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CHAPTER 1  
**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 lit-

erally 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 organiza-

tions 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.