonagricultural employment was approximately 51 million in these 16 States in 1980. While employment in high-technology industries may not constitute a significant fraction of total employment, it is clearly an important component of manufacturing employment and has accounted for approximately one-fourth of the employment growth (and a higher fraction of job creation) in the manufacturing sector in the 1975-80 period. The employment statistics in table 7 show several patterns that may be useful in evaluating the effects of their high-technology strategies and programs.

First, the survey States demonstrate a wide range of employment size and mix, ranging in size from California, with over 10 million persons employed outside agriculture, to Rhode Island, with fewer than 400,000. On average, however, the total work force in the pre-1981 States is 70 percent larger than that of the 1981-82 States. Similarly, there is a wide range of employment in the manufacturing sector, from over 2 million in California to less than 35,000 in New Mexico; manufacturing ranges from 35.3 percent of total nonagricultural employment in North Carolina to only 7.4 percent in New Mexico. However, while the average number of manufacturing employees is higher in the pre-1981 States, they represent a slightly higher percentage of the work force in the 1981-82 States.

High-technology employment shows a similar diversity, ranging from 3,500 in New Mexico to over 600,000 in California. As a share of the manufacturing work force, it ranges from 34.8 percent in Massachusetts to only 5.5 percent in Georgia, both pre-1981 States. On average, the pre-1981 States have a substantially higher proportion of high-technology employment than the 1981-82 States—21.8 percent and 15.5 percent, respectively. However, much of this difference is accounted for by California and Massachusetts; excluding these recognized leaders reduces high-technology employment to 16.8 percent of overall manufacturing in the pre-1981 States, much closer to the level in the 1981-82 States. In addition, Minnesota's level of high-technology employment is higher than the average for the pre-1981 States, while three pre-1981 States-North Carolina, Tennessee, and Georgia—have high-technology employment levels lower than the average for the 1981-82 States.

Table 7.-Employment in the Survey States, 1980

State	Total nonagricultural employment (thousands)	Manufacturing employment		High-technology employment		
		Number (thousands)	Percent of total	Number (thousands)	Percent of manufacturing	Percent of total
United States	90,657.0	20,381.0	22.5	3,676.4	18.1	4.1
16 Survey States	50,821.4	12,879.4	25.3	2,481.0	19.3	4.9
Pre-1981 States	32,037.4	7,757.1	24.2	1,666.5	21.8	5.3
California	10,104.3	2,008.9	19.9	801.2	29.9	5.9
Connecticut	1,413.8	440.0	31.1	98,6	22.4	7.0
Georgia	2,115.1	519.1	24.5	28.7	5.5	
Massachusetts	2,595.7	674.5	28.0	235.0	34.8	9.1
New York	7,113.6	1,46.7	20.5	374.5	25.7	5.3
North Carolina	2,328.5	82.0	35.3	87.1	10.6	3.7
Pennsylvania	4,621.2	1,333.2	28.8	213.8	16.0	4.6
Tennessee	1,747.2	502.7	28.8	47.6[a]	9.5	2.7
1981-62 States	18,784.0	5,122.3	27.3	794.5	15.5	4.2
Illinois	4,692.9	1,239.2	28.4	237,0	19.1	5.1
Indiana	2,137.1	658.0	30.8	134.5[b]	20.4	6.3
Michigan	3,291.6	968.5	30.0	80.9	8.2	2.5
Minnesota	1,710.3	371.1	21.7	108.7	28.8	6.2
Missouri	1,989.8	437.0	22.2	60.3[a]	13.8	3.1
New Mexico	485.4	34.4	7.4	3.5[c]	13.8	3.1
Ohio	4,119.2	1,265.0	30.7	151.4	12.0	3.7
Rhode Island	397.7	129.1	32.5	20.2	15.6	5.1

[a] Total employment in high-technology industries not available due to lack of detailed Information at the 3-digit SIC level Number indicated is total employment in 2-digit sectors 36 (electronic and electric equipment) and 38 (instruments and related products). These figures represent downwardly biased estimates of total high-technolgy employment in the state, asemploymant in selected 3-digit SIC high-technology sectors is omitted.
[b] Employment in SIC sectors 36, 38, and 372 only.
[c] Employment in SIC sector 36 only.

SOURCE: Massachusetts Divsion of Employment Security, *High-Technology Employment: Massachusetts and Selected States* 1975-81 *July 1981;* and U.S. Department of Labor, Bureau of Labor Statistics, *Supplement to Employment and Earnings, State and* Areas, Bulletins 1370-13 and 370-16.

These comparisons show little consistent difference between the two groups of survey States, but they fail to reflect variations in industrial base and other regional differences that may influence employment trends. While the precise effect of these factors is unclear, analysis reveals that States with high-technology programs in place before 1981 have experienced a higher rate of growth in both manufacturing and high-technology employment in recent years. Table 8 presents employment growth rates for the 1975-80 period and for two subperiods, 1975-78 and 1978-80.

During the 1975-80 period as a whole, high-technology employment grew faster than overall manufacturing employment for the Nation as a whole, in both groups of survey States, and in every individual survey State. However, both manufacturing employment and high-technology employment expanded far more rapidly in the pre-1981 States, and high-technology employment outperformed overall manufacturing by a greater margin. An explanation for this emerges from the far different patterns that result when the 1975-80 period is broken into subperiods.

Between 1975 and 1978, manufacturing employment in the 1981-82 States expanded more rapidly than in the pre-1981 States or the Nation as a whole. Surprisingly, high-technology employment growth for both groups of survey States was lower than the U.S. average. But during the 1978-80 period, which includes part of the recent recessionary cycle, a strikingly different pattern of employment growth became evident. Manufacturing employment grew more slowly in the pre-1981 States (1.3 percent) but actually declined in the 1981-82 States (–7.6 percent). The pre-1981 States, which by then had many of their high-technology programs in place, experienced a continued expansion in high-technology employment (9.5 percent); in fact, their high-technology employment growth was sufficient to offset what would otherwise have been a decline in overall manufacturing employment. By contrast, the 1981-

Table 8.—Employment Change in Survey States, 1975-80

State	Percent change, 1975-60		Percent change, 1975-78		Percent change, 1978-80	
	Manufacturing	High-technology	Manufacturing	High-technology	Manufacturing	High-technology
United **States**	11.1	26.1	11.9	17.3	– 0.7	7.5
16 **Survey States**	8.6	21.6	11.3	16.1	–2.5	4.7
Pre-1981 States ., ... , . . .	122	28.0	10.7	16.9	1.3	9.5
California	26.8	42.9	18.5	24.6	7.0	14.7
Connecticut	12.8	23.2	7.6	14.6	4.9	7.5
Georgia	18.5	51.0	17.9	36.3	0.6	10.8
Massachusetts	16.8	40.2	13.0	23.2	3.3	13.9
New York	2.1	9.4	4.3	5.4	–2,2	3.8
North Carolina	17.6	58.4	15.2	35.8	2.0	16.6
Pennsylvania	–0.6	8.7	2.2	6.3	–2.7	2.3
Tennessee	9.5	30.4[a]	14,6	31.0[a]	–4.4	– 0 . 1[a]
1981-82 States	3.6	9.9	12.2	14.5	–7.6	–4.1
Illinois	2.4	3.1	4.5	5.0	–2.1	–1.8
Indiana	1.7	4.6[b]	14.6	14.8[b]	–11.3	–8.9[b]
Michigan	3.3	10.4	22.7	24.7	–15.9	–11.5
Minnesota	19.1	40.8	15.5	28.2	3.1	9.8
Missouri	7.8	26.2[a]	12.7	21.6[a]	–4.3	3.8[a]
New Mexico	20.3	20.7[c]	16.8	27.6[c]	3.0	–5.4[b]
Ohio	–0.1	1.7	8.8	12.8	–8.2	–9.9
Rhode Island	12.3	26.2	18.5	31.2	–5.3	–3.8

[a] Total employment in high.technology industries not available due to lack of detailed information at the 3-digit SIC level. Number indicated is total employment in 2-digit sectors 36 (electronic and electric equipment) and 38 (instruments and related products). These figures represent downwardly biased estimates of total high-technology employment in the state, as employment in selected 3-digit SIC high-technology sectors Is omitted.
[b] Employment in SIC sectors 36, 38, and 372 only.
[c] Employment in SIC sector 36 only.

SOURCE: Massachusetts Divsion of Employment Security, *High-Technology Employment: Massachusetts and Selected States 1975-81 July 1981;* and U.S. Department of Labor, Bureau of Labor Statistics, *Supplement to Employment and Earnings, State and Areas,* Bulletins 1370-13 and 370-16.

82 States, which had not yet implemented their programs, experienced a decline in high-technology employment (-4. 1 percent) that contributed to their general decline in manufacturing employment. High-technology employment continued to outperform manufacturing employment generally, and in each individual State except Ohio and New Mexico; but six of the 1981-82 States nevertheless experienced a real decline in high-technology jobs, compared to only one of the States with HTD programs in place.

These comparisons do not provide a statistically sound basis for inferences concerning the effectiveness of HTD initiatives or the effects of other differences between the two groups of survey States. Comparable data for the 1980-82 period are not yet available, for example, and high-technology's countercyclical performance maybe more strongly related to the industrial mix or general economic health of a given region. Far more sophisticated econometric analysis will be required before these differences can be attributed even in part to the presence or absence of State government HTD programs. Nevertheless, the far more favorable employment experiences of the pre-1981 States during the early stages of the recent recessionary period may have provided much of the impetus for the 1981-82 States (and many States not included in the survey) to initiate their own high-technology programs in hopes of improving the employment conditions in their own economies.

CHAPTER 3

University Initiatives

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Summary

Colleges and universities play two very important roles in technological innovation and regional economic development. First, they play a central role in training scientists and engineers and expanding the base of scientific and technical knowledge. Second, by transferring this talent and information to the private sector, they provide a vital nucleus for the diffusion of innovation to existing firms and the creation of new businesses and industries. Although cooperation between the educational and industrial sectors is not a new phenomenon, the growing economic importance of technological innovation has created a greater need, and new opportunities, for cooperation.

The university sector has developed several types of programs to carry out these roles, including:

- *research and science parks,* clusters of research-intensive firms and facilities on a site near a university;
- *research and technical centers* that disseminate information, provide technical assistance, and perform short- or long-term research for local businesses in exchange for fees and other support;
- *university/industry collaboration,* including cooperative research ventures and research consortia;
- *entrepreneurship training and assistance,* including courses, seminars, and internships; technical and management advice; and incubator facilities dedicated to nurturing new ventures by students and local entrepreneurs; and
- *direct and indirect investment,* usually from endowment funds, in spinoffs, venture capital partnerships, and seed capital funds.

These programs bring financial rewards to universities at a time when many are experiencing a drop in student enrollment, a shortage of qualified faculty, and a decline in Federal support for research and development (R&D). The private sector, recognizing the importance of new knowledge and trained personnel to further innovation, is providing financial and technical support for university-based research centers, as well as grants for special research projects and assistance to precollege technical education. State governments, which have traditionally had a close relationship with higher education (two-thirds of U.S. Ph. D.-granting institutions are publicly supported), also are expanding their support for university-based initiatives because of the need for a well-educated work force and the recognition that the growth of high-technology complexes is closely linked to the presence of research-oriented educational institutions. The Federal Government's involvement in the development of university programs has been primarily indirect, usually taking the form of research contracts and grants; but the presence of a Federal facility may in itself be enough to attract other tenants to a university research park.

Collaboration at various levels offers solutions to several crucial needs of both universities and high-technology industries. Given strong leadership and sustained commitment, as well as stable sources of long-term funding, these initiatives and the cooperation they foster could contribute to industrial innovation and regional economic development by:

- reorienting university research toward the needs and interests of industry;
- increasing the speed with which research results become available to industry;
- allowing wider and more efficient use of university facilities, equipment, and personnel;
- improving the quality of training for scientists and engineers;
- attracting high-technology firms and encouraging the creation of new businesses; and
- improving the productivity and competitiveness of businesses already in the region.

These new developments involve difficult institutional changes, and it is too soon to determine their long-term effect on the creation and growth of high-technology businesses. While *existing* high-technology firms consider local educational resources and technically trained personnel in their decision to locate or relocate operations, the exact relationship between university initiatives and the creation of

new high-technology businesses is not fully understood. These programs may have less impact on the development of new technologies than on developing better relations with and services to existing businesses. Several of the programs identified in this chapter could be transferred to almost any university center, although the nature of the program will depend on the character of the university and the needs of local industry.

Introduction

Colleges and universities play two very important roles in technological innovation and its diffusion through the economy.[1] First, they play a central role in preparing scientists and in expanding the base of scientific and technical information. Second, by transferring this talent and information to the private sector, they foster the commercialization and diffusion of innovation.

Cooperation between the educational sector and industrial sectors is not a new phenomenon—Stanford Industrial Park dates from the 1940's and Research Triangle Park from the 1950's. However, the growing economic importance of technological innovation has created a greater need for cooperation. Recognizing this, universities, industry, and State governments have responded by developing programs to mobilize the resources of the educational sector for local economic development. These efforts address not only the preparation of students but also the needs of new and expanding high-technology businesses, particularly the need for increased R&D and technology transfer and the need to provide technical/vocational skills to the local work force.

These programs bring financial rewards to universities at a time when many of them are experiencing a drop in student enrollment and a decline in Federal support of R&D. Ironically, it has often been the university sector that suffers from the apparent "shortage" of qualified engineering and science professionals. Industry can offer higher salaries and more modern facilities, which could attract faculty into industrial research and management and students away from graduate study. Industry is sensitive to this problem, and both groups have begun to search for solutions.

As the growth of Government R&D funding has slowed in the face of inflation and budgetary pressures, the education sector has become more active in soliciting funds from industry. In the 1980-81 academic year, according to the National Science Foundation (NSF), colleges and universities reported *$778* million in voluntary donations from corporations.[2] This business support takes the form of grants, fellowships, or fees, and it is motivated by the need for trained technical staff and early access to basic research results. NSF surveys also show that two-thirds of all academic engineers now do paid consulting, compared to only one-third of their counterparts in the physical and biological sciences.[3] The private sector also is collaborating with State and local governments to improve the quality of math and science education, and to provide training, retraining, and employment development.

A study by the U.S. General Accounting Office (GAO) concludes that these developing linkages between university and industry can not only enhance technological innovation but can also stimulate regional economic development.[4] Research and science parks affiliated with universities attract new high-technology firms to their areas, and they also provide excellent seedbeds for spinoff companies. Technical centers and industrial extension services benefit existing local businesses by increasing the rate of innovation diffusion and increasing their access to facilities, equipment, and expertise. Coop-

[1] The material in this chapter draws heavily on the following documents: U.S. General Accounting Office, The *Federal Role in Fostering University/Industry Cooperation,* GAO/PAD 83-22, May 1983; National Science Foundation, *University/Industry Research Relationships: Myths, Realities and Potentials,* NSB 82-1, October 1982; "Universities Emerge as an Important Catalyst in the New Business Development Process," *Venture Capital Journal,* vol. 23, No. 8, August 1983, pp. 7-12; and National Governors' Association Task Force on Technological Innovation, *Technology and Growth: State Initiatives in Technological Innovation,* October 1983.

[2] National Science Foundation, op. cit., p. 10.
[3] National Science Foundation, **op.** cit., p. 11.
[4] General Accounting Office, **op.** cit., pp. 15, 24, 40, 47-48.

erative research activities provide industry with early access to the results of university research and improved training for scientific and engineering personnel.

While stronger links between the university sector and industry might enhance technological innovation, institutional differences can make such cooperation and collaboration difficult. According to the GAO study:

> To realize their full potential, cooperative arrangements between universities and industry must reconcile long-standing differences . . . in [the] research objectives, management philosophies, organizations, and reward structures of the two sectors. [5]

The most fundamental of these differences is the question of research philosophy. The traditional role of the university is to educate and conduct basic research, but cooperative ventures give the university a proprietary interest in the results of research. The university, traditionally the trustee of the "public good" of basic knowledge, could now own and license information it used to provide freely. In addition, proprietary concerns may restrict the flow of information between individual scientists, the lifeblood of basic research. Several of the newest contract agreements between industry and universities reflect possible solutions to these problems, including the right of individual university researchers to publish their findings.

A second problem is the ownership of intellectual property, the main product of research. The ownership of this property is of primary concern to the universities, their faculty, and the supporting industries. Universities are examining their policies in light of the increased patentability of university-conducted applied research, and several of the most active research universities are interested in retaining their rights and commercializing products themselves.

This chapter identifies a cross section of university-related high-technology development (HTD) initiatives, discusses the problems they may create, and identifies some of the factors and conditions that may contribute to their success.

[5] General Accounting Office, op. cit., p. 1.

University-Based Programs

University initiatives in industrial R&D are driven in part by the need to diversify funding sources, retain faculty, and attract students. However, changing technological and economic conditions have also led to a greater emphasis on commercializing research results, particularly when the university has royalty rights; on providing assistance to small businesses, particularly those started by faculty or students; and on cooperating more closely with State and local governments in economic development.

The university initiatives described below, which address specific business needs that can be served by university resources, fall into five general categories:

- *research and science parks,* clusters of research-intensive firms and facilities on a site near a university;
- research and *technical centers* that disseminate information, provide technical assistance, and perform short- or long-term research for local businesses in exchange for fees and other support;
- *university/industry collaboration,* including cooperative research ventures and research consortia;
- *entrepreneurship training and assistance,* including courses and internships, technical and management advice, and incubator facilities dedicated to nurturing new ventures by students and local entrepreneurs; and
- *direct and indirect investment,* usually from endowment funds, in spinoffs, venture capital partnerships, and seed capital funds.

Research and Science Parks

An increasingly popular economic development initiative is the research or science park, on or adjacent to a university campus. Such parks general-

ly are composed of clusters of research-intensive firms and facilities on dedicated sites. They are often encouraged by State or local tax incentives, but many universities have also seen the advantage of encouraging this type of development.

Four basic benefits can result from locating a research or science park near a university. First, increased interaction and easier communication between university and industry researchers helps to broaden the mutual understanding of problems and needs. Second, business gains quicker access to new developments through increased information and knowledge transfer. Third, business also gains access to student workers and faculty consultants, as well as laboratory, computer, library, and other resources. Finally, the increased interaction opens opportunities for creating new businesses and new university/industry programs.

- The Stanford Research Park in California is often cited as the model for university/industry science parks. So is the Research Triangle Park in North Carolina, although it was originally a State government initiative. A more recent example of this initiative is at Washington State University, which recently established a research and industrial park to provide consulting opportunities for faculty, employment opportunities for students, and enhanced research funding for the university. The University of Utah has a science park specializing in biomedical R&D. Rensselaer Polytechnic Institute, a leader in university/industry cooperation, has a new high-technology industrial park 15 minutes from campus. The University of Illinois is working with the State to set up a high-technology research park on land donated by the city of Chicago. Similar efforts are underway in Florida, Michigan, New Jersey, Connecticut, and several other States.

Research and Technical Centers

University-based research centers perform applied research in exchange for fees and other support, allowing firms to pool their resources to support long-term research of shared interest. The firms can thereby avoid duplicating expenses for facilities and equipment, and they also gain access to relatively inexpensive student labor. At the same time, the university benefits from the fees and increased research activities and from improved student training. The concentration of technical know-how, and often the availability of capital and business experience, makes these research centers fertile ground for the creation of new high-technology businesses. Because they also have been cited as a major factor in the development of high-technology complexes, a number of States have begun to encourage the development of of such centers.

- Examples of such research centers include the Microelectronics Center of North Carolina, the Center for Applied Microelectronics at the University of Wisconsin, and the California MICRO research center. The Surface Science Center at the University of Pittsburgh will provide basic and applied research results applicable to industrial technologies, and the University of Wyoming has set up an Industrial Fund to provide applied research to area businesses.
- The University of Minnesota's Microelectronics and Information Sciences Center (MEIS) was formed in 1979 with initial funding of $6 million from Control Data, Honeywell, 3M, and Sperry. It utilizes the facilities of the corporate participants in order to minimize laboratory investment and has already attracted almost $1.5 million in Federal research awards. MEIS received $1.5 million in 1983 from the State legislature, which is also considering a proposal to create a Supercomputer Institute at the University of Minnesota.

Several universities have also set up special offices or technical centers to provide short-term technical assistance to local businesses, including patent searches, technical staff, and other research services. Rather than establishing long-term research agenda, these centers tend to emphasize technology transfer and consulting services. In some ways, they can be viewed as applying the Agricultural Extension Service model to nonagricultural industries. Such centers can be particularly helpful in communities with fragmented industrial bases where firms are unable to pool their resources effectively.

- The Center for Industrial Cooperation at the State University of New York at Stony Brook, for example, provides research and technical assistance on specific industry projects for 15 dues-paying industrial affiliates. Another technical center is the George Mason Institute at George Mason University in Virginia, which provides technical

assistance to high-technology business and education groups in the State. The Delaware Technical and Community College (with funding from the U.S. Economic Development Administration) is setting up a similar center to work with technology-based businesses in Delaware; the school is also working with General Motors to develop a joint training and retraining program for auto workers. The University of Missouri also is working closely with the auto industry to train and retrain workers for the new technical demands of automated manufacturing. The New Enterprise Institute at the University of Southern Maine helped to introduce computer-aided design and manufacturing to Maine's shoe and leather industry. Finally, the University of Wisconsin has an Industry Research Program that provides business with information on the results of its research.

University/Industry Collaboration

In addition to providing funds for research activities, high-technology firms are beginning to participate more directly in university research initiatives. (See ch. 5 for a discussion of this and other private sector initiatives.) Several university/industry research partnerships have been formed to match the special technical needs of high-technology industry and the unique resources of the educational sector. The two most common forms of cooperative ventures are joint ventures between a university and a single firm, and research "consortia" involving several companies and/or universities. Such arrangements can take many legal forms, including long-term research contracts and limited partnerships.

Recent legislation enables industrial partners to obtain tax credits for investments in university research, in addition to capital gains treatment for profits on the products of the research. However, not all of the problems created by jointly owned intellectual property have been resolved. In the past, universities have preferred to receive grants to conduct independent research, rather than joint ownership of discoveries developed with industry technical personnel and equipment. However, shortages of technical personnel in some fields, as well as the cost of facilities and operations, have made it necessary—and in some cases, financially attractive—to share research staff and equipment.

Cooperative Research Ventures. -Although several substantial ventures have been launched in the last few years, university/industry cooperative research ventures still represent a very small portion of university research. Most universities appear to be waiting to see the results before attempting a venture of their own. The most visible and substantial agreements have been signed between Harvard University and Monsanto; Washington University and Mallinckrodt; Harvard Medical School and Seagrams; Massachusetts Institute of Technology (MIT) and Exxon; Carnegie-Mellon and Westinghouse; and most recently, Washington University and Monsanto.

- The Washington University-Monsanto agreement reflects awareness of some of the common problems experienced by previous agreements. The 1982 grant of $3 million will eventually grow to $7 million per year, or about 5 percent of the Monsanto research budget. The agreement is institutional in that it avoids a direct relationship with any individual faculty member. It provides for the review of research requests through a system of peer review by scientists from both organizations. Research will be conducted in basic science areas in which the organizations report complementary expertise; the first research project will focus on proteins and peptide cellular function. The university will hold the patents on any invention that emerges from the research, with the royalties accruing to the department responsible for developing it. Monsanto will have exclusive licensing rights to such patents, but faculty members will be free to publish their research results.

Research Consortia.–This type of program may include either one company and several universities, several companies and one university, or several companies and several universities. An example is the research center at Purdue University in Indiana, jointly sponsored by five corporations, to develop computer prototypes. Similarly, Pennsylvania State University has 20 sponsoring industries for a cooperative program in recombinant-DNA technology. Other examples include the Cal Tech Silicon Systems Project, Stanford's Center for Integrated Systems, the Polymer Affiliates Program at Drexel University, and (perhaps the most complicated example) the Center for Biotechnology Research.

- The Center for Biotechnology Research is sponsored by Engenics Corp. (itself a Stanford spin-off) along with six other companies: Bendix, Elf Technologies, General Foods, Kopvenco, Mead, and MacLaren. Three universities are involved: Stanford, the University of California, and MIT. Resulting patents will be held by the universities, with the center receiving royalties, and the contributing corporations having exclusive rights to the patent licenses. The object of the center is to provide multiyear funding for university research and to enhance the effectiveness and efficiency of basic and applied research. It will also allow universities to benefit from a product's financial success, as well as providing industry with incentives to justify long-term research investments.

Entrepreneurship Training and Assistance

Universities have also become more active in training entrepreneurs and supporting their efforts to create new technology-based enterprises. The number of colleges and universities offering entrepreneurship courses grew from less than 10 in 1960 to over 200 in 1980 and has doubled since then.[b] In some cases these programs are supported by the private sector, which sees in them an opportunity to promote the values of capitalism as well as the university's role in entrepreneurship education and technological innovation.

- The University of Texas, for example, has not only a Chair of Free Enterprise (established in 1976) but also an Institute for Constructive Capitalism, funded by Mobil, Shell, Tenneco, and other corporations. Similarly, two leading venture capitalists have recently endowed a chair at the Harvard Business School devoted to the creation and management of new business ventures.
- The Center for Entrepreneurship and Small Business Management at Wichita State University, established in 1977, is supported by over 50 local businesses.

Several universities have also established special internships or degree programs designed to provide students with practical experience in technology-based businesses. Lehigh University in Pennsylvania, for example, has a cooperative master's and Ph.D. program directed toward students employed in industry. The students' graduate work is a combination of professional work (directed by industry advisors) and university study and research conducted in cooperation with professional work. Similar programs exist at Carnegie-Mellon University, the University of Detroit, and other universities and colleges.

In addition to courses for full-time students, many universities also provide seminars and conferences on business development topics, notably how to raise venture capital, or provide technical and management assistance to local entrepreneurs and inventors. Baylor and Case Western Reserve, among other universities, provide innovation evaluation programs in addition to courses and seminars. Carnegie-Mellon and the University of Pittsburgh jointly sponsor the Pittsburgh Enterprise Corp. to foster new business development. These efforts are notable for their success in involving local professionals–lawyers, accountants, bankers, consultants, and government officials-as well as university officials in supporting and securing finding for local entrepreneurs. The MIT Enterprise Forum, sponsored by the alumni association, conducts "incubator forums" in several cities.

Finally, several universities have established "incubator" facilities to make their resources available to new businesses or entrepreneurs developing a new product or process. Such a center recognizes and formalizes the university's role as a seedbed for new technologies and new technology-based companies. This approach incorporates and exploits several resources of the university, including low-cost office and laboratory space, as well as access to capital, business planning, and management advice from faculty members and local professionals. While some of these centers extend eligibility to qualifying small business, their emphasis is on the enterprising student or faculty member who needs a head start in commercializing a promising innovation.

- The oldest such facility is the University City Science Center in Philadelphia, founded by 23 colleges and universities in 1967, but similar centers exist at Rensselaer Polytechnic Institute, Georgia Tech, Carnegie-Mellon, MIT, Wichita State, and the University of Missouri.

[6] *Venture Capital Journal,* op cit., p. 8.

- The Utah Innovation Center, set up by the University with an NSF grant in 1978, has continued as a private concern following the loss of its Federal funding.

Direct and Indirect Investment

In addition to their efforts to promote new linkages with industry, many colleges and universities have begun to take a more active role in financing new technology-based companies.[7] These investments are usually made from the university's endowment or alumni fund, with capital gains rather than new business development as the object.

In some cases, they invest directly in companies that have spun off from research and technical centers. Examples include Boston, Harvard, Lawrence, and Stanford Universities; the Universities of Chicago, Notre Dame, and Rochester; Rensselaer Polytechnic Institute; and Grinnell College in Iowa. Brown University recently acquired a major interest in a spinoff in return for its contribution of technology.

In other cases universities work to make capital available to new starts by investing in venture capital partnerships. About $350 million has been invested in such partnerships, most of it since 1980, by universities such as Carnegie-Mellon, Harvard, MIT, Stanford, and Yale. Michigan Tech has just formed the first university-based Small Business Investment Corporation, the Michigan Tech Capital Corp. Other universities (including Carnegie-Mellon, Georgia Tech, Case Western Reserve, and the University of Pennsylvania's Wharton School) are supporting the formation of seed capital funds for early stage spinoffs, often in connection with their incubator facilities and entrepreneurship assistance programs (see above).

[7] *Venture Capital Journal*, op. cit., pp. 11-12.

State Government Involvement

A number of State governments are working with their public universities to set up programs aimed at the stimulation of innovation and development. This includes the broader aims of encouraging engineering and science education, R&D on campus, precollege science and mathematics training, and technical skill training. State governments are ideally situated to encourage these efforts, according to the National Governors' Association Task Force on Technological Innovation:

> Of the 184 Ph. D. granting research universities of the United States, 119 are public institutions supported by State and local governments . . . [which] are the prime points of contact with respect to locational issues, labor relations . . . provision of capital . . . and other facets of economic activity that entail industry -government-education interaction.[8]

An example is Arizona's Center for Excellence in Engineering, a joint program sponsored by the State government and Arizona State University to improve engineering education and coordination of industry and university resources. Wayne State University in Michigan is the home of the new Metropolitan Center for High Technology, which will provide R&D, incubator space, and industrial training. Also in Michigan is the Innovation Center at the University of Michigan, which will help Michigan firms improve productivity by adopting new manufacturing technologies. Similar initiatives are underway in several other States:

- The Illinois Legislature provides part of the funding for FRATS—Faculty Research Assistance to the State—which provides computerized information about faculty research capabilities to State business.
- The Florida Research and Development Commission is working closely with State universities to set up several research parks on campuses.
- Science Park, a cooperative venture among Yale, the State of Connecticut, and the Olin Corp., takes advantage of the Connecticut enterprise zone tax and trade incentives.

[8] Governors James Hunt of North Carolina and Dick Thornburgh of Pennsylvania, "To Our Fellow Governors," July 1983, p. iii.

- The Industrial Research Extension Center, located at the University of Arkansas at Little Rock, provides information on technical issues to both the public and private sectors.
- The Mississippi Board of Higher Education has a similar program at the Mississippi Research and Development Center. This program provides information about technology issues to the State Legislature while aiding in technology transfer between State universities and industry.
- Both the University of West Virginia and University of Kansas have State funding for a center for entrepreneurship. They provide both students and local entrepreneurs with the management and technical information needed to commercialize an idea.

A number of community and junior colleges are working with their State, local government, or local industry to provide training in technical skills needed by high- technology industry. In some cases, these programs take the form of a general training course; in others, these institutions work directly with a local firm to train the labor needed for expansion. An example of this is the Albuquerque Vocational-Technical Institute's Laser/Electro-Optics Technicians Program, which not only trains students in this high-technology field and helps them find jobs, but also helps local firms with R&D and assists them in manufacturing implementation and product inspection.

State and Federal agencies have provided support for such research cooperatives. Stanford University will be the location for an innovative cooperative effort called the Center for Integrated Systems, in which 20 industrial cosponsors are cooperating with the Federal and State governments to fund the development of an "umbrella" facility for R&D.

Conditions That Foster Success

The barriers to improved collaboration between university and industry include the sectors' different objectives, values, reward structures, attitudes, and research agendas. The examples cited above demonstrate that these barriers are not insurmountable, or at least can be worked out to the extent necessary for any particular effort. GAO listed the following factors as essential to resolving such issues for successful collaborative arrangements:

- *commitment by both faculty and administrators* at a university to the concept of orienting some portion of university research and expertise toward industrial research;
- *commitment by participating firms* to explore and utilize the strengths of the university while simultaneously honoring university objectives;
- *flexibility in the university* to allow policies and organizational developments for interaction that are responsive to industrial objectives but do not compromise the academic mission of the university;
- *a strong leader* highly respected by both the academic and industrial communities to establish and maintain the partnership;
- *matching the needs, interests, and resources* (both physical and human) of both university and industrial partners; and
- *sustained sources of funding.*[9]

Many of these same factors, as will be seen in the following chapters, are also critical to the success of the public/private partnerships involved in industry and local government high-technology initiatives.

In addition to the above conditions, specific factors are also important for the success of different types of university-based initiatives. Efforts are not likely to be successful unless the needs and resources of the participating firms and universities are matched. GAO points out, for example:

> Research parks work best at first-tier research universities where a significant proportion of administrators and faculty favor interaction with industry, Industrial participants most likely to benefit from this arrangement are high-technology firms that depend strongly on technological innovation for their success.

[9] General Accounting Office, op. cit., p, 50.

Cooperative research centers require a university with strong departments in areas relevant to the focus of the center. industrial participation is most successful with medium to large-sized firms which have their own research and development capacities adequate to translate the research results into commercial technological applications.

Industrial extension services are best performed by a university with a strong commitment to community service and a technology focus to assist local, fragmented industrial clients.[17]

[10]General Accounting Office, op. cit., p. 50.

CHAPTER 4

Local Initiatives

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Local Initiatives

Summary

The success or failure of State and university initiatives for high-technology development (HTD) is often affected by the complementary efforts of local governments. These local high-technology initiatives are often based on strategies to develop the characteristics of such models as California's Silicon Valley or Boston's Route 128. Based on how much they vary from these models and the resulting initiatives they undertake, OTA identified five types of communities:

- high-technology *centers,* which already have a strong base of high-technology firms, research universities, and venture capital;
- *diluted high-technology centers,* whose large high-technology base is diluted in a larger and more mature local economy;
- *spillover communities,* located near high-technology centers, whose proximity allows them to exploit the centers' resources, amenities, and high-technology base;
- *technology installation centers,* where the presence of a major research facility attracts specialized suppliers and creates a local base of researchers and skilled workers that can be exploited for economic development; and
- *bootstrap communities,* which lack most of the characteristics of high-technology centers but offer low operating costs and high quality of life that make them attractive for branch plants of expanding high-technology companies.

Local strategies usually address perceived weaknesses by exploiting local resources in order to build on the existing technology base. Some of the most common initiatives are:

- *land-use planning and zoning,* including the creation of science or research parks;
- university *improvements;*
- *vocational and technical training;*
- *incubator buildings;*
- *marketing programs;*
- *high-technology task forces,* involving government, university, and private sector representatives; and
- other initiatives, including networking, venture capital mechanisms, cultural amenities, and partnerships with local universities or business groups.

Local officials report that information for high-technology program design comes from a variety of sources, including journals and newspapers, government reports, and the experience of other communities, as well as the community's past experience with other types of industry. State and Federal government officials participate directly in many local initiatives, and others make use of funds or development tools made available by the Federal Government.

The success of these local programs is affected by a number of factors, including:

- *sustained effort,* often over a period of decades;
- *identifying local needs and resources;*
- *adapting to external constraints,* including climate, distance from existing high-technology centers, and other factors over which the community has no control;
- *linkage to other, broader development efforts;* and
- *local initiative and partnership* in the initiation, implementation, and operation of the program.

Private sector participation plays an important role in these efforts, but local governments have at their disposal a wide range of policy tools that provide incentives or remove barriers to private initiative. These policy tools include the following:

- *provision of public services and facilities;*
- *tax policies,* such as relief or incentives for inner-city location, as well as lower overall tax rates;
- *regulatory policies,* including zoning changes;
- *administrative reforms,* such as one-stop per-

mitting or streamlined licensing and inspection systems; and
- *public advocacy,* including public recognition for private initiatives and support for business interests in State legislatures.

Introduction

Chapters 2 and 3 identify a wide range of programs implemented by State governments and universities to encourage HTD, but many initiatives also have been launched by local governments and other community organizations.[1] These local programs usually arise from the specific needs and goals of particular communities, whereas State programs may not always be appropriate or useful for individual cities or regions. University programs, on the other hand, usually focus on improving linkages with the local business community. Consequently, the success of State and university programs often is affected by the presence or absence of these local initiatives.

OTA identified and analyzed a representative cross section of local HTD initiatives in order to determine what types of programs have been attempted, how well they have worked, and the factors that affect their effectiveness and their transferability to other communities. The material in this chapter is based on interviews with community representatives and detailed investigation of 54 separate high-technology initiatives in the following 22 communities:

Huntsville, Ala.	Binghamton, N.Y.
Phoenix, Ariz.	Cincinnati, Ohio
San Diego, Calif.	Portland, Oreg.
Colorado Springs, Colo.	Philadelphia, Pa.
Brevard County, Fla.	Oak Ridge, Term.
Orlando, Fla.	Austin, Tex.
Chicago, Ill.	San Antonio, Tex.
Lowell, Mass.	Salt Lake City, Utah
Montgomery County, Md.	Burlington, Vt.
Minneapolis-St. Paul, Minn.	Seattle, Wash.
Albuquerque, N. Mex.	Milwaukee, Wis.

Concise descriptions of the local high-technology initiatives in these communities are presented in appendix A.

[1] 'Material in this chapter is based on the contractor report, *Local High-Technology Initiatives Study,* prepared for OTA by the Fantus Co., Charles Ford Harding, principal investigator, April 1983.

Community Typology

Sub-State and local efforts to stimulate HTD are driven by the increased jobs and tax base that would result for local economies. In deciding to focus on HTD as opposed to other possible avenues, the communities 'are generally influenced by the rapid growth of technology-based industry compared to other sectors of the economy and by the tremendous contributions that high-technology companies have made to the local economies of Silicon Valley and the Boston area. The use of these areas as models for development is made clear by efforts of communities to promote themselves as "Silicon Mountain," "Silicon Coast," or "Silicon Plain." Thus, one useful typology of communities is in the degree to which they vary from these model communities.

Indeed, OTA found that many local initiatives can be described as strategies used to develop the characteristics of the model communities. The type and importance of the resulting initiatives will depend, in part, on the principal shortcomings that community leaders believe are keeping their city from being a center of HTD like Santa Clara County or the Boston area. Using this criterion as the principle means of classifying cities, OTA has identified five types of communities:

- high-technology centers;
- diluted high-technology centers;
- spillover communities;
- technology installation centers; and
- bootstrap communities.

High-Technology Centers

Typified by Santa Clara County and the Boston area, these communities already have a high concentration of research-oriented companies and a major research-oriented university (Stanford and Massachusetts Institute of Technology). The large companies and universities, in turn, continually spin off other small companies, generally founded by researchers who have an idea for a product that they choose to develop on their own rather than within the environment of the larger firm. While some of these new companies fail, enough succeed and grow to increase the concentration of firms in the area.

Other important elements of the high-technology centers include a skilled work force, a university catering to the continuing education needs of local researchers, and the availability of venture capital. The skilled work force is trained by the large companies located in the area. The demands that these companies and their smaller counterparts make on the labor market encourage local workers to develop skills in technological areas; demand also makes it worthwhile for local vocational/technical schools to develop appropriate training programs. The depth of the local base of skilled workers, in turn, makes it possible for entrepreneurs to hire employees they might not otherwise have the resources to train.

Due to the rapid change of technology, engineers and technical workers at the technology-based companies must study constantly to keep abreast of their fields of interest. Others may take courses outside their fields of specialization. In both cases, many workers find it valuable to be able to continue their education in evening programs at nearby universities. Interestingly, in both Boston and Santa Clara County, this service is not provided by the major research university: the largest number of continuing education students in Boston attend Northeastern University, while in Silicon Valley they attend the University of Santa Clara.

Finally, the rapid growth of smaller companies with new products attracts the development of venture capital firms that specialize in identifying and providing capital and managerial advice to new and expanding technology-based companies. It is not surprising that, between 1970 and 1980, Massachusetts and California were the only States that consistentl$_y$ attracted a positive inflow of venture capital.

One problem for the high-technology centers, however, is that they tend to export many of the jobs that are generated through the innovations of local companies. The rapid growth of local firms tends to push up land and labor costs, and—at the point in a product's lifecycle when it no longer requires the highly skilled work force—the company will have a strong incentive to export its production to a lower cost area while concentratin$_g$ the energies of the skilled work force on the innovations that require their talents. A community that exports its technologies must continually develop new ones to keep its economy healthy.

Diluted High-Technology Centers

These cities also have a base of large technology-oriented companies, skilled work forces, research universities, and venture capital firms. But in these cases, the high-technolog$_y$ orientation of the area is diluted in larger, broader, and more mature economies. Metropolitan areas such as New York and Chicago typify this group of communities.

The Chicago area, for example, possesses most of the characteristics of a high-technology center, including: *major research institutions* (Universit$_y$ of Chicago, Northwestern University, Illinois Institute of Technology, University of Illinois at Chicago, Fermi National Labs, and Argonne National Labs); *major technology-basal companies* (Baxter-Travenol Labs, G. D. Searle, Abbott Labs, Motorola, Gould, Northrop, and others); *continuing education courses in science and engineering* (offered at the Illinois Institute of Technology); *vocational technical training* (offered at several 2-year community colleges in the area); and *venture capital* (provided by venture capital firms and the Continental and First National Banks). However, these high-technology characteristics are diluted in Chicago's much broader econ-

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omy, many parts of which are unrelated to high technology.

This dilution seems to reduce the innovative and entrepreneurial fervor of an area. In such an area, skilled workers are more likely to be lost to nontechnological endeavors, and universities are more likely to support a broader set of community needs. In addition, venture capital firms may be less likely to specialize in new businesses based on technological innovation. Consequently, a major focus of high-technology initiatives in such areas has been to increase the communication among the various participants in HTD in the area. Thus, the high-technology newsletter in Chicago and the University City Science Center in Philadelphia are seen by those who developed them as a means of bringing the high-technology players in the community together and making them aware of local resources that they might not otherwise find. It is reasonable to perceive these efforts as attempts to overcome the effects of dilution.

Spillover Communities

Spillover communities are those located adjacent to a high-technology center or diluted centers. While these communities typically lack most or all of the ingredients that make up a high-technology center, they are close enough to such a city to take advantage of its resources. A high-technology company located in such a community can exploit the research capabilities at the nearby universities, visit venture capital firms easily, and hire engineers and scientists from the large technical work force around the high-technology center and within commuting distance. Employees seeking graduate courses in their field can commute to universities in the adjacent city. Typically, the objective of such communities is to capture the spillover of companies from the center looking for lower cost land and a less competitive labor market. Three examples of this type of community are Lowell, Mass.; Naperville, Ill.; and Montgomery County, Md.

Lowell provides a particularly instructive case. With the exception of a university, the community lacked most of the ingredients of a high-technology center, but it is located adjacent to the Boston area. Through careful land-use planning, the city was able to induce Wang Laboratories to locate a plant in the area. Later, when Wang was looking for a new headquarters site, the community successfully pursued and won it with aggressive initiatives. Wang has since contributed to the further growth of high-technology infrastructure and the creation of new firms in the area.

For communities located adjacent to a high-technology center, this type of strategy has obvious appeal. They often must overcome perceptions of distance and an older image that may not be compatible with a high-technology firm. Lowell's success at overcoming its "mill-town" reputation shows that this can be done. A principal means of doing this is by creating a physical environment attractive to technology-based companies.

Technology Installation Centers

These communities are the home of a major research or technology-based institution, but they lack most or all of the other ingredients of a high-technology center. The installation creates a local base of researchers and skilled workers, and in some cases, this has led to extensive spinoff activities in the local economy. In other cases, however, the technical base created by the research installation produces few new firms and often remains unavailable to new employers coming into the area. This is because payscales are usually quite high at such operations; additionally, the organization's rules regarding the rights to innovations have sometimes made it difficult for its research staff to start companies of their own.

As a result, local development initiatives often are begun after a downturn in the fortunes or finding of the major research installation. Thus, layoffs at Boeing in Seattle, program cutbacks at the Kennedy Space Center in Brevard County, Fla., and staff reductions at the Redstone Arsenal in Huntsville, Ala., all resulted in intensified development efforts, usually directed at technology-based companies that could take advantage of the skilled work force released by the installation.

These problems do not always apply, however, and the installations also attract a wide variety of suppliers that could be useful to other technology-based enterprises. For this reason, and because of the prestige associated with them, competition

for such installations is usually intense, as was the case before the Microelectronics & Computer Technology Corp. (MCC) chose to locate in Austin, Tex., after considering over 50 candidate communities. Several communities are seeking to attract or establish such installations in the hope that this will attract others from outside the area and, eventually, lead to the creation of new, indigenous technology-based firms.

Bootstrap Communities

A number of communities began their development efforts possessing none of the characteristics of the high-technology centers. They have depended instead on low operating costs and attractive living environments to attract the expansion plants of high-technology companies. These branch plants generally manufacture products which no longer have a high technological input; at this stage in their lifecycle, competitive operating costs are far more important than the research capabilities of a high-technology center. However, when several of these plants have located in an area, their combined work forces create a pool of skilled labor that a more sophisticated operation can build upon. Additionally, the combined engineering work forces at such plants create enough demand to merit the addition or improvement of engineering and science courses at local universities.

As these things occur, the community is able to attract increasingly sophisticated operations and, eventually, foster the creation of local spinoffs. Communities that fall into this pattern include Austin, Colorado Springs, Orlando, Phoenix, and San Antonio. These cities have enjoyed rapid job growth from new branch plants of technology-based companies. Interestingly, two of the most recent announcements of new facilities in Austin were the research laboratories of Lockheed Corp. and MCC. Although the growth of a local base of "indigenous" high-technology firms has been slower, it too has been impressive.

Initiatives in these communities generally focus on developing the technical infrastructure and institutional linkages that will permit progressive increases in the technological sophistication of new facilities in the area. Such initiatives include the development or improvement of engineering courses at local universities, the addition of vocational/technical courses to provide workers with needed skills, and the development of research parks to create the environment desired by technology-based firms.

Implications for Local Initiatives

As one would expect, not all cities fit neatly into this typology. Minneapolis-St. Paul, for example, fits somewhere between the true high-technology centers and the diluted centers. Cincinnati, on the other hand, has some of the characteristics of a diluted center, but its high-technology base is limited; its development efforts have focused on creating a research installation, developing a venture capital fund, and increasing the flow of technological information among local machine tool companies. The value of the typology is not that any one city fits it neatly, but rather that by determining which type a city most closely approximates, it can launch the initiative that will be most appropriate and effective in developing a more sophisticated technological base.

A word of caution however, is in order. Before deciding upon a high-technology program, a community should investigate other approaches to development that might result in a greater return on its investment. Not all communities can expect to enjoy rapid growth from high-technology operations. For example, OTA experienced difficulty in identifying small rural communities with effective initiatives; this suggests that relatively few such towns will receive direct benefits in jobs and taxes from high-technology plants.

Common Initiatives

Some of the most common types of initiatives used by sub-State and local organizations to attract high-technology industry include the following:

- land use, planning, and zoning;
- university improvements;
- vocational-technical training;
- incubator buildings;
- marketing programs;
- high-technology task forces; and
- venture capital funds.

Land Use, Planning, and Zoning

High-technology firms generally are quite concerned about the quality of the environment in which they are located. They want land use to be compatible with their own needs but not so restrictive that they will find it impossible to expand as their need for space grows. Many communities control land use through planning and zoning with a careful concern for high-technology firms' requirements. Such controls include limitations on types of uses permitted, to ensure that only clean and attractive operations are located on the site; coverage, set-backs, construction code, and maintenance restrictions, to ensure that properties are compatible in appearance; and park provisions. Streets and utilities often are developed by local government to a required standard, with access controlled to limit traffic. Lowell's attraction for Wang Laboratories was based, in part, on such initiatives. Many locally developed research parks (in which parcels are sold only to firms conducting research) can be viewed as a subclassification of this type of initiative.

Communities of each of the categories described above have engaged in these types of initiative. Such programs are not without risk. Carrying costs can be high if suitable users are not attracted, and the parks can monopolize valuable land that could be put to other productive use. Some communities ultimately have had to relax usage criteria to attract nontechnological users. Pressures for such relaxation is constant, but once undermined in this manner, the research parks may lose much of their appeal to technology-based companies.

University Improvements

A number of communities have worked hard to develop engineering programs at local universities. Such initiatives have been most important in the technology installation and bootstrap communities, where local demand for such programs previously had been modest. Such initiatives have been of crucial importance in San Antonio, San Diego, Phoenix, Colorado Springs, Huntsville, and Seattle, to name the most striking examples identified in this survey. Such initiatives include efforts to create an engineering department at a university that has not had one; add graduate programs; upgrade the overall quality of the program; and\or bring faculty to the university with specializations in areas of importance to local industry. Another university-related initiative is the establishment of a research center to conduct contract research for industry. (See ch. 3 for further information on university initiatives.)

Vocational/Technical Training

As a specific initiative for the purpose of attracting high-technology firms, this approach is most common in diluted centers, technology installation centers, and bootstrap communities. It can take the form of adding specific training programs required by local industry or the development of high-technology "magnet" high schools. Such initiatives often begin with an assessment of what skills are required by local industry; courses are then designed with input from those businesses most likely to hire graduates.

Incubator Buildings

These are most often built in areas where the quantity of high-quality speculative space for small users is limited. Such areas include inner-city portions of diluted centers and smaller communities without a large high-technology base. Such facilities require experienced real estate management, and (as with research parks) carrying costs can be high if they are not utilized. In addition, technology-based tenants often require technical and management as-

sistance. Similar initiatives have been undertaken by both universities and private industry (see chs. 3 and 5).

Marketing Programs

Virtually all communities conduct marketing programs to attract new industry. However, those localities with the most sophisticated programs directed at high-technology companies tend to be those that already have experienced the greatest success in attracting them. These include communities in all of the categories listed above, with the exception of the high-technology centers themselves, but the programs differ in their focus depending on the type of community involved. For example, the spillover communities are most likely to direct their efforts toward companies located in the city to which they are adjacent, while bootstrap communities primarily seek to attract labor-intensive, less technical branch operations of technology-based companies.

Key ingredients of these initiatives include the identification of specific firms to which the community would have the greatest appeal, the improvement of the community to make sure that required infrastructure or amenities are in place, and a concerted marketing effort through direct mail, telephone contacts, and personal visits to the prospect companies.

In some cases, marketing programs have been conducted without an adequate understanding of the requirements of high-technology firms or without a thorough evaluation of the community attributes that high-technology firms are likely to find of interest. This can result in missing the market or overselling the community. In such cases, the time, funds, and effort spent on marketing bring poor results.

High-Technology Task Forces

Engaged in by many communities and States (see ch. 2), this initiative serves to focus local attention and resources on high-technology economic development. Local task forces usually are appointed by mayors, although they are sometimes an adjunct of the chamber of commerce (see ch. 5). They generally include representatives from industry, education, and government. They are distinct from other initiatives in that they are not designed to overcome some limitation in a community's ability to attract or retain high-technology companies. Instead, they have a designing function and, in some cases, participate in implementation. They also have a pronounced networking effect and thus are used most commonly in diluted high-technology centers, such as Chicago and Minneapolis, where such efforts are the first step in overcoming the effects of dilution.

Venture Capital Funds

Most of the local representatives interviewed for this study recognized the importance of venture capital to HTD, but few expressed satisfaction with their initiatives to fill this need. Planned and existing efforts included seminars or conferences for venture capital firms and local entrepreneurs, the identification of local venture capital resources, and consulting assistance in procuring venture capital. (For similar university initiatives, see ch. 3.) Only one community of those surveyed, Cincinnati, was seriously considering the establishment of a venture capital fund. However, OTA has identified such efforts in a few other communities (see ch. 5).

Effective venture capital programs directed at high-technology companies presuppose a substantial number of high-technology innovations in a community each year. Without a major university or a large existing base of research-oriented firms, it is doubtful that an adequate number of innovations with commercial potential will be found in a community. The critical mass of innovations is most likely to be found in the true high-technology or diluted high-technology centers. These areas are also the ones most likely to have existing, private venture capital operations, which may explain some of the problems that other communities are having with this type of initiative.

Other Initiatives

Other, less common initiatives include efforts to attract a specific company. In some cases, the contributions of a single firm to an area were viewed as being so great and as having such an impact on the future HTD of the area, that a major initiative was devoted to the specific firm. The efforts to bring Wang Laboratories' headquarters to Lowell provide

the best example of such a focused marketing drive; Austin's successful campaign to attract MCC provides a more recent example.

Also, realizing that companies seeking to recruit large numbers of researchers are concerned about amenities and cultural opportunities for these workers, one community (Huntsville) developed a large civic center to house visiting orchestras and other cultural events. Several cities are considering the establishment of research institutes (private contract research organizations not directly affiliated with a university), with Cincinnati's Institute of Advanced Manufacturing Sciences being the most developed. In one diluted high-technology center, Chicago, a high-technology newsletter was felt to be an important tool for overcoming the effects of dilution.

Several initiatives are based on "partnerships" between local government and the various components of the community's educational and technological base. For example, there is usually a strong relationship between research parks (occupied by industrial research laboratories) and local universities; in many of the cases discussed in ch. 3, the development of research parks was a cooperative initiative in which the original stimulus was the university. Local vocational/technical programs, too, typically have strong ties to both State and local training programs, and many have received Federal finding. Additionally, the private sector (and especially the technology-based business already located in the community) has made major contributions of time and effort to local initiatives. This is particularly true of task forces but also of programs to improve university engineering and scientific programs. (See ch. 5 for a discussion of private sector initiatives.)

Program Design and Effectiveness

Sources of Information

The surveyed communities got their ideas for high-technology initiatives from a variety of sources. Most local officials followed discussions of high-technology and economic development in journals, magazines, and newspapers; many also had collected reports issued by State and local governments on the subject. Additionally, there was often direct contact among the communities on high-technology issues related to economic development. (This was also the case among State initiatives—see ch. 2.) For example, in several cases, public officials who were investigating the development of a research park visited successful parks in other communities. This was true in Binghamton, Chicago, Orlando, and Montgomery County, among others. The Puget Sound task force, which was seeking to improve scientific and engineering education in the Seattle area, invited the president of MIT to speak at a meeting. Information on other areas' initiatives also was collected through consulting studies, phone interviews, and letter requests.

Another important source of information on initiatives is the industrial prospects themselves. For example, public officials in San Antonio began lobbying for engineering programs in the city's State college after a major electronics company announced that it would not build a plant in the area because of the lack of continuing education opportunities for its employees. Local industry and business groups frequently exerted similar pressure for the improvement of vocational/technical programs to train skilled workers (see ch. 5). In several cases, the State government or a statewide business organization encouraged initiatives by counties and universities to establish research parks. In Wisconsin, for example, both the State and the city of Milwaukee are participating in a joint marketing effort directed at the robotics industry. A final source of information for program design was the community's development efforts with other types of industry. Many high-technology marketing initiatives are adaptations of successful efforts used for many years by local economic development organizations. Similarly, task forces were a common mechanism used to address a wide

range of community concerns long before this technique was applied to HTD.

Implementation

Like information gathering, program implementation followed common patterns in most communities. The first step was usually to identify the need for something lacking in the community or the importance of a particular service to local high-technology firms or prospects. Once the need or opportunity was identified, many communities explored their resources and policy tools with consultants, local businessmen, and other knowledgeable informants. For example, in exploring potential participation of the local government or university in a research park, the community would need to know what protective covenants or tax changes would help as well as what types of firms would qualify for the park and how many jobs they would create. In launching and operating the program, communities must adapt the experiences of other communities to their own specific situation and avoid the weaknesses and pitfalls (if any) of their models.

Federal and State Participation

Agents of the Federal Government participated directly in the initiatives in several of the surveyed cities. For example, the High Technology Task Force in Chicago was chaired by the director of the Argonne National Laboratories. Significantly, the local organizations responsible for high-technology programs made frequent use of the funds and other development tools made available by the Federal Government. The most frequently mentioned Federal programs and development tools in relation to specific initiatives in 22 surveyed communities were:

Urban Development Action Grants	9
Industrial Development Bonds	5
Economic Development Administration grants	4
Community Development Block Grants	3
Comprehensive Education and Training Act programs	2
Free Trade Zone	2
Appalachian Regional Commission programs	2
Small Business Administration loan programs	1

Although none of these Federal programs were designed specifically to help with high-technology development, this finding shows that they have been successfully applied to such purposes.

Major Federal R&D installations frequently provided the base around which high-technology programs are built. In several cases, in fact, it was the reduction of Federal support for these installations that provided the impetus for developing a local economic development program directed at high-technology companies. This was true in both Brevard County and Huntsville. Also, military bases were often cited as good sources of skilled labor for high-technology companies located in an area. This is true in such cities as San Antonio, San Diego, and Colorado Springs. In such cases, the Federal Government has in effect subsidized technical training for workers who subsequently feed into the local private economy.

State governments also participated in local initiatives, frequently through their control of university and vocational/technical education resources. State marketing programs also complemented those of the local communities. (See ch. 2 for a discussion of State government initiatives.)

Innovation v. Attraction

Although most of the local representatives interviewed for this survey recognized the importance of stimulating new local companies built around innovative products, the greatest efforts were directed at attracting branch operations of large high-technology firms. This strategy pays more immediate dividends in terms of job creation, but another reason seems to be the relatively small number of communities in which a significant number of innovative new products are developed. In the true high-technology centers, there seems to be a "critical mass" for the creation of new companies, which in turn warrants the concentrated attention of venture capital firms and other development organizations. This critical mass is missing in cities with smaller technology-oriented industrial bases. At least initially, it may not be cost effective in such cities to devote local resources to initiatives aimed at entrepreneurial ventures. In time, however, the attraction of several branch plants may result in the necessary concentration of firms, technical workers, and potential entrepreneurs. Several cities reviewed for this study—including Minneapolis-St. Paul, Austin, and San Diego—are reaching the stage at which a significant number of new high-technology companies can be spawned, but they are the exception rather than the rule.

Factors Affecting Success

Not all of the communities investigated for this study have been equally successful in becoming high-technology centers. Given the differences in their goals and strategies, absolute criteria for success are difficult to determine and, as with State initiatives (see ch. 2), these programs have not been subjected to rigorous comparative analysis or evaluation. As a result, measures of success are somewhat impressionistic. Nevertheless, the collective experience of these 22 communities indicates that the following factors condition the effectiveness of local programs for HTD:

- *sustained effort,* often over a period of decades;
- *identifying local needs and resources;*
- *adapting to external constraints,* including climate, distance from existing high-technology centers, and other factors over which the community has no control;
- *linkage to other, broader development efforts;* and
- *local initiative and partnership* in the initiation, implementation, and operation of the program.

Sustained Local Effort

Although some of the 22 communities were able to reap rapid results from their initiatives, few have developed large concentrations of high-technology establishments in a short time. A minimum of 20 years may be a realistic period for a community to develop to the stage where a significant number of local jobs can be credited to products created by local entrepreneurs or local research establishments of larger companies. This long timeframe should not be discouraging, however, since many of the "bootstrap" and "spillover" communities improved their economies quickly and significantly by attracting branch plans of technology-based companies. Huntsville, Phoenix, San Diego, Colorado Springs, Lowell, and Austin, had all been working successfully for many years to attract technology-based branch operations.

Identifying Needs and Resources

A second factor is clear recognition of the local attributes, both strengths and weaknesses, that influence a community's ability to attract high-technology industry. In the more successful cases, such analyses of the community were conducted by local representatives or by outside consultants. With clear objectives, the community was then able to develop appropriate development strategies.

Adapting to External Constraints

There are other factors over which a community has little control, such as climate, terrain, and proximity to existing high-technology centers. The successful communities recognized these external constraints and adjusted their objectives and strategies accordingly. Thus, both Colorado Springs and Austin initially focused their marketing efforts on branch plants rather than on research-or technology-intensive establishments. Over time, as these branch plants created a base of skilled labor and technical infrastructure, they have been able to attract more sophisticated operations and encourage local spinoffs.

Linkage to Other Efforts

The local initiatives that formed part of a broader development strategy often produced the most substantial results. Two examples of this pattern are worth reviewing. San Diego had conducted several analyses to determine the types of industry that would find the area most attractive and had targeted several specific high-technology operations like consumer electronics. The community also identified the large quantity of available land as a major asset, and most of its initiatives are based on exploiting this resource to achieve its HTD objective. In Huntsville, community leaders commissioned a detailed assessment at the time of the downturn in employment at the Redstone Arsenal, and the pool of skilled labor created by the Arsenal was recognized as a major attribute that could be marketed to technology-based firms. Other initiatives were also developed to make the community more attractive to such operations, including the creation of a research park and the construction of the community center. Huntsville conducts periodic reassessments to monitor changes in local conditions that would warrant shifts in this strategy.

Local Initiative and Partnership

Finally, it is worth noting that in the successful communities, most of the effort has been initiated and implemented locally. Some communities received substantial help from State governments in developing university resources and complementing the local marketing program. Others have used funding and a number of development tools made possible by the Federal Government. But in most cases, the objectives and strategies were developed locally, and local representatives had a major part in design and implementation of the programs. In addition, cooperation or "partnership" with local entrepreneurs and business groups plays an important role in successful programs, since the public and private sectors are far less distinct at the local level.

Local Policy Tools

Local governments have at their disposal a wide range of policy tools that have been used to provide incentives for the necessary private sector participation.[2] Some, like zoning bonuses or minority hiring quotas, encourage or require private initiative; others, like administrative reform, tax relief, or infrastructure improvements, remove barriers to private initiative. The effectiveness of some of these tools may be constrained by the policies and regulations of State or Federal Government; in such cases, public and private leaders at the local level often have joined forces to overcome these constraints (see ch. 3). Policy tools that are in the control of local government include the following:

- *provision of public services,* including improved public safety, education system reforms, and recreational or cultural programs;
- *provision of public facilities,* such as improvements to water, sewer, and road systems, improved mass transit, and public parks;
- *tax policies,* such as relief from property tax or incentives for inner-city location, as well as lower overall tax rates;
- *regulatory policies,* including changes in zoning or building codes that will encourage rehabilitation;
- *administrative reforms,* such as improved financial practices, one-stop permitting, or streamlined licensing and inspection systems; and
- *public advocacy,* including public recognition for private initiatives and support for business interests in State legislatures.

The role played by the private sector, and the initiatives it has launched, are discussed in greater detail in the following chapter.

[2] Tom Chmura, et al., *Redefining Partnership-Developing Public/Private Approaches to Community Problem Solving: A Guide for Local Officials* (Menlo Park, Calif.: SRI International, January 1982), p. 16; see also SRI International, "Developing Public/Private Approaches to Community Problem Solving," *Management Information Service Report*, International City Management Association, vol. 14, No. 7, July 1982, pp. 5-6, 17.

CHAPTER 5

Private Sector Initiatives

CHAPTER 5

Private Sector Initiatives

Summary

Private sector participation is an important ingredient in successful high-technology development (HTD) programs by State and local governments, and both individual firms and business organizations have undertaken similar initiatives of their own. Recent changes in public policy have made their participation more valuable and more welcome. The business community has practical reasons for encouraging community and economic development, as well as the desire to be a good citizen, and high-technology firms in particular have many resources that can be applied to community needs and problems. The nature of their efforts vary with the size and nature of the firm, but in general their initiatives fall in one of four categories:

- *business investment and operations,* notably site location decisions, but also including targeted bank deposits and real estate development, preferential hiring or procurement practices, and expanded employee services;
- *education development,* including philanthropic contributions, loaned personnel, donated equipment, technology-transfer mechanisms, and cooperative research arrangements;
- *business development and risk capital,* including entrepreneurship training and assistance, small business incubators, and geographic investment pools for venture and seed capital; and
- business/civic advocacy, usually through trade or business executive associations, to express support for public leaders or policies, encourage participation by other firms, and promote community involvement by individual employees.

Social and economic conditions, as well as the political and business climate, affect the willingness of business to participate in HTD programs. Perhaps the most important factor is the history of public/private collaboration, but local government has a number of policy tools with which to remove barriers to private sector initiatives. Three factors appear to contribute to the success of these initiatives:

- an organizational culture that promotes a *common civic perspective* and a positive attitude about the attributes and prospects of the region;
- an environment that nurtures *leaders, both public and private,* who combine an established track record for innovation and entrepreneurship with a broader view of their community's resources and promise; and
- a network of *business/civic advocacy organizations* that attracts the membership of top officers of major companies and receives from them the commitment to work on efforts of mutual. concern, including cooperation with the public sector.

Introduction

The Changing Environment

1 he preceding chapters have shown that private sector participation is an important feature in the design, operation, and success of HTD initiatives at the State and local levels. The targets of these efforts, after all, are the decisions of individual entrepreneurs and firms about where to start, expand, or relocate their business activities. The private sector, however, is seldom a passive player in these initiatives; increasingly, corporations and individual executives play an active role as a stimulus or collaborator in HTD efforts of State governments, universities, and local communities. Recent changes in public policy, including the new emphasis on HTD, have made their participation more valuable and

more welcome. The past 15 years also have produced a variety of successful business efforts that can serve as models for future initiatives by the private sector in this area of economic development.

Business is directly affected not only by business conditions but also by conditions in the external environment. For most of the past 30 years, these conditions have been assumed to be the responsibility of the public sector, and during the 1960's the Federal Government created a number of development-oriented agencies including the U.S. Economic Development Administration (EDA), the U.S. Community Services Administration (CSA), and the various regional commissions, as well as other programs in the U.S. Small Business Administration (SBA) and the Departments of Commerce and Housing and Urban Development (HUD), The 1960's also saw an increase in grass roots activism that led to the creation of numerous community-based development organizations.

During the 1970's, however, State and local governments and the private sector began to assume a larger role in community development. In part this was due to changes in Federal policy, exemplified by the Community Development Block Grant (CDBG) and Urban Development Action Grant (UDAG) programs, which required matching or leveraged funds from other sources. The effort to secure additional public and private resources led to the creation of local "partnerships" involving Government, community groups, and the private sector. Growing public concern about the cost and effectiveness of government programs has led, in the early 1980's, to further reductions in Federal funding for economic development and a further transfer of responsibility to local jurisdictions. This trend, reinforced in many cases by similar changes in State policies, is expected to continue.

Studies by SRI International indicate that this changing environment represents both a challenge and an opportunity for the private sector. On the one hand, responsibility and the burden of performance are being shifted to local governments, which sometimes lack the manpower and experience to deal with economic development problems as complex as high-technology industrial growth. At the same time, growing fiscal constraints at all levels of government make it increasing clear that public resources are insufficient to meet all of the problems faced by local communities. The public sector therefore must find a way of collaborating with the private sector to bring its resources to bear on these problems. In short, "there appear to be no viable alternatives to an increased corporate community involvement and private/public partnership in dealing with local problems. "[1]

On the other hand, there are several problem areas in which corporate action or public/private partnership has been especially successful. These include economic development, job creation, and education and training. SRI also found that it is no longer as difficult as it once was to launch such initiatives and that there are several different approaches that any company can undertake, regardless of its size.

Reasons for Business Involvement

Business involvement in regional economic development often results from company policies that reflect the personal beliefs and commitment of their executives. In other cases, business involvement addresses community problems that affect the general business climate or the particular firm's operating costs and profits. In general, however, the private sector has three practical reasons for participating in community and economic development initiatives:

- "business" motives strictly defined, such as reducing the cost of doing business, expanding markets, and increasing return on investment;
- meeting the social needs of its employees, in order to make them more reliable and productive; and
- improving the quality of life in the community.

Research cited by SRI indicates that companies pay, directly or indirectly, for community problems that are not strictly part of the business environ-

[1] Tom Chmura, *et al.*, *Redefining Partnership—Developing public/Private Approaches to Community Problem Solving: A Guide for Local Officials* (Menlo Park, Calif.: SRI International, January 1982), p. 6; see also SRI International, "Developing Public/Private Approaches to Community Problem Solving," *Management Information Service Report*, International City Management Association, vol. 14, No. 7, July 1982, whole issue. Both reports are based on research conducted by the Public Policy Center of SRI International, with funding from the Office of Community Planning and Development of HUD.

ment. Business needs adequate public services and facilities in order to operate and grow; it also needs adequate protection for its plant and personnel. Business requires a well-trained labor force and social and health services to help it be more productive but business also wants to control its local tax burden and the costs of employee services to reduce operating expenses. Roads that need repaving, police and fire departments without funds to respond to emergencies, school systems too poor to improve teaching, service agencies that cannot provide treatment or counseling, high rates of unemployment and business failures, shrinking tax bases and rising rates—all of these community problems result in identifiable costs on the firm's balance sheet.

At the same time, business wants to be perceived as a good citizen, and an important byproduct of public/private ventures is the improved communication and understanding that results between participants from local government and the business community. Finally, SRI suggests that business "will probably benefit by keeping its end of the implicit bargain with the Federal Government that social problems can be better handled by the private sector if taxes are reduced and Federal programs cut, as the Federal Government has done."[2]

High-technology firms appear to benefit particularly from economic development and the creation of new firms or branch plants, both as a source of specialized production inputs and as a potential market for their innovative products and services. They also benefit from the cultural and recreational amenities that attract and retain scientific and managerial talent. The following material addresses the resources that the private sector brings to bear on 1ocal problems, the roles each has played in economic development, and the typical strategies it employs. In each case examples are provided that relate these general topics to specific HTD initiatives.

[2]Chmura, et al., op. cit., p.6.

Private Sector Roles and Initiatives

Introduction

Private sector firms and executives have a wide range of resources that can be applied to problem-solving and economic development in their communities.[3] Different types of firms possess different kinds of resources, and these resources often determine the roles firms play, the problems they address, and the specific initiatives they launch. In general, however, these strategies can be classified as follows:

- *business investment and operations,* notably site location decisions, but also including targeted bank deposits and real estate development, preferential hiring or procurement practices, and expanded employee services;
- *education development,* including philanthropic contributions, loaned personnel, donated equipment, technology transfer mechanisms, and cooperative research arrangements;
- *business development and risk capital,* including entrepreneurship training and assistance, small business incubators, and geographic investment pools for venture and seed capital; and
- *business/civic advocacy,* usually through trade or business executive associations, to express support for public leaders or policies, encourage participation by other firms, and promote community involvement by individual employees.

These four strategies are generic to all businesses, but the resulting initiatives show distinctive patterns associated with particular industries. Financial institutions, for example, find investment and business development a logical extension of their normal activities; their decisions are motivated by profit, but they also take into consideration the special needs of the community, such as housing or neighborhood revitalization. Nonfinancial corporations, on the other hand, are more likely to use philanthropic contributions as the mechanism for community involve-

[3]The following material is based on the contractor report, *Private Sector Initiatives: High Technology and the Local Economy,* prepared for OTA by Renee A. Berger with research assistance by Robert Guskind, April 1983.

ment. In addition, the patterns of involvement often reflect the particular self-interest of the firm: pharmaceutical companies make donations to medical schools, accounting firms give to business schools, and high-technology firms focus their donations on engineering or computer science programs.

High-technology firms have made use of all four of these strategies. As nonfinancial institutions, they seldom make use of special investment strategies, but high-technology businesses have made substantial contributions to educational institutions, often commingled with investments in cooperative research and development (R&D) programs (see ch. 3). Company size affects the firm's ability to draw upon internal resources: large, well-established firms such as IBM, Honeywell, Sperry, or Xerox are able to draw upon vast amounts of capital, personnel, and business experience, as well as a longstanding network of contacts. Also, as with other corporations, high- technology firms tend to focus their involvement near the headquarters, although there are numerous examples of company involvement at branch sites.

The sections that follow will explore these strategies and roles, providing examples of initiatives that have been carried out by high-technology firms and entrepreneurs in various regions and communities. They demonstrate that, although local economies are affected by forces over which they have little control (e.g., demographic shifts, structural changes in industry, and State and Federal policy), local initiatives by the private sector frequently have made a difference in regional economic development by influencing the factors that can be controlled (e.g., business climate, labor pool, and quality of life).

Business Investment and Operations

New enterprises and business expansions strengthen the local economic base by creating jobs and generating revenue. Deciding to start a company or locate a plant in a particular community is the most direct way of making this contribution, but other investment approaches also can enhance particular aspects of a local economy. In some cases these initiatives involve targeted business operations; others are based on a company philosophy of making "socially responsible" investments.

Site Location.—Some high-technology companies have contributed to community development through a deliberate decision to locate in a depressed or disadvantaged area.

- Wang Laboratories, Inc., after outgrowing its location in Tewksbury, Mass., decided to locate its new headquarters in nearby Lowell. Wang made its decision based on Lowell's proximity, its highly skilled labor pool, and the tax and financing incentives provided by the city. However, Wang is now building both a new office building and a downtown research center in Lowell without further tax breaks, and its presence has attracted numerous suppliers who create additional high-technology employment.
- Digital Equipment Corp. (DEC) has sited a plant in the Roxbury-South End area of Boston, near a poor and predominantly minority neighborhood. The startup cost to the company was $4.2 million, of which $2.9 million for land acquisition was financed by an industrial revenue bond. The plant, which began operations in 1980, now has an annual payroll of $4 million and its work force is 63 percent minority.

Site location activity in the greater Boston area, however, may well be unique to that region. MIT and Harvard have been the incubators for numerous entrepreneurs who have started their businesses in or near Boston. Over 80 percent of the chief executives in the Massachusetts High Technology Council (including An Wang and Kenneth Olsen of DEC) received their degrees from schools in the greater Boston area. These people are now part of a tightly knit network of local entrepreneurs who are devoted to strengthening the economic base of Massachusetts. In addition to this entrepreneurial network, Massachusetts provided a highly skilled labor pool, available financing (public and private), and land ready for adaptive reuse (particularly mill facilities). The Wang and DEC decisions result from this mix of economic factors and chief executives' personal preferences. The desire to stay in Massachusetts was a powerful factor in these decisions and, while they have had a positive impact on the local economy, they may not be replicable.

Business Operations.-Companies can also address special needs and provide opportunities for particular populations through selective real estate

development (see above), targeted banking or bidding procedures, and working with minority-owned businesses. Large companies such as Xerox and IBM, as suppliers to the Federal Government of standard commercial products, are required to implement affirmative action purchasing programs.

- Xerox has for many years had an affirmative action program that targets contracting with minority owned businesses. Their policy states that "(l) small businesses and (2) small businesses owned and controlled by socially and economically disadvantaged individuals shall have the maximum practicable opportunity to become suppliers of materials and services. " Xerox's program predates Federal Government requirements.
- Numerous companies that donate equipment to schools and universities (see below) also see this as a marketing opportunity. Executives at Honeywell, Sperry, and Texas Instruments acknowledged that they had expectations of selling their equipment in markets that had been created in this way.

Company Philosophy.–Some high-technology companies pursue strategies that combine business investment with broader community objectives. Control Data Corp., for example, has adopted a business strategy of "addressing society's major unmet needs as profitable business opportunities. " Rather that advocating philanthropy, this approach calls on corporations to use their business skills to address such needs in partnership with government and other sectors of society. For instance, Control Data is a founder and principal investor in City Venture Corp., a for-profit consortium that plans and invests in inner-city development projects emphasizing better housing, job creation, and more effective education and vocational training. Rural Venture addresses these same social needs in rural areas.

Similarly, Control Data's Business and Technology Centers (BTCs) address the need for job creation by providing "incubators" for small businesses, which create the most jobs. BTCs provide entrepreneurial firms with basic shared services (e.g., computer time, office and laboratory space, and manufacturing facilities) on an affordable basis. These and other Control Data efforts (see below) are designed to earn a fair return on investment, and to create a larger market for Control Data products and services, by helping communities set up "job creation networks" that promote innovation at the grass roots level.

Education Development

Corporate practices regarding education can be viewed as initiatives to create the innovations and intellectual infrastructure-the raw materials—they need to survive. Several research studies have concluded that the presence of a major university research facility is essential to fostering HTD. Executives of high-technology firms also note that the lack of high-quality engineering talent could be a constraint on their future expansion. As a result, business executives–working as individuals, participating on advisory councils, or as members of a business organizations—have focused their attention on ways to strengthen educational institutions, promote R&D, and-encourage entrepreneurship. Business benefits by expanding the labor supply, getting tax benefits from contributions, and speeding the-flow of innovation. Universities see a means of achieving several objectives: upgrading education, providing research opportunities for faculty, finding jobs for students, and generating income. Businesses are also working with public school systems to improve primary and secondary science and mathematics instruction. The initiatives they have launched to achieve these goals may be classified in four general categories:

- philanthropy;
- lending personnel;
- donating land and equipment;
- technology transfer; and
- cooperative R&D.

Philanthropy .–Many high-technology firms contribute funds to universities and other nonprofit organizations. Investments like those described above may lead to direct and visible enhancements of the local economy, but philanthropy involves a simpler administrative mechanism (and greater tax benefits) while still making a longer term (if less visible) contribution to the community's physical and human capital. Mature high-technology firms such as IBM, General Electric, and Xerox tend to have diversified giving patterns, ranging from the arts to

education and health. The second-generation high-technology firms increasingly are channeling their contributions to university-affiliated R&D institutes (see ch. 3). Several trade associations have issued policy statements encouraging their membership to give at the "2-percent level."

- The American Electronics Association has set a goal of 2 percent of each member firm's annual research budget to be contributed to universities for supplementing faculty salaries and developing research facilities.
- Stanford University has received grants from 20 corporate cosponsors for the construction and operation of its $12-million Center for Integrated Systems.
- The Massachusetts High Technology Council in January 1982, asked its members to raise their level of support for higher education to 2 percent of their annual R&D expenditures. In December 1982, they announced they had met their $15 million goal.

Lending Personnel.–Another method of providing resources for economic development is by lending personnel. Company personnel have technical skills that may be of assistance to prospective entrepreneurs or to educational institutions. Numerous corporations lend personnel, and high-technology companies such as IBM and Xerox have been leaders in this area, particularly for training endeavors. There are two principal motivations for lending personnel: improving the local labor pool and providing technical assistance to potential entrepreneurs.

- The Harris Corp. in Florida operates an extensive program with local junior and senior high schools. Company personnel give lectures and work with school personnel to promote interest in science and mathematics. Harris' activities are motivated by a desire to retain their present employees (whose children attend these schools) and to engender positive attitudes toward technology among high school students (who are potential future employees).
- Honeywell is involved in the creation of a new magnet program in a local high school in Minnesota. This program will focus on science and math skills but also will promote a broad skills base. Honeywell has worked with the school system to develop a strategic plan for technical skills development, and the company has contributed funds as well as lending personnel.
- The Minnesota Cooperation Office (MCO) is a nonprofit corporation with directors from business, labor, education, and government that helps entrepreneurs who want to start a new company. A small permanent staff draws on a volunteer advisory panel of engineers, scientists, and executives to help clients prepare and evaluate business plans and obtain financing. Financed in its early years by contributions and grants, MCO's goal is to become self-supporting from client fees and return on investment in client companies. MCO has served as a model for similar initiatives in many other communities, including Competitive Wisconsin and Cleveland Tomorrow (see below), both of which are civic advocacy groups initiated by chief executives.

Donating Equipment.–Donating equipment represents a comparatively small but growing component of education development initiatives by high-technology firms. According to Independent Sector, an association representing nonprofit organizations, the value of corporate noncash giving (equipment and materials) was approximately $6 billion in 1983. Deductions created by the Economic Recovery Tax Act of 1982 are expected to increase corporate equipment donations. Though data are not available, it appears the principal beneficiaries of high-technology equipment donations are university science and research centers (see ch. 3). Corporations also view donating equipment as cultivating a market for their high- technology products.

- The Massachusetts High Technology Council estimates that the 1982 value of equipment donations by member companies will reach $40 million.
- Harris Corp., Sperry, Motorola, and Honeywell have contributed equipment valued in excess of $2 million to the new Center for Engineering Excellence at Arizona State University.

Technology Transfer.–Technology transfer is a means of moving an invention to market and generating sales or royalty income. Traditionally, technology transfer has been handled by university administrations, but more recently this important commercialization function has been assumed by private nonprofit alumni foundations. Some of these foun-

dations are independent of the university, others are not; but all of them rely on university research capability for inventions that can be commercialized.

- The Wisconsin Alumni Research Foundation is the largest and oldest university technology-transfer operation. It is a multimillion dollar operation. Its 1929 patent of vitamin D has provided $14 million in license income.
- More typical is the University of Virginia Alumni Patent Foundation. Funds for the program were provided initially by the alumni foundation, but subsequent funds were raised from the private sector and from royalty and licensing agreements. Patent income averages between $50,000 and $100,000 per year. The foundation has processed approximately 200 faculty and alumni inventions, working with patent attorneys, arranging for licensing, and identifying market opportunities.
- The Washington Research Foundation (WRF), a nonprofit organization established in 1982, seeks to increase Washington State's share of the market in high-technology products and processes. WRF plans to work closely with the State's universities as well as other research centers. A bank loan of up to $1 million has been guaranteed by pledges from individuals, law and accounting firms, and manufacturing establishments.

Cooperative R&D.–Numerous universities have established cooperative relationships with industry and government to expand the high-technology labor pool and to promote research. The relationships vary greatly, from simple corporate grants to complex contracts giving the private sector firm control over intellectual products. This is a promising source of income for the university (and therefore the community) as well as for the firm. It is also a highly sensitive matter because of ethical concerns and questions over academic freedom. (See ch. 3 for more detailed information on cooperative R&D initiatives.)

- The direct grants approach is exemplified by the $6 million, 5-year immunogenetics program sponsored by DuPont at Harvard; the $7 million, 10-year combustion science grant from Exxon to MIT; and the $5 million, 5-year robot development project sponsored by Westinghouse at the Carnegie-Mellon Robotics Institute. These grants are are targeted for specific research and have a turnback arrangement so that the corporation can benefit from inventions.
- A few universities, seeing the potential for income from cooperative research, have become entrepreneurial. Stanford University, in 1981, created Engenics, a for-profit company to develop large-scale chemical processing techniques, and the Center for Biotechnology, a nonprofit research organization provided with $2 million by the six corporate supporters of Engenics. Stanford holds 30 percent of the equity in Engenics.
- There are other university programs sponsored by individual firms to target particular problems. For example, IBM has a launched a $50 million program of grants and equipment donations to improve manufacturing engineering, and Exxon sponsors a $16.8 million engineering faculty assistance program to supplement junior faculty salaries.
- Recently, several companies have organized into consortia to pool resources for several universities and special programs. For example the 10 major makers of semiconductors (including Honeywell, Hewlett-Packard, and IBM) have established the Semiconductor Research Cooperative, which will identify generic research needs and work with university research departments.

Business Development

Private industry also contributes to regional HTD through business development initiatives. These efforts, which are often associated with the educational efforts outlined above, take three forms:

- entrepreneurship assistance;
- small business incubators; and
- geographic investment.

Entrepreneurship Assistance.–one of the most highly developed set of initiatives for promoting high-technology entrepreneurship and small business development has been created by the private sector in Minnesota, in cooperation with the University of Minnesota and State and local governments, StarCo (Start-a-Company), sponsored by the Minnesota Business Partnership (see below), is a program through which established firms assist in the creation of new small businesses through technology spinoff, management consulting, and/or equity in-

vestments. Some 35 large corporations have already committed to assist in the startup of two new companies apiece, and smaller firms will assist in the startup of one new company. A related initiative is the Minnesota Project Innovation (MPI), launched in November 1983, which in addition to technology spinoff and entrepreneurship assistance will help the State's small high-technology firms compete for grants under the Federal Government's new Small Business Innovation Research (SBIR) program. MPI, created at the recommendation of the Governor's Commission on SBIR Grants and initially funded by a State grant, will be coordinated through and use the resources of the Control Data BTC in Minneapolis (see above). Private sector participation in such initiatives is encouraged by State legislation passed in 1983 that provides tax credits for technology transfers or investments in qualified small businesses, as well as for contributions to private sector organizations like StarCo., MPI, the Minnesota Cooperation Office (see above), and the Minnesota Seed Capital Fund (see below).

Programs in entrepreneurship have also been created at numerous universities, typically supported by private sector contributions and individual executives loaning their time (see ch. 3). Conferences and referal services connected with these programs have been helpful in mobilizing local professional networks and finding financing for aspiring students and local entrepreneurs.

- Wichita State University established a Center for Entrepreneurship and Small Business Management in 1977. The force behind the creation and development of the program is a professor who is also a successful entrepreneur, but the Center is supported by over 50 area businesses. In addition to seminars and publications, the Center has an executive series that has brought in the heads of Federal Express and Mellon National Corp., as well as local entrepreneurial talent. The Center is about to start a small business incubator.
- The Institute for Constructive Capitalism at the University of Texas is supported by Mobil, Shell, Tenneco, and others.
- Cornell University's Chair in American Enterprise was endowed with funds from the Olin Corp. and the Continental Group.

Small Business incubators.–Another recent innovation in business-university relationships is the small business incubator or technical assistance center. Recent data on the role small business plays in innovation and job creation has sparked interest in this mechanism, which is modeled on the success of the University City Science Center in Philadelphia. In order to sustain the entrepreneur as he brings his invention into the marketplace, these facilities often provide technical and financial assistance as well as low-cost office and laboratory space (see ch. 3).

- The Advanced Technology Development Center (ATDC) at the Georgia Institute of Technology is a new effort to promote indigenous high-technology industry in the Atlanta area. The effort is State-initiated, but the private sector will contribute $1.7 million of the projected $5.1 million budget. Facilities now under construction will provide low-cost space for entrepreneurs. As of 1982, the Center was working with 30 companies. One of its most successful programs is an annual venture capital conference that brings together startup hopefuls with potential investors.

Geographic Investment.-Geographic investment is a method of channeling risk capital and other financial resources to targeted areas and opportunities. Several State initiatives involve venture capital mechanisms with explicit requirements to fund in-State endeavors (see ch. 2), but because the private sector generally prefers operating with no strings attached, geographic criteria historically have been shunned. Recently, a few private sector initiatives in this area have emerged. Organized venture capital is composed of independent firms (55 percent), corporate subsidiaries (27 percent), and small business investment companies (18 percent). As of mid-1983, the total pool under management was $9 billion. Large venture capital firms play an important role in financing high-technology endeavors, but the opportunities they identify often are not local, so their investments do not stay local.

Seed capital, on the other hand–at least when flowing from organized seed capital firms-does tend to stay local. (Seed capital is also available from large venture firms, but in this case it is difficult to define

and more difficult to trace.) It has been estimated that less than 2 percent of venture activity is targeted for seed efforts, and there are only a few firms that specialize in seed investments, although the number is growing. Interviews conducted with four firms in the San Francisco-Palo Alto corridor indicated that they tend to invest in enterprises within a one-hour drive. In the case of *formal* seed capital firms, therefore, there appears to be a local economic impact; and the tendency may be even more pronounced for *informal* seed capital investments.

- Bay Venture Group was established and completed its first deal in 1976. The limited partners are primarily wealthy individuals (in excess of $40-million net worth). They assume that from concept (seed) to public offering will take from 8 to 12 years. Their deals are made on the market promise of "several hundred million dollars" in sales per year. Ideas are found "word of mouth," and the firm provides significant technical assistance.
- Alpha Fund is based in Palo Alto and raised $13 million from individuals, corporations, and endowment funds to support seed investments. Its brochure states that "because of the close interaction between Alpha and its investments, preference is given to opportunities in the San Francisco Bay Area."

Where there is little local venture capital activity, the private sector can seek to establish a "presence" by creating an investment vehicle to pool local risk capital and encourage local entrepreneurs. This approach, however, doesn't necessarily apply a geographic criterion. There is a greater likelihood that locational criteria would be specified at the State level (by a State government-initiated firm, or by a private sector pool with a specified aim of serving State economic needs) than locally.

- The Minnesota Seed Capital Fund was an outgrowth of the Minnesota Business Partnership, a statewide business executives group (see below). The fund has attracted initial capitalization of $10 million from individual investors and several pension funds and support from major Minnesota corporations. It was formed because capital from more conventional sources like venture capital companies and banks is often not available to new firms in their startup and early development phase. It invests exclusively in Minnesota and works closely with the Minnesota Cooperation Office, a nonprofit organization that provides technical assistance to new businesses (see above).
- The Michigan Investment Fund (MIF) is a limited partnership that was initiated by the Charles S. Mott Foundation. The Foundation, working with a nonprofit small business expert, developed a blueprint for a limited partnership to primarily serve the economic needs of the State. MIF plans to direct 60 percent of its investment in-State, but not all the funds will be invested in high-technology firms. The remaining 40 percent will be used to establish relationships with out-of-State venture firms in hopes that those investments will lead later to capital returning to the State of Michigan. (The Mott Foundation has a blueprint for a similar endeavor that will involve three Michigan counties. Presently in the planning stage, the Flint River Capital Fund will work closely with the General Motors Institute on new technologies.)
- The Cincinnati Chamber of Commerce, with the aid of the Gannett Foundation, is in the planning stage of creating a venture capital firm. The firm will not be required to invest in Cincinnati. The Chamber feels that a local presence will enhance the likelihood of promoting entrepreneurship but will not be directly responsible for generating this capability.
- In Cleveland, on the other hand, the Gund Foundation sponsored a study of the city's economic profile that recommended the creation of three entities—one for research coordination, one for technical assistance, and one to provide local venture capital. The first two initiatives are in the planning stage; the third, Primus Capital Fund, has $30 million capitalization and will start making investments in early 1984. These investments will be limited to Ohio, with an emphasis on the greater Cleveland area, and will be targeted for "high-growth" opportunities in medical technologies and factory automation.

Business/Civic Advocacy

One of the most powerful resources that high-technology firms can utilize to influence public policy is the prestige of their executives. Corporate execu-

tives, because of their position, visibility, and business connections, have the capacity to influence their peers and suppliers as well as public policy. The "new" entrepreneurs—in California, David Packard and Stephen Jobs; in Massachusetts, Alex and Dee D'Arbeloff, Kenneth Olsen, and An Wang–have had considerable influence on public policy, both as individuals and through the business groups they join. These organizations provide a broad-based network for building consensus, generating ideas, and implementing programs. They also provide a meeting ground for government officials and their private sector counterparts and thereby play a crucial role in shaping the economic priorities of States and localities.

- A prominent example is the Massachusetts High Technology Council (MHTC), one of the most successful business/civic advocacy organizations in the Nation. In 1979 they established a "social contract" with the Massachusetts government to create 60,000 jobs if the State brought total taxes to a level competitive with the 17 other States against which local high-technology firms competed for technical talent. Taxes have dropped, and MHTC has fulfilled its part of the contract.

Trade Associations. -Trade associations, which try to influence both public policy and the practices of their member companies, can be broad-based or specialized. National trade associations tend to focus on Federal policy, but State groups promise to have increasing influence as the locus of governmental responsiblity for economic development shifts to State and local governments.

- The National Association of Manufacturers (NAM) and the American Business Conference (ABC) are broad-based associations. NAM has over 13,000 member companies, over 80 percent of which are small businesses (employ under 500 people). NAM has issued a white paper on the impact of HTD. ABC was established in 1980 and is comprised of mid-size high-growth firms. Membership is limited to 100 firms, and, although ABC covers all industry sectors, high technology is a particular interest. The chairman of ABC, Arthur Levitt, Jr., has promoted 2-percent giving.
- The Computer and Communications Industry Association and the American Electronics Association (AEA) are examples of specialized trade associations. AEA produced a highly publicized study on the shortage of engineers and has issued a policy statement encouraging 2-percent targeted giving by member firms.
- MHTC is an example of a State-level specialized trade association. 'Several governors have also established high-technology task forces with business members, but these groups are often temporary bodies that function in an advisory capacity (see ch. 2).

Business Executive Associations.–These organizations, which operate at the national, State, and local levels, usually are made up exclusively of business executives, although some include representatives of labor, education, and government. They typically have a small staff, rely on borrowed executives, and play an initiating role, although a few have implemented ongoing programs. These associations provide a locus of power for business executives, and in the past few years several local business-executive groups have included high-technology in their development planning. State business-executive associations are also likely to become a focal point for geographically motivated high-technology programs in the future.

- Cleveland Tomorrow, Inc., created as the result of a study of the Cleveland economy, is spearheaded by the business community. It has three efforts underway: a venture capital firm that will invest exclusively in Ohio, a research program that will specialize in applied manufacturing, and a program to provide technical assistance to local businesses.
- The Cincinnati Chamber of Commerce received a grant from the Gannett Foundation to establish a venture capital firm. This effort began in partnership with the city, the *Cincinnati Enquirer,* and the chamber. Now in the planning stage, the firm will seek private capital but will not have geographic restrictions on investment. The chamber is also working with the University of Cincinnati to develop a research center specializing in applied manufacturing processes.
- The Santa Clara County Manufacturers Group, established in 1978 as a mechanism for business people to work with government on issues of mutual concern, has a diverse membership including banking, technology, and real estate com-

panics. The organization has established a task force with the county district attorney's office to explore ways of preventing the loss of high-technology trade secrets.

- Competitive Wisconsin, inc. (CWI), established in 1981 to strengthen the State economy, is composed of representatives from labor, business, agriculture, and education. It has established a for-profit venture capital subsidiary that will invest in Wisconsin enterprise. CWI will work with Wisconsin for Research (WFR), a new group designed to coordinate university research with the business community. WFR already has created a subsidiary that will be establishing business incubators in the State.
- The Minnesota Business Partnership, founded in 1981, is credited with fostering the creation of the Minnesota Seed Capital Fund and the Minnesota Cooperation Office, as well as several other HTD initiatives in the State (see above).
- A 1981 *Harvard Business Review* article noted that, "Besides California, whose organization was founded several years before the Minnesota Business Partnership, business executives in Ohio, Massachusetts, Pennsylvania, and Delaware have joined to create similar groups. . . . Activity is stirring also in New York, New Jersey, Connecticut, Virginia, Indiana, and a few other States. "[4]

[4]Judson Bemis and John A. Cairns, "In Minnesota, Business is Part of the Solution," *Harvard Business Review*, vol. **59, No. 4,** July-August 1981.

Factors Affecting Success

Different regions and communities have different needs and different resources with which to address them. What works in one area may not work in another, and it is unlikely that a single, all-purpose approach or program design will work in all settings. While individual communities can learn from the successes of others, local organizations and individuals will have to experiment and innovate in order to find their own approach to successful public/private partnership. This calls for creativity and determination, but it also requires a detailed knowledge of local conditions and factors that are likely to influence the success of their efforts.

Research conducted by SRI International has identified a number of factors affecting private sector initiatives and joint public/private ventures for community economic developments Perhaps the most important of these is the past history of public/private development initiatives in the community: a strong history of collaborative efforts provides a base of positive experience to build upon, as well as building trust and understanding among business, government, and community groups. Social and economic conditions will also influence what initiatives are needed and possible: tensions in the community or weakness in its economy can inhibit private sector initiatives and cooperation. Stable political climate and local government with a efficient, probusiness image are positive influences, as is the existence of intermediaries, brokers, or organizational mechanisms to bring together public and private leaders.

However, no single factor explains why some communities and regions have been more successful than others in nurturing and benefiting from private sector initiatives for HTD. For every locational determinant identified in economic theory or implicit in government practice, examples can be provided of cities that have several or all of the ingredients but have not yet achieved success. A strong research university, skilled labor pool, available financing, the presence of corporate headquarters, transportation, good climate, cultural amenities—all may be desirable or necessary preconditions. But it appears that sustained effort and innovative behavior by public and private individuals and organizations provide a catalyst to bring the ingredients together.

OTA's investigation of private sector initiatives for HTD indicates that the local communities that

[5]SRI International, op. cit., pp. 2-3.

have benefited the most have had three characteristics in common:

- an organizational culture that promotes a common civic perspective and a positive attitude about the attributes and prospects of the region;
- an environment that nurtures *leaders, both public and private,* who combine an established track record for innovation and entrepreneurship with a broader view of their community's resources and promise; and
- *a network* of *business/civic advocacy organizations* that attracts the membership of top officers of major companies and receives from them the commitment to work on efforts of mutual concern, including cooperation with the public sector.

Appendixes

APPENDIX A

Descriptions of Local High-Technology Initiatives

The following pages present concise descriptions of the major high-technology initiatives undertaken by 22 county, municipal, and other communities. These initiatives, which are analyzed in chapter 4, are described in terms of the participating organizations, the technology-related resources or bases they build on, the history and design of the initiatives, their effectiveness and transferability, and the nature and degree of State and Federal Government participation. This material was collected for OTA in early 1983 as part of the contractor report, local High-Technology Initiatives Study, by the Fantus Co., Charles Ford Harding, principal investigator, April 1983.

Huntsville, Ala.

High-Technology Related Bases in the Local Economy

Activity declined at the Redstone Arsenal after World War II, and in the late 1940's the 38,000-acre installation was up for sale. In 1950, however, the Army (wishing to centralize its missile activities and make use of its investment at Redstone) moved Wernher von Braun and his team of 109 technicians from Fort Bliss, Tex., to the Arsenal. Between 1950 and 1960 there was a buildup of Government operations and missile activity at the arsenal. About 14,000 military and civilian personnel worked at the facility during these years.

After Sputnik was launched, President Eisenhower established the NASA Marshall Space Flight Center on a 1,500-acre island in the center of Redstone Arsenal in 1960. NASA, unlike the Army, encouraged contractors to locate in the area, and many—including Northrop, Lockheed, Boeing, GE, and IBM–came to Huntsville. The population of Huntsville grew from 16,000 in 1950 to 72,000 in 1960, 126,000 in 1963, and 139,000 in 1970. During this period of tumultuous growth, the city reacted with grace under pressure. The private sector built tract housing, and, at one point, the city government was adding a classroom a day to local schools.

Von Braun left Huntsville in 1970, and the peak expenditure days of NASA were over. While many research and development (R&D) people were transferred, however, others stayed on to form their own companies. The city concentrated its efforts in the 1970's on creating a more diversified, though still high-technology-oriented, industrial base to make use of the skilled work force developed by the arsenal. Today Redstone has 10,000 civilian personnel and Marshall 3,500, but by the end of 1983, commercial high-technology firms employed more than 23,000 in Madison County and may employ more than 35,000 by 1987.

Besides the University of Alabama in Huntsville, the area has John C. Calhoun Community College and J. F. Drake State Technical College. There is also one city and one County technical high school.

Initiative #1 —Establishment of University of Alabama in Huntsville (UAH)

Background.–The establishment of UAH was the result of the cooperative efforts of the Huntsville City Council, the Madison County Commission, and the University of Alabama in Tuscaloosa. In the early 1950's, evening classes were offered in rooms of the Huntsville school system. Responding to the increasing need for graduate engineering and continuing education programs, the city and county donated land to the university and worked out a financing plan. The first building was opened around 1960. A research institute for pure and applied research also was developed. Today, UAH has not only a full undergraduate curriculum but also a new Center for High Technology Management and Economic Research.

Cost *and* Effectiveness. -Through a combination of community fund raising drives and the issuing of bonds, the city was able to proffer to the university initial financing of $250,000, and $900,000 at a later date.

Transferability. -No contact was made with other cities that had developed or attracted universities.

Federal and State Involvement. -The bond issue for the research institute had to be approved by the State.

Initiative #2—Research Park District/ Cummings Research Park

Background.– In March 1963, the City zoned 3,700 acres as a research park district. (This zone is second in size only to Research Triangle Park). The ordinance provided for a campus-like setting conducive to R&D activities and high-technology manufacturing. UAH is located on 380 acres in this district. Cummings Research Park consists of 1,000 developed acres and is contiguous to UAH, which performs contract research for firms in the park. There are 37 companies in the park, including IBM, Teledyne, Boeing, and GE, with a total of 11,000 employees. These firms are 75 percent nondependent on defense. Almost all, however, are strictly related to the electronics industry in one fashion or another. The city recently purchased 750 acres to expand the park and will offer sites at reasonable prices. Incubator space is being considered.

Cost *and Effectiveness.*–*The* city paid for the 750 acres out of general funds and will also issue bonds.

Transferability. –The city was aware of Research Triangle Park.

Federal and State Involvement.—Possible use of U.S. Economic Development Administration (EDA) funds for site improvement.

Initiative #3—Huntsville-Madison County Jetplex Foreign-Trade Zone/Industrial Park

Background.-1n February 1983, 1,300 acres at the airport became a Foreign Trade Zone (FTZ) after 3 years of community wide effort to obtain this designation. The airport authority is the sponsor and manager. Companies may also apply for subzone status, which would give them the advantages of the FTZ without having to move to the airport.

cost and Effectiveness.-Not applicable.

Transferability. –FTZS (duty-free areas) are considered attractive to electronics companies, especially those that use high value foreign components in their manufacturing processes. Lower duty is paid in an FTZ, and if finished products are shipped outside of the United States, no duty is paid at all.

Federal and State Involvement.–U.S. Department of Commerce's approval of FTZ status.

Initiative #4—Von Braun Civic Center

Background. —In 1975 Huntsville built the Von Braun Civic Center. It contains a 9,000-seat arena, an exhibit hall, a playhouse, a concert hall, and an art museum. The city was attempting to develop the amenities that it lacked and that were important to the research and engineering population brought to the area by high-technology operations. Such amenities were felt to be important to the long-term growth of the city's high-technology base. The Huntsville Symphony Orchestra, Broadway shows, ballets, and professional touring companies appear regularly in the Civic Center.

Local Organizations Working on High-Technology Initiatives

Huntsville Chamber of Commerce
Telephone: (205) 533-4141
Contact: Mr. Bruce Smalley

Huntsville Planning Department
Telephone: (205) 532-7353
Contact: Mr. Dallas Fanning

Phoenix, Ariz.

High-Technology Related Bases in the Local Economy

High-technology employers in the Phoenix area include Motorola, Honeywell, Digital Equipment, Sperry Flight Systems, Goodyear Aerospace, and GTE Automatic Electric. Hughes Aircraft recently began construction of a major aerospace facility in the Phoenix area. Arizona State University provides a broad variety of technical degree programs and has conducted contract research for local industry.

Initiative #1 —Excellence in Engineering for the 1980's

Background. —In late 1979, officials at Arizona State University (ASU) and the Phoenix Metropolitan Chamber of Commerce began to work together with Phoenix industry to improve engineering education at ASU. The steering group for this effort was the Advisory Council for Engineering (ACE), representing over 40 Phoenix-area companies. ACE developed a 5-year plan known as "Excellence in Engineering for the 1980's," which pro-

vialed recommendations concerning engineering education and facilities at ASU. ACE also acted as an advocacy group, meeting with the Governor and key State legislators to obtain funding for needed improvements at ASU. The 5-year program emphasizes six areas of learning that are of interest to Phoenix industry: computers, computer-aided processes, solid state electronics, thermo sciences, transportation, and energy.

Cost *and* Effectiveness.-A number of the goals in the 5-year plan already have been achieved, notably the creation of 60 new faculty positions at ASU and the construction of a 5-story, 120,000-square-foot (ft^2) research facility on the ASU campus known as the Center of Excellence. The Center of Excellence is to be completed in October 1983 and will house joint university/private industry research efforts, The total budget for the 5-year plan is $32 million.

Transferability.—Many communities and universities are aware of what has been accomplished at ASU.

Federal and State Involvement.—The State is the major source of funds for this initiative. However, it is expected that local private industry in the Phoenix area will contribute approximately $20 million to equip the new research center.

Initiative #2—Zoning and Planning

Background.-The Phoenix Metropolitan Chamber of Commerce is very aware that high-technology companies typically want to locate new manufacturing facilities in attractive surroundings. In order to ensure a good supply of esthetically pleasing industrial sites, the Chamber has established a committee to review Phoenix's current zoning ordinances. The committee hopes to persuade City officials to expand the number of industrial zoning districts to include a high-quality research park district with more restrictive design standards.

Cost and Effectiveness.–Staff time is the only cost associated with this effort. It is too early to judge the committee's effectiveness since it was just recently formed.

Transferability.– None.

Federal and State Involvement.—hJone.

Initiative #3—U.S. Small Business Administration Loan Program

Background.-The city of Phoenix makes loans to small business under the section 503 program of the U.S. Small Business Administration (SBA). The city conducts credit analyses, and packages and makes loans to businesses with a net worth of about $6 million for fixed-asset purchases. About 20 percent of these loans are made to suppliers to area high-technology companies. The city sells debentures to finance the program, as well as using Community Development Block Grants (CDBG) funds.

Cost *and Effectiveness.*–The total budget for the overhead of the operation is $250,000 per year. None of the loans made have been lost.

Transferability. —Tucson and several other cities have similar programs.

Federal and State Involvement.—The Federal government has been involved through the SBA. CDBG and Urban Development Action Grant (UDAG) funds have also been used to finance portions of several deals,

Local Organizations Working on High-Technology Initiatives

Office of Community Services
Telephone: (602) 262-6004
Contact: Mr. Brian H. Aby

Phoenix Metropolitan Chamber of Commerce
Telephone: (602) 254-5521
Contact: Mr. Walter Caddow

San Diego, Calif.

High-Technology Related Bases in the Local Economy

A number of high-technology companies have operations in the San Diego area, including Hughes Aircraft, General Dynamics, Cubic, General Atomic, NCR, Teledyne, Burroughs, and others. The University of California-San Diego is a major research institution and is one of several campuses in the system designed to be strong in technological fields. There are also several other universities in the area offering programs in engineering and science.

Initiative #1 —Attraction of the University of California

Background.–In the 1960's, when the University of California was developing new campuses around *the* State, the city of San Diego donated land to the university as an inducement to the State to locate a major

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branch in the city. The University of California-San Diego was designed as a science-intensive institution from its inception. The city also developed roads, sewers, and water systems in the area.

Cost and Effectiveness.–Since the city already owned the land **from a** Spanish land grant, the only cost associated with the donation was the opportunity cost of the property. The cost of local utility and road improvements were also borne by the city.

Transferability. –The quantities of land that the city owned are somewhat unique. For this reason, transferability is limited.

Federal and State *Involvement.–The* State was responsible for the construction and staffing of the university.

Initiative #2—Research Parks

Background. -At the time the university was built, the city planned the surrounding land that it owned for compatible uses. One of these uses was research parks for companies that wanted locations near the university. The city prepared the appropriate zoning laws, developed several parks, and managed and sold the land through its property department.

Cost and Effectiveness.—The cost was only for site development. The first development, Torrey Pines Science Park, is now almost fully developed and houses such organizations as the Salk Institute, General Atomic, Aerojet General, and others. The newer Campus Point Research Park is now about two-thirds occupied by research operations of local, national, and international companies.

Transferability .–The city is aware of research parks in other cities.

Federal and State Involvement.—None.

Initiative #3—Land Development and Sale

Background.-The city has developed additional property from its land-grant holdings for sale to private industry. Though so-me cost discount was offered to the purchasers in some cases, the principal advantage was the availability of fully developed sites in attractive areas.

cost and Effectiveness.–The opportunity cost of any discounts given were the only identifiable costs of the initiative. Such companies as Cubic and General Dynamics have acquired these properties.

Transferability. –The large quantities of land owned by the city are unique.

Federal and State Involvement.—None.

Initiative #4—Marketing Program

Background. -At various times over the past 20 years, the city, council of governments, chamber of commerce, and the Economic Development Corp. have conducted studies to determine the types of industries that would find a San Diego location attractive and developed marketing programs to attract them. The most recent of these studies, known as "Operation Bootstrap," was completed in the late 1970's. Generally, these programs have focused on such high-technology industries as electronics, aerospace, and biomedical products.

Cost *and Effectiveness. -Staff* time and organizational budgets are the principal costs. Numerous companies locating in the area have worked with these development organizations, including NCR, Sony, and others.

Transferability. –The staff of the Economic Development Corp. is well aware of the marketing programs run by other cities with which it competes.

Federal and State Involvement.—None.

Local Organizations Working on High-Technology Initiatives

Department of Planning, City of San Diego
Telephone: (619) 236-6450
Contacts: Mr. Michael Stepner, Assistant Planning Director and Mr. Tim O'Connell

San Diego Economic Development Corp.
Telephone: (714) 234-8484
Contact: Ms. Jane Signiago-Cox

Colorado Springs, Colo.

High-Technology Related Bases in the Local Economy

The military presence in Colorado Springs is considerable. Besides the U.S. Air Force Academy, North American Air Defense (NORAD) headquarters, Peterson Air Force Base, and Fort Carson, the Air Force's new Space Command located there last year. The Consolidated Space Operations Center (CSOC), for which Congress has allocated $67 million, is expected to be fully operational by 1987.

'Eighty percent of the manufacturing base in the city is composed of electronics firms, and Colorado Springs has established ties with venture capital firms in the San Francisco Bay Area. Ford Aerospace plans to add a $100-million complex to its current facility because of CSOC

and NORAD. An advisory council made up of local electronics executives helps the Engineering School at the University of Colorado at Colorado Springs (UCCS) to develop its curriculum. NCR Microelectronics has donated an integrated circuits laboratory to the university.

Initiative #1 —Targeted Marketing Efforts

Background.-The chamber of commerce's economic development department was established in 1970, when it prepared a study that identified high-value, low-bulk products as being most appropriate for manufacture in Colorado Springs. Many high-technology products have these characteristics.

Cost *and* Effectiveness.-The high percentage of electronics firms in the city is indication of the effectiveness of this initiative.

Transferability .–The chamber was aware of other cities' marketing efforts.

Federal and State Involvement.–None.

Initiative #2—University of Colorado at Colorado Springs

Background. -In 1965 a campus for UCCS did not exist. Over the last 10 to 15 years, the chamber and existing industry have lobbied for university development. Since 1976, there has been an even more determined push with incremental goals. The UCCS Task Force, made up of local business leaders who volunteer their time, came into being 2*/2 years ago.

Cost *and Effectiveness. -It* is expected the UCCS will be designated a research university in early May, with doctoral programs in electrical engineering and computer science. UCCS also hopes to receive funding for a new engineering building.

Transferability .–No other cities which attracted universities were studied.

Federal and State Involvement.–The State awards the designation of research university. State funds also are involved.

Initiative #3—institute for Business and Industrial Technology (IBIT)

Background.-The idea for this skills center, which has been in operation for a year, emerged when the community perceived the need for an educational facility that could change rapidly with high-technology employers' needs. It trains qualified students to fill entry-level technical positions, and there are currently 150 students in the standard electronics curriculum, which provides the equivalent of a 2-year associate science degree in only 11 months. The title to a condemned school building was given to the city. The city then applied for Federal grants for rehabilitation purposes. IBIT is staffed by employees of the city's Industrial Training Department, and the city also provides services in kind for the Institute. There is no rent, and the city provides the funds for day-to-day operations.

Cost *and* Effectiveness.-The Institute was funded by Comprehensive Education and Training Act (CETA) funds until October 1983, when the Job Training Partnership Act took over. Federal funds are used for instructors, textbooks, training supplies, and equipment. Some equipment has been donated by local industry as well. When Texas Instruments needed optical fabricators, IBIT was able to set up a program quickly. Equipment was purchased and instructors were hired from Texas Instruments' headquarters in Dallas.

Transferability.—Skills centers in other cities were visited, but the local tax base in those cities would not have provided for the extremely up-to-date facilities in Colorado Springs.

Federal and State involvement.–Heavy Federal involvement—the city said it could not have created this facility without Federal funds.

Local Organizations Working on High-Technology Initiatives

Economic Development Department
Colorado Springs Chamber of Commerce
Telephone: (303) 471-8183
Contact: Mr. Frank O'Donnell

Industrial Training Department
City of Colorado Springs
Telephone: (303) 578-6870
Contact: Mr. Michael St. Clair

Brevard County, Fla.

High-Technology Related Bases in the Local Economy

Cape Canaveral, first developed by NASA in 1957, profoundly affected the subsequent development of Brevard County. Firms that originally came to the area to be close to the Cape (encouraged by NASA, as had been the case in Huntsville) now have worldwide markets. Members of the high-technology community in Brevard County include Dictaphone, Collins Avionics, and Documentation. In 1978, Harris Corp. moved its headquarters to Melbourne to be closer to its high-technology facilities located there. However, there are no local seed or venture capital funds.

Years ago, Kennedy Space Center offered an interactive audiovisual program called the Graduate Engineering Education System (GENESYS) with worksite classrooms from which students can tune into courses anywhere in the State. GENESYS has recently been reinstituted with State and private funds, and Harris Corp. currently uses it. To encourage more sophisticated training and continuing education for those in high-technology fields, the University of Central Florida (UCF) has opened the Lifelong Learning Center on the Brevard Community College campus. Students attend Brevard Community College for 2 years and then, if they wish, complete their junior and senior years at UCF's Brevard campus. Five master's programs will be offered.

Initiative #1—Melbourne Airport Authority "Incubator Facilities"

Background.—The naval air station installation in Melbourne was deeded to the city in 1947, and in 1951 Federal legislation permitted the facilities to be used for purposes other than those considered airport-related. The Melbourne Airport Authority saw this as a means of increasing revenue. For over 20 years, the barracks were rented at reasonable rates to fledgling businesses, a number of which were high-technology oriented. Radiation, Inc., a company later merged with Harris Corp., got its start in the barracks, as did Opto-Mechanik. Although most of the original buildings have been demolished, several firms still claim the airport as home, including Hetra Computer & Communications and Campbell Optics. Florida Institute of Technology (FIT), currently celebrating its 25th anniversary, also was born at the airport, and today several high-technology executives are on FIT's board of trustees.

Cost and Effectiveness.–The low cost space has helped a number of local firms with innovative products get started, and the airport authority recovers its costs through rental income.

Initiative #2—Labor Needs Survey/ Educational Task Force

Background.—In 1982, the Brevard Economic Development Council, Brevard Community College, and other groups conducted a "Labor Needs Survey. " Firms in Brevard County were asked to project their labor requirements through 1986. An outgrowth of the survey is the new educational Task Force, whose purpose is to encourage dialoge between industry (especially the high-technology segment) and education. The Melbourne Area Committee of 100 (an economic development unit associated with the chamber of commerce) spearheaded this effort, and the volunteer task force members represent FIT and other educational institutions (Brevard Community College, UCF, and the branch of Rollins College at Patrick Air Force Base), the Brevard Economic Development Council, and industry leaders.

Cost and Effectiveness.-The Labor Needs Survey was well received—there was an 80-percent response rate, with large high-technology firms accounting for much of this—and the results of the survey served as a catalyst for further improvements of technical training and development.

Transferability.–Familiar with the output of educational task forces in other parts of Florida.

Federal and State Involvement.–None.

Local Organizations Working on High-Technology Initiatives

Brevard Economic Development Council
Telephone: (305) 453-9519
Contacts: Mr. John McCauley, Executive Director, and Mr. Bruce Ingram (located at Melbourne Chamber)

City of Melbourne
Telephone: (305) 727-2900
Contact: Mr. Edward Washburn, on retainer with the city as city planner

Melbourne Airport Authority
Telephone: (305) 723-6227
Contact: Mr. Edward Foster, Director

Orlando, Fla.

High-Technology Related Bases in the Local Economy

The University of Central Florida (UCF) will soon have an endowed chair in Computer Science, the fourth such chair in the United States (Yale, Harvard, and MIT have the other three). About 90 percent of the graduates of UCF remain in the area, which is home to half of all the engineers in Florida.

The world headquarters of GE Robotics is in Orlando. Martin Marietta, which already has an older facility in the area, plans to open a new plant in Orlando devoted to research and manufacturing of laser optics and microcircuits. Westinghouse opened the world headquarters of its Steam Turbine Generator Division in Orlando in 1983.

Though there is a shortage of venture and seed capital, the community does not view this as a serious problem.

Initiative #1 —Central Florida Research Park

Background. —In 1978-79, the State passed legislation enabling counties, in conjunction with universities, to form research park authorities. Orange County and UCF petitioned the Florida Research and Development Commission, the petition was approved, and the Orange County Research & Development Authority was formed. This five-person volunteer body, which oversees the park, is chaired by the provost of UCF, and its executive director is on a leave of absence from UCF.

The park is to the south of the university and is also close to the new Westinghouse and Martin Marietta facilities. It consists of 1,440 acres, 250 of which are completely developed. It is not solely high-technology oriented: any company, small or large, with research needs and/or capabilities in various disciplines is a candidate. The key to the park is the university/industry link, but the cooperation of the county has been important in its development. For example, it has permitted the park to contract with the university to use UCF's excess sewage treatment capability. At some future date, when county treatment facilities are improved, the park will use those facilities.

Cost *and Effectiveness.* –The park is a privately financed venture. Some of these funds are borrowed and will be paid back by the park. The acreage will be sold or leased except for one parcel of land owned by the university, which will be leased on a long-term basis.

Ground soon will be broken for two incubator buildings, and a third one is scheduled. These facilities are being planned and financed by a group of Boston developers.

The American Electroplates' Society will establish its new world headquarters in the park. The authority has also granted 40 acres to the Naval Training and Equipment Center (NTEC)—an R&D facility for training devices—and the Navy plans to invest $25 million in a facility of up to 300,000 ft^2. The project will be funded in October 1984.

Transferability. –Research Triangle Park was studied, as were parks at MIT, Stanford, and Princeton.

Federal and State Involvement.–The Federal Government is involved only as an occupant of the park. The State passed the enabling legislation and is involved through the university.

Local Organizations Working on High-Technology Initiatives

Industrial Development Commission of Mid-Florida, Inc.
Telephone: (305) 422-7159
Contact: Mr. Roy L. Harris, Executive Vice President

Central Florida Research Park
University of Central Florida
Telephone: (305) 275-2275
Contacts: Dr. Ralph Gunter, Executive Director, and Mr. Ben E. Whisenant, Director of Marketing

Chicago, Ill.

High-Technology Related Bases in the Local Economy

The Chicago area is the home of several major universities (University of Chicago, Northwestern University, Illinois Institute of Technology, University of Illinois at Chicago, and others), well-known medical centers (Rush Presbyterian –St. Lukes Medical Center among them), two major Federal research installations (Fermi and Argonne National Labs), and the headquarters of numerous technology-based companies in pharmaceuticals (Baxter-Trevenol, G. D. Searle, Abbott Laboratories and

American Hospital Supply), communications and electronics (Motorola, GTE Automatic Electric, Zenith, Gould), and chemicals and petrochemicals.

Initiative #1 —Mayor's Task Force on High-Technology Development

Background .-The task force was established in August 1981 by Mayor Jane Byrne to "advise the City how it could attract and develop high-technology growth industries in the Chicago area [and] develop strong links among the city administration, the region's universities, industries, and research and development centers." Dr. Walter E. Massey, director of Argonne National Laboratory, was chairman of the task force with membership from government, industry, and academia. In May 1982 he also was named to the city's Economic Development Commission.

The final report of the task force, submitted in October 1982, presented 10 detailed recommendations, including the development of a seed capital corporation; improvements in precollege math and science programs; increased cooperation between universities and industries; and the importance of a welcoming attitude on the part of the city. It also targeted four growth fields especially suitable for the area. Since then a plan for the implementation of these recommendations has been developed at the request of the Mayor and the Governor.

Cost *and Effectiveness.* –The time and effort of members of the task force were volunteered. Word processing facilities at Argonne were used (pro bono) so that all the city paid for was the printing of the report. The task force has resulted in increased public awareness and media attention to high technology, and it has encouraged new linkages between various sectors of the city's economy.

Transferability. —The idea for the task force was proposed by an alderman at a City Council meeting.

Federal and State Involvement.–The chairman of the task force was a Federal employee. Also, certain members of the Task Force worked closely with members of Governor Thompson's High Technology Task Force, since the city and State were working toward the same ends.

Initiative #2—High-Technology Development Unit, Chicago Department of Economic Development

Background. –This city unit was formed in October 1981 as a staff initiative for the task force. It serves as a clearinghouse for all sorts of high-technology news and happenings in the city and as a catalyst for other high-technology programs. It publishes a bimonthly newsletter, the "Chicago Tech Connection," focusing on pertinent topics, interviewing area entrepreneurs, and listing available Chicago resources. It is sent to members of the Chicago High Tech Association, which has recently been formed under the auspices of the department of economic development. The association also will host bimonthly luncheons.

Cost and Effectiveness.-The unit is funded by the city budget, and the allotted funds cover staff salaries. Various expenses of the unit come under the aegis of other city departments. Since the publication of the first newsletter in January 1983, the unit has been receiving phone calls continually, asking to see a sample copy of the newsletter and requesting information about the association. The association already has over 100 members.

Transferability. –The city is not aware of another city having a unit similar to this one.

Federal and State Involvement.–None.

Initiative #3— Biomedical Research Park

Background.–The University of Illinois, the city, and the State are cooperating in a joint venture to acquire 46 acres of land (mostly vacant) adjacent to the University's near west side campus and its newly opened genetics research center. The site is planned as a high-technology research park, including a building formerly owned by the Chicago Medical School, which will be developed as an incubator facility. The university's architectural school will do the landscaping of the Park.

Cost and Effectiveness.-About 85 percent of the land area of the park is in the custody of the city and the Chicago Medical District Commission (CMDC). The City will turn over its share to CMDC, which has the power of eminent domain over areas close to the University of Illinois at Chicago. It is expected that the State legislature will turn the title to the Chicago Medical School building over to the university for use by entrepreneurial firms. In a sense, the CMDC will be the manager of the park. The city plans to apply for $11 million in U.S. Department of Housing and Urban Development (HUD) and EDA funds to be used for site planning and infrastructure development.

Applied Molecular Genetics, Inc. (AMGen), a California-based biotechnology firm, plans to break ground soon for a pilot plant. AMGen chose Chicago because of its central location and proximity to scientific and medical centers and also because of city and State support. Both the city and State have worked closely with AMGen to secure a $2-million UDAG and an $8-million Industrial Revenue bond (IRB) (guaranteed by Continental Bank). The city has received many other inquiries about the proposed incubator space, where firms would have to make lease-hold improvements but would have ready access to all the normal funding mechanisms and training programs of the city and State.

Transferability. -The city studied and/or visited research parks in Philadelphia, at the University of Utah, and the Incubator Space Project at Rensselaer Polytechnic Institute in Troy, N.Y. The Task Force Report suggests Control Data Corp.s Business and Technology Centers as models for incubator facilities. The high technology unit has received a number of phone calls from neighboring States regarding the new research park.

Federal *and State* Involvement.–Federal funds have been and will be employed as stated above. CMDC is a State-level entity, with members appointed by the Governor.

Local Organization Working on High-Technology Initiatives

High Tech Development Unit,
Chicago Department of Economic Development
Telephone: (312) 744-3911
Contact: Ms. Linda Darragh, City Planner

Montgomery County, Md.

High-Technology Related Bases in the Local Economy

Montgomery County, Md., has a high concentration of medical science installations, including the National Institutes of Health (NIH), the Food and Drug Administration, the National Library of Medicine, and the Naval Medical Center. NIH alone employs 13,000, and it has awarded 21 percent of its total R&D contract budget to Montgomery County firms. Access to major educational institutions is easy—for example, Johns Hopkins, Georgetown University, and the University of Maryland, which provides an applied molecular biology program.

The Department of Economic Development has been courting high-technology actively since 1978. Its goal is to encourage existing high-technology firms (40 percent of firms in the County) and to attract new companies. The majority of new high-technology jobs have come from the expansion of firms already in the county.

Initiative #1 —Shady Grove Medical Park

Background. -Shady Grove Medical Park is a 230-acre medically oriented science park. The inner core, 60 acres, is devoted to a hospital, an ambulatory care facility, and a psychiatric institute—all private institutions that are currently in operation. The outer area is intended for medically oriented companies engaged in R&D or manufacturing. The University of Maryland may establish a health research facility in the park.

Cost *and* Effectiveness.-The county owned this land, and county funds were used for its development. The land will be leased below market rate to companies who build in the Park. These companies will have access to IRBs, as well as loan guarantees from the Maryland Industrial Development Financing Authority. The county currently is negotiating with four companies that may locate in the Park.

Transferability.–A number of counties in Maryland are interested in Shady Grove, and they hope to develop a similar type of area. Local officials recently traveled to New Jersey to inspect Scanticon Princeton, a conference center and hotel located in the Forrestal Center. This type of facility is being considered for Shady Grove.

Federal and State Involvement.–No Federal involvement. The State is involved only in the sense that the normal State financing mechanism is available to those building in the Park.

Initiative #2—Upgrading Skills Training Program/Corporation for Technical Training

Background.-The Upgrading Skills Training Program is run by the Department of Economic Development with CETA/JTPA funds. It involves all types of firms, high-technology included. It identifies firms that need to upgrade their employees' skills and then works with the company to design a curriculum and select employees for the program. Half of the time is spent in a classroom and half on the job. Once the employee has been upgraded, the county will refer a eligible client to fill the vacated position.

The Corporation for Technical Training (CTT) is a quasi-public corporation whose board of directors, a$_p$-pointed by the county executive, includes man$_y$ executives of high-technology firms. CTT's mission is to design and implement training programs that would expand *the* high-technology labor force. CTT will contract with various educational institutions in the area to provide the actual training. These programs were supplemented in

December 1983 by the creation of the Technical Occupations Employment Group (TOEG), a private nonprofit labor exchange program. Using computers, TOEG tests applicants for general and math skills and refers them to high-technology firms that are seeking new employees.

Cost and Effectiveness.–Instructors are paid by the county. The budget for the CETA/JTPA program depends on the needs of the companies. This program has been operational for a year and appears successful, The budget for the first year of the CTT is $230,000, and that of TOEG is $410,000.

Transferability. -In terms of the CTT, the County did not study other areas.

Federal and State Inolvement.–JTPA funds the "Upgrading Skills Training Program," and funds for the CTT come from the JTPA, the State, the county and, eventually, from the private sector. TOEG's budget comes from matching county and State funds.

Additional Comments

It is debatable whether Montgomery County's communication/marketing efforts should be classed as a high-technology initiative since they are similar to many communities' normal marketing approach. However, they are definitely geared toward high-technology and should be mentioned because of their innovative features.

Of the county's total economic development budget of $650,000, some $140,000 is allotted for marketing. One month of advertising in other areas is followed by a direct mail campaign, with respondents receiving a booklet on "High Tech Business Opportunities in Montgomery County, Maryland." The Department also visits existing firms frequently and conducts a tour of the county every 2 years for high-technology executives (the executives pay their travel expenses).

An annual Consensus Conference held in May allows corporate executives in the county to air their problems; two of the major issues at last year's Conference were training and the lack of venture capital. The county has been working with local and regional banks since then to try to arrange some help. There is also a plan to create a science advisory board to provide a forum for informal communication between the County and the scientific community.

Local Organization Working on High-Technology Initiatives

Montgomery County Department of
Economic Development
Telephone: (301) 251-2345
Contact: Mr. Duc Duong, Assistant Director of
Economic Development

Lowell, Mass.

High-Technology Related Bases in the Local Economy

Lowell's promixity to Boston's Route 128 and the academic institutions in the Boston area is a key factor in its high-technology strategy. Another resource is the University of Lowell, formed in the 1970's through the merger of the Lowell Technological Institute and the Lowell State Teacher's College.

Initiative #1 —Wang World Headquarters Decision

Background. -In the mid-1970's, the most serious issue facing the city of Lowell was the fact that two-thirds of its industrial property was vacant. Several things occurred as a result of this problem. A new city manager was hired, one from outside the area with no political ties. The city's Department of Planning and Development was formed and now has a staff which is the second largest in the State. With the support of this department, the city manager recruited Wang. The company opened a small manufacturing facility in Lowell because of the low cost of the land. In 1978, when Wang was deciding on its world headquarters location, Lowell responded and eventually convinced the company to locate there.

Cost and Effectiveness.—Wang chose Lowell for two reasons. The city obtained a $5-million UDAG, which was loaned to Wang at 4-percent interest. Wang was also impressed with the city's Department of Planning and Development, whose staff of 32 reduced red tape for the company and convinced it that development would be attractive and orderly. Since Wang opened in the area, many support industries have also sprung up with 30 to 100 employees each. There is currently no vacant industrial land, and the city is considering rezoning. In May, Wang will begin construction of a $10 million research training center in downtown Lowell, in addition to its two 12-story office buildings and 250,000-ft^2 manufacturing facility.

Transferability.–Lowell was aware of the tremendous potential and activity in the nearby Boston area and deliberately set out to tap it,

Federal and State involvement.–The Federal Government was the source of the $5-million UDAG. There was no State involvement.

Local Organization Working on High-Technology Initiatives

Department of Planning and Development
Telephone: (617) 454-8821
Contact: Mr. James Cook

Minneapolis-St. Paul, Minn.

High-Technology Related Bases in the Local Economy

The Twin Cities are the home of such major computer manufacturers as Honeywell, Control Data, and Cray Research. Other technology-based companies headquartered in the area include 3M and Medtronic. These larger firms have spun off many smaller ones that are still located in the area, most recently ETA, a supercomputer firm. Roughly 34 percent of the area's manufacturing employment is high-technology oriented. Several venture capital companies operate in the area, and the University of Minnesota and local private colleges offer many technical programs. The area is noted for its activist business leaders and a history of successful public/private partnership.

Initiative #1 —Blue Ribbon Task Force on Research and Technology

Background. -This task force, appointed by Minneapolis Mayor Donald Fraser, was composed of business executives, venture capitalists, bankers, and others. Its mandate was to design a program to increase the high-technology component of the city's economy. Among the recommendations in its report, published in August 1983, was the creation of a high-technology park with additional incubator facilities and low-cost office space for small firms.

As a result of the task force recommendations, Minneapolis has just completed the development plan for Technology Corridor, a 60-acre riverfront site between the downtown area and the University of Minnesota. The area contains many underutilized buildings that, once renovated, would be appropriate for startups and small growing firms. The Minneapolis Business and Technology Center (BTC, see below) and another private incubator facility are already located in the Corridor, and the city hopes that their "graduates" will remain in the area once their need for special support services is past. In addition, the site is coterminous with a State enterprise zone, which will provide tax and other incentives for existing companies to locate in the Corridor. The city hopes to attract research installations from some of the major high-technology corporations in the region.

Cost *and Effectiveness. -The* task force was composed largely of volunteers, so its cost was modest. Costs for land acquisition and building renovation have not yet been determined but may be considerable. The city has entered into a cooperative, cost-sharing arrangement with the University of Minnesota and also hopes to obtain additional seed money from the State. The project will generate income in the form of rents and tax revenues, but it is too soon to project the eventual return on investment.

Transferability.– Similar task forces have been created elsewhere, and Technology Corridor is similar to initiatives undertaken in Philadelphia to leverage the resources created by the University City Science Center and BTC (see below). These advantages exist in *only* a few other communities.

Federal and State Involvement.–No Federal involvement. The project will take advantage of State enterprise zone legislation and may obtain State funds for site acquisition and preparation.

Initiative #2—Energy Park

Background.—Concerned with the loss of population and employment in the central city, public and private officials in St. Paul saw an opportunity for job creation and economic development in the growing importance of energy-related technologies and the strong high-technology resources of the Twin Cities region. One result was Energy Park, a joint undertaking of the City of St. Paul and the State-chartered Port Authority of St. Paul, on which work was begun in 1981. It consists of218 acres of mixed-use development that includes 950 units of housing, as well as retail, office, and manufacturing space. The buildings include both new and rehabilitated structures, including some 100-year-old railroad repair shops. All of the buildings are designed or retrofitted to be highly energy-efficient, and they are heated and cooled by a central plant whose heat pumps are connected to an aquifer 500 ft beneath the site.

Related development efforts in St. Paul include the Homegrown Economy Program, which provides financial and technical assistance and incubator space to new and existing small businesses that will create quality jobs and diversify the local economy; and the recently announced World Trade Center in downtown St. Paul, in which 10 percent of the building has been reserved as incubator space for small businesses and spinoffs that will generate exports. These efforts emphasize modernization and advanced technology applications, as well as new high-technology products.

Cost *and* Effectiveness. -Public costs of Energy Park total almost $50 million, including two UDAGs totaling $15.5 million and an EDA public works grant of $2.3 million, plus $31 million in IDBs issued by the city and loaned to the Port Authority, which administers the Park. The Port Authority has issued additional IDBs, most of which have been bought by private investors and local financial institutions. Private investment in the park will eventually exceed $100 million.

The park includes a 240,000-ft^2 incubator facility, Control Data's Energy Technology Center, which houses some 20 new companies. One of these is ETA, a firm recently spun off by Control Data to develop supercomputers, which plans to begin construction of its own 200,000-ft^2 building in the park in late 1984. Other technology-related tenants of Energy park include GNB Batteries Inc., a manufacturer of advanced automobile batteries, as well as a number of small computer- and energy-related manufacturing and service companies. The Port Authority hopes that other firms spawned by the Energy Technology Center and the St. Paul BTC (see below) will eventually lease or build in the park, and projects the creation or retention of 6,500 jobs over 5 years.

Transferability.—No other cities' initiatives were studied, but the Port Authority has received inquiries and visitors from a large number of economic development agencies, utility companies, and foreign countries.

Federal and State Involvement.–Federal involvement included an EDA grant and UDAG funds for site acquisition and rehabilitation, as well as tax exemptions for IDBs issued by both the city and the Port Authority. St. Paul's other initiatives have made use of CDBG, UDAG, and SBA loan programs. State funds will be involved in the World Trade Center.

Initiative #3—Business and Technology Centers

Background. —The original Control Data BTC was established in St. Paul in 1979, and the Minneapolis BTC was established in 1982. These incubator facilities are important components of a "job creation network" that provides small enterprises in the Twin Cities with the services and facilities they need to survive. The BTCs themselves are a profit-making venture of the Control Data Corp., but prospective clients are referred to them by the city governments and local banks. They maintain close ties with other HTD organizations, such as the Minnesota Cooperation Office and the Minnesota Seed Capital Fund, and they provide a necessary foundation for subsequent business development initiatives like StarCo and Project Innovation (see ch. 5).

Cost and Effectiveness.-The St. Paul BTC consists of two existing buildings that were purchased and renovated by Control Data without financial assistance from the city, the first containing 200,00062 of mixed office and manufacturing space and the second 100,000 ft^2 of manufacturing space. The Minneapolis BTC contains 200,000 ft^2 of mixed-use space in a building that was also purchased and renovated without public funds. The space is leased to small new enterprises, and Control Data provides the tenants with shared services, including computer time and technical assistance as well as utilities and maintenance, at reasonable rates.

These BTCs have proven to be highly effective in promoting the survival and growth of small entrepreneurial firms. The St. Paul BTC has helped to create 126 new companies representing over 1,000 new jobs. While as many as 80 percent of all new businesses fail in the first 5 years, the survival rate for St. Paul BTC clients is 88 percent over the same period. The Minneapolis BTC is fully occupied after less than 2 years and has already helped to launch 113 new companies. The majority of tenants in both BTCs are service companies.

Tranferability.–These efforts have been widely and successfully replicated. BTCs have already been established in 10 other U.S. cities, including Philadelphia (see below), Toledo, and Baltimore. The BTC in Charleston, S. C., has in 2 years helped to launch over 100 new firms, most of them minority owned. Control Data plans to open as many as 13 additional BTCs during 1984. Many universities and communities have established similar incubator facilities, often citing the BTCs as their models (see above and ch. 3).

Local Organizations Working on High-Technology Initiatives

City Planning Department
City of Minneapolis
Telephone: (612) 348-2576
Contact: Mr. Philip Meininger

Port Authority of the City of St. Paul
Telephone: (612) 224-5686
Contact: Mr. Ken Dzugan, Project Director

Division of Business Revitalization
Department of Planning and Economic Development
City of St. Paul
Telephone: (612) 292-1577
Contact: Mr. Alan D. Emory, Deputy Director

Business and Technology Centers
Control Data Corp.
Telephone: (612) 853-8802
Contact: Mr. Wilbur D. French, Vice President

Albuquerque, N. Mex.

High-Technology Related Bases in the Local Economy

Sandia Laboratories, a federally funded research facility, started operations in the early 1950's and currently employs 7,000 people, of whom 3,000 have advanced degrees in physics, chemistry, and electrical engineering. Other high-technology employers in the Albuquerque area are GTE Lenkurt, Sperry Flight Systems, Intel, Signetics, and Motorola. Albuquerque is the home of the University of New Mexico, which has a total enrollment of 23,000 students and provides technical degrees in a number of fields.

Initiative #1 —Venture Capital Conference

Background.–Albuquerque officials were disturbed by the number of companies that have started up locally and then have had to relocate to get venture capital. One example of such a company is Microsoft, which is now a multimillion dollar operator. To counteract this trend, the Albuquerque Industrial Development Service (AIDS) identified sources of venture capital available locally (only two or three) as well as sources in other parts of the country. Last year, AIDS cosponsored a conference on venture capital funding that was attended by 25 to 35 local entrepreneurs who listened to presentations by a number of persons involved in venture capital financing.

Cost and Effectiveness. -Minimal cost. While no deals were struck at the venture capital conference (this was not its purpose), it did serve to acquaint local business interests with the financing opportunities available. AIDS has no plans to sponsor a similar conference in the future but plans to work on an individual basis with companies seeking this type of financing.

Transferability. -AIDS is aware that other communities have sponsored conferences of this type, but did not specifically seek the advice of other communities.

Federal and State Involvement.–Former U.S. Senator Jack Schmitt gave the keynote address at the venture capital conference.

Initiative #2—incubator Space

Background. -AIDS owns a 40,000-ft^2 building which it leases at below market rates to encourage development of new or expanding industry. In the past the facility has been used primarily as temporary quarters by such high-technology companies as Motorola and EG&G. A new company planning to manufacture wind-driven energy devices (a Sandia Labs spinoff) began leasing 5,000 ft^2 in May 1983.

Cost and Effectiveness–AIDS has owned its building since 1962, so the only ongoing costs are for insurance, property taxes, and utilities. When the building is fully occupied, the organization breaks even on expenses. AIDS is pleased with the building since it provides one more way that it can accommodate the needs of new and expanding industry. Discussions have been held about building more space, but this has met resistance from local real estate developers who do not want additional competition.

Transferability.—AIDS has not investigated incubator buildings in other communities, nor have other communities inquired about its space.

Federal and State involvement.—None.

Local Organization Working on High-Technology Initiatives

Albuquerque Industrial Development Service
Telephone: (505) 842-0400
Contact: James A. Coven

Binghamton, N.Y.

High-Technology Related Bases in the Local Economy

The Binghamton area contains a number of high-technology companies, including IBM, General Electric-Aircraft Equipment Division, Singer-Link Division, and Universal Instrument. In addition, Savin Co. opened a new facility in the Binghamton area in 1981. The State University of New York (SUNY) at Binghamton began offering a master's degree program in electrical engineering in fall 1983.

Initiative #1 —High Technology Council

Background.–The Broome County Chamber of Commerce formed the High Technology Council in 1980. The council is composed of representatives from local government, private industry, educational institutions, and other organizations. The chamber of commerce serves as staff for the council. The main thrust of this group has been to improve educational opportunities for engineers in the Binghamton area. The council found that development of local graduate engineering training was the area's biggest need in order to retain, expand, and attract high-technology employment. The council commissioned a study by the National Center for Higher Education Management Systems to verify the area's need and worked actively at the State level to obtain approval and funding of the engineering program at SUNY-Binghamton.

Cost and Effectiveness.-SUNY-Binghamton began offering a master's degree in electrical engineering in fall 1983. Local employers are pleased that the program was approved and that the State legislature reacted so quickly to the area's need. By 1987, it is expected that SUNY-Binghamton will award master's degrees in mechanical and industrial engineering, and provide the last 2 years of engineering training at the undergraduate level.

Transferability.–The High Technology Council is aware of efforts by other communities to attract and retain high-technology employment. Specific areas investigated included Long Island, N. Y., and Raleigh, N.C.

Federal and State Involnement.–State funds will provide the bulk of money for the engineering program at SUNY-Binghamton. Local industry also plans to donate funds and equipment to the engineering program.

Initiative #2—incubator Space

Background.–A 27,000-ft² incubator facility has been in operation in the Binghamton area since the mid-1970's. The building is owned and operated by the Broome Country Industrial Development Agency, a unit of county government. The building, formerly a bowling alley, was donated to the county by a local company and has been used to foster growth of emerging high-technology businesses and to serve as temporary quarters for companies locating in the Binghamton area. The county has used two low-interest revolving loan funds to provide financial assistance to building occupants.

Cost and Effectiveness.–Local officials are pleased with the success of the incubator building. Two high-technology-related companies employing a total of over 200 workers have been developed in the facility and now are operating independently. The building currently is occupied by four companies, three of which are high-technology-related.

Transferability.–Binghamton's incubator facility has been publicized in economic development journals and has been investigated by other communities.

Federal and State Involvement.—The county received a grant from EDA to modify the building for industrial use. EDA funds were also used to establish one of the county's low-interest revolving loan funds. Appalachian Regional Commission funds were used to establish the other loan fund.

Local Organizations Working on High-Technology Initiatives

Broome County Chamber of Commerce
Telephone: (607) 772-8860
Contact: Mr. Hal Kammerer

Broome Country Industrial Development Authority
Telephone: (607) 772-8212
Contact: Mr. Peter Kay

Cincinnati, Ohio

High-Technology Related Bases in the Local Economy

Cincinnati is the home of Cincinnati Milacron, a leader in the robotics industry, and General Electric has its jet engine operations in the area. The University of Cincinnati offers a variety of technological degrees. The U.S. Environmental Protection Agency (EPA) also has a major research facility in the area.

Initiative #1 —Cincinnati Venture Capital Fund

Background.–In October 1982, the city asked for and received a grant of $150,000 from the Gannett Foundation (the *Cincinnati Enquirer is* a Gannett paper). The city will contribute at least $50,000 (using CDBG funds) and, combined with the Gannett grant, this will provide the startup for a venture capital pool. A blue ribbon committee hopes to raise an additional $15 million in private funds. The venture capital fund will be private once in operation.

Cost *and* Effectiveness.-The cost to the city will be at least $50,000. It is felt the fund will be most effective on a private basis. It will lend capital wherever deemed appropriate, anywhere in the country, but will encourage recipients to explore the possibility of moving to Cincinnati with potential investments. The board of directors will be made up of knowledgeable people from the private sector. The chamber and the city will have direct input.

Transferability.–Minnesota's program was studied, though it was decided that a State fund was too restrictive and could not be as successful as a private one.

Federal and State Involvement.–Use of CDBG funds.

Initiative #2—Long View Research/ Manufacturing Park (tentative name)

Background.-The city bought a former State hospital property (Long View) for $1.25 million and hopes the State will give additional acreage to form a 150-acre site. There is also a 150-acre golf course adjoining this property, which the city also hopes to buy through a grant arrangement using UDAG, EDA, or CDBG funds. Site improvements for this intiative will cost about $6.5 million more, and again the city will have to arrange financing, possibly through a combination of Federal, State, and city funds. Federal and State funds also will be required to complete a highway interchange in the area.

Cost and Effectiveness–The $2 million for the first 150 acres will come out of the city's budget.

Transferability.–City officials are aware of research parks in other cities.

Federal and State involvement.–Definite use of Federal funds. State funds will probably be used also.

Initiative #3—institute of Advanced Manufacturing Sciences (IAMS)

Background. -IAMS will be located at Long View and was created at the initiative of the city and chamber of commerce. The State will lend the city $8 million for its construction, and the city will donate its 300 acres to the Institute. IAMS will support itself through contractual research, Federal research grants, and by leasing the land to appropriate tenants, i.e., those who are research-oriented. It will be a combination of a factory/ laboratory environment, where new technologies may be developed or new applications discovered for existing ones. The University of Cincinnati is 10 to 20 minutes away, and it is hoped there will be interaction. IAMS also would attract faculty members to the university.

Cost and Effectiveness.-The startup costs of IAMS would be paid from the university (State budget) and private contributions.

Transferability. -No apparent transferability, though initiative is not unlike other specialized research centers.

Federal and State Involvement.—Heavy State financial involvement.

Local Organization Working on High-Technology Initiatives

Department of Development, City of Cincinnati
Telephone: (513) 352-3783
Contact: Mr. Ralph D. Grieme, Jr. (industrial development consultant on retainer to the city)

Cincinnati Chamber of Commerce
Telephone: (513) 579-3100
Contact: Mr. Bruce Crutcher

Portland, Oregon

High-Technology Related Bases in the Local Economy

High-technology companies in the Portland area include Tektronix, E1ectro-Scientific Industries, Intel, Floating Point Systems, Wacker Siltronic, and Hewlett Packard. Technical degree programs are offered at several schools in the area, including Portland State University, the Oregon Graduate Center, and the Oregon Health Sciences University.

Initiative #1 —Marketing the Portland Area

Background. –Officials in the three-county Portland area have begun a coordinated effort to market and develop their community to attract new industry. Much of this effort is directed toward attracting high-technology jobs. A steering group for this effort was formed in early 1983 and is called the Metropolitan Chambers Economic Development Council. The steering group has established six task forces composed of representatives from local government, private industry, chambers of commerce, educational institutions, and other organizations. The task forces are addressing such issues as coordinated private/public funding of marketing efforts in the Portland area; labor availability and training; retention of existing industry; development of industrial sites; and State legislation that would encourage Oregon's development.

Cost and Effectiveness. —Portland area officials are pleased with the success of their marketing efforts, as demonstrated by recent plant location activity. Costs for many of the area's marketing activities (advertising, brochure preparation, direct mail campaigns) will be shared by both the public and private sector. Mayor Frank Ivancie has made a special effort to recruit Japanese high-technology companies into the Portland area.

Transferability. -officials are aware of high-technology marketing efforts in other communities.

Federal and State Involvement.—None.

Initiative #2—Portland State University Expansion

Background. —Portland State University, the area's largest technical-degree-granting institution, is located near Portland's central business district where expansion space is limited. A university benefactor recently donated a high-powered computer to the school, and the university faced the possibility of not having sufficient space to house the new (and much needed) computers. The city of Portland agreed to lease a vacant city-owned building to the university for $1 per year. The building is being renovated and will contain, in addition to the university's new computer, PSU's enginering school and physics department.

Cost and Effectiveness.–The city's action has been well received by community leaders. The cost to the city for this initiative consists of the revenue lost because the building is not leased at market value. However, the university will have to purchase the building or pay market value in the near future.

State and Federal Involvement.—State funds were used to prepare the city building for occupancy.

Local Organization Working on High-Technology Initiatives

Portland Chamber of Commerce
Telephone: (503) 228-9411
Contact: Ms. Sharon Kafoury

Portland Development Commission
Telephone: (503) 796-5300
Contact: Mr. Carter MacNichol

Philadelphia, Pa.

High-Technology Related Bases in the Local Economy

The Philadelphia metropolitan area is the fourth most populous in the country. As such, it is a major manufacturing, banking, education, insurance, and trade center. High-technology companies operating locally include Smith-Kline Beckman, McNeil Pharmaceutical, Wyeth Laboratories, Commodore Computer, Sperry Univac, General Electric-Space Division, Franklin Computer, and Kulich & Soffa. Among the many colleges and universities located in the area are the University of Pennsylvania, Drexel University, and Temple University. The Philadelphia area also has one of the highest concentrations of medical schools—six—anywhere in the United States.

Initiative #1 —University City Science Center

Background.–According to Philadelphia officials, the Science Center is the country's only urban research center. The center is located in West Philadelphia on 16 acres of land that were cleared and prepared for redevelopment by the city of Philadelphia. The city, in turn, sold the land for development to a consortium of 28 colleges, universities, and professional health institutions. The city and the consortium currently have a redeveloper's agreement whereby the city will sell additional land as it is needed. At the present time, the Science Center has nine buildings containing 1.1 million ft^2 of space and houses over 60 companies and organizations employing approximately 5,000 workers. Many of the companies are engaged in high-technology activities, and the center has been a breeding ground for over 30 new businesses, some of them also in the high-technology sector. The two most notable examples of high-technology companies that got their start in the Science Center are Centocor and Biological Energy.

Cost and Effectiveness. -It is hard to estimate the cost of this project. Front-end costs for the city of Philadelphia included land acquisition, demolition, and upgrading utility services. Local officials are pleased with the success of the Science Center to date. Long-range plans for the Science Center call for it to contain 5 million ft^2 of space (representing an investment of $250 million) and house 20,000 employees.

Transferability. -The Science Center has been visited by representatives of over 50 cities in the United States and abroad.

Federal and State Involvement.—Federal urban renewal funds were used to prepare land for development. The Federal Government is also *one* of the major tenants in the center, with regional offices employing a total of 2,000 people. Pennsylvania Industrial Development Authority funds were used to help finance construction of buildings. A $5-million UDAG has been received for construction of a residential conference center.

Initiative #2—Business and Technology Center

Background.–Control Data Corp. has agreed to establish a Business and Technology Center (BTC) in the city of Philadelphia. Control Data has purchased an existing 300,000 ft^2 building that will be renovated and leased to other companies. The building is located on a 5-acre site adjacent to a 60-acre abandoned railroad yard, which the city of Philadelphia plans to purchase and redevelop, using the BTC as an anchor. It is hoped that companies that outgrow the BTC will construct facilities in the adjacent parcel. Local community groups and colleges have initiated training programs in connection with the BTC.

Cost and Effectiveness.–It is too early to judge the effectiveness of this initiative. However, city officials hope that this development will offer reasonably priced alternatives for companies once they pass the product development stage. Cost of purchasing and renovating the 300,000 ft^2 building is $5.9 million. It is hoped that half of the building will be ready for occupancy by the end of 1983. Costs of purchasing the adjacent 60-acre site and preparing it for development have not been determined.

Transferability. –Control Data Corp. has established similar developments in 11 other cities, including Baltimore, Toledo, and Minneapolis-St. Paul, and plans to open as many as 13 additional BTCs in 1984 (see above and ch. 5).

Federal and State Involvement.–A $1 .3-million UDAG grant was obtained to purchase the 300,000-ft^2 building.

Local Organization Working on High-Technology Initiatives

Department of Commerce, City of Philadelphia
Telephone: (215) 686-7302
Contact: Mr. John Claypool

Parkside Association of Philadelphia
Telephone: (215) 877-1199
Contact: Mrs. Ella Francis, President

Oak Ridge, Term.

High-Technology Related Bases in the Local Economy

The U.S. Department of Energy's (DOE) research and manufacturing facilities employ 17,000 people in the Oak Ridge area. Other high-technology employers are EG&G-ORTEC, Boeing Co., Tennelec, Remote Technology, and Elo Graphics. The University of Tennessee at Knoxville (located 25 miles east of Oak Ridge) offers a wide variety of technical degree programs. In addition, the University of Tennessee operates the Oak Ridge School of Biomedical Sciences.

Initiative #1 —Incubator Space

Background.-The city of Oak Ridge owns a 12,000-ft^2 incubator building which has been operating for 2 years. This is the city's second incubator building; the first contained 7,500 ft^2 of rentable space, was in operation for 15 years and was recently demolished.

Cost and Effectiveness.–Cost of constructing the new building was $300,000, and it is currently fully occupied by seven companies, six of which are classified as high-technology firms. The first incubator building led to development of at least two manufacturing companies now employing a total of 110 people, although neither of these companies was in a high-technology field.

Transferability.—The city is aware that other communities have built incubator space but has relied solely on its own experiences.

Federal and State Involvement.–The city received a $96,000 grant from the Appalachian Regional Commission to help construct the new incubator building.

Initiative #2—industrial Site Program

Background.–Since 1%5, the city of Oak Ridge has developed three industrial parks containing a total of 300 acres. Roughly half of the acreage has been sold to new and expanding industry and roughly 20 percent of this amount (30 acres) has been purchased by high-technology companies,

Cost and Effectiveness.–Generally, the city purchases land for development at the prevailing market rate, pays to extend utilities to the site, and then resells the land to industrial users for less than the cost of comparable land in the Oak Ridge area. The city is pleased with its industrial site program and is currently negotiating to buy an additional 280 acres for industrial development. In the last 3 or 4 years, city officials have seen an increase in the number of high-technolog, companies interested in low-cost industrial land.

Transferability.-Other communities in east Tennessee have visited Oak Ridge to investigate the city's industrial parks.

Federal and State Involvement.–The city of Oak Ridge has used DOE funds to purchase land for this program. In addition, the city received a $276,000 grant from the Appalachian Regional Commission to provide utility services at one industrial park.

Initiative #3—Selection of New Contractor-Operator for DOE in Oak Ridge

Background.-DOE recently selected Martin-Marietta Corp. as the new contractor-operator for its Oak Ridge facilities. The Oak Ridge Chamber of Commerce and city officials had desired that the company selected by DOE address the community's private employment needs by encouraging development of spinoff companies and assisting in attracting support industries to the area. DOE therefore agreed to add a clause in its request for proposal that emphasized the need for the new contractor-operator to be responsive to the community's private employment concerns.

Cost and Effectiveness.–Staff time is the only cost associated with this initiative. It is too soon to gauge its effectiveness since the new contractor-operator has only recently been selected.

Transferability.–Oak Ridge officials report that this approach was also used by a community in the State of Washington.

Federal and State Involvement.–DOE cooperation is required.

Local Organizations Working on High-Technology Initiatives

City of Oak Ridge
Telephone: (615) 483-5671
Contact: Mr. Ric Sonnenburg

Oak Ridge Chamber of Commerce
Telephone: (615) 483-1321
Contact: Ms. Louise Dunlap

Austin, Tex.

High-Technology Related Bases in the Local Economy

The University of Texas is a major institution of higher learning and one of the wealthiest, with a permanent endowment fund of approximately $2 billion. There are about 25 science and engineering laboratories at the university's 475-acre Balcones Research Center. Plans call for a new facility to house the Center for Electromechanics and the Center for Energy Studies.

In the late 1950's, four graduates of the University of Texas School of Engineering founded Tracer, Inc., which now employs about 1,5(X) at its Austin headquarters. Between 1965 and 1980, Austin's manufacturing employment increased by 25,000 jobs. IBM, which arrived in 1967, focuses its worldwide development of office systems in Austin. IBM has been joined by Texas Instruments, Motorola, Data General, Advanced Micro Devices, Rolm, Tandem Computers, and others. This high-technology base is one of the reasons Austin was recently selected over 50 other communities as the site of the Microelectronics and Computer Technology Corp.

Initiative #1 —Targeted Marketing Effort

Background.—In the early 1960's, local leaders of Austin were aware that the job base of the city had to be expanded. Austin was not as well situated geographically for heavy industry as some Texas cities, and there was concern for the environmental problems those industries might bring. A University of Texas Bureau of Business Research study recommended that the city should recruit high-technology industries.

Cost and Effectiveness. -Since the mid-1960's, the Economic Development Department has actively solicited these "clean" industries. Their efforts have met with great success. This year's economic development budget is approximately $170,000. Between 70 and 80 percent of this budget is geared toward attracting high-technology firms and the remainder toward nonpolluting low-technology operations that would provide jobs for less skilled workers.

Transferability. -Austin is aware of other cities' marketing efforts.

Federal and State Involvement.—None.

Initiative #2—Austin Community College

Background. -Responding to a need in the city that was emphasized by the chamber, the Austin Independent School District (AISD) established Austin Community College 5 years ago. It is housed in AISD facilities and offers academic courses at the freshman and sophomore levels; occupational and technical education programs such as electronic technology; and adult education courses.

Cost and Effectiveness.- 20,000 students are enrolled in Austin Community College. The school is funded by the State and by student tuition.

Transferability.– Other cities have similar facilities.

Federal and State involvement.–State funds employed,

Local Organization Working on High-Technology Initiatives

Economic Development Department
Austin Chamber of Commerce
Telephone: (512) 478-9383
Contact: Mr. John H. Gray, Manager

San Antonio, Tex.

High-Technology Related Bases in the Local Economy

High-technology establishments in the San Antonio area include branch plants of Datapoint, Advanced Micro Devices, Tandy, Harris-Farinon Division, and Control Data. With the exception of Datapoint, these have all opened plants in the area in recent years. San Antonio is also the home of the Southwest Research Institute and the South Texas Medical Center. The University of Texas at San Antonio provides degree programs in a number of technical fields.

Initiative #1 —Mayor's High-Technology Action Plan

Background.-San Antonio's Place in the Technology Economy: A Review of Opportunities and a Blueprint for Action, a 65-page report (plus 177-page appendix of high-technology readings) written by San Antonio Mayor Henry G. Cisneros, was distributed to the public in late 1982. The report addresses eight broad initiatives that San Antonio can take to expand its base of high-technology employment, including developing research parks, improving technical education, creating venture

capital firms, attracting foreign high-technology investment, and encouraging high-technology development in Texas through State policies. Discussion also focuses on current and emerging research in five high-technology industries: industrial processes equipment, electronics and communications, aerospace and defense, agriculture, and biomedicine.

Cost and Effectiveness.—A 22-page questionnaire was distributed along with the mayor's report, asking readers to assess the importance of each initiative and its chance of succeeding in San Antonio. Survey results were tabulated by the mayor's staff and reported to the public in March 1983. A network of groups has been formed to address each initiative, and implementation of recommendations is now under way.

Transferability .–Requests for the mayor's report have been received from business leaders, educators, and government officials all over the country. Mayor Cisneros was subsequently appointed vice-chairman of the Governor's Task Force on Emerging Jobs and Unemployment.

Federal and State Involvement.—None.

Initiative #2—High-Technology High School

Background.-The mayor's office also began this initiative, with the cooperation of the Alamo Community College District, United San Antonio, and the area's independent school districts. The school opened in fall 1983 with 100 students and will develop strengths in math, science, and technology.

Cost and Effectiveness.—It is anticipated that startup costs will be $150,000. Operating the school will cost approximately $300,000 per year. Plans are now being developed for second "magnet" high school focusing on medical technologies and jobs.

Transferability .–Similar schools in Houston, Dallas, and California were investigated.

Federal and State Involvement.–State funds will be used for startup and the first 3 years of operation, after which the school most likely will be locally funded.

Initiative #3—Vista Verde South

Background.–Vista Verde South is a 145-acre urban redevelopment area located in San Antonio's inner city. The project was initiated by the city of San Antonio and entailed land acquisition, relocation of area businesses and residents, demolition of existing structures, upgrading public utility services, and redevelopment of the project area. Control Data Corp.'s 60,000-ft^2 building, which presently employs 300 people making electronic components, is the anchor for the project. The company is currently completing construction of an additional 200,000 ft^2 building that eventually could employ 1,000 workers, and Control Data also plans to open a Business and Technology Center in Vista Verde South that would serve as an incubator facility for new local businesses (see above and ch. 5). Several other small manufacturers (at least one of which is high-technology related) are located in the development area.

Cost *and Effectiveness.*—Project costs are approximately $98 million, San Antonio officials are pleased with the benefits the redevelopment has created.

T'ransferability.–Control Data has been involved in similar redevelopment projects in several cities, including Minneapolis-St. Paul and Philadelphia (see above).

Federal and State involvement.—The project was funded by an $18.8-million UDAG, plus $4 million in CDBG funds. Highway funds have been made available to improve access to a nearby Interstate highway.

Initiative #4—Engineering Programs at University of Texas-San Antonio

Background. -Community leaders decided to press for the creation of an engineering school at the University of Texas at San Antonio after a major high-technology company dropped the city from consideration for a large plant because of the absence of engineering courses. The initiative was spearheaded by United San Antonio, a local civic organization with strong representation from local government as well as industry and community groups. Studies of need were conducted among local industry, reports were prepared, funds raised, and a lobbying effort was conducted.

Cost *and Effectiveness. -The* community raised over $6 million for faculty salaries, equipment, and other needs of the school. Only 250 students were expected the first year, but enrollment is already up to 500. The San Antonio Economic Development Foundation has found that the community is much easier to market to high-technology prospects now that the program is in place. It is considered so successful that the community is now planning an initiative to develop graduate programs in engineering.

Transferability. –The Oregon Graduate Center in Beaverton may be used as a model for developing graduate programs.

Federal and State Involvement.–The University's Board of Regents and Coordinating Board had to approve the establishment of the program, and State funds were used.

Initiative #5–Marketing to High-Technology Industry

Background. -The San Antonio Economic Development Foundation (EDF) was created by the chamber of commerce in 1974 to help attract industry to the city.

EDF works closely with the city's Department of Economic and Employment Development (DEED), and many of their cooperative marketing efforts have been directed at branch plants of expanding high-technology industries. For example, one of EDF's newsletters was directed toward the electronics industry, and Mayor Cisneros has accompanied EDF representatives on sales trips. Other techniques have included direct mail, telephone, and advertising campaigns in national newspapers and magazines,

Cost and Effectiveness. -EDF's annual budget of about $700,000 is raised from dues of member firms, but the city makes contributions for specific programs. A number of high-technology firms have located in the area after working with the foundation.

Transferability.—No similar cooperative marketing initiatives were studied, but EDF and DEED have received inquiries about their high-technology development programs.

Federal and State Involvement.–Some of DEED's activities have been supported by EDA planning grants and CETA funds, but there is no Federal or State involvement in the EDF/DEED marketing efforts.

Local Organizations Working on High-Technology Initiatives

Department of Economic and Employment Development
City of San Antonio
Telephone: (512) 299-8080
Contact: Dr. Kenneth Daly, Acting Director

Mayor's Office, City of San Antonio
Telephone: (512) 299-7063
Contact: Ms. Frances Rios

San Antonio Economic Development Foundation
Telephone: (512) 226-1394
Contact: Mr. Terry J. Britton

United San Antonio
Telephone: (512) 277-0207
Contact: Ms. Lila Cockrell

Salt Lake City, Utah

High-Technology Related Bases in the Local Economy

Some 15 to 30 percent of the manufacturing sector in the area is high-technology oriented. Sperry-Univac is the major employer. A number of Eastern venture capital firms have investments in Salt Lake City. The University of Utah is well known in a number of areas—engineering, physical sciences, law, and medicine, to name a few. The university's research park is about 12 years old, and several firms that have spun off from the university are located there. Some of these are involved in biomedical and gene research, and the city is also known for its bionic organ development. The Utah Innovation Center, also located in the park, began with a National Science Foundation grant and is now a private venture.

Initiative #1 —Communications and Networking: the "Key Person Network"

Background. -Within the last year or so, the State, the chamber of commerce, the city, the county, and other municipalities in the area have pooled and shared their resources in a determined effort to attract new high-technology industry. The resulting "Key Persons Network" is essentially a joint targeted marketing program. A select group of people will be available to entertain or travel to other parts of the country. They will meet with those individuals or companies with a vested interest in Utah, such as suppliers and university alumni.

Cost and Effectiveness.-This high-technology development effort will be funded primarily by the county commission, under the direction of the chamber of commerce. Aside from the salary of a new staff person, about $25,000 to $50,000 will be allocated for the operation of the network.

Transferability.--Aware of other cities' marketing efforts.

Federal and State involvement.–The State is involved but does not provide funding.

Local Organization Working on High-Technology Initiatives

Salt Lake City Chamber of Commerce
Telephone: (801) 364-3631
Contact: Mr. Brad Bertock

Burlington, Vt.

High-Technology Related Bases in the Local Economy

Burlington is the medical, cultural, and educational center of the State. The University of Vermont has a well-developed medical center, which accounts for the interest of biotechnology firms. Champlain College sponsors a nationally known computer camp for children up to 16 years of age.

IBM has been in the Burlington area since 1957. GE has a facility there, as does Digital Equipment with 180 acres. Historically, Vermont has not attacted "smokestack" industries. Canadian firms (some of them high-technology) also have shown an increasing interest in Burlington; because of its proximity to the border, Burlington is viewed as a base from which to enter U.S. markets. A research park is under consideration, and the venture capital process is being explored.

Initiative #1 –Foreign Trade Zone (FTZ)

Background. —The Greater Burlington Industrial Corp. (GBIC) applied for FTZ status, considering it a significant economic development tool due to the city's proximity to Canada. An area at the airport was designated an FTZ in 1980.

Cost and Effectiveness.-The FTZ was a major factor in Mitel's decision to establish a manufacturing facility in Burlington. The company is now expanding its building at the airport and is constructing a second facility outside the FTZ.

Transferability.—Awareness of FTZ in other cities.

Federal and State involvement.–U.S, Customs approval of FTZ status.

Local Organization Working on High-Technology Initiatives

Greater Burlington Industrial Corp.
Telephone: (802) 862-5726
Contact: Ms. Judy Miller

Seattle, Wash.

High-Technology Related Bases in the Local Economy

Seattle is the home of Boeing, which employs approximately 80,000 Seattle-area residents in research, engineering, and manufacturing activities. Other high-technology companies in the Seattle area include Hewlett-Packard, Fairchild Semiconductor, John Fluke Manufacturing, Honeywell-Marine Electronics, Digital Equipment Corp., Physio-Controls, and ELDEC. The University of Washington is the largest source of technical degree recipients in the Seattle area, and its research labs have spun off several biomedical firms.

Initiative #1 —Engineering Education Task Force

Background.–The Engineering Education Task Force was formed by the Economic Development Council (EDC) to upgrade the quality and quantity of engineering education in the Seattle area and the rest of the State. The task force was composed primarily of representatives from private industry, and was created in response to private industry's concern about current and projected shortages of engineering skills. Also included were representatives from the University of Washington, Seattle University, Washington State, and the State Council for Post-Secondary Education. EDC provided staff support for the task force, The task force's recommendations, published in 1982, included the following: increasing the number of baccalaureate and Ph. D. degrees awarded in engineering; offering new continuing education opportunities for degreed engineers; forming a Washington State High Technology Center; offering State tax incentives to private industry investing in engineering education; and increasing opportunities for joint industry/State/university research activities.

Cost *and Effectiveness. -In* response to the EDC's study, the University of Washington initiated a bill in the Washington State Legislature to create a high technology research center and fund it at $17 million.

Transferability. -The task force investigated high-technology research centers at Arizona State University, Stanford, Research Triangle Park, MIT, and other locations. The president of MIT spoke to the task force members.

Federal and State involvement.—State interests were represented on the task force by the Council on Higher Education. There was no Federal participation.

Initiative #2—industry Attraction Program

Background. -EDC also has made a concerted effort to attract new industry into the Seattle area, and virtually all of its efforts are directed toward high-technology companies. Prospects are identified by seeking leads from Seattle area companies and by inhouse research. Prospects are contacted through telephone calls and personal visits. No funds are spent on media advertising. EDC also works to overcome any obstacles that might prevent a company from locating in the area, This includes working to obtain necessary zoning and environmental approvals for new industry as well as seeking State and Federal funds for site improvements (roads, water and sewer line extensions).

Cost and Effectiveness.—EDC has a budget of $585,000 for business development. A number of new companies recently have located in the Seattle area, including branches of Hewlett-Packard and Fairchild Semiconductor.

Transferability.– Similar to targeted marketing strategies in many other cities.

Federal and State involvement,–Federal and State funds totaling $6 million were used for site improvements for the Fairchild Semiconductor facility, Assistance from the Washington Department of Commerce and Economic Development is sought on an "as needed" basis to help obtain environmental approvals for new industry.

Local Organization Working on High-Technology Initiatives

Economic Development Council of Puget Sound
Telephone: (206) 622-2868
Contact: Lee Smith, Executive Director

Milwaukee, Wis.

High-Technology Related Bases in the Local Economy

A number of technology-based companies are headquartered in the area, including Allen-Bradley, Johnson Controls, Cerac, and the Astronautics Corp. of America. Both Marquette University and the University of Wisconsin-Milwaukee are located in the area and offer technical degrees. The Milwaukee School of Engineering has an Applied Technology Center which performs contract research. The Metropolitan Milwaukee Association of Commerce (MMAC) works with high-technology development through two organizations, the New Business Ventures Office and the Economic Development Group.

Initiative #1 —Milwaukee Area Robotics Task Force

Background.-The task force is a voluntary cooperative effort coordinated by the association to market the Milwaukee area to robotics designers and manufacturers. Members include representatives of the city, MMAC, Wisconsin Electric Power, Milwaukee Area Technical College, and other companies and institutions. Activities include sending 30 Milwaukee executives to market the community at Robotics 7, an industry trade show.

Cost and Effectiveness. -The task force made a presentation to ASEA, a Swedish manufacturer of robots, which induced that firm to locate its industrial robots division headquarters in the Milwaukee area. In order to win the division to the area, the task force asked the University of Wisconsin to design a state-of-the-art communication network to link ASEA personnel located in separate States. The promise of the customized software program was a crucial element in the firm's selection of Milwaukee as the headquarters location. It will be paid for through donations to MMAC and given to ASEA.

Transferability.— Milwaukee is aware Michigan also has a program to attract the robotics industry.

Federal and State involvement.—There has been no Federal involvement with the task force to date. The State has become involved through the university.

Initiative #2—Hilltop Parish Research Park

Background.–This is a newly developed park on the city's northwest side. Phase I consists of 30 acres, with another 50 available for later expansion. The city rezoned the area from residential to planned development, allowing only research activities. A conference center may be developed in the park. Though the park is privately owned, the city helped acquire UDAG funds to prepare the site.

Cost and Effectiveness. –The UDAG funds totaled $200,000. The owner of the site, Marquette Electronics, currently is constructing its research facility there and so far is the only user.

Transferability. –The city and Marquette Electronics were aware of other research parks. Those in California were cited specifically.

Federal and State Involvement.-The Federal Government was involved through the UDAG program. There has been *no* State involvement.

Initiative #3—Research Lab Retention

Background,—When Pabst was acquired by another brewer, the company no longer had a need for its subisdiary, PL Biochemical, which sells fine research chemicals for genetic engineering. In order to avoid the loss of this high-technology resource, the city issued industrial revenue bonds to Pharmacia, the operation's new owner, to finance rehabilitation of the building. The city will also apply for UDAG funds for expansion, as required.

Cost and Effectiveness. —Industrial revenue bonds totalling $8 million were sold. The laboratory was retained in the area.

Transferability. –N.A.

Federal and State Involvement.—Indirect Federal involvement through IRB legislation.

Local Organizations Working on High-Technology Initiatives

Division of Economic Development, City of Milwaukee
Telephone: (414) 278-2672
Contact: Mr. James Sherer, Manager of Redevelopment

Metropolitan Milwaukee Association of Commerce
Telephone: (414) 273-3000
Contact: Ms. Mary E. Frymark, Economic Development Representative

APPENDIX B

Index of Initiatives Cited in This Background Paper

This index includes only those initiatives and activities that are described **or cited as** examples **in this background paper. It does not represent a comprehensive effort to identify all existing initiatives in every category or every State. For more comprehensive information on State government initiatives, refer to the appendix, "Directory of State High-Technology Strategies and Programs," in the OTA background paper,** ***Census of State*** **Government** *Initiatives for High-Technology Industrial* ***Development*** **(Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-BP-STI-21, May 1983), pp. 13-74.**

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