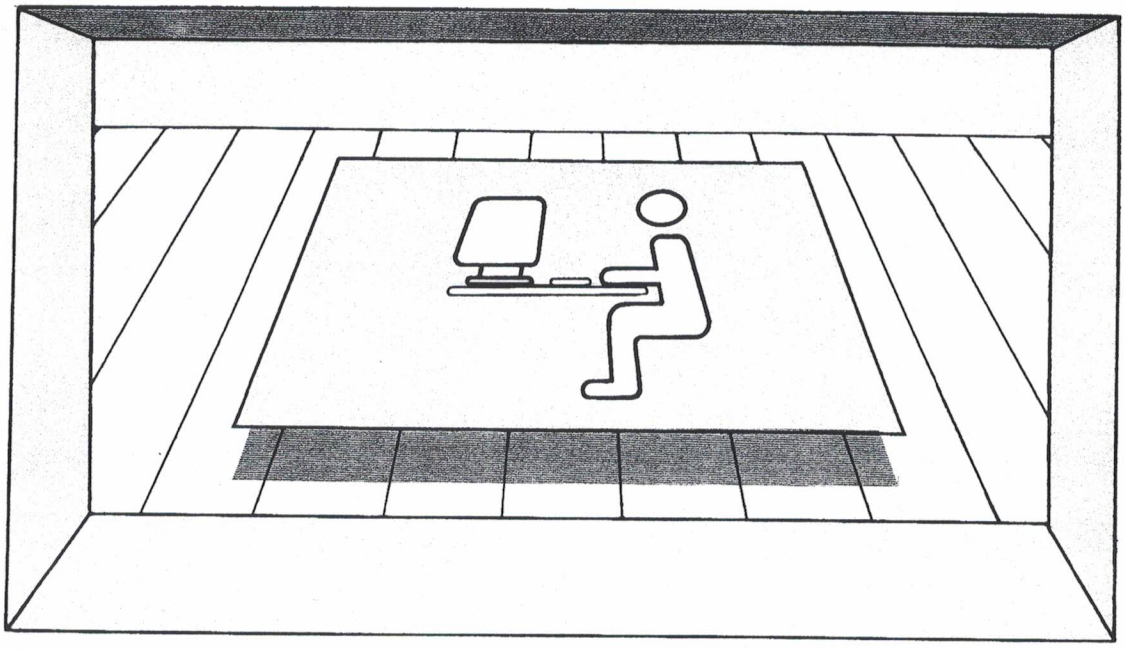
High Technology: The Southeast Reaches Out For Growth Industry



High-tech industry is introducing new, enlightened management concepts as well as jobs into the Southeast. An Atlanta Fed research team takes a searching look at the industrial phenomenon that could change the region

Since 1970, U.S. companies have added more than 20 million people to payrolls. Yet surprisingly few of those jobs were created by large industrial corporations. In fact, total employment of the Fortune 500 companies declined between 1970 and 1982 from 14.6 million to 14.4 million.

Instead, small growth companies are the force behind the nation's employment gains. Many of these companies are in the high-technology industry where phenomenal success stories abound. At Apple Computer Inc. in Cupertino, California, for instance, employment doubles every year. In just six years, this company has expanded its two-man garage operation to a $600 million enterprise with over 3,400 people employed.

In an attempt to understand the high-tech industry and the potential it brings to the Southeast, we visited high-technology firms, venture capitalists, securities analysts, educators, regional economists, and even an executive search firm. Our interviews and extensive conversations distilled the elements critical to developing a high-tech industry and the benefits that result when a region becomes home to such firms.

Several factors stand out:

(1) High technology is a growth industry. The prospect of adding a vibrant, growing industry to the southeastern economic mix is exciting. The markets for electronic components, communications equipment, and computer services are growing in excess of 15 percent per year.

(2) The Southeast enjoys a comparative advantage in attracting and developing new industry. The region offers relatively low cost

able 1. High-Technology Employment

	Manufacturing						Services		
	Employment			Percentage of Total Manufacturing Employment			Employment		
	1977	1982	Percent Change 1977-1982	1977	1982	Change 1977-1982	1977	1982	Percent Change 1977-1982
abama	26,701	33,368	24.97	7.54	9.90	2.37	3,605	6,125	69.90
orida	85,995	126,087	46.62	22.58	27.42	4.84	10,679	21,298	99.44
eorgia	23,639	38,379	62.35	4.78	7.66	2.88	4,171	10,307	147.11
uisiana	24,328	25,486	4.76	11.97	12.39	.42	1,978	4,218	113.25
ssissippi	9,510	9,210	–3.15	4.13	4.53	.39	1,109	1,662	49.86
Carolina	64,721	76,832	18.71	8.29	9.83	1.55	2,350	6,213	164.38
Carolina	45,778	48,733	6.46	12.04	13.45	1.41	838	2,395	185.80
nnessee	71,951	69,778	–3.02	14.18	14.91	.73	2,533	5,542	118.79
utheast	352,623	427,873	21.34	10.59	12.89	2.31	27,263	57,760	111.86
S.	3,098,500	3,780,600	22.01	15.74	20.06	4.32	225,298	464,578	106.21

rce: Bureau of Labor Statistics.
ual average employment for selected high tech SIC codes. (see footnote 7 for specific SIC codes included in manufacturing employment). 1982 data are age employment for the 1 st 3 quarters of 1982, from unpublished BLS data. High-Tech service employment is limited to SIC codes 489 and 737 which ıde communication, computer and data processing services.

labor, the quality of life desired by professionals, a low tax burden, and a good transportation network.

(3) Several clusters of technology have already developed in the Southeast. These pockets of activity are in various stages of approaching the critical mass of human talent necessary to develop a true high-technology region. Having an established base of technical organizations, people and educators is essential in recruiting high technology from outside the region. It also breeds "home-grown" high tech—the development of new firms by entrepreneurs in the Southeast.

(4) As in most small businesses, new ventures often fail. Yet a growing number of southeastern high-technology firms can be considered successful. These firms share common characteristics that have contributed to their growth and profitability. Most firms have identified a market niche in which they maintain a comparative advantage in producing a product. This niching strategy, accompanied by a creative, innovative and flexible management style, most often seems to be the key to their success.

Building a Base of High Technology

Southeastern states and localities are competing aggressively for a piece of the high-technology pie. Like their counterparts throughout the country, southeasterners want their fair share of these environmentally clean industries that bring tremendous growth, profitability, and resilience to the business cycle. Behind the intense competition is the hope that high-technology firms will help revitalize state and local economies by diversifying the economic mix, producing state revenues to offset federal budget cuts, and absorbing workers left unemployed by a wave of plant closings in the last few years.

While everyone is talking about it, the term "high technology" eludes a precise definition. Many prefer the term "advanced technologies," arguing that technology is a continuum on which

High Technology As a Growth Industry

We are witnessing a revolution in the way we live, think, act and process ideas—a revolution led by emerging technologies. Just as the telephone promoted communication in the late 1800s, the automobile facilitated local travel in the 1920s and commercial airlines transformed business transportation in the 1940s, electronic technologies are changing the way people process information for business and personal use. Those three innovations—the telephone, automobile and airplane—allowed a diverse group of people to share ideas more easily. As electronic technology progresses, information will be exchanged even more freely.

"Computer-aided" processes are the newest trend in increasing productivity. Manufacturers are using computers to control inventories, to schedule production, to design optimal plant layouts, to design new products, to facilitate assembly and to analyze operating results. Office workers in all industries are using computers to analyze and produce information. Hospitals are monitoring and diagnosing patients using computer-aided systems. Schools are teaching children with the help of computer software programs. Computers are helping to train technicians, machine operators, pilots, and others. Consumers are using personal computers for entertainment, education, shopping, financial planning, and banking services.

The engine driving high technology is the microprocessor embedded on a silicon wafer the size of an infant's thumbnail. These semiconductor chips contain thousands of transistors that hold electrical charges. The semiconductor is at the heart of standard computer equipment, but its positive and negative charges can be "programmed" with the logic to provide any device with decision-making ability, memory for instruction, and self-adjusting controls. Chips are now used in watches, cash registers, pacemakers, thermostats, radios, gas pumps, and car engines.

Technological development in the semiconductor industry is the catalyst behind new applications. As more memory is squeezed onto a single chip and the cost per bit of memory drops sharply, price sensitive applications become feasible. Just 13 years ago, the 1K chip (1,024 memory cells) was the industry standard. Today the 64K chip is dominant, and soon 256K will prevail. A 256K chip can store 5,200 words of text compared to 1,300 on a 64K chip. A maximum of 500,000 transistors can be stored on a chip today; industry sources expect 15-20 million transistors to be compressed onto a single chip by 1990. Shipments of semiconductors produced in the U.S. are expected to grow by 16 percent a year in the next five years despite intense Japanese competition.[1]

If the semiconductor is the engine of the high-technology industry, then communications technology is the driveshaft. Major advances in satellite, microwave, lightwave, and fiber optics communication media allow computers to link together efficiently from remote locations. Shipments of communication equipment are expected to grow 9 percent a year through 1987 with satellite communications leading the industry at 20 percent a year.[2]

As semiconductors and communications equipment rapidly decrease in cost and increase in efficiency, the market for many high-technology products has improved. Shipments of computer equipment are expected to continue at a strong pace of 18 percent a year through 1987. Worldwide sales of desktop computers priced under $10,000 reached two million units in 1982—almost half of the five million units installed as of early 1983.[3]

Growth in computer equipment implies a strong demand for related services. Software suppliers, systems integrators, and technical educators should flourish. The Association of Data Processing Service Organizations reported that computer services revenues grew 18 percent in 1982. The software products segments surged 41 percent that year and integrated systems grew 21 percent.[4]

Many electronics sectors will be spurred by increased Department of Defense expenditures on electronic weaponry, surveillance and communication equipment. In 1979, almost half of the communications industry's output was used in defense applications. That market share is expected to increase to 63 percent by 1987.[5]

Compare these growth rates to the projected five-year growth rates in more traditional industries—lumber, 5 percent; food processing, 2 percent; and automobiles, 1 percent.[6] Large firms, entrepreneurs, venture capitalists, investors, state and local governments, and educators are all trying to capitalize on this growing industry.

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[1] **1983 U. S. Industrial Outlook,** Michael W. Kubiak and Jack Clifford, Science & Electronics Division.
[2] **1983 U. S. Industrial Outlook,** U. S. Department of Commerce (January 1983). Arthur Pleasants, Science & Electronics Division.
[3] Ibid. John McPhee and Tim Miles, Science & Electronics Division.
[4] Association of Data Processing Service Organizations, telephone conversation, August 1983.
[5] **1983 U. S. Industrial Outlook,** U. S. Department of Commerce (Janary 1983).
[6] Ibid. David K. Henry, Bureau of Industrial Economics, Adair A. Mitchell, Office of Basic Industries, Donald A. Hodgen, Office of Consumer Goods and Service Industries, and Robert V. Coleman, Office of Producer Goods.

it is difficult to separate high from medium and low. Describing high-technology firms is easier and more meaningful. Such firms are science-driven in that they develop marketable applications of science and technology in the form of new products and production processes. Compared to more traditional industries, high-tech firms devote a much larger share of their resources to research and development. They also are labor-intensive, employing a higher percentage of technicians, engineers and scientists.

Under the umbrella of "high technology" are organizations that develop new technologies, find new applications for existing technologies, manufacture the products incorporating advanced technology, market commercial products, and provide services related to high-technology products. The industry includes manufacturing plants, research and development operations, and service companies such as engineering, consulting and data processing.

Fields such as semiconductors, telecommunications, lasers, fiber optics, computer-aided design and manufacturing, bioengineering and robotics are easily identified as high technology. Because of heterogeneity among the firms within each industry and a lack of consensus on the definition of high tech, identifying all the broad industries to include is difficult. Analysts are usually forced by data availability to define high-tech in terms of the Commerce Department's Standard Industrial Classification codes. The industries categorized as "high technology" vary from study to study. Not surprisingly, employment estimates also vary widely.

Table 1 shows employment in those industries we have identified as best representing high technology for eight southeastern states and the U.S.[7] Between 1977 and 1982, high technology provided over 105,000 new manufacturing and service jobs in the Southeast representing 6 percent of the 1,828,000 new jobs created in the Southeast during the five year period.

Florida clearly has the strongest high-tech sector in the Southeast and ranks seventh nationally. High-tech in Florida is largely composed of the rapidly growing electronics, communications and aerospace industries. These dynamic high-tech industries are also dominant in Georgia, where high-tech manufacturing increased 62 percent between 1977 and 1982. Growth has been slower in Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee, where high-tech employment is more heavily weighted in the chemical and drug industries.

High-technology industries' share of total manufacturing employment has been increasing. Nationwide, high-technology employment (by our definition) accounted for 20 percent of total manufacturing employment in 1982, up from 16 percent in 1977. Florida, where high-tech employment comprises 27 percent of total manufacturing, is the only southeastern state exceeding the national average.

Compared to high-tech manufacturing, employment in the high-tech services such as communications, computer services, and data processing is small but rapidly growing. In 1982 almost 58,000 southeasterners were employed in these service areas, up 111 percent from 1977. Florida leads the Southeast in high-tech service employment, followed by Georgia.

"Clearly, not all communities pursuing high technology will succeed in reaching the dynamic critical mass."

But statewide figures fail to tell the whole story. First, aggregate employment figures are merely body counts and give no indication of the composition of activity, such as how many workers are in production and how many are in research and development. Second, in the Southeast as in the rest of the country, these companies tend to cluster in areas offering an ample supply of highly trained technical labor. Once an area accumulates a group of firms similar in technological expertise, processes, and products, this "critical mass" encourages new start-up firms and acts as a magnet in attracting related companies. Clearly, not all communities pursuing high technology will succeed in reaching the dynamic critical mass. The areas with the greatest chance of capturing a large share of future operations are those with an existing nucleus of activity.

The Southeast boasts several such pockets of activity. North Carolina's Research Triangle Park

[7] SIC codes included in high-technology manufacturing employment 281, 282, 283, 348, 351, 357, 366, 367, 372, 376, 381 382, 383, 384 385, 386, 387. The codes used are the manufacturing codes recommended in "Defining High Tech," an unpublished paper by Delsie M. Gandia, Maryland Department of Economic and Community Development, May 1983.

with its campus-like atmosphere has attracted a wide range of government and private R&D laboratories. The Triangle is often referenced along with California's Silicon Valley and Route 128 outside Boston as one of the top three technology centers in the United States. In Florida, high techology is becoming a significant sector in the state economy and is recognized nationally as one of the major new centers of high-tech activity. While NASA and government defense contracts were instrumental in building the base of technical expertise, the state has attracted or spawned commercial enterprises at rates unmatched in the Southeast. Other emerging centers in the Southeast include Atlanta, Huntsville, Alabama and Tennessee's Oak Ridge-Knoxville corridor.

There are two ways for a community to build a high-technology base and the infrastructure to support it. One way is to recruit from outside, inducing established firms to move existing operations into the market or place new ventures there. The other way is to "home grow" companies, encouraging the incubation and growth of new small firms from their embryonic beginnings to the point where they contribute substantial employment, income and tax revenues to the community.

"Southeastern states want a balanced mix of research and development facilities along with production and assembly operations."

Interestingly, the resources, amenities and "infrastructure" that tend to spawn and encourage home-grown firms are the same ones that make a site attractive to established firms. Whether recruited from outside or home-grown, high-technology companies are essentially "footloose." That is, their proximity to material suppliers or markets is unimportant. The environment conducive to their expansion contains, foremost, a broad pool of well-trained technical specialists from which to draw, plus the quality of life, educational and cultural attributes valued by the professional.

Key Location Factors

In a comprehensive report on location decisions of high-technology companies, the staff of the Joint Economic Committee of Congress confirmed that the availability of skilled labor is the primary consideration.[8] The staff reported that the most desirable location attributes for technology firms planning expansions are, in order of importance: the availability of a skilled work force, low labor costs, favorable business and tax climate, academic institutions, a high quality and low cost of living, and good transportation. Table 2 gives a ranked listing of locational attributes based on the JEC survey of 691 companies.

How does the Southeast stack up against these criteria?

1. Availability and Cost of Labor

Personnel needs cover a broad spectrum from the unskilled production line worker to the scientists and engineers in research and development. The mix varies with the type of operation. R&D facilities employ a high percentage of scientists and engineers. Production and assembly plants employ mostly unskilled and semi-skilled workers.

The Southeast's large pool of cheap unskilled and semi-skilled labor traditionally has made the region attractive for the production facilities of a wide range of industries. Manufacturing wages averaged $13,949 a year in 1982, compared to $17,194 nationwide.[9] While 25 percent of workers nationwide are unionized, only 14 percent of workers in the Southeast belong to a union.[10] Compared to six other regions, the JEC survey ranked the South first in "labor cost/availability."

But southeastern states want a balanced mix of research and development facilities along with the production and assembly operations. While high tech's light manufacturing element could help absorb some of the region's unemployed low-skilled workers, assembly operations are

[8] Robert Premus, "Location of High Technology Firms and Regional Economic Development," Staff Study prepared for the use of the Subcommittee on Monetary and Fiscal Policy of the Joint Economic Committee of the U. S. Congress (GPO, 1982).

[9] **Employment and Earnings,** U. S. Department of Commerce, May, 1983.

[10] United States Bureau of Labor Statistics, **Directory of National Unions and Employee Associations, 1971, 1975, 1979,** and unpublished data.

Table 2. High-Tech Companies' Location Choices

	FACTORS THAT INFLUENCE REGIONAL LOCATION CHOICES		RANKING OF THE SOUTH COMPARED TO SIX OTHER REGIONS
Rank	Attribute	Percent Significant or Very Significant[1]	
1	Labor skills/availability	89.3	1
2	Labor Costs	72.2	1
3	Tax climate within the region	67.2	1
4	Academic institutions	58.7	6
5	Cost of living	58.5	1
6	Transportation	58.4	6
7	Access to markets	58.1	6
8	Regional regulatory practices	49.0	1
9	Energy costs/availability	41.4	1
10	Cultural amenities	36.8	7
11	Climate	35.8	3
12	Access to raw materials	27.6	6

[1]Respondents were asked to rate each attribute as "very significant, significant, somewhat significant, or no significance" with respect to their choices. The percent of very significant and significant responses were added together to obtain an index of overall importance.

Source: JEC survey. See footnote 8.

perenially vulnerable to foreign competition or off-shore production by U.S. companies.

Expansion plans of the responding companies suggest that the Southeast should benefit from an increased share of the high-technology industry between now and 1986. Unfortunately the survey did not distinguish between R&D facilities and production facilities. To compete successfully for R&D facilities, the southeastern communities must be able to supply or attract skilled technicians and professional scientists and engineers.

One of the most important discoveries of the JEC survey was that the availability of technicians is more important than the availability of scientists and engineers for high-tech firms making location decisions. Technicians such as machinists, draftsmen, computer operators, and engineering technicians are highly immobile but essential to both research and production activities. The demand for skilled technicians can strain local labor markets in communities with a cluster of high-technology companies. Judging from the survey, relocating or branching companies recognize the potential shortages and carefully assess the availability of skilled technicians.

Professional scientists and engineers, on the other hand, are highly mobile. High-tech companies consider not just the existing pool of professionals in a location, but whether they will be able to recruit needed professionals to the area. The ease of attracting this group is a major consideration for most firms selecting a location.

One way to ensure a supply of highly trained technical and professional employees is to locate near other companies in the same or similar businesses. Southeastern communities with a cluster of high-tech activity are particularly attractive sites.

2. Business and Tax Climate

Like all businesses, high-technology companies are sensitive to an area's business climate, including the state and local tax structure, community attitudes toward business, available financing, and regulations governing business start-up and operations. And, from that standpoint, times have never been better for high-technology companies. In their zeal to lure such firms, states and communities offer an array of incentives including tax breaks and a streamlined process for obtaining permits and setting up business. Florida increasingly is regarded as one of the best states in which to do business. In fact, the Alexander Grant & Company business climate survey rated Florida's business climate the best in the nation in 1981 and 1982.

Two-thirds of the JEC survey respondents considered the region's tax climate a significant

location attribute, and ranked the South highest of any region on this attribute. While the survey did not consider personal and corporate taxes separately, our discussions with companies suggest that the state and local personal income tax is of primary concern because of its importance in relocating professional employees. State taxes on a per capita basis fall short of the U.S. average in all southeastern states, except Louisiana. Florida's state taxes compare favorably with those of other high-tech states. For example, companies recruiting professionals to Florida can boast a tax level 37 percent below California and 28 percent below Massachusetts, two states where high-tech job opportunities abound.[11]

3. Education

Quality education at all levels is important in attracting high-technology firms. Primary and secondary schools educate their staffs' children and provide the educational base for potential employees. Vocational schools provide the essential technicians. Universities with strong technical programs played a major role in the development of Silicon Valley and Route 128 and provide graduates, training, and professional networking relationships to the high-tech community. Much of the effort to attract high technology has been directed toward improving education at one or more of these levels.

"Many states have expanded and altered their vocational programs in response to the changing needs of industry."

Professional personnel hold quality primary and secondary education in high regard, primarily from a conviction that good education has been a key to their own success. While they can send their children away to college, the community must provide the early education. Good public education, particularly in math and science, is also important to the firm hoping to draw skilled and trainable employees from the local labor market. In Florida, the drive to upgrade public education has led to increased funding and differential pay for teachers in science and math. Some large companies also have channeled funds and manpower into education enhancement through programs such as the general education courses for secondary teachers sponsored by the Harris Corporation of Melbourne, Florida.

The growth of high-technology industries and the modernization of existing industry have increased the demand for engineering and science technicians. A study of vocational-technical schools found that the competition for highly trained technicians is so intense that in many states companies are hiring students before they finish their programs.[12] High starting salaries and career opportunities are attracting a growing number of students into the vocational education system, thus heightening its importance in training tomorrow's labor force. Many states have expanded and altered their vocational programs in response to the changing needs of industry. North Carolina has strengthened the technical programs offered through its re-organized community college network. Technical training has expanded in Florida, where per capita vocational education expenditures are the highest in the nation. South Carolina offers vocational training to employees of targeted industries that move into the state.

In attracting high-tech industry, how important is proximity to a good university with strong science and engineering programs? Clearly there are advantages to having a good technical university nearby. The graduates constitute a local supply of inexperienced professionals, simplifying the recruitment process. Universities offer continuing education and libraries stocked with technical materials to the professional trying to stay abreast of changes and developments in his or her specialty. Professionals who plan to start or resume an academic career often serve as adjunct professors in the universities. The schools also offer a network of specialists for consulting and

[11] **Book of the States, 1982-1983,** (Lexington, Ky.: The Council of State Governments).

[12] C. L. Aton, et al., **An Advanced Technology Study For Post-Secondary Area Vocational-Technical Schools,** Report submitted to the Division of Program Development, Office of Vocational Education, Georgia Department of Education, (Atlanta, Ga.: Georgia Institute of Technology) August, 1982.

joint projects. Finally, informal relationships between academic and industry professionals allow for a steady flow of ideas and information.

Many economic development specialists have taken the approach that proximity to a top-flight university with strong university-industry linkages is critical in attracting technology firms. The JEC study is frequently cited as providing evidence of the overwhelming importance of university-industry linkages. However, some analysts have questioned this widely held belief and argue that the JEC survey results are frequently misinterpreted on the point.[13]

The JEC survey included a question specifically asking companies what they look for from nearby universities. Companies responded that they primarily look for (1) college graduates; (2) degree programs for employees; and (3) access to libraries and information systems. These answers suggest that universities are important primarily as a provider of the all-important technical labor, and secondarily as a source of technical materials. But universities can meet these needs even if they are not located next door. In Florida, technology industries have been growing in areas not served by the state's major educational institutions, offering proof that dynamic clusters of activity can emerge without the benefit of a nearby university. Though the university system is not in close proximity to the high-tech centers, it is still attuned and responsive to their needs.

Despite such initiatives, the Southeast clearly remains handicapped by the perception of substandard education. In the JEC survey, respondents gave the South low marks for its academic institutions. Since technology professionals are the group most concerned about quality education, the Southeast's poor image makes it more difficult for it to compete for headquarters and R&D facilities.

The Southern Regional Education Board in June reported that southern states are moving toward the goal of quality education.[14] They note the initiative shown by state and local leaders and the increased focus on improving education. However, the educators acknowledge that, despite the gains, the South still lags in educational achievement. For example, achievement test scores of southern students still fall behind national norms. On the National Assessment of Educational Progress, the average score for 17-year-old southeastern students was 4 percent below the national average in reading and 7 percent in math.[15] Also, education levels are lower in the Southeast, where only 13.8 percent of the population are college graduates compared to 16.3 percent nationwide.[16]

Southeastern states have made closing the education gap one of their chief priorities. Even if high technology fails to provide the jobs and income anticipated by state officials, the increased quality of education alone will bring many long-term benefits to this region.

4. Quality and Cost of Living

In selecting sites for operations requiring many scientists and engineers, a company most often chooses an environment with educational, recreational and cultural amenities appealing to professionals and technicians. When considering job offers, engineers and scientists in high demand can afford to be selective about choosing an area with a high quality of life.

"...the increased quality of education alone will bring many long-term benefits to this region."

Preferences differ on the specific attributes that contribute to the "liveability" of an area. Undoubtedly, Florida's climate and recreational amenities have been major drawing cards to many professionals who have moved to the state and contributed to its rapid growth. Atlanta is attractive to many who prefer living in a major metropolitan center, while most employees in Research Triangle Park enjoy the slower pace and lack of congestion that area offers.

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[13] Jacques D. Bagur, "High Technology and the Universities: The Premus Study" Gulf South Research Institute, Baton Rouge, La.

[14] "Meeting the need for quality: action in the South," Progress Report to the Southern Regional Education Board by its Task Force of Higher Education and the Schools, June 1983.

[15] Ibid.

[16] U. S. Bureau of the Census, **1980, Census of Population and Housing, Supplementary Reports,** Series PHC8-S1-1, **Provisional Estimates of Social, Economic, and Housing Characteristics.**

The JEC survey gave the southern region of the U.S. the highest rating on cost of living. This is clearly one of the Southeast's major drawing strengths. Housing remains affordable throughout the region, particularly in comparison to major high-tech centers.

5. Transportation

Good transportation is another important consideration for the high-tech company. The high ratio of value to weight for most of its products and the need to transport people and components quickly and reliably place a high premium on airports and airline connections. Although respondents of the JEC study rated the South very low on its available transportation network, Atlanta is particularly well situated as the transportation hub of the Southeast, and South Florida benefits from a more extensive schedule of international flights.

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Recruiting from Outside

Most industry-hunting states and communities turn first to recruiting firms from outside. An established firm's move into an area attracts much more recognition and prestige, typically, than a locally-established operation that may grow to support the same jobs and income. So, despite the tough competition from throughout the nation, the visibility and immediate results have made outside recruiting the favored approach.

Attracting employers from outside is a familiar proposition in the Southeast, where most states diversified rural economies and raised income in the 1950s and 1960s by recruiting light industry to take advantage of an underemployed agricultural labor force. Their success is documented by the textile, apparel and auto component factories that now dot southeastern states.

But the "we did it with textiles; we can do it with semiconductors" approach of many southeastern communities appears unlikely to succeed. While this approach may work with some assembly operations, the key ingredient for recruiting a mix of headquarters and R&D laboratories is a "critical mass" of skilled and educated technical workers, which very few communities in the Southeast have or can hope to attract.

The vital nucleus of technical experts that has formed the base of many active high-tech centers has come from universities, public research facilities, and large scientific corporations. Each of the active and emerging centers in the Southeast was built on an existing pool of skilled technical workers. They provided the human capital for the companies and acted as a magnet in attracting similar enterprises to the area.

In Florida, the NASA build-up in the early 1960s drew the initial large pool of scientists and engineers into the state. Specialists working at NASA and large subcontractors such as Martin-Marietta Corporation and Harris Corporation provided the pool of trained professionals and a technical environment into which outside specialists have been willing to come. In the Atlanta area, the magnet unquestionably has been Georgia Tech and the thousands of Tech-trained engineers who have stayed in the Atlanta community.

In North Carolina the three universities in the Raleigh-Durham-Chapel Hill triangle formed the initial base. In fact, one major objective in forming Research Triangle Park was to provide in-state jobs for graduates of the three universities. The original base was augmented by employees and ex-employees of the major national corporations that located in the triangle in the 1950s and 1960s. In Huntsville, Alabama the skilled technical workers have come from NASA and the Army's Redstone Arsenal. In the Oak Ridge-Knoxville corridor in Tennessee, thousands of highly trained scientists were pulled to the corridor by Department of Energy research facilities.

Home-Grown High Tech

The other way to get high-tech jobs is to develop new businesses locally. This side of development gets less publicity. Its progress is gradual, and for every success there are several failures. Nevertheless, with intense competition to attract relocating firms, it may be the only way for many communities to develop a strong high-technology presence.

High technology, by its nature, is fast-changing. New applications and markets are developing

almost weekly in many fields. This gives an advantage to the small, responsive firm that can identify and exploit the market opportunity faster than larger counterparts, where time-consuming divisional and corporate approvals are typically necessary. While market opportunities promote start-ups of new firms, the turbulent and strongly competitive environment allows relatively few to enjoy long-term success. From our interviews with entrepreneurs, financiers and chief executive officers, we identified common experiences of the start-up firm and the critical elements required to succeed in the industry.

A peculiar kind of environment spawns the development of new high-tech companies. Just as in the case of corporate recruiting, a critical mass of technical professionals is essential. Most entrepreneurs come from this pool, which also provides professional reassurance and role models in the process of starting a new firm. It is easier to take the plunge into forming a company if friends have done it and succeeded. Home-grown high tech, at the spawning, almost never involves relocation. An engineer in Atlanta will start his firm in Atlanta; a scientist in Melbourne, Florida will start in Melbourne. The universities, major technical employers, and public research centers provide this pool of incipient technical entrepreneurs. Often an engineer in a large corporation will spot a market niche, become convinced of its importance, try unsuccessfully to get the corporation to exploit it, and finally resign in frustration to exploit the niche himself.

Ironically, personnel layoffs and uncertainties impart a positive impetus to the formation of new technology companies. The cutback of NASA operations in Huntsville left many engineers unemployed and therefore unusually willing to start their own companies, just as had happened in central Florida. There may be a silver lining even in clouds of technical dislocation.

To get a new business going takes money. The initial investment usually comes from the entrepreneur's savings, from family members, and friends—perhaps a successful entrepreneur who wants to help other fledging businesses. After a product has been developed, market demand tested and production ability proven, the entrepreneur usually seeks venture capital. Venture capitalists offer management counsel and funds for expansion in return for part ownership in a business. Those we spoke to place a strong emphasis on management skills and on the market niche the company is trying to exploit. They usually read a company's prospectus from the back to the front, focusing on the founders' skills, rather than on the stated purpose or the meaningless financials of a start-up company.

Many new businesses fail, in the high-tech field as elsewhere. When they fail, the critical missing ingredient appears to be business or management expertise, rather than technical knowledge. Often, the entrepreneur is dedicated to a particular process or technology, and is unrealistic about the success of its commercial applications. Many engineers have no knowledge about how to structure a business plan, finance a venture, or distribute a product.

Financiers often agree to grant venture capital only if a firm hires a particular skill that it lacks - such as a marketing person or a strong manager. The alliance between the technical entrepreneur and the professional manager can be an uneasy one, for each is generally convinced that his expertise is the essential ingredient of success. We talked to companies that had floundered for years, then became suddenly profitable and started growing when a strong manager was brought in. Other companies had gone through two or three presidents in search of the right entrepreneurial/managerial combination. Another group of companies was started by engineers and continues to be managed by engineers. These firms generally place more emphasis on technological perfection than on market demands.

"High technology, by its nature, is fast-changing."

Attracting venture capital can be a stumbling block for inexperienced entrepreneurs, particularly since the sources are almost always located outside the region. Universities in the region, notably Georgia Tech, are arranging contacts between small high-technology companies and venture capitalists. Commercial banks in the Southeast typically have shown little interest in such investments, because local institutions lack the expertise to analyze the inherent risks involved. Law firms and public accounting firms

are becoming increasingly interested in arranging such financing. These firms contribute an important part of the infrastructure to support home-grown high tech.

Certain characteristics and qualities dominate high-tech firms that have grown large and profitable enough to enter the realm of public financing. We visited various firms in the region, all of which had sales over $12 million and at least a 10 percent profit margin. Most were publicly held or had the ability to make a successful public offering sometime in the future. We found two common elements within most of these companies—a strong management team and a well-defined market niche.

Management Style

The management style of high-technology companies is similar in many ways to the styles described in Thomas Peters and Robert Waterman's **In Search of Excellence.**[17] Top officers are called by first names. The executive offices

"Successful companies have each identified something unique that they can bring to the marketplace."

are generally not separated from other offices. The CEO's "office" in two of the companies we visited is a cubicle with no door and open at the ceiling. Decisions are pushed down to the lowest level. Formal memoranda are almost nonexistent.

These successful companies have an action bias. One CEO said an employee is never penalized for taking an action even if it is wrong. Only those who fail to act are asked to leave. Status and seniority seem unimportant. The people who can get results get rewards. People are given opportunities to grow. At one company assembly-line workers rotate as receptionists and every employee gets a chance to represent the company at a trade show.

Employees feel a strong sense of ownership. They act as owners, not workers. Employee stock ownership plans and bonuses based on profits are common. Company slogans are symbolized on pins worn by employees. Quality is stressed at every level of production.

The clean nature of the manufacturing process allows the production line and the office work to be housed in the same facility. Top management is close to the production process and can spot inefficiencies or opportunities for improvement early.

There are few layers of management. A few key players usually guide the direction of the firm. Organization charts and titles are relatively meaningless as the shape of the company changes regularly.

Market Niche

An essential ingredient for success is to find a "market niche"—a commercially viable new application for an established technology. The application should not be so big or so apparent that it will be immediately attractive to larger corporations with economies of scale in production. Small businesses rarely prosper by simply being in the right place at the right time. Careful attention to identifying a market niche is a continuous process. Particularly in the market for consumer electronics products, successful companies must plan on a product life-cycle as short as six months. The company must keep generating new "sub-niches" in response to small technical improvements or new interests on the part of customers.

The strength of the management team lies partly in its ability to identify a market niche. All the management, marketing and financing skills in the world are of no use unless the proper niche is identified. Sometimes this niche is in the form of a product; it also may be a process or a marketing strategy. But successful companies have each identified something unique that they can bring to the marketplace. What are some of the strategies that have made southeastern technology companies successful?

1. **Price Leadership** - Distinguish products from those of competitors through performance, technological innovation, or special service. This allows for pricing at the high end of the market. Harris Corporation of Melbourne, Florida has followed this strategy successfully even in the

[17] Thomas J. Peters and Robert H. Waterman, Jr., **In Search of Excellence** (Harper & Row, 1982).

exceptionally competitive semiconductor market.

2. **Brand Recognition** - In an intensely competitive market, distinguish the product through brand recognition, creative packaging and advertising. Quadram Corporation of Norcross, Georgia sells a microcomputer expansion board among a sea of competitors, capturing market share through name recognition, attractive packaging and heavy advertising. Hayes Microcomputer Products Corp., also of Norcross, is recognized as the industry leader in microcomputer modems. "Hayes" is often used as a generic name for intelligent modems. Peachtree Software of Atlanta uses a "peachy" theme along with attractive advertising to differentiate its basic software products.

3. **Automation** - Target an industry that needs to automate a specific process. Integrate hardware from reliable equipment manufacturers and write specific software. With this partially customized problem-solving package, a company can penetrate a virtually untapped market. HBO & Co. of Atlanta sells a turnkey system to hospitals to manage patient information systems. Its market is easily identified as all the hospitals in the U.S. currently without systems. Scientific Systems Services, Melbourne, Florida, markets integrated software and hardware systems specializing in control systems for the utility industry.

4. **Specialization** - Develop an expertise in a particular technology. Outfox competition by knowing more about the technology than anyone else. This can be done best in areas where cutting-edge technology is in demand—most often military and space applications. DBA Inc. of Melbourne specializes in photogrammetry and is awarded defense contracts with little competition. Electromagnetic Sciences Inc. of Atlanta has assembled a group of experts specializing in using magnetics to manipulate microwave signals.

5. **Technology Transfer** - The U. S. government contracts for research on technologies that may have some useful applications for military or space programs. Companies that conduct the research can then use their findings in commercial ventures. In essence, the R&D effort is subsidized and makes the introduction of new commercial products more cost effective. Harris Corporation has been successful at employing this strategy. Many of its commercial satellites and other communications products were developed in conjunction with government-funded research.

6. **Market Expansion** - A product may be useful to a broad market, but its price may prohibit its justification at the lower end of the market. A company can modify the technology to reduce both its performance and its price. The reduced capabilities may well be acceptable to the user who can afford only the lower price. Intelligent Systems Corp. of Norcross adopted this strategy at its inception. Entrepreneurs developed a color terminal to be used in process control systems—at less than half the price of existing terminals.

Conclusion

The positive forces generated by the presence of high-technology companies in the Southeast should help change the region's economic landscape. The promise of high technology is fostering a new sense of cooperation between legislators, educators, and businesses. Governments are putting resources into promoting industry growth and improving public education.

"High technology is not a cure-all for the southeastern economy."

While governments have emphasized attracting firms from outside the region, home-grown high-tech firms are just as likely to add to southeastern economic growth. Each successful venture by an entrepreneur generates millions of dollars of new wealth—which is inevitably reinvested in the same community.

High technology is not a cure-all for the southeastern economy. The areas likely to benefit most from this growth industry have already established some of the critical ingredients necessary to foster technical activity—an ample supply of skilled labor, a favorable business and tax climate, a superior education system, a high quality of life and access to markets through good transportation. Geographic areas that can offer all these assets to a relocating firm or to an entrepreneur starting a new company should be able to profit from the

tremendous growth opportunities in high-technology markets.

High-technology companies bring to a region not only new jobs, but also new ways of managing people to produce a product in a highly competitive environment. Our research brought to light a quiet revolution going on in American industry. Those companies on the cutting edge of technological change are also on the cutting edge of behavioral change. Successful high-technology companies are led by enlightened managements. They are disillusioned with traditional corporate structures. They believe there must be a better way to operate a business. The model they provide is one of integrating people with technology to get results.

The ingredients necessary for successful operation of a technology firm are increasingly becoming the same ingredients needed to operate successfully in traditional industries. High technology is a product of the information age. A management style conducive to this age naturally has developed. The age of mass production, standardization, and broad interpretations of customer needs appears to be nearing an end. High-technology producers have been forced to operate in a rapidly changing environment early in their development. Companies in traditional industries that recognize the need for a "renaissance" in management style and strategy can successfully embrace new challenges. The presence of a dynamic industry such as high technology may develop a pattern for others to follow as the Southeast's economic environment continues to change.

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FLORIDA

Florida's high-technology industry is by far the largest in the Southeast and is increasingly recognized as one of the nation's leading up-and-coming centers. The diversification of Florida's economy has resulted from the directed and cooperative effort of interested parties in state government, education, and business. Florida's favorable business environment and quality of life also have played a big role in the success.[18]

The presence of such companies strongly contributed to Florida's resilience during the last recession. With a heavy reliance on government defense contracts, Florida's industry has amassed a solid base of technology primarily in the areas of defense, satellite telecommunications, and aviation. The two heaviest concentrations are in Central Florida from Tampa through Orlando to Melbourne and along the Southeast coast.

In 1982, over 126,000 Floridians were employed in high-technology manufacturing, representing 27 percent of all manufacturing workers.[19] The five-year increase in high-tech manufacturing employment between 1977 and 1982 was 47 percent, over twice the nationwide growth rate. Much of the employment is concentrated in Florida's large companies. Florida's five largest manufacturing companies are all in high-technology industries. The state's two largest industrial employers, Harris Corporation of Melbourne and Martin Marietta Aerospace in Orlando, each employs over 10,000 in Florida facilities.

Florida also has a strong high-tech service sector. Over 21,000 Floridians were employed in data processing, communications, and computer service companies in 1982, up 100 percent from 1977 levels.

Florida's efforts to make the state more attractive must be working. Alexander Grant & Co. ranked Florida first in 1981 and 1982, up from twelfth in 1979 and eighth in 1980.

The same attributes that have made Florida a retiree's mecca have also helped lure technology to the state. Florida's rapidly growing companies say that Florida's climate and recreational amenities make recruiting professionals to the state easy. They say that the lure is strong enough to compensate in most cases for any perceived inadequacies in the state's education system and cultural activities. Though residential property is high-priced along southeastern Florida's Gold Coast, housing is still affordable in central Florida.

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[18] For a related discussion, see Hank Fishkind, "High Technology in Florida's Economy" **The Florida Outlook**, 1983, Vol. 7, No. 2 (June 1983).

[19] For our definition of high-tech manufacturing, see footnote 7.

Much of Florida's efforts to make the state more attractive are focused on improving education at all levels. Enhancing the universities' engineering programs is a priority. Large sums have been appropriated to improve the quality and number of engineering graduates. One goal has been to expand the Florida Engineering Education Delivery System that conducts masters level programs in electrical engineering statewide through tutored videotape instruction, electronic blackboards and live video links.

To help ensure that the state has an adequate pool of technical workers, Florida has created an Office of High Technology and Industry in the State Department of Education to coordinate the educational needs of industry. Florida's expenditures on vocational education per prime working age population are the highest in the nation and 82 percent higher than the national average.[20]

Florida now ranks 7th among the states in high-tech employment. Florida has achieved the desirable "critical mass" in its concentrated areas that are already spawning spin-off and new start-up firms, and the state is poised to benefit from the increased national emphasis on defense spending.

RESEARCH TRIANGLE

North Carolina's Research Triangle Park (RTP) covers 5,500 acres within the triangle formed by North Carolina State University in Raleigh, Duke University in Durham, and the University of North Carolina in Chapel Hill. As the world's largest planned research park, it is normally rated only behind Silicon Valley and Route 128 as a premier center of high technology.

From its inception, RTP has been supported by the state government, and the surrounding academic community. Its early start enabled RTP to attract quality organizations before the competition stiffened. IBM built a facility in the park in 1965 that has grown to a million square feet of lab space housing R&D in telecommunications and data processing systems. IBM, the park's largest employer, has other facilities in the surrounding area. Becton Dickinson & Co., a leading international manufacturer of medical instrumentation and health care products, moved to the park in 1968. Burroughs Wellcome, the British pharmaceutical firm, moved its American research headquarters from New York in 1970.

Today the park is home to a prestigious collection of around 40 industrial and governmental R&D laboratories employing about 20,000 people; annual payrolls total about $500 million. Other occupants include the EPA's Environmental Research Center, the agency's largest field installation employing over 400 scientists such as research physicians, engineers, veterinarians, and epidemiologists. Unlike other high-tech centers, the researchers usually are engaged in long-term, basic research rather than applied research to develop commercial products. The tempo is relaxed, and most employees stick to a 9 to 5 workday, a marked contrast to the frenzied, workaholic pace in other leading centers.

The academic nature of park research is reinforced by the campus-like appearance, which was the product of careful planning and controlled, focused development. Admittance has been selective, with occupancy limited to organizations engaged in research, development, and scientifically oriented production.

The park's "academic ambiance" has been a recruiting asset. It not only looks like a campus but increasingly functions like one. Researchers interact frequently, both professionally and personally. The park contributes to this air of collegiality by providing frequent seminars and public lectures.

The proximity to three strong universities obviously has contributed to the park's success, and the benefits seem to have been mutual. Many of the employees serve as adjunct professors while in the area. Maintaining contact with a university is particularly important for those planning to begin or to resume an academic career.

While North Carolina intends to preserve the park's pristine research environment by allowing very little manufacturing within its borders, the state actively recruits high-technology manufacturing for the surrounding areas and in other parts of the state. High-tech manufactuing in North Carolina currently provides almost 77,000 jobs, important in a state where textile industry declines have left many jobless.

North Carolina hopes more companies with R&D labs in the park will follow the example of Data General in locating its manufacturing plants nearby. Data General moved its R&D center to the park in 1976.

North Carolina aspires to become a leader in microelectronics. As a big step in that direction, the state is building a Microelectronics Center with $24 million from the state legislature and donations from the three universities and a few corporations. Plans for the center influenced General Electric to choose the park for its own microelectronics center, where GE will design and manufacture silicon chips to supply most of its internal demand.

ATLANTA

Atlanta was a late entry in the high-technology race and has been struggling to catch up. Though running a distant third behind Florida and North Carolina, Atlanta's high-tech has picked up in the last few years. Led by Technology Park/Atlanta in the northeast suburb of Norcross, technology parks have sprung up throughout the metropolitan area. Over 33,000 people in metropolitan Atlanta are employed by the 150-plus technology companies, which have a collective payroll over $500 million annually and revenues exceeding $2 billion.[21]

The majority of Atlanta's companies are in service areas such as computer programming, software, and

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[20] Telephone conversation with Linda Klein, Florida Department of Commerce, Division of Economic Development, August 23, 1983.

[21] Jan Jaben Weiner, "High Tech: Taking over our lives, creating jobs, wealth, competition," **Atlanta Business Chronicle,** April 4, 1983.