CRS Report for Congress
Received through the CRS Web

State Technology Development Strategies: The Role of High Tech Clusters

October 21, 1998

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ABSTRACT

This report provides a framework for exploring the feasibility of generating high tech clusters in states where they currently do not exist or are not easily identifiable. The information may be used to provide a common frame of reference for key decisionmakers as they examine the possibility of creating clusters. The reasons for such actions are presented here, as are the characteristics typically associated with high growth entrepreneurial regions. A summary of the lessons learned by the successes and failures of other jurisdictions may provide a guide for additional discussion. Also offered are selected options for further consideration in designing next steps for the community. The report will be updated if events warrant such action.

State Technology Development Strategies: The Role of High Tech Clusters

Summary

There has been increasing congressional interest in efforts across the country to generate expanded regional economic growth through technological development and the creation of new firms. Concurrently, and often in conjunction with on-going federal programs, state activities to promote an environment conducive to technological innovation have expanded, typically focusing on the development of concentrations of high tech firms in specific localities. These clusters are groups of interrelated firms and institutions (including suppliers, service providers, universities, and trade associations) located in a specific area that cooperate as well as compete. As such, clusters provide the opportunity for on-going innovation to meet new demands for products and processes generated by the dynamic relationships among the players.

Technological advancement is a key element of economic growth. Experts widely accept that technical progress is responsible for up to one-half the growth of the U.S. economy and is one principal driving force for increases in our standard of living. Entrepreneurial firms often play an important role in technological progress. It usually is through these companies that the results of research and development (R&D) are commercialized and brought to the marketplace. They are also instrumental in allowing economic benefits to remain within a region. Such firms create wealth through value added jobs that are long-term and require highly skilled employees that subsequently generate additional income, spending, and growth, as well as more jobs.

States are attempting to fashion an entrepreneurial climate by undertaking a variety of programs to assist existing technology-related businesses, to promote the development of new companies, and to facilitate the application of technologies and techniques in all industries. While it often takes long periods of time to establish regional clusters, with the attendant risks and uncertainties, several characteristics are common to entrepreneurial areas. These regions typically have a knowledge source, generally a university that can provide a supply of ideas and employees, and on-going R&D. Venture capital is available as is skilled labor. Clusters (or agglomerations) of similar entrepreneurial firms exist as do opportunities for generating new businesses through science parks or incubators. Good transportation and a high standard of living are also complementary. In addition, successful state and local efforts to develop an entrepreneurial environment generally exhibit sustained leadership in such endeavors, support for education and training, use of R&D resources, and public-private cooperation.

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Introduction

There has been increasing congressional interest in efforts across the country to generate expanded regional economic growth through technological development and the creation of new firms.[1] Concurrently, and often in conjunction with on-going federal programs,[2] state activities to promote an environment conducive to technological innovation have expanded, typically focusing on the development of concentrations of high tech firms in specific localities. This report provides a framework for exploring the feasibility of generating such high tech clusters in states where they currently do not exist or are not easily identifiable. The information contained in these pages may be used to provide a common frame of reference for key decisionmakers as they examine the possibility of creating clusters. The reasons for such actions are presented here, as are the characteristics typically associated with high growth entrepreneurial regions. A summary of the lessons learned by the successes and failures of other jurisdictions may provide a guide for additional discussion. Also offered are selected options for further consideration in designing next steps for the community.

Economic Growth

Technological advancement is a key element of economic growth. Experts widely accept that technical progress is responsible for up to one-half the growth of the U.S. economy and is one principal driving force for increases in our standard of living. Historically, industrial expansion was based on the use of technology to exploit natural resources. Today, such growth tends to be founded on scientific discoveries and engineering knowledge (e.g. electronics, biomedical applications) and is even more dependent than before on the development and use of technology. Technological advance can drive the economy because it contributes to the creation of new goods and services, new industries, new jobs, and new capital. It can expand the range of services offered and extend the geographic distribution of those services. The application of technology also can contribute to the resolution of those national problems that are amenable to technological solutions.

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[1]For a detailed discussion see: Congressional Research Service, *Technology Development: Federal-State Issues*, by Wendy H. Schacht, CRS Report 96-958, 22 November, 1996.

[2]For additional information see: Congressional Research Service, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, CRS Issue Brief 91132, updated regularly.

Technological progress is achieved through innovation, the process that provides new and improved products, manufacturing processes, and services. It is an activity that may involve, among other things, idea origination, research, development, engineering, commercialization, and diffusion throughout the marketplace. A concept can become an innovation without evolving through those separate steps. An invention becomes an innovation when it has been integrated into the economy such that the knowledge created is applied in production to increase productivity and quality, or results in a new or improved product or service that can be sold in the marketplace. It is only then that a significant stimulus to economic growth occurs.

Entrepreneurial firms often play an important role in technological advancement and economic growth. It usually is through these companies that the results of research and development are commercialized and brought to the marketplace. Thus, the current interest in creating an environment to facilitate the development of indigenous talent and to attract outside players. While the manufacturing facilities of high technology companies can bring an infusion of new jobs to a region, studies have shown that branch plants do not provide much additional high technology development.[3] Such businesses tend to move when it is cheaper to manufacture elsewhere even though they utilize a skilled workforce. In contrast, the R&D facilities of high tech companies generate higher value added jobs. It might be possible to devise mechanisms to use the location of a production plant to stimulate involvement of the R&D sectors of the relevant corporation. However, concentrating on branch plants poses problems in that "[t]he stifling effects of a branch plant economy on entrepreneurship are great and cannot easily be overcome by policies to locate government research facilities in backward regions in the hope of generating spin-offs."[4]

Economic benefits remain within a region through the creation of new firms.[5] These companies create wealth through value added jobs that are long term and require highly skilled employees that generate additional income, spending, and growth, as well as more jobs. The regions that display an active entrepreneurial environment embody distinctive, and similar, characteristics. These areas typically have a knowledge source, generally a university that can provide a supply of ideas and employees, and on-going R&D. Venture capital is available as is skilled labor. There are clusters (or agglomerations) of similar entrepreneurial firms and opportunities for generating new businesses through science parks or incubators. Good transportation and a high standard of living are also complementary to entrepreneurial activity.

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[3]Amy Glasmeier, "High-tech Policy, High-tech Realities: The Spatial Distribution of High-tech Industry in America," in *Growth Policy in the Age of High Technology, The Role of Regions and States,* ed. Jurgen Schmandt and Robert Wilson. (Boston: Unwin Hyman, 1990), 92.

[4]Edward J. Malecki, "Entrepreneurs, Networks, and Economic Development: A Review of Recent Reserch," *Advances in Entrepreneurship, Firm Emergence and Growth* 3 (1997): 60.

[5]Edward J. Malecki, "Technological Innovation and Paths to Regional Economic Growth," in *Growth Policy*, 99.

A critical mass of high technology companies is necessary to sustain indigenous economic growth. "An existing agglomeration [cluster] of firms in similar or related sectors is a principal determinant of both birth rates and the distribution of small technology-based firms."[6] Clusters are groups of interrelated companies and institutions (including suppliers, service providers, universities, and trade associations, etc.) located in a specific area that cooperate as well as compete.[7] As such, clusters provide the opportunity for on-going innovation to meet new demands for products and processes generated by the dynamic relationships among the players. Diversity within the types and sizes of businesses contributes to a good entrepreneurial environment.[8] A varied, educated, and skilled workforce also contributes to the technological advancement in and around the cluster.

Clusters are important not primarily because of production but because of the opportunities for knowledge spillovers.[9] "[I]nnovative activity is more likely to occur within close geographic proximity to the source of . . . knowledge, be it a university research laboratory, the research and development department of a corporation, or exposure to the knowledge embodied in a skilled worker."[10] Innovation tends to cluster around industries where knowledge plays an important role[11] as evidenced by the biotechnology, computer, advanced materials, and telecommunications sectors, among others.

Lessons From the Past

In the quest for regional growth, state economic development strategies are based upon expansion of indigenous innovation and adaptation of technology in the private sector. Efforts are focused on the creation of high technology firms and the use of advanced technologies in the traditional manufacturing and service sectors. States are attempting to fashion an entrepreneurial climate by undertaking a variety of programs to assist existing technology-related businesses, to promote the development of new companies, and to facilitate the application of technologies and techniques in all industries. These endeavors vary by state and often several approaches are supported simultaneously. What they all have in common, however, is the potential to generate a large number of new, high value added jobs.

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[6]Patricia M. Flynn, "Technology Life Cycles and State Economic Development Strategies," *Federal Reserve Bank of Boston, New England Economic Review*, May/June 1994, 24.

[7]Michael E. Porter, "Clusters and Competition: New Agendas for Companies, Governments, and Institutions," *Harvard Business School, Division of Research Working Paper,* Sept. 1997 (revised 25 March, 1998), 1.

[8]Malecki, *Entrepreneurs*, 68.

[9]David B. Audretsch and Maryann P. Feldman, "R&D Spillovers and the Geography of Innovation and Production," *American Economic Review*, June 1996, 631.

[10]Ibid., 638.

[11]Ibid., 635, 637.

The economic distress brought about by the decline of traditional industries in the 1970s and 1980s and the subsequent loss of thousands of jobs helped spur the formulation of many of today's state programs.[12] The conditions precipitated a shift away from state policies to promote "smokestack chasing" — attracting large manufacturing firms away from other areas — toward assistance to high technology companies in the areas of research, development, commercialization, technology transfer, and capital formation, among others. Many of these efforts have crystalized into state "industrial policies" under which particular businesses or industrial sectors are selected as the nexus of state investment endeavors.

The activist nature of these state ventures has a foundation in their responsibilities to promote the economic viability within their jurisdictions. State involvement initially developed based on the idea that these non-national governments must take action in areas where the private sector was unwilling to play a role. Thus, the government was not seen as replacing the business community in the decisionmaking process, but as filling a void left by inaction.[13] In filling this void, the states saw an opportunity to attract or develop high technology firms which contribute to the area's economic growth through high-wage employment; low environmental costs; high rates of expansion; long-term growth potential; clustering of other similar firms and suppliers; export orientation; and prestige.[14]

Over the years, planned, coordinated efforts have been undertaken by states and localities to facilitate technological advancement and generate economic growth. Several have been highly successful; others have failed. In order to provide a framework for decisions in a particular area, it might be helpful to analyze efforts by several other regions and identify activities which might parallel the current situation under discussion. The study of Austin, Texas; Cape Canaveral, Florida; Research Triangle Park, North Carolina; Phoenix, Arizona; and Lowell, Massachusetts may offer insights into what activities might be appropriate to areas of the country with few existing or identified clusters. The focus of this section is on *early* efforts by several communities because of perceived parallels with the current situation in many regions.

Critical to local technology development is a strong technological infrastructure and an entrepreneurial network.[15] This presents opportunities for state and local governments in pursuit of their responsibilities to promote economic development. However, it is important to keep in mind that some argue government policies are limited in what they can do to create entrepreneurs. Policy does not create entrepreneurs but can encourage them to stay in a location. There is a general finding that "...due to the complexity of the firm formulation process, it is hard for policies

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[12]Matthew I. Slavin and Sy Adler, " Legislative Constraints on Gubernatorial Capacity for State Industrial Policy: Evidence from Oregon's Regional Strategies Program," *Economic Development Quarterly*, August 1996, 226.

[13]Jonathan Rauch, "Stateside Strategizing," *National Journal*, 27 May, 1989, 1296.

[14]Larry Dildine referenced in Keith Ihlanfeldt, "Ten Principles for State Tax Incentives," *Economic Development Quarterly*, November 1995, 344.

[15]Malecki in *Growth Policy*, 99.

to transform an environment adverse to entrepreneurial activities into a favourable [sic] one."[16] By identifying what worked in other areas, decisionmakers can identify what resources their individual state or locality has to offer the entrepreneur and what might be done to augment this foundation.

The history of the Austin area provides an interesting study for decisionmakers in regions with federal facilities. Several of the factors necessary for a strong technological infrastructure were already in place; others needed to be developed. Federal facilities played a role in generating the critical mass required for the effort in Austin to succeed. Bergstrom Air Force base employed a large number of trained individuals and placed government funds into the local economy. Balcones Research Park was created in the early 1940s when the federal government provided land to the University of Texas and funded research tied to World War II.[17] The federal government has continued to facilitate development in the area by on-going funding for R&D.

The contribution of a strong academic institution in generating entrepreneurship and technological development is underscored by the role of the University of Texas (UT) in the Austin area. The University has been the source for the development of numerous indigenous firms. Over half of the small and medium sized companies existing in the locality during 1986 were spun-off from UT. The potential for on-going interaction with the university was part of the decision for entrepreneurs to remain in Austin.[18] Tracor Corporation, a Fortune 500 company in the mid-1980s, exemplified the generation of new, entrepreneurial growth through a research university. Created by a UT graduate, over 16 companies had spun-out of the original firm, employing almost 5,500 people in 1985. These spin-offs also spawned additional new companies. This growth would not have occurred without the existence of the University of Texas.[19]

The depth of higher education within Texas also played an important role in the 1983 decision by the Microelectronics and Computer Technology Corporation (a joint R&D venture supported by various companies) to locate in Austin. Between 1970 and the early 1980s, Texas undertook a planned program to improve the state university system and 800 new chairs were endowed at UT.[20] This was accompanied by local level promotion of technology development that resulted in various public-private initiatives. A study of the reasons for the location decision by the Microelectronics and Computer Technology Corporation identified as significant the coordinated and cooperative effort by academic, business and government (state and

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[16]E.J. Malecki and F. Todtling, "The New Flexible Economy: Shaping Regional and Local Institutions for Global Competition," in *Technological Change, Economic Development and Space*, ed. C.S. Bertuglia et al. (Berlin, Springer, 1995), 281.

[17]David V. Gibson and Raymond W. Smilor, "Creating and Sustaining the U.S. Technopolis," in *Growth Policy*, 392.

[18]Ibid., 388.

[19]Ibid., 404.

[20]Jurgen Schmandt and Robert Wilson, eds., *Promoting High-Technology Industry, Initiatives and Policies for State Governments* (Boulder, Westview Press, 1987), 242.

local) leaders to offer a wide range of incentives including support for education at the University of Texas and Texas A&M University.[21] Similarly, the primary reason given for the decision by SEMATECH (a consortium of semiconductor manufacturing firms) to locate in Austin was the "support and cooperation of state and local public and private agencies."[22] The Chamber of Commerce provided information to and support of high tech companies while local groups brought together key individuals and organizations in a strategic approach to meeting their goals.[23]

Efforts to develop viable high tech industrial expansion in Florida coalesced around the federal facilities in Cape Canaveral.[24] Large aerospace and defense contractors were able to induce high tech growth through the recruitment of skilled workers and the training of local employees. The state also made a commitment to the pursuit of technological advancement to ensure that the opportunities presented were not lost. The area's infrastructure, particularly transportation, was strengthened. Academic resources were considered inferior and a concerted effort was made to improve the system at all levels including pre-college through graduate school, as well as vocational education. Educational programs were designed to meet industry needs and state funding was provided for engineering and science programs in the universities and for community and vocational schools. By 1987, there were over 400 specialized academic research programs of interest to industry in the state,.

Another region which focused on improvements in the educational establishment was Research Triangle Park, North Carolina. There are three research universities in the area including the University of North Carolina, North Carolina State University, and Duke University. In 1959, Research Triangle Park (RTP) was created as a university affiliated research campus. The objectives of the Park were the diversification of the economy, the augmentation of high value added jobs, and additional employment opportunities for university graduates.[25] Although the state provided no direct funding, it built the necessary roads for the Park[26] and donated the land for the Research Triangle Institute.[27] The Institute offers research and development staff and facilities to companies.

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[21]Raymond W. Smilor, George Kozmetsky, and David V. Gibson, eds., *Creating the Technopolis* (Cambridge, Ballinger, 1988), 174-175.

[22]Gibson and Smilor in *Growth Policy*, 385.

[23]Smilor, Kozmetsky, and Gibson, in *Creating*, 167.

[24]Discussion from Schmandt and Wilson, eds., in *Promoting*, 45-63.

[25]Michael I. Luger and Harvey A. Goldstein, *Technology in the Garden, Research Parks and Regional Economic Development* (Chapel Hill: University of North Carolina Press, 1991), 82.

[26]Schmandt and Wilson, eds., in *Promoting*, 171.

[27]Ibid., 186.

A planned attempt was made to develop high technology industry by attracting the R&D facilities of large, established companies.[28] The area developed slowly until IBM moved in and the National Institute of Environmental Health Science (National Institutes of Health) located in the Park partly as a result of political influence by the U.S. Secretary of Commerce Luther Hodges, the former governor of North Carolina, and then Governor Terry Sanford. Numerous other R&D organizations have set up facilities in the Park since that time. Among the reasons for the decision to relocate were the "prestige" of being associated with the Park; the ability to interact with professionals in other organizations; and access to entry level graduates for recruiting purposes.[29]

The ability for an area to develop a viable and prosperous research park is dependent on several factors, although all need not be present for success. An existing R&D infrastructure and on-going research activity is one potential element. The availability of local research universities, engineering schools, or medical schools also plays a role along with good air transportation as well as technical and businesses services. Leadership is important and should include representatives from the political, academic, and business communities.[30]

The focus on recruiting existing firms has resulted in slower growth for the Park as other areas across the nation have been successful in developing additional resources. Through the early 1990s, there were few efforts within Research Triangle Park to generate new, start-up, high-tech companies and it was often too costly for small firms to locate within its confines.[31] However, there were other efforts, outside of RTP, to facilitate new firm growth. The state concentrated on improving the educational system to mold indigenous scientific and technical talent and developed job training programs through an extensive number of community colleges to attract new industries.[32]

Educational opportunities also played a significant role in high tech development around Phoenix, Arizona. One 1987 study funded by the National Science Foundation found that 70% of microelectronics firms attributed their decision to locate in Phoenix to the proximity of Arizona State University.[33] The state had made a coordinated effort to strengthen and expand the undergraduate and graduate engineering programs at the University. In 1979, a 50 member council was formed to review engineering education. Representatives from industry, academia, state government, and faculty developed a plan to strengthen the university's educational programs as well as its research capabilities. As a result, the engineering curriculum was augmented, centers of excellence were created, and facilities for

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[28]Ibid.,63.

[29]Luger and Goldstein, *Garden*, 85,87.

[30]Ibid., 175.

[31]Ibid., 78.

[32]Ibid., 173, 188.

[33]Gibson and Smilor in *Growth Policy*, 388-389.

continuing engineering education were established, as was a research park to foster industry-university cooperative activities.[34]

Part of the success of Phoenix has been attributed to the mix and diversity of industry in the area. Relocation of high technology firms to the region was one factor in its economic growth. However, concerns were raised as to the reliance on branch plants.[35] In the early 1980s, the state made a clear statement of commitment to the expansion of local businesses and the encouragement of entrepreneurial start-up firms as part of its strategic plan.[36] High tech growth in the region has been due to the expansion of existing firms, relocation of national corporations, spin-offs, or new start-ups.[37] Firms are attracted to Phoenix, or decide to remain, because of the availability of a trained work force and on-going R&D.[38]

Other lessons might be learned from the experience of Lowell, Massachusetts. In the mid-1980s, Lowell had become a "high tech success" after having experienced economic decline with the deterioration of traditional manufacturing in the area.[39] This success was based on attracting one major computer company, Wang Laboratories, and the subsequent location of several other similar firms in the region. The factors which contributed to the growing economy were familiar: entrepreneurial and skilled workers; a local competitive advantage in high technology; public and private financial resources; and effective local leadership. However, this did not last. The economic decline in the United States and particularly in the Northeast, a regional banking crisis caused by too many high risk loans to small and medium sized companies, the effects of development life-cycles in the computer industry, and an over-reliance on one industrial sector and on one firm, all combined to negate the prior economic growth. This situation highlights the importance of diversifying the industrial and employment base, and providing the skills necessary to support various sectors. Sustained growth requires on-going investment in R&D and innovation and the support of entrepreneurs in numerous types of businesses.

As discussed above, certain characteristics are found in entrepreneurial areas, including a knowledge source, on-going R&D, a skilled workforce, clusters of high tech firms, and good transportation. Commonalities associated with successful programs designed to encourage entrepreneurship include on-going leadership, either by state or local officials or representatives of the private sector. Strategic studies that identify the strengths and weaknesses of the area, increase the visibility of the effort, expand awareness of the process, and develop support are often important.

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[34]Ibid., 389-390.

[35]Smilor, Kozmetsky, and Gibson, *Creating*, 201.

[36]Peter K. Eisinger, *The Rise of the Entrepreneurial State* (Madison, University of Wisconsin Press, 1988), 238.

[37]Smilor, Kozmetsky, and Gibson, *Creating*, 190.

[38]Ibid., 192, 194.

[39]Discussion from Ross J. Gittell and Patricia M. Flynn, "The Lowell High-Tech Success Story: What Went Wrong?" *Federal Reserve Bank of Boston New England Economic Review*, March/April 1995, 57-68.

The critical role of education can not be ignored nor can the development of human resources through training.[40] Also present are research and development activities directed toward new products and processes. Promotion of entrepreneurship, often through incubator programs, aims at developing the critical mass necessary for innovative activity. Public-private cooperation is also necessary for developing a commitment by all involved parties, particularly when such efforts tend to require patience.[41]

Ideas for Consideration in Employing the High Tech Cluster Concept

It should be recognized that "the development of regional research and development and scientific complexes takes long periods of time, and economic effects such as the generation of new local industries are highly unpredictable."[42] It might be helpful to states interested in using high tech clusters to stimulate economic growth to identify local resources including universities, technical and vocational colleges, industrial facilities, small businesses, federal institutions, and federal laboratories. Also of importance is information on research and development expenditures in the state. What is the percent of R&D as a portion of gross domestic product in the state? What is the role of federal funding for R&D in the area, what does the state finance in this arena, and how much does industry spend? In addition, questions need to be answered as to where the educational system stands, particularly in the areas of science, technology, and engineering. What is the level of state support for education, higher education, and academic R&D? This material, as well as related economic, educational, scientific, and technical data particular to each state often can be obtained from the National Science Foundation or from state agencies.

A detailed guide for any community attempting to plan for an entrepreneurial environment is published by the Economic Development Administration of the Department of Commerce. Titled *Cluster-Based Economic Development: A Key to Regional Competitiveness*, this report furnishes a discussion of the specific steps that may be involved in an organized effort at the state and local level. In addition, if a pro-active approach is to be taken, certain ideas may need to be considered. Several are identified below.

Cluster Development

- What industry clusters exist in the region, if any?
- What might be done to support/expand existing clusters?
- What clusters might be developed given resources in the area?
- What might be necessary to develop new clusters?
- Is there sufficient R&D/industry support for clusters?

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[40]Schmandt and Wilson, *Promoting*, 260-261.

[41]Ibid., 261.

[42]Malecki in *Growth Policy*, 99.

- What are the characteristics of the state that might support clusters?

The Workforce

- What is the make-up of the existing workforce in the state?
- What are the current workforce needs of the state?
- What are the future needs of the state's workforce?
- How should the workforce be trained/educated?
- Who should train/educate the workforce?
- Who will pay for workforce training?

Education

- What are the educational resources of area universities?
- What is the status of academic programing tied to high tech development?
- What new or expanded programs are needed to meet the demands of the cluster(s)?
- What type of vocational education is available?
- What vocational education programs are needed?
- Who will pay for expanded university and vocational education activities?

Research and Development

- What are the R&D resources of any federal laboratories in the area?
- How can the resources of such federal laboratories be utilized?
- What existing federal R&D programs might be relevant?
- How can on-going federal programs be incorporated into state efforts?
- What is the role of any existing science parks?
- What are the R&D resources of the universities?
- What is the proper level of R&D in the universities?
- Who should pay for the proper level of R&D in universities?
- How best can knowledge spill-overs be captured in the state?

Business Environment

- What are the benefits/costs of small business incubators in cluster development?
- How can venture capital be created or attracted to the state?
- How can a diversified industrial base be achieved?
- How can existing branch plants attract R&D facilities?
- How can indigenous entrepreneurs be encouraged?
- What are the high tech clusters?
- Is transportation sufficient to support high tech entrepreneurship?

Developing high tech clusters is one approach to creating increased economic growth through technological development and the generation of new firms. While this primarily may be a state function, much of what can be done depends on building upon federal programs, utilizing federal facilities, and leveraging federal funding for R&D and education. In addressing the issues, it should be noted that the experiences

of other regions indicate that the development of public-private partnerships are critical to generating and taking advantage of the opportunities for economic growth. Representation from federal, state, and local governments as well as the business and academic communities can insure that all players are committed to the process and that unnecessary duplication of effort does not occur. It has been shown that each sector needs to have a stake in the planning and implementation of any coordinated effort for it to be a success.