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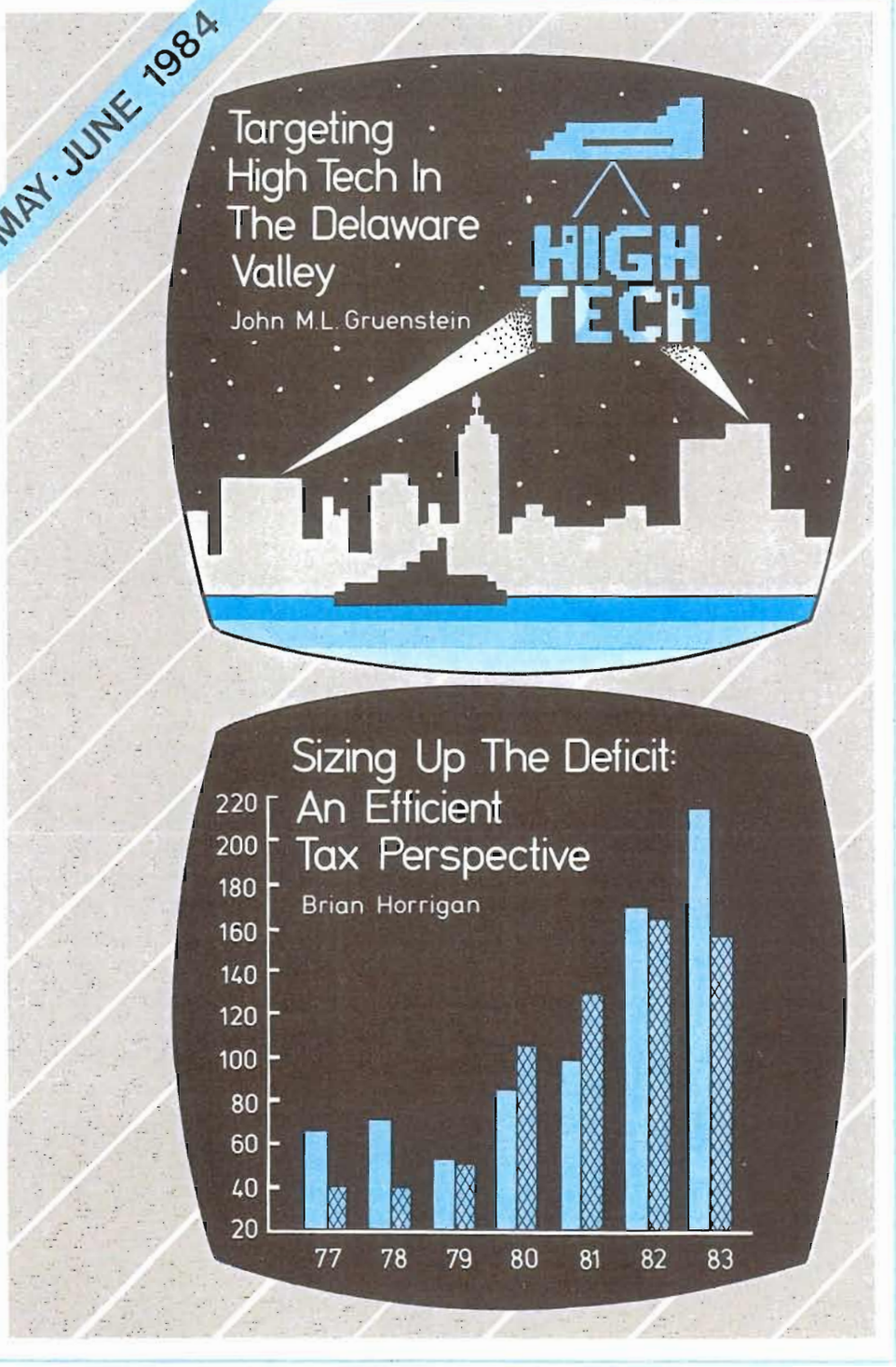

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Targeting High Tech In The Delaware Valley

*John M. L. Gruenstein**

Around the country and around the world, economic development officials are trying to jump on a speeding bandwagon called high tech. Places with high tech concentrations like California's Silicon Valley, the Boston area's Route 128, and North Carolina's Research Triangle have become the new models for job creation efforts. Targeting technological frontrunners—like computers, robotics, and genetic engineering—has become a new gospel of development strategy for planners from Peoria to Paris.

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In the Delaware Valley, as elsewhere, however, there is a broad range of opinion about development efforts that focus on industries at the leading edge of rapid technological change. Some view the game as not worth the candle, because of the relatively few jobs that high tech industries are expected to produce and the intense competition involved. Others say it's how you play the game that matters for success—for instance, whether you try to lure branch plants of giant firms like IBM, or whether you nurture local entrepreneurs who might be able to create the IBMs of the future in your own backyard. To analyze the local prospects for success, it is useful to look at examples of how high technology industries have developed

in the places where they have grown fast, and then to make a more systematic comparison of the factors which promote high tech growth with the strengths and weaknesses of the region.

CHARACTERIZING HIGH TECH

Before anyone can figure out whether to take aim at high tech, the first thing that has to be settled is, what is "high tech." In general, high technology industries are usually taken to mean those at the leading edge of rapid technological change. Such a definition by its very nature produces a list of industries that changes over time—Philadelphia's Baldwin Locomotive Works was a high tech firm in the nineteenth century, and robotics could become a "smokestack" industry of the twenty-first. Using research and development (R & D) spending and the proportion of technical workers as criteria, the U.S. Bureau of Labor Statistics (BLS) has proposed three different definitions of high tech industries (see DEFINING HIGH TECH). The six industries in the most narrowly defined group—office equipment and computers, communications equipment, electronic components, aircraft, guided missiles, and drugs—are included in virtually all lists of high tech industries. Therefore they provide a good starting place for discussing the characteristics that make these industries attractive to economic development planners.

One attractive feature is fast-growing sales. Recent studies predict larger average annual growth rates for sales and shipments in most high tech industries over the next five years than for industry in general (see TABLE 1). Projections are particularly strong for computers and electronics. Fast-growing sales means fast-growing employment, although not usually on a one-to-one ratio. The narrowly defined group of six high technology industries showed job growth of 39.8 percent between 1972 and 1982, compared to 20.1 percent for all wage and salary workers. For 1982-95, the BLS projects that employment in these industries will register growth between 34 and 38 percent, while employment in all industries grows between 25 and 31 percent.

A particular advantage of high tech industries is that a high proportion of the goods and services they produce are sold in national and global markets—that is, outside the region where they are produced. This is important to state and local economic development planners because it means that money spent to stimulate local growth of high tech firms has the potential to generate a net gain of jobs for the region. A plant manufacturing

DEFINING HIGH TECH

A number of researchers have drawn up lists of high tech industries, which are usually based on the percentage of revenues allocated to research and development (R&D), the proportion of technical or scientific workers in the industry's employment, or a combination of these factors. A recent study by the U.S. Bureau of Labor Statistics laid out three alternate definitions of high tech industries.[a] The broadest definition includes those industries with at least 1.5 times the average proportion of technology-oriented workers (engineers, life and physical scientists, mathematical specialists, engineering and science technicians, and computer specialists) compared to the average for all industries.[b] This wide-ranging group contains 48 industries, not all of which would be commonly thought of as high tech. The next broadest group is defined to include

> manufacturing industries with a proportion of technology-oriented workers equal to or greater than the average for all manufacturing industries, and a ratio of R&D expenditures to sales close to or above the average for all industries. Two non-manufacturing industries which provide technical support to high tech manufacturing industries are also included.

This definition brings the list of included industries down to 28, eliminating such mature industries as heavy construction, tire production, motor vehicles, and household appliances. The criterion for inclusion in the third group, the most narrowly defined, is a ratio of R&D expenditures to sales at least twice as large as the average across industries. Only six industries meet this criterion—drugs, office equipment and computers, communications equipment, electronic components, aircraft, and guided missiles.

[a]Richard W. Riche, David E. Hecker, and John U. Burgan, "High Technology Today and Tomorrow: A Small Slice of the Employment Pie," *Monthly Labor Review*, (November 1983), pp. 50-58.

[b]Industries as defined by three-digit Standard Industrial Classification (SIC) codes.

TABLE 1

GROWTH PROJECTIONS FOR HIGH TECH INDUSTRIES

Industry Shipments, 1983 - 1988
(Adjusted for Inflation)

Industry	Annual Average Compound Rate of Growth[a]
Computers	17 %
Electronics	14.5%
Telecommunications Equipment	
Radio and Television	8 %
Telephone and Telegraph	5 %
Drugs	4 %
Aerospace	3 %
All Manufacturing	4.8%[b]

[a]U.S. Bureau of Industrial Economics, *1984 U.S. Industrial Outlook*. (Washington, D.C.: U.S. Department of Commerce, 1984).

[b]Estimated average annual growth rate of output, adjusted for inflation, 1983-88. Source: Interview with Gorti Narasimham, U.S. Bureau of Industrial Economics, March, 1984.

computers, for instance, will likely sell well over 90 percent of its products outside the area where it is located. If such a plant is stimulated to operate in a region, the revenues it generates to pay its employees will generally be a net gain to the region. Even if the new sales cut into competitors' revenues, those competitors are likely to be hundreds or thousands of miles away. In contrast, if economic development funds are expended to help firms in industries which provide goods and services only to local consumers—for instance, grocery stores, dry cleaners, or beauty parlors—the net effect on local jobs is most likely to be near zero, because by and large the firms which are helped can expand employment only by taking sales away from other local firms in the same industry, who will therefore have to cut employment.[1]

On the other side, however, even though high tech industries are fast-growing, the absolute number of jobs they will provide over the next ten years will probably be relatively small for most regions, because the number of current high tech jobs is small. High tech industries will likely contribute far fewer jobs than the much larger service industries, for instance. Overall, the BLS projects that only about one million of the new jobs created between 1982 and 1995 will be in the six narrowly defined high technology industries, representing about 3 percent of all new jobs created over that period. Of course, it is true that high tech industries also indirectly stimulate job growth in other sectors through local purchases of goods and services by high tech firms and their employees. Some of the growth in business service industries, for instance, is attributable to the growing demand from the high tech sector. But even taking direct and indirect effects together, high tech industries alone will not be a panacea for regions that have been hard hit by losses in traditional manufacturing sectors.

Balancing the pros and cons, state and local economic development officials around the country have opted in many cases to make high tech targeting a substantial part of their overall strategy. One strong motivating factor in their decisions has been that, despite the statistics suggesting relatively small overall job growth, some particular places have benefited greatly from high technology growth. Planners point to these examples of success as possible models for the development of their own regions.

HIGH TECH SUCCESS STORIES

State and local planners who look with enthusiasm toward high technology industries are encouraged to do so by several well-known places where fast employment growth has been fueled by high technology development. Three areas in particular stand out—Silicon Valley (Santa Clara County, California), Route 128 (the highway ringing the Boston-Cambridge metropolitan area), and

[1]It is true that some services do constitute part of the export base of many regions. See John Gruenstein and Sally Guerra, "Can Services Sustain a Regional Economy?" this *Business Review* (July/August 1981) pp. 15-24.

Research Triangle, North Carolina. These areas have similarities and differences which provide useful information about the possibilities and prospects for regional high tech targeting.[2]

Historical studies of the development of Route 128 and Silicon Valley indicate that much of their growth came from new high technology ventures started up by engineers and scientists who were already working for other technology-oriented companies or for universities in the same geographic area. A good deal of the impetus for these new ventures came from defense spending by the U.S. government for research and new product development. The excellence of the engineering and science faculties at M.I.T. and Harvard (in Cambridge) and Stanford and Berkeley (in the San Francisco area) drew a large proportion of technologically-oriented defense spending to these universities, and created opportunities for faculty members to start new firms based on research they were pursuing under federal grants. State and local government incentives for high tech development in these two areas, however, were largely nonexistent during their first few decades of growth, although in recent years, both Massachusetts and California have initiated programs to promote the development of high tech industries. Rather than reflecting the success of local targeting efforts, the development of Route 128 and Silicon Valley reflected the entrepreneurial response of scientists, engineers, venture capitalists, and real estate developers to the stimulus of demand for high technology products by the federal government and subsequently by firms in other industries. This entrepreneurial response took place in geographically concentrated areas around the universities which provided the initial impetus. It became self-sustaining as other resources needed for its further growth—like capital, skilled manpower, and office and production space—were made available in the same area.

By contrast, the Research Triangle Park in North Carolina was the result of a deliberate effort by academic, private sector, and government leaders to target the attraction of scientific research facilities as a way of stimulating local economic development. In 1958, a committee organized by the state governor, Luther H. Hodges, and including prominent businessmen, bankers, and university presidents, raised about $2 million in private contributions to buy the 5500 acres of pineland in the triangle formed by Duke University, the University of North Carolina, and North Carolina State University that was to become the park. The committee then formed the non-profit Research Triangle Foundation, the owner and manager of the development. The Foundation's sole asset is the land inside the park, and its only source of revenue is from leasing and selling the land.[3]

While the park is not run by the state, there has been strong indirect state government support for the development. In 1963, North Carolina set up the first state agency in the U.S. directed at encouraging scientific research and technological applications. State funds have been forthcoming for educational programs that tie into the activities of prospective park tenants. In 1980, for instance, the state allocated $24 million to fund microelectronics research at the three universities surrounding the park, which helped to attract a $100 million General Electric Microelectronics Research Center.[4] Another way government has helped the park grow is through salesmanship—for instance, James Hunt, the current governor, has visited Silicon Valley to try to induce firms there to relocate or open branches in North Carolina.

Unlike Route 128 and Silicon Valley, Research Triangle Park has grown principally through the attraction of outside establishments instead of through the start-up of indigenous firms. The majority of the 20,000 jobs currently located in the park are in research or manufacturing facilities of corporations headquartered elsewhere, such as IBM and Monsanto, and of federal agencies, such as the Environmental Protection Agency. The presence of the park has also lured some heavy manufacturing branch plants of companies like

[2] A good overview of the development of Route 128, Silicon Valley, and Research Triangle is in Robert Premus, "Location of High Technology Firms and Regional Economic Development," Joint Economic Committee of Congress, (Washington, D.C.: Government Printing Office, 1982), Appendix A.

[3] See Paul Horvitz, "A Park That's Always in Season," Raleigh, N.C. *News and Observer*, (February 27, 1977), p. 1.

[4] See Roger Lopata, "Research Triangle: A Far Out Concept That Worked," *Iron Age*, November 23, 1981.

General Electric and SCM Glidden Metals to locations just outside the park's boundaries. By and large, however, relatively little employment has been generated in the area through start-ups of small high tech companies.

These three examples show two alternative ways in which high tech concentrations have grown: through civic efforts to attract branch facilities of large multi-establishment organizations, as in North Carolina, or through largely private initiatives leading to the growth of new high tech ventures, the type of development that has characterized the Boston-Cambridge nexus and Silicon Valley. Both components of employment growth probably generate a sizable proportion of new high tech jobs.[5] Both branch plants and new firms can expand over time, adding to the third important source of job growth, expansions of existing firms. Both can themselves spin off still more new firms, as employees with a desire to run their own business and the technological know-how to create a new product decide to become entrepreneurs. Since traditional economic development activities have emphasized attracting facilities from outside, success stories like Research Triangle's have prompted many states and localities to adapt their programs to attracting branch facilities of high tech firms.

GOING AFTER BRANCHES

As high tech markets expand, and high tech firms expand to meet the demand, they often set up new branch establishments. This growing pool of new high tech branches is a tempting prize for regions to compete for. States and localities have a variety of instruments at their disposal to try to attract high tech branches, including low interest loans, tax abatements, providing land at below market value, and other potentially costly programs. For any region, the amount they want to spend depends on the probability of success, which, in turn, depends on the number of competitors and the comparative advantage of the region.

Stiff Competition. While high technology markets are growing fast, so is the number of state and local initiatives aimed at high technology development. Before 1981, the U.S. Office of Technology Assessment (OTA) reported nine state programs. Ten more were started in 1981, fifteen in 1982, and by May 1983, there were 38 state programs in 22 states exclusively dedicated to high technology development—including Pennsylvania's Ben Franklin Partnership Fund.[6]

Two aspects of the pursuit of high tech branches deserve to be noted. First, regions are unlikely to be able to induce firms to make a decision to branch; they can only try to induce firms to locate establishments in their area once the firms themselves have decided to branch. So the number of branches that regions are competing for is largely a result of macroeconomic and industry conditions, and therefore out of the control of regional policymakers. Second, the competition for those branches is stiff, and such strong competition among regions means that high tech firms looking to construct a new branch plant can do a lot of shopping around to get the best deal from local economic development agencies. Officials in one region are under great pressure to match the interest rate subsidy, tax break, site price, or special training programs that other localities are offering. Thus, competition pushes up the costs of putting

[5] A substantial percentage of total employment growth in all industries—not just high tech—comes from start-ups and branches. Researchers at M.I.T. have estimated that between 1979 and 1980, 4,275,000 million net new jobs of all types were added in the U.S. by start-ups, and 1,903,000 net new jobs of all types were added through new branch plants. See David Birch and Susan MacCracken, "The Small Business Share of Job Creation: Lessons Learned from the Use of a Longitudinal File," M.I.T. Program on Neighborhood and Regional Change, March 1983 (mimeo), Table 8. Researchers from the Brookings Institution using the same data base had previously come up with smaller totals for the number of jobs generated by new ventures and a larger proportion for the number generated by branches for 1976-1980, but the percentages are still large for both components. See Catherine Armington, "Further Examination of Sources of Recent Employment Growth: Analysis of USEEM Data for 1976 to 1980," Business Microdata Project, The Brookings Institution, March 1983 (mimeo). It is likely that job growth in high tech industries follows roughly the same pattern as total employment growth.

[6] U.S. Office of Technology Assessment, *Technology, Innovation, and Regional Economic Development*, Background Paper #1 (May 1983) and Background Paper #2 (February 1984). The state programs described in these publications include ones directed at stimulating high tech entrepreneurship and technology transfer to firms in older industries, as well as high tech branch plant attraction.

together a winning hand in the game of attracting branches.

To a large extent, the costs of attracting branches depend on a region's initial comparative advantage—the underlying structure of cost and market factors that an incoming firm faces. A poker player may improve his hand by drawing new cards, but the probability of winding up with a winning hand depends a lot on how good his hand was to begin with. So, in assessing the prospects for improving the Delaware Valley's chances for attracting high tech branch plants, it is important to know what factors are the most significant to high tech location decisions and how the region stacks up on these factors.

High Tech Location Factors. Three recent studies, one by the Joint Economic Committee (JEC) of Congress, one by the Fantus Company, a consulting firm, and one by a research group at Berkeley, have attempted to find out what factors are important to location decisions of high tech firms. In June 1982 the JEC released a study of high technology manufacturing industries based on a survey sample of almost 700 high tech firms.[7] The respondents were asked what were the most significant factors influencing a firm's choice of region. Highest rated was the availability of skilled labor: about 90 percent of the respondents stated this was a "significant" or "very significant" factor. The next most important factors were labor costs and taxes, followed by the presence and quality of academic institutions, cost of living, transportation, and access to markets. Some factors associated with more traditional manufacturing concerns, such as energy costs and access to raw materials, were ranked fairly low. Somewhat surprisingly, climate and cultural amenities, which are sometimes described in the popular press as quite important to high tech firms, were also rated low.

The second report, undertaken by the Fantus Company (a consulting firm which specializes in helping firms find sites for new facilities), reviews 86 location studies for high technology facilities, and it supports and refines the JEC results.[8] The Fantus study divides high technology facilities into three categories based on the stage of product development, with the two later stages most relevant to branch plant location decisions.[9] In the second stage of development, the facility is described as *product-driven.* In this stage, the product is commercially viable, but without strong competition. Close monitoring of production to assure quality control is important, and there may be a need to modify individual units to meet customer specifications. Here, the main location factors are availability of technicians and skilled workers, accessibility to the R&D facility of the parent firm, attractive living conditions, and a favorable business climate. At the third stage of the high tech product life-cycle, the *market-driven* phase, price competition from other firms pushes the location choice toward the lowest cost location. At this stage, the most important locational criteria are the availability of low cost labor, low cost utilities, and government incentives.

A third study, conducted by researchers at the University of California at Berkeley in 1983, found a very different pattern.[10] Instead of relying on survey data, the Berkeley study analyzed actual concentration and growth patterns of high technology employment and plants across regions during the period 1972-1977. In contrast to the JEC study, the Berkeley group found virtually no relationship between labor costs (as measured by average manufacturing wages in 1977) and high technology activity. In fact, after examining a wide range of variables, the Berkeley group found very little explanatory power from most of the common hypotheses concerning high tech location factors, and found conflicting results from different sorts of tests. In general, high defense spending and

[7]Robert Premus, "Location of High Technology Firms and Regional Economic Development," Joint Economic Committee of Congress, June 1, 1982.

[8]Robert M. Ady, "High-Technology Plants: Different Criteria for the Best Location," *Economic Development Commentary,* (Winter 1983), pp. 8-10.

[9]Facilities in the first stage of development, described as *theory-driven,* are primarily embryonic firms doing advanced theoretical research. As the discussion of new high tech ventures in the next section points out, most firms at this stage of development do not make an explicit location decision, but rather start up wherever the founders happen to be.

[10]Amy K. Glasmeier, Peter Hall, and Ann R. Markusen, "Recent Evidence on High Technology Industries' Spatial Tendencies: A Preliminary Investigation," Institute of Urban and Regional Development, University of California, Berkeley, Working Paper No. 417, (October 1983).

good access to major airports were most consistently related positively to growth of high technology industries. Less consistently, the presence of major universities with good engineering or business schools was also found to be associated with high tech activity.

From the point of view of an economic development planner trying to assess the attractiveness of his region for high tech branch plants, the Fantus and JEC studies are probably better guides than the Berkeley study. It is true that the latter has the advantage of looking at the results of actual location decisions, rather than merely asking respondents before the fact what they would do, as the JEC study does. But this advantage is counterbalanced by the fact that the Berkeley study analyzes aggregate employment changes, which include employment increases due to new start-ups and expansions of existing firms, as well as those due to branch plant openings, along with employment decreases due to facility lay-offs and closings.[11] Thus, the lack of significance for most location factors found by the Berkeley study, and its lack of consistency with the more narrowly focused surveys, may very well be a good indication that different factors influence these different components of change—a point that relates closely to the Fantus study's finding that facilities at different stages of production respond to different location factors.

Delaware Valley's Climate for Branch Plants. Because the relatively consistent results of the Fantus and JEC studies likely provide a good indication of factors important to high tech branch plant location decisions, they are useful for analyzing the strengths and weaknesses of a particular region for branch plant attraction. In general, the Delaware Valley seems to rank about average on factors that the two studies found most significant, such as labor skills and costs and taxes (see TABLE 2 page 10). Some of the area's stronger attributes, such as the presence of high quality academic institutions and a major airport, lie in the middle range of high tech facility location attributes as described by the JEC study. In some cases, what are perceived to be Delaware Valley strengths, like the presence of strong arts and cultural institutions, seem to be relatively unimportant to high tech firms. (Separating branches into the two categories of the Fantus study indicates that the area does somewhat better on factors affecting product-driven facilities than on factors for market-driven facilities, but even so, the pluses and minuses are relatively equal.)

The overall impression is that in terms of competing for high tech branches, the Delaware Valley's advantages compared to other areas are balanced by factors on which the region rates no better than average. Given the stiff competitive environment, these results suggest that while some benefits can be gained by targeting branches, it is likely to be a costly, uphill battle. But this need not mean that an emphasis on high technology has little place in local economic development efforts. An alternative to targeting high-tech branch plants for economic development is to focus instead on stimulating start-ups of new high technology firms by local entrepreneurs.

TARGETING HIGH TECH START-UPS

An advantage of targeting start-ups is that an entrepreneur's decision to set up a business very rarely involves a location decision. Most people who decide to produce and market a new product or service usually start up wherever they happen to be at the time—the decision is *whether* to set up the firm, not *where*. Because of this, one region's gain in an additional new venture isn't necessarily another region's loss, as it is in the case of high tech branches. So local efforts to increase the rate of start-ups may actually be able to expand the total number of new ventures nationally, creating a larger overall pot for regions to go after, as well as increasing the probability of getting a share. Thus, economic development activities directed at start-ups run into less direct competition with other areas than those directed at branches.[12]

[11] Employment changes due to all these other components combined have been shown by other researchers to be far larger than the changes due to branch location. Birch and MacCracken, in "The Small Business Share of Job Creation . . .," found employment changes for all industries (not just high tech) due to new branch plants were only 12 percent of *gross* employment change from all components and only about 39 percent of *net* change, for 1979-80.

[12] Regions attempting to stimulate start-ups would be competing indirectly, however, in the sense that an entrepreneur in one region could be competing with a firm in another.

TABLE 2

DELAWARE VALLEY RANKING ON HIGH TECH LOCATION FACTORS

Factor	Effect on Firms		Attractiveness of Delaware Valley
	JEC	Fantus	
Good Labor Skills	High	Strong	Medium
Low Labor Costs	High	Strong	Medium
Good tax climate	High	Strong	Low to Medium
Academic Institutions	Medium	Strong	High
Low Cost of Living/ Low Housing Prices	Medium	Strong	Medium
Good Access to Markets	Medium	Not Strong	High
Good Regional Regulatory Practices	Medium	Strong	No good measure
Low Energy Costs/ Availability	Medium	Strong	Low
Cultural Amenities	Low	Strong	High
Climate	Low	Strong	Medium
Access to Raw Materials	Low	Not Strong	Medium

NOTE: This table summarizes the JEC and Fantus studies results. In the JEC study, respondents were asked to rate each factor as "very significant, significant, somewhat significant, or no significance," with respect to location choices. The percent of "very significant" and "significant" responses were added together to obtain a ranking of overall importance. "High" represents 70-90 percent response, "Medium" represents 40-60 percent response, and "Low" represents under 40 percent response. The Fantus study rankings are relevant for product-driven or market-driven stages of firm development.

The Delaware Valley rankings were constructed by using variables corresponding to the JEC and Fantus categories that were available either for SMSAs, states, or cities (Delaware Valley is defined here as the Philadelphia SMSA, including Philadelphia, Bucks, Chester, Delaware, and Montgomery counties in Pennsylvania, and Burlington, Camden, and Gloucester counties in New Jersey). In some cases the ranking among the largest states or the largest cities was used. "High" indicates best third, "Medium," middle third (or, in some cases, within 10 percent of the U.S. average), and "Low," bottom third, where order reflects attractiveness to high tech branches.

The labor skills variable was measured as percent of high school graduates and percent of college graduates in population aged 20-64.[a] The labor costs variable was measured as average hourly earnings of production workers in manufacturing.[b] The tax climate variable was based on a study comparing state and local taxes paid by a model manufacturing corporation in various cities.[c] Academic institutions, cultural amenities, and climate variables were measured among SMSAs.[d] Cost of living/housing was also measured among SMSAs, and was chiefly determined by the median value of owner-occupied homes.[e] Energy costs were measured as the average prices of residential utility, gas, electricity, and fuel oil #2.[f] Objective measures for the remaining variables were not available, and those rankings reflect the author's judgment.

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[a]U.S. Bureau of the Census, *U.S. Summary of Census of Population, 1980,* (Washington, D.C.: Government Printing Office, 1982).

[b]U.S. Bureau of Labor Statistics, *Employment and Earnings* (Washington, D.C.: Government Printing Office, March, 1984).

[c]Pennsylvania Economy League, *Taxes in Philadelphia Compared to Other Large Cities.* Report No. 415 (Philadelphia, 1980).

[d]Richard Boyer and David Savageau, *Places Rated Almanac: Your Guide to Finding the Best Place to Live in America* (N.Y.: Rand McNalley & Co., 1981).

[e]Ibid., and U.S. Department of Commerce, *State and Metropolitan Area Data Book* (Washington, D.C.: Government Printing Office, 1982).

[f]U.S. Bureau of the Census, *Statistical Abstract of the U.S., 1982 - 1983* (Washington, D.C.: Government Printing Office, 1984).

Targeting start-ups involves risks for a community as well. Many new firms fail in the first few years of business. To expand employment significantly, regions need to create conditions which increase both the probability that people will choose to start new high tech firms and the probability that their ventures will succeed. A number of studies have investigated the factors important to new ventures. In general, these studies have found that the needs of start-up firms are very different from those of new branch plants.[13]

Factors Important to Start-Ups. One factor important to a region's probability of generating start-ups is the *pool of potential entrepreneurs.* Entrepreneurs are often people in existing technology-oriented firms who have an idea which the company is unwilling or unable to develop. Such people may be tempted to start up a new firm if entry into the particular field is not too difficult for a small firm. (Some fields, like pharmaceuticals, are harder for small firms to compete in because of high development, testing, and market costs, while others, such as electronics, are easier to enter.) Faculty and students in universities in the area also are potential business founders. How large the pool is depends partly on numbers of businesses and local academic institutions, but size isn't everything. Different places seem to have different *entrepreneurial climates*—that is, cultures encouraging or discouraging entrepreneurship. A positive climate, which feeds on demonstrations of previous successes, can encourage people to take the risks and endure the hardships associated with start-ups.

A very important factor for new ventures is the *availability of capital.* New firms need different types of financing at different stages of development. In the earliest phase, prototypes of the product or service are typically being developed, a management team is being assembled, and business plans are being formulated. Financing for this stage, commonly called seed money, is often provided by informal sources, family and friends, or through personal resources. At the next stage, in which a high tech firm gears up for commercial production levels, financing is often provided through venture capital—fairly risky equity financing that is unsecured by assets. Decades ago, venture capital, if available at all, was usually provided by wealthy individuals through private placements. Since World War II, formal organizations devoted to providing venture capital, mainly limited partnerships and small business investment corporations (SBICs), have provided increasing amounts of such financing. At a later stage of development, when assets have been acquired and the firm is operating close to or at profitability, capital may be available from a wider variety of sources, ranging from ordinary commercial loans from a bank to a public stock offering.

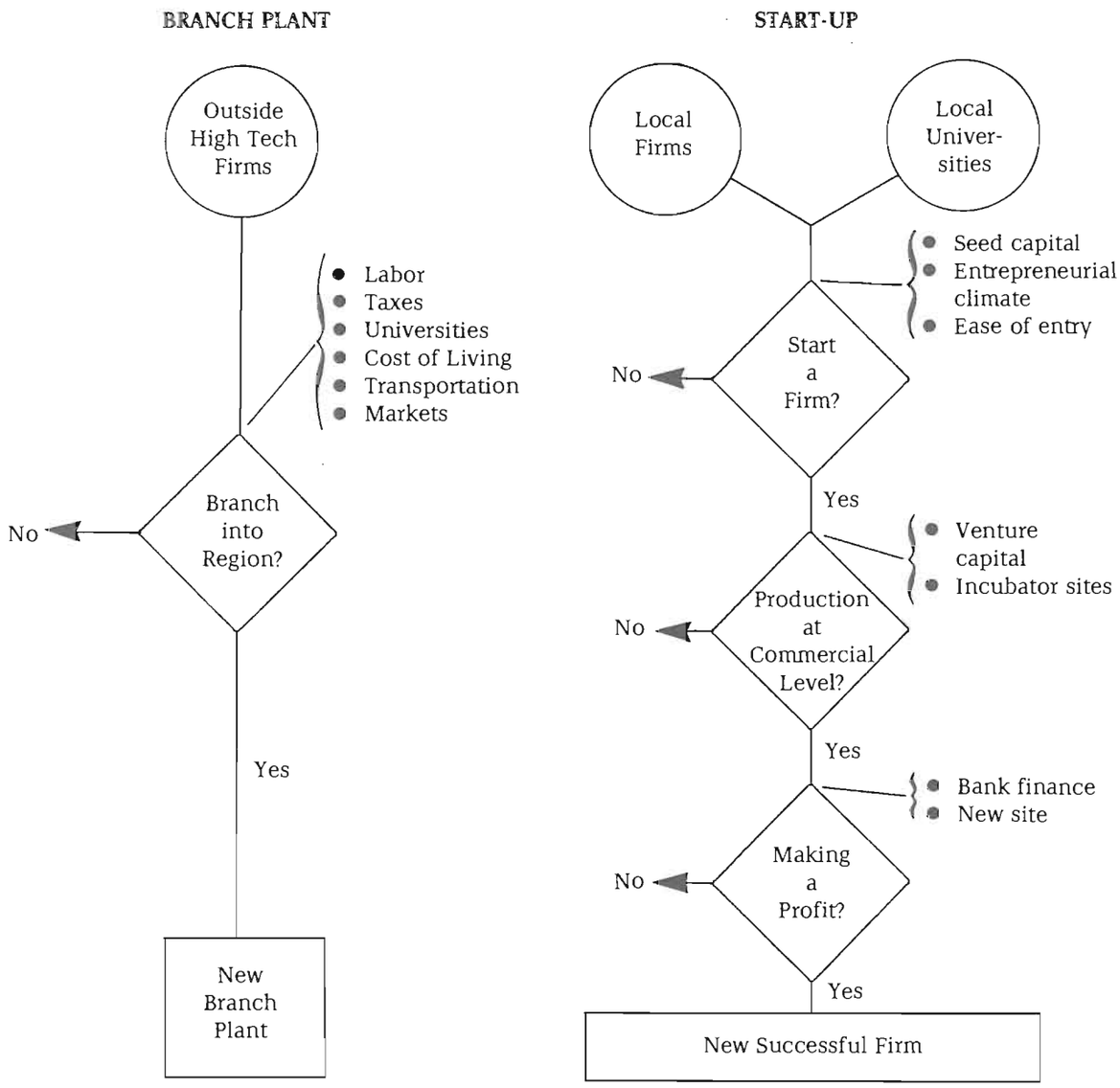
The existence of *suitable sites* for operations is another factor in the start-up process. The site requirements of a new venture are typically very different from those of a branch plant of a large firm. Low-rent space is usually vital to hold down costs in the beginning. Sometimes it is important for such a site to be close to a university or research facility—for instance, if specialized laboratory equipment or professional libraries available on campus can be used, if the founders are still faculty members or students, or if consulting help is needed. Access to shared business services, like photocopying or a receptionist, can be another useful feature of an incubator site. Only at a later stage of growth will a new company often be able to afford the large new facility in a suburban light industrial park setting that a branch plant may prefer.

Most of the factors influencing the development of new firms are quite different from those affecting branch plant location decisions (see FIGURE 1 page 12). Capital—particularly venture capital—the entrepreneurial climate, and low-rent sites foster start-ups, but are relatively unimportant for branch plant location decisions. Labor quality, labor cost, and taxes probably play a role for branches, but have little likely effect on entrepreneurial vigor—at least at an early stage. Universities affect both kinds of decisions, because

[13]Studies describing the factors important to high technology start-ups include Edward B. Roberts, "How to Succeed in a New Technology Enterprise," *Technology Review* (December, 1970); Karl H. Vesper, *New Venture Strategies* (Englewood Cliffs, NJ: Prentice-Hall, 1980), Arnold C. Cooper and John L. Komines, eds., *Technical Entrepreneurship: A Symposium* (Milwaukee, Wisconsin: The Center for Venture Management, 1972), and Elizabeth P. Deutermann, "Seeding Science-Based Industry," this *Business Review,* (May, 1966).

FIGURE 1

DIFFERENT FACTORS INFLUENCE HIGH TECH BRANCH LOCATION DECISIONS AND THE SUCCESS OF NEW VENTURES



they provide a pool of technical people who can become either employees of high tech branches or entrepreneurs themselves.[14] Because of these differences, a region's comparative advantage in fostering new high tech ventures could be quite different from its comparative advantage for at-

[14]Universities probably attract branches and stimulate start-ups in some other ways as well, for example, by providing possibilities for further study or teaching for branch employees or by sharing equipment and libraries for start-ups.

tracting high tech branches.

Delaware Valley's Climate for Start-Ups. The Philadelphia metropolitan area has a large pool of potential entrepreneurs. The region has many existing technology-based firms, several high quality universities, six medical schools, and many other research facilities, which serve as a breeding ground for new high tech ventures. Researchers from the University of Pennsylvania, for example, have founded several biotechnology companies in recent years, including Centocor, Biological Energy, and Phospho-Energetics. SMS Corporation of Malvern, Pennsylvania, a software company with revenues over $200 million, was started in 1969 by three locally-based salespeople for IBM. SMS has itself been the source of more local spin-offs, including fast-growing Rabbit Software, founded in 1982.

Despite this large pool of potential company founders, the entrepreneurial climate of the Delaware Valley has been described as being somewhat weaker than that of other parts of the country that have experienced fast high tech growth.[15] Assessing anything so hard to quantify as a cultural factor of this sort is a risky business, of course, and systematic studies are hard to come by, but a general feeling that this is true has persisted. Over the past few years, a group of new regional organizations—including the Technology Council of the Greater Philadelphia Chamber of Commerce, the Delaware Valley Venture Group, and the Advanced Technology Center of Southeastern Pennsylvania—have worked to improve the climate for high tech entrepreneurship through the provision of free legal and accounting services, technology transfer conferences, the publication of a technology newsletter, and other means.[16]

Capital availability—particularly venture capital—has been a problem in the past, but conditions have changed greatly in the last year. As recently as 1982, a report on venture capital in the area stated that

> the net impression is that there is little money currently available in the Philadelphia area which is oriented toward start-up and first-stage venture financing and virtually no "organized" money available in the seed financing category.[17]

The same report pointed out that Pennsylvania, New Jersey, and Delaware ranked low on the number of venture capital limited partnerships, compared to states like California, Massachusetts, and New York. But in the last year, conditions have changed. One local venture capital partnership, capitalized at $20 million, has started up, and a half dozen other funds are in various stages of development locally.[18] Although probably not all of these partnerships will get off the ground, the supply of venture capital in the area coming from organized sources is definitely increasing.

Site availability for high tech start-ups in the area is good. In addition to having a stock of older buildings, which provide low-rent space, the region has at least three facilities explicitly designated as incubators—the University City Science Center and the Business Technology Center in West Philadelphia, and the Technology Center in Montgomery County. The Route 202 Corridor near King of Prussia and Malvern has provided another fertile area for start-ups, like Rabbit Software, and for relocating firms, like Centocor, which began elsewhere in the area and needed more space.

Because the requirements of new high tech ventures are harder to quantify (aside from capital) than those of high tech branches, assessing how the Delaware Valley ranks in this area is more of a judgment call. As with high tech branch location factors, the metropolitan area probably falls somewhere in the middle range compared to other regions. But in some ways the possibilities for improving the conditions for high tech entrepre-

[15] Digby Baltzell, in *Puritan Boston and Quaker Philadelphia* (New York: Free Press, 1980), puts forth a form of this thesis.

[16] These organizations are also working actively to promote the transfer of new technologies to mature industries in the region as another way of spurring economic development.

[17] Robert Mittelstaedt and Thomas A. Penn, "Venture Capital (or Lack Thereof) in the Philadelphia Area," A Report of the Venture Capital Ensemble Group: Philadelphia, Past, Present and Future Project (Philadelphia: Wharton Innovation Center, University of Pennsylvania, August 1982).

[18] Although capital in general is a very mobile resource, venture capitalists often like to finance nearby deals or have a local partner in a syndication, because the early stage of the venture requires a large information flow and much face-to-face interaction. So having locally based venture capital firms increases the probability that local entrepreneurs will secure financing and reduces their costs (time and money) of getting it.

neurs are better than for improving the conditions for branch location. Improving labor skills, lowering labor costs, and creating a better tax climate—the factors conducive to branch location—involve very broad institutional changes, whereas setting up a venture capital partnership, while difficult, requires the cooperation of far fewer people.

IN SUM

Motivated by success stories in other regions, Delaware Valley policymakers are turning to high tech industries as a component of an overall regional growth strategy. Competition is stiff—other regions are wooing electronics, biotechnology, and computer firms with great vigor—and stiff competition means that the potentially large payoff from attracting a high tech branch plant can be offset by the increasingly high cost of trying. The Delaware Valley ranks about average on the factors which influence high tech location decisions, so the probability of attracting high tech branches, particularly those for which cost competition is extremely important, is somewhere in the middle range.

An alternative to trying to attract high tech branches is trying to stimulate high tech entrepreneurship. The Delaware Valley has the advantage of a large pool of potential entrepreneurs. While many regions also are striving to promote high tech entrepreneurship, competition in this sphere has less of an effect on the probability of success and the net payoff. As with branches, the Delaware Valley's underlying conditions for fostering entrepreneurship are about average, but it may be easier to change features of the area, such as a lack of venture capital, which hold down new venture formation, than to change those factors which make it less attractive for high tech branches. So if Delaware Valley planners decide to play a "high tech" game, they have a better chance to score with start-ups than with branches.

FURTHER REFERENCES

In addition to the references cited in the footnotes, the following Federal Reserve System publications provide valuable analyses and information about high tech.

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