Technology Life Cycles and State Economic Development Strategies

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States have become increasingly active in promoting industrial competitiveness and economic development in recent years. Some of these efforts involve the reorientation of existing institutions and programs that provide training, small business assistance, and recruitment incentives. In addition, states have undertaken a variety of new initiatives with respect to technology transfer, venture capital, and the modernization of established firms.

An extensive literature has emerged on state economic development efforts. The results, however, have not been of much help to states in terms of developing competitiveness strategies, for two major reasons. First, the materials are primarily descriptive, highlighting the actions of various communities, states, and regions. Little evidence is given on the success or failure of such experiences. Moreover, for many programs, not enough time has elapsed to evaluate effectiveness, at least over the long term.

Second, state experiments and initiatives have not been viewed in a larger analytical framework that would permit generalization and an understanding of the dynamic processes underlying these changes. Lacking this larger context, information about the experiences of other states, no matter how detailed or successful, is of limited value to states operating under different industrial and technological conditions.

This article adopts production life-cycle models as a framework in which to analyze systematically the interrelationships between industrial and technological change, human resource needs, and state economic development policies. This framework—in which products, production processes, and technologies are seen as dynamic phenomena whose locational, skill, and training requirements change as they evolve—provides a conceptual model useful for evaluating and designing state economic development policies.

The life-cycle framework suggests that states that incorporate the dynamics of industrial and technological change into their competitive-

ness strategies will reap employment and productivity benefits that technology can provide. In contrast, states that fail to address these issues increase their vulnerability to the negative impacts of technological change, including widespread unemployment and job loss.

I. Trends in State Economic Development Efforts

State economic development efforts revolve around three major strategies: the recruitment of firms to the state, the development of high-tech start-up firms, and the revitalization of established businesses. All state economic development strategies attempt to boost the local economy. States hope such steps will result in net increases in the private employment base (direct and indirect), in state and local tax revenues, and in long-term economic growth. The number of jobs created or maintained is not the only factor to consider. The quality and level of income associated with the jobs and the potential for spin-offs and other positive externalities play key roles in the long-term results.

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Recruitment of Firms

In the 1960s and 1970s, state economic development efforts focused on the recruitment of employers and jobs, either luring existing plants to relocate or attracting new plants. Seeking to differentiate themselves, states offered tax and financial incentives to encourage firms to relocate within their borders. A relatively low-wage work force and a good labor climate—which generally meant accommodating labor or no unions—were often highlighted in recruitment packages, particularly those offered by southern states.

Historically, North Carolina has been noted for its ability to attract manufacturing plants—a majority of the Fortune 500 companies have at least one plant located in this southern, right-to-work state. More recently, Tennessee, Kentucky, South Carolina, and Alabama have been successful industrial recruiters. A Nissan plant located in Tennessee in 1980, and in 1985 the state won its bid for the General Motors Saturn plant. Kentucky attracted a Toyota plant in 1985 and was first runner-up in the Saturn contest. South Carolina was successful in recruiting a BMW plant in 1992, and Alabama was the site selected in 1993 by Mercedes-Benz for its first North American plant.

More generally, states throughout the country sought to recruit high-tech industries during the late 1970s and early 1980s. These efforts included various tax and financial concessions and promises of work forces trained to accommodate the needs of individual employers.

Recruitment efforts continue to be an active component of many states' economic development plans. The competition for the Saturn plant, for example, included 38 states and 1,000 local communities. Further, state recruitment packages have become more complex as well as more expensive. In its winning proposal for the Saturn plant, Tennessee provided a significant property tax abatement and infrastructure improvements and promised to spend an extra $45 million on higher education, in order to offer a range of technical courses (such as robotics and automation) for upgrading General Motors employees. Michigan's recruitment of a Mazda plant in 1986 included $19 million to train new workers, and Illinois offered $64 million in 1988 in hiring and training assistance in its successful bid for a Mitsubishi/Chrysler plant (U.S. Congress, Office of Technology Assessment 1990b).

In the 1990s, the stakes escalated. South Carolina offered a $130 million incentive package in its successful bid in 1992 to lure a 2,000-job BMW assembly plant. South Carolina reportedly offered Mercedes Benz a similar package to that offered BMW but lost out to Alabama, which promised a record-setting incentives package worth over $300 million. In addition to the price, another unusual feature of the package was Alabama's agreement to pay the salaries of the 1,500 workers (at an estimated $45 million) while they were being trained during the first year or so on the job (Applebome 1993; Browning and Cooper 1993).

In recent years, recruitment efforts in many states have focused on attracting new plants of firms that are expanding, rather than trying to induce employers to relocate existing facilities. The trend has also been toward greater emphasis on international investors, as states hope to lure plants of Japanese and other foreign companies.

High-Tech Job Creation

In the 1970s and early 1980s, many states began supplementing industrial recruiting strategies with efforts to create jobs at home. The impetus behind this trend came partly from some states' disappointment with their lack of success in recruiting jobs from outside. It was also in response to growing evidence nationally that the key to employment growth and good jobs lay in "growing your own" (Grubb and Stern 1988).

The experiences of California's Silicon Valley and Massachusetts' Route 128 provided tempting examples of the high-tech job creation approach. Seeking to replicate the success of these areas, many states adopted a range of high-tech development initiatives that focused on research, development, and technology transfer.

Efforts to stimulate technological innovation have taken a variety of forms, including research centers, industry–university partnerships, matching grants, and research parks. Research centers, often operated in conjunction with universities, conduct applied research and allow firms to pool their resources for facilities and equipment. Research parks, which encompass concentrations of R&D firms, are designed to generate the exchange of new ideas and hasten their transfer to the market. By the mid 1980s, approximately 150 research parks were in operation in the United States, almost double the number a decade earlier (Eisinger 1988).

Programs to support high-tech start-up firms have also grown in recent years. All states now operate programs to assist small businesses and most have programs designed to stimulate new firm formation. Traditionally, small business assistance programs offered technical and managerial help; states are expanding these efforts to include more entrepreneurial and financial assistance. A few states have created small business "incubators," which provide shared services such as legal assistance, conference rooms, accounting services, and research facilities at relatively low rents to start-up firms.

Increasingly, state initiatives to create and develop new firms have influenced private investment practices and filled gaps in capital markets. By the mid 1980s, most states had funded venture capital programs to finance new and emerging businesses. These programs, some of which require matching funds from the firms, are generally quite small. They often seek to expand or change existing lending practices in the private sector. They may support firms that might not have approached traditional sources of seed money, or encourage private investments in potentially productive projects traditionally bypassed because they were considered too risky.

These entrepreneurial venture capital programs have brought states into relatively unfamiliar territory for public sector institutions. Traditionally, state industrial development loan programs worked with existing firms that backed their loans with collateral. In contrast, the new loan programs often focus on start-up operations and new product development, for which collateral is often not required (Eisinger 1988).

Revitalization of Established Businesses

Recent years have also witnessed a shift in emphasis in state economic development programs toward assistance to established businesses (Ganzglass and Heidkamp 1987; Osborne 1987; Rose and Kotlowitz 1991). Efforts to help established firms in the United States historically have focused on the prevention of job loss or on the reemployment of workers displaced from their firms. Measures to retain jobs in mature or declining industries, for example, have often included import quotas, domestic content rules, restrictions on outsourcing, and protection against unfair competition.

At the state level, cost-reduction incentives (for example, reductions in unemployment insurance, workers' compensation, or taxes and direct subsidies) have been used in attempts to offset cost disadvantages in an area and to keep employers in the state. States have also taken an active role in seeking to offset the adverse consequences of structural change. Many states have developed worker assistance centers or emergency teams to assist with plant closings and provide job search assistance, supplemental unemployment benefits, and assistance in moving.

Some states have created programs to assist existing firms before a shutdown becomes imminent. Michigan's Jobs Opportunity Bank, Delaware's Blue Collar Jobs Act, and the New Jersey Jobs Training Program specifically target resources to retrain current workers and possibly forestall plant closings.

Skills corporations, in which business and academic institutions work together and share training and retraining costs, emerged in the 1980s to assist established firms that were growing rapidly and facing skill shortages.

Increasingly, states have begun to take broader measures, which include programs for modernization and the development of new, foreign markets, in order to bolster the competitiveness of existing firms. Michigan's Modernization Services Program and Massachusetts' Center for Applied Technology, for example, seek to revitalize the states' traditional manufacturing sectors, such as auto parts, apparel, and cutting tools. These programs assist firms in the integration of new technologies by identifying both technological and training needs and by providing support and technical assistance.

In a multistate effort, the Southern Technology Council Consortium for Manufacturing Competitiveness was established in 1988 to utilize the states' vocational schools and community colleges to assist small and medium-sized enterprises with new technologies. Some states have begun experimenting with programs to stimulate exports by helping small and medium-sized enterprises market their products overseas.

Some state-financed training programs have shifted their efforts toward retraining the potentially unemployed and upgrading the skills of current workers. California's Employment Training Panel, the nation's largest state-financed training program, funded at approximately $55 million a year, was originally designed to assist firms moving into the state. It now focuses on helping existing businesses retool and reorganize in order to enhance productivity.

A few states have begun linking their training funds for established firms to capital investments. Indiana's Basic Industrial Training Program, for example, requires firms in mature industries (such as transportation, steel, and heavy machinery) that are expanding or modernizing to invest in capital equipment in order to be eligible for retraining assistance. The state covers between 10 percent and 50 percent of training costs, depending on the level of investment. Illinois' Industrial Training Program, which added a mature industry component to complement the traditional support of new and expanding companies, also makes training contingent on capital investment by the firms.

While the revitalization of established businesses has taken on increasing importance, the shift in this direction is still quite limited. Most states continue to focus their technology program funds on university R&D and on assisting start-up firms, rather than on the integration of new technologies into established firms. For instance, only about 10 percent of the $550 million spent on various kinds of technology programs in 1988 was spent on technology transfer and on technical and managerial assistance. As of 1990, only 10 states operated programs whose primary function was to assist manufacturers in technological adoptions. A mid 1980s survey by the Office of Technology Assessment (1990a) showed that only 2 percent of small and medium-sized enterprises had received industrial extension services from the state.

The recent Department of Defense "build-down" and growing defense conversion efforts will bring greater attention and funding to industrial modernization activities. The federal Advanced Research Projects Agency will be providing hundreds of millions of dollars nationwide for R&D and dual use (defense and commercial) technologies. In October 1993, for example, Massachusetts received $10.6 million in the Clinton Administration's first round of defense conversion grants. These funds will be used to create a statewide Manufacturing Modernization Partnership Program to help small and medium-sized firms diversify into commercial markets.

II. Technology Life Cycles, Competitiveness, and Economic Development[1]

Life-cycle models emphasize the evolutionary character of production and employment needs. The "industry life cycle" concept dates back to the 1930s, when industries were found to undergo a sequence of stages—experimentation, rapid growth, diminished growth, and stability or decline—as they developed. Separate "life cycles" have subsequently been delineated for products, for production processes, and for technologies.

Technology and Skill-Training Life Cycles

The technology life cycle, in particular, is a valuable tool in understanding the impact of industrial change on jobs and employment (Ford and Ryan 1981; Shanklin and Ryans 1984). Technologies—such as a numerical control technology, a microelectronics

[1] This section draws heavily upon Flynn (1991, 1993).

Table 1
Skill Training Life Cycle

	I Introduction: New and Emerging Skills	II Growth: Increased Demand for Skills	III Maturity: Slower Growth in Demand for Skills	IV Decline: Skill Obsolescence
Nature of Tasks	Complex	Increasingly routinized	Increasingly routinized	Narrowly defined
Type of Job Skills	Firm-specific	Increasingly general	General: transferable	General: transferable
Effects on Job Structure	Job enlargement: new positions created when significant change in skill needs occurs	Emergence of new occupations	Relatively rigid job hierarchy; occupations associated with formal education and related work experience requirements	Elimination of occupations
Skill Training Provider	Employer or equipment manufacturer	Market-sensitive schools and colleges	Schools and colleges, more generally	Declining number of schools and colleges; some skills provided by employer

Source: Adapted from Patricia M. Flynn, *Technology Life Cycles and Human Resources*, Lanham, MD: University Press of America, 1993, p. 19.

technology, or a data-processing technology—exhibit patterns of development in which they are introduced slowly at first, become more widely adopted as intensive research and development efforts lead to improved performance, and are then replaced by a new, superior technology.

A clear understanding of the technology cycle can provide signals of impending changes in products and production processes. Rapid product innovation accompanies the earliest phases of a technology's development, whereas process innovation peaks later in the technology's cycle as product design stabilizes. As a technology matures, uncertainty about its capabilities and limitations declines, and products and processes can become more standardized. Innovations in the later stages of development of a technology, if they occur at all, are primarily minor improvements in equipment rather than major, fundamental changes in either product or production processes.

Just as the production processes change over the life cycle of a product, so do the skill and training needs of industry over the life cycle of a technology (Table 1). The early stages of a technology, which are characterized by a high degree of product innovation, are relatively skill- and labor-intensive; professionals such as engineers and scientists perform most of the tasks later assumed by production and marketing managers, technicians, and skilled craftsworkers. The firm-specific nature of skills required by the new technologies also means that employers must provide their own training or rely on equipment vendors to do so.

As a technology becomes more widely adopted and equipment standardized, skills that were once firm-specific become general skills transferable among employers. Increased demand and standardization of skills permit their "production" on a larger scale and at locations away from the R&D sites. As a result, skill development tends to shift from the workplace to the formal education system as technologies mature. Computer programming, keypunching, and word processing are classic examples of this transfer.

As technologies become obsolete, training focuses on replacement needs and on the retraining of workers for other areas. A limited market for these skills and declining student enrollments result in the termination of school-based training programs in these fields. The responsibility for training to fill relatively short-term, skilled replacement needs, thus, shifts back to firms.

The Geographic Location of Jobs

In addition to altering production processes and skill needs, technology and production life cycles affect the geographic location of jobs. Patterns of

regional specialization occur, as employers seek to locate different production activities in areas best suited to their needs. Furthermore, changes in the labor and skill requirements over a product's life can trigger geographic shifts in employment over time.

The "regional life cycle model" suggests that the attractiveness of regional and local economies varies with the skill needs of products at different stages of development (Rees and Stafford 1984). Early stages of product innovation and development occur in areas in which highly skilled professional and technical workers are available to conduct R&D. Standardization and increasing output of the product trigger reduced skill requirements, inducing production shifts to geographic areas characterized by lower labor costs.

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Similarly, on a global level, the "international product cycle model" posits that firms initially locate close to the source of demand for their newly developed products so they can rapidly communicate market information into product changes (Wells 1972; Vernon 1979). As foreign markets emerge for the product, they generate exports for the producing country. At some point, depending on the nature of the products and the characteristics of foreign demand, the expanded foreign market attracts its own production base. When production costs abroad are low enough to compensate for transportation and other costs, such as tariffs, the country that originally produced the product becomes a net importer of the good. At the final stages of product development, production activities may shift from the sites of product demand to lower-cost areas in other countries.

Industries usually rely on a range of technologies, have products in several phases of development, and are characterized by diverse skill needs and employment patterns. The electronics industry, for example, produces both highly sophisticated products that incorporate technologies on the cutting edge and more mature consumer electronics goods, such as radios and televisions. Firms manufacturing the newer goods tend to concentrate their production operations near R&D. More mature products are produced in lower-cost areas. Similarly, while an increasing share of the world supply of semiconductors is produced outside the United States in countries with relatively abundant supplies of low-cost labor, the design and development work is still highly concentrated in Silicon Valley.

The computer industry shows similar patterns of regional specialization and employment trends (Hekman 1980). R&D, design, and production of state-of-the-art equipment continue to be geographically concentrated in Massachusetts and California, along with company headquarters. In contrast, the large-scale production of relatively standardized computer components and routinized assembly activities have dispersed away from R&D centers, taking place in large branch plants in states with relatively low labor costs (such as Tennessee, South Dakota, and North and South Carolina) or in low-wage countries (such as Mexico, Hong Kong, and Taiwan).

III. State Strategies and Life Cycles

When viewed in the life-cycle framework, the evidence on recruitment, high-tech job creation, and business revitalization strategies sheds new light on the role of states in fostering economic development.

Recruitment Strategies

Relocation incentives will have different effects on different types of production activities. In the early stages of product development, firms compete mainly via innovation and through product differentiation. In contrast, for firms that produce relatively standardized products, competition is mainly a function of cost. Incentives such as low wages and tax abatements will, therefore, be a greater inducement to plants operating at the later stages of production cycles than to firms involved primarily with R&D and entrepreneurial activities. Similarly, short-term customized training programs are likely to appeal to employers engaged in large-scale, mass production processes, but be of little value to firms characterized by complex, nonstandardized activities, which require relatively high-skilled and broadly trained workers.

The life-cycle framework accentuates the need to look beyond industry aggregates in fashioning recruitment strategies for economic development. Most industries and many, especially larger, firms encompass products, processes, and technologies at various stages of maturity. Industrywide data, therefore, combine production activities requiring different capital and labor requirements, and with diverse location needs.

In the life-cycle perspective, the concept of a high technology *industry* is a misnomer. "High tech" is a dynamic and relative concept that describes the earliest phase of development. "High-tech employment" should refer only to those jobs involved with R&D, innovation, or nonstandardized production activities—jobs that exist across a wide range of industries, including those that are relatively mature. "Low-tech" or routinized production activities (at the other end of the development cycle) also are found across a variety of industries, including computers and electronics.

In attempts to recruit "high-tech" employers during the late 1970s and early 1980s, many states used incentives including tax abatements and short-term customized training programs to pursue a list of "high-tech" industries. While the industries were selected on the basis of their relatively high proportions of R&D expenditures and of professional and technical workers, the bulk of the employment in these industries was in blue-collar and clerical jobs. Many states succeeded in recruiting only the relatively low-skilled, standardized manufacturing jobs (for example, the assembly of printed circuit boards) in these industries.

Earlier recruitment activities yielded similar results, with jobs relocating from other states primarily in manufacturing branch plants (Malecki 1983). These jobs are more apt to involve relatively standardized production activities and be more vulnerable to further dispersion to lower-cost locations than are jobs in firms indigenous to a geographic area. Many of the northern firms that relocated to southern states to take advantage of a low-wage work force and company-specific training, for instance, subsequently relocated to still lower wage areas (Southern Growth Policies Board 1988; Rosenfeld 1992).

The bulk of recruitment incentives used by states are still those (for example, tax and financial abatements, customized training) that appeal primarily to plants with relatively low-skilled and low-wage positions. The attractiveness of the Carolinas to German firms locating plants there in recent years, for instance, has been attributed to trained and malleable labor, low wages, and cheap land. With respect to workers, in particular, the Germans are said to have found "a work force willing to tolerate management practices that Americans often find idiosyncratic, if not obnoxious. . . . Such adaptability has more than made up for the skill levels of many of the workers" (McCarthy 1993). In 1993 Mercedes-Benz sought a U.S. location in order to move closer to the vast American market and avoid a 25 percent tariff on imported trucks. The Alabama site selected offered relatively low labor costs and a tax and incentive package that will result in Mercedes paying the equivalent of $100 for the site (Applebome 1993).

Few businesses move their operations between states, and very little employment growth is attributable to the migration of jobs into a state.

While many states continue to actively recruit employers, a relatively small number of states can be expected to launch effective recruitment strategies that contribute significantly to the number of "good" jobs and to long-term economic development. Few businesses move their operations between states, and very little employment growth is attributable to the migration of jobs into a state.

Moreover, recruitment strategies, even those initially appearing quite successful in terms of numbers of new jobs, can actually undermine long-term economic growth. For instance, if tax and other financial incentives have a negative impact on the quality of life by restricting education and services in the area, relocation incentives could deter the entry of employers whose work force contains relatively high proportions of professional and technical workers. In addition, the recruitment of new industries and firms can backfire if, in the process, incentive packages to new firms impair the competitiveness of established employers or prompt their "premature" departure from the area. Expensive recruitment packages, for instance, can drain resources from more traditional sources of employment, which comprise the bulk of all jobs in local economies. Existing companies may

also suffer if the state subsidizes the entry of firms that are their direct competitors.

The external control inherent in branch plant economies, whereby major corporate decisions are made elsewhere, suggests that local employment and other community concerns may not be a top priority in discussions of firm location and restructuring. Further, given their mix of production activities and occupations, branch plants are less likely than indigenous new firms to act as a "seed bed" or "growth pole" in stimulating spin-offs and new employment opportunities in an area.

Recent anecdotal evidence does indicate, however, that several foreign auto assembly plants (for example, Toyota in Kentucky, Honda in Ohio, Nissan in Tennessee) have attracted supplier branch plants to the area. Moreover, if state recruitment strategies provide longer and more complex education and training programs than in the past, states may be able to attract better-quality jobs. More highly skilled and more broadly trained work forces are incentives that appeal to firms in innovative, nonstandardized activities in earlier stages of development. Michigan, for example, one of the top three contenders for a Saturn plant in 1985, offered a recruitment package that encouraged development of "world-class" manufacturing and engineering talent. While it lost its bid for the manufacturing plant, it won the company headquarters and R&D facilities, and the relatively high-skilled jobs that accompany these functions (Fosler 1988).

High-Tech Job Creation Strategies

The life-cycle framework helps to clarify the role of new and emerging businesses in economic development. The creation and development of new entrepreneurial firms require strategies that focus on the characteristics and needs of products and technologies during their early stages.

In the high-tech success stories of the Silicon Valley and Route 128, growth was driven by local start-ups and spin-offs from companies already in the area. The technical infrastructure of both areas encompasses applied research and product development at universities, informal local communication networks, a scientific and technical labor force, and proximity to complementary and competitive firms and to distributors and markets. These examples accentuate the importance of innovation, research, product design, and non-routine production activities. Venture capital can provide the means to create and develop these new and emerging firms. Research on the location of technology-based entrepreneurial firms confirms these life-cycle hypotheses with regard to the importance of R&D, venture capital, and skilled labor in high-tech development strategies (Malecki 1990, 1991).

"High-tech" job creation strategies are not likely to be very effective for many states (Browne 1983; Gittell and Flynn 1994). Historically, small technology-based firms, and high-tech employment more generally, have accounted for a relatively small proportion of all employment. High-tech employment in the United States is geographically concentrated, with most found in New England, California, and Texas. R&D activities, in particular, remain geographically concentrated in a few areas of the country.

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States with significant university R&D, venture capital, and highly skilled labor have the most potential for implementing a successful competitive strategy based on entrepreneurial new firms. In addition, an established base of high-tech employment provides an area with a competitive edge in the creation of new entrepreneurial firms. An existing agglomeration of firms in similar or related sectors is a principal determinant of both birth rates and the distribution of small technology-based firms. Concentration of these resources in one area enhances the firms' productivity by creating external economies of scale in production and marketing. A self-sustaining "critical mass" of employers can develop, as the concentration of entrepreneurial firms attracts additional firms and venture capital, strengthens the technological infrastructure, attracts and retains skilled professionals, further promotes informal communication networks, and encourages innovative activities (U.S. Congress, Office of Technology Assessment 1984; Malecki 1990, 1991).

The flow of venture capital further highlights the advantages of an established high-tech base and the presence of research universities in the formation of new firms. The availability of venture capital varies widely by state and region, with funds flowing from U.S. financial centers like New York and Chicago to centers of innovation and technology. California, Massachusetts, and Texas regularly attract venture capital, with California alone often accounting for one-third to one-half of all U.S. venture capital. In contrast, many states have virtually no venture capital funds.

While an established high-tech employment base gives an area a decided advantage in new firm formation, relatively little is known about the initial generation of local start-ups. The initial "confluence of technological opportunity," or the appearance of the first entrepreneurs, appears to be due to the availability of start-up financing and the existence of informal (noninstitutional) personal and local contacts supportive of new, unproven entrepreneurs (U.S. Congress, Office of Technology Assessment 1984). Small firms, that is, those with fewer than 100 employees, are the major source of entrepreneurs, although a significant number of founders do originate from large firms.

It is important to differentiate among small firms in fashioning a high-tech development strategy. Most small businesses create no jobs after the first few years and many, particularly in the service sector, generate lots of relatively low-paying, dead-end jobs conducive neither to innovation nor to entrepreneurship. Relatively few small firms have the potential for growth and expansion and act as "seed beds" for future jobs. Such firms are dominated by innovative, nonstandardized activities.

A high-tech job development strategy will be extremely difficult, if not impossible, for relatively small areas that lack universities, existing technology-based companies, and skilled labor. Areas dominated by relatively mature industrial bases and technologies are also unlikely to be able to implement an effective economic development strategy around technology-based entrepreneurial firms.

Empirical evidence confirms that most research parks fail (Eisinger 1988). Some are unable to attract tenants; others fail to generate spin-offs; almost all fail to stimulate technology transfer. With respect to venture capital, most state programs are quite small and probably will not prove effective in establishing the "critical mass" of high-tech firms needed to generate a self-sustained growth environment.

Business Revitalization Strategies

The life-cycle framework also sheds new light on strategies to revitalize traditional and established firms, whose activities are primarily beyond the initial stages of development. Some established firms involve "mature" production activities. Representing the extreme opposite of high-tech activities, mature activities are those in which technologies and products are relatively standardized, mass production predominates, skill requirements are relatively low, and little or no innovation is taking place. Competition is primarily a function of cost.

The potential across states for programs to enhance productivity and competitiveness through revitalization of established businesses is extensive.

Considerable diversity exists among traditional industries in terms of their organizational structures, occupations, wage rates, and skill requirements. Within industries and even firms, mature segments often coexist with high-tech segments, as well as with activities that involve products and technologies along the mid-range of the development spectrum. Effective revitalization strategies for these industries will take a variety of forms, including integration of new technologies, better utilization of mature technologies, development of specialized product niches, and reorganization of the workplace.

In contrast to the recruitment and high-tech job creation strategies, the potential across states for programs to enhance productivity and competitiveness through revitalization of established businesses is extensive. There are two main reasons for this. First, the dynamics of technological and industrial change accentuate the ongoing need for upgrading of human resources and facilities to maintain competitiveness. Second, states have only just begun to tap the opportunities available to them regarding business modernization strategies.

The introduction of new technologies across a variety of established industries can benefit states by

fostering product and process innovations that lead to new and improved products and new markets. States need not have high-tech firms located within their boundaries in order to benefit from such a strategy. While still a strong competitor in terms of R&D and innovation, the United States continues to fare poorly with respect to the transmission of "best practice" technologies throughout the industrial structure. U.S. rates of adoption of robotics, computerized numerical control devices, and other advanced technologies continue to fall behind those of our industrial competitors. Moreover, even when adoption rates are similar, U.S. firms have been found to be less efficient in their implementation (Osterman 1988; Dertouzos, Lester, and Solow 1989; U.S. Congress, Office of Technology Assessment 1990a, 1990b).

The failure of firms to remain technologically competitive contributes more to worker displacement and job loss than does the adoption of new technologies.

Some observers express concern that adoption of new technology causes permanent job loss. In fact, however, the failure of firms to remain technologically competitive contributes more to worker displacement and job loss than does the adoption of new technologies (U.S. Government Accounting Office 1986; Cyert and Mowery 1987; OECD 1988). Adoption of technologies in their relatively early phases of development has primarily positive impacts such as upgrading and job enlargement. In contrast, the preponderance of negative impacts such as mass layoffs, unemployment, and job downgrading relate to adoptions of relatively mature technologies or to the failure of firms to adapt at all.

An alternative to the technology-based approach for enhancing the competitiveness of established firms involves a shift toward customization and market niches. Flexible manufacturing systems that make shorter production runs economical and encourage product differentiation have promoted a trend toward greater use of small-batch production of relatively specialized products. More flexible production processes and highly skilled labor also facilitate adoption of more advanced technologies (Doeringer, Terkla, and Topakian 1987).

Organizational and managerial changes are often necessary to fully exploit the potential productivity gains of new technologies and corporate restructuring. U.S. managers have been criticized, however, for several shortcomings in this area: (1) failure to evaluate effectively both the short-term and the long-term costs and benefits of technological adoptions; (2) inadequate development of human resources to meet changing needs; (3) insufficient development of organizational structures that can fully exploit the productivity gains associated with new technologies; and (4) failure to establish fruitful cooperative relationships with workers (Hayes and Abernathy 1980; Cyert and Mowery 1987; Drucker 1988; Hayes and Jaikumar 1988).

Small firms, in particular, have difficulties with technological adoptions because of costs, skill and retraining requirements, and the need to keep up-to-date. State industrial extension and training efforts, however, reach relatively few small firms. State officials indicate that it is hard to find small companies, assess their needs, and spend enough time with them to make a difference.

The fact that industrial extension programs are rarely integrated with state training efforts highlights other missed opportunities. Neither technology nor training in isolation from systemwide support will effectively increase productivity and jobs. The recent trend, albeit small, to link training with capital investments is a good step in promoting industrial competitiveness.

The shift in some state-financed training programs away from recruitment and toward the more efficient use of existing state resources and firms also has the potential to enhance competitiveness and long-term economic growth. However, while modernization efforts generally require flexible and more broadly trained workers, most state-financed training programs continue to provide relatively short-term training for individual firms (Creticos and Sheets 1990). In-plant training provided by state-financed training programs has not been assessed on a sustained basis; skills corporations, too, have had few evaluations. Furthermore, the firms accepting public funds might have provided the training anyway. Matching requirements help to limit the degree of substitution taking place; questions remain, however, about the transferability of the skills being provided.

IV. Development of State Strategies

The life-cycle perspective on competitive strategies is useful to states for several reasons. First, states can use it to assess where their economies are in terms of emerging, evolving, and maturing employment opportunities, and thus what economic development needs might be. Second, states can use it to guide their determination of where they might want to be, the feasibility of their aspirations, and the economic development issues that must be addressed to move in that direction. Third, states can use it to determine the relevance of the experiences of other states to their own competitiveness strategies.

Tailoring Competitiveness Strategies to Individual States

Most states will select a mix of strategies (recruitment, job creation, retention) to promote competitiveness and long-term economic development. A state's economic development goals should reflect its competitive strengths and opportunities. In addition, the selection and design of strategies and particular programs should be linked to the state's employment base and resource mix.

States will differ with respect to composition of employers, characteristics of the work force, institutional capabilities, and other resources. Goals and strategies, therefore, are expected to vary from state to state. In tailoring their strategies, states should assess their existing employment base, the characteristics and potential of state resources, and the strengths on which they can build competitive advantage.

Initially, states should analyze the nature and mix of their employers and jobs. This analysis requires looking beyond industry aggregates and identifying the types of production activities (for example, R&D, standardized assembly), types of employers, occupational requirements, and skill needs. Business revitalization strategies, in particular, further accentuate the importance of understanding the existing employment base. While each state is likely to identify additional questions relevant to its particular circumstances, the first box provides guidelines for conducting this employment assessment.

States should then develop an inventory of labor and other resources available (educational and training institutions, R&D facilities, venture capital) that can influence competitiveness efforts. Does the state have the types of resources necessary to effectively implement a high-technology job creation strategy or to recruit good jobs? The characteristics (age distribution, education levels, occupations, wages) of the state's labor force should be compared with national averages to identify state strengths or potential problems. A state with a relatively old work force, for instance, will face more replacement needs than others. A state with relatively high proportions of engineering and technical talent can have an advantage over others in high-tech development possibilities. A state with relatively low production wages can attract manufacturing plant production jobs. The overall structure of a state's education and training

State Employment Assessment

- How does the state's industrial structure compare with the national economy? How has this been changing over time?
- How does the state's occupational mix in its major industries compare with the national averages in those industries?
- Describe the extent of various kinds of production activities located in the state (the mix of branch plants, headquarters, and R&D facilities). Is there a trend in recent years?
- Make a grid classifying the state's major industries and employers by development stage (emerging, growing, stabilizing, declining).
- What is the birth rate of new firms in the state? How does this compare with the national average?
- What are the characteristics (industries, firms, products, technologies) of the state's high-tech employment?
- What are the characteristics (industries, firms, products, technologies) of the state's major traditional employers?
- What is the extent of entrepreneurial small firms within the state? Identify potential high-growth areas.
- What industries have been the primary sources of plant closings, layoffs, and unemployment in the state in recent years? What were the reasons for these events?
- What are the needs (skills, technological, financial) of the state's traditional employers?

State Resource Inventory

- How does the state's work force compare with national statistics regarding demographic and educational factors? What are the implications in terms of education and training needs?
- What are the major R&D institutions in the state?
- What are the extent and sources of venture capital available to new firms?
- Describe the "business culture," labor climate, and status of labor relations in the state. Give examples.
- What major skill shortages and surpluses have occurred in recent years? How were these imbalances resolved?
- Describe the evolution and current status of the state's education and training network. What are the strengths and weaknesses of the various institutional components of this network?
- Which firms have used state-financed training programs? Describe the extent and types of skills provided.
- What relationships/partnerships exist between education and training institutions and employers (for example, co-op programs, apprenticeships, advisory boards)? Have these met expectations?

network should be identified. Further, the roles and track records of the institutional components of the education and training network should be assessed in terms of skill generation and responsiveness to changing labor market needs, in order to understand the capabilities of the system. The second box provides guidelines for the development and assessment of the state's resource inventory.

Lastly, competitiveness strategies and programs should be assessed in light of the state's employment and resource bases. In which activities is state policy likely to be most effective in generating good jobs and long-term economic development? In which industries? In which types of firms? Assessments should be made of various recruitment, job creation, and business revitalization programs previously implemented in the state. Such assessments should include both the short-term and the long-term impacts. In addition, potential barriers and constraints to implementing strategies and programs should be identified. When policy options have been identified as particularly appropriate for the state, the experiences of other states in that regard may then prove particularly useful. What were the impacts of those programs elsewhere, and what problems were encountered? The third box provides guidelines for thinking strategically about the state's economic development policies and employment and work force needs and opportunities.

"Defensive" and "Proactive" State Actions

The life-cycle framework highlights the importance of distinguishing between "defensive" and "proactive" actions in seeking to bolster a state's competitive advantage and long-term economic development. Defensive actions represent an expedient way of improving competitive position by lowering costs. They do not, however, address issues of work force quality and technological change that underlie business performance. In contrast, proactive or innovative adjustment mechanisms can lower costs by increasing labor productivity, motivating workers, improving efficiency, and increasing the quality of the work force (National Center on Education and the Economy 1990; Doeringer and others 1991).

Classifying state actions as defensive or proactive can be useful in understanding the impacts and trade-offs, both short-term and long-term, of various policy options. Defensive state actions such as tax abatements or other financial incentives can quickly lower costs to potential employers and perhaps attract relatively large numbers of jobs to some states in a short period of time. As discussed above, however, these mechanisms may undermine long-term economic growth, as the jobs recruited are often relatively low-skilled and vulnerable to further relocation to even lower-cost areas. Proactive strategies may increase costs initially and will take longer to reduce costs via productivity increases. However, the ultimate impacts on jobs and growth are likely to be more positive and longer-lasting.

The defensive/proactive dichotomy highlights the importance of having public policies focus on "good jobs" as opposed to "jobs" per se. Moreover, "output" should be viewed in addition to jobs in evaluating policy effectiveness, particularly with respect to relatively mature industries where increasing competitiveness and long-term viability are often achieved with lower employment levels.

Strategic Thinking about Economic Development Policy and Employment and Work Force Needs

- What are the areas in which the state has particular strengths, in light of the employment and resource inventory assessments?
- What firms have moved into the area in recent years? Did they relocate from another state (if so, which)? Are they foreign-owned? What are their major production activities and the nature and extent of their jobs?
- What incentives have been used by the state in recruiting firms? Did those firms that have moved in take advantages of these?
- To what extent have new, high-tech firms been created in the state in recent years? In what fields? What was the source of venture capital?
- What are examples of traditional industries and firms in the state that have modernized their workplaces in recent years? Were state-financed training programs involved? Were any education and training institutions directly involved?
- Has the state been able to leverage funds to provide for training? To what extent? With which employers?
- What types of coordination and cooperation of education and training institutions appear necessary to implement the programs that appear to meet best the state's current and future employment and training needs?
- What barriers and constraints may inhibit the implementation of strategies and programs that appear to meet best the needs of the state?

In recent years, state economic development strategies have begun to focus more on proactive options and less on defensive responses. The trend away from an almost exclusive focus on recruitment toward job creation and business revitalization, for instance, is indicative of this shift away from a pure cost orientation to one that emphasizes productivity and technological competitiveness. The policy options being used within these broader strategies have been evolving in a similar direction. More complex recruitment packages that include training grants for upgrading and for relatively skilled positions, for example, can reduce labor costs through productivity gains—in contrast to tax abatements and other financial incentives.

With respect to business revitalization, while efforts are still limited, states are experimenting with a range of options with the potential to enhance productivity at the workplace. These include helping older firms adopt new technologies or make more effective use of traditional technologies, and helping them develop new markets by customizing or exporting their products. This shift toward more proactive approaches promises more highly skilled jobs. Proactive approaches also should provide real cost savings over time, whereas defensive ones threaten to become increasingly expensive. With respect to recruitment strategies, for example, when the first few states began offering tax abatements and customized training, these incentives helped to differentiate one state from another as they sought to attract new employers. Over time, more and more states have found it necessary to follow suit or risk not being considered a serious contender. Now virtually all states offer tax and financial incentives and customized training, so states are incorporating additional features into recruitment packages in order to distinguish themselves from the others.

Proactive approaches have a further advantage: At the national level the likelihood is greater of real net employment gains, rather than just a reshuffling of jobs among states. Moreover, proactive approaches have the potential to lead the way to an economic development outcome with relatively high wages, high skills, and high living standards, effectively bypassing low-wage, low-skill alternatives.

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