

Benchmarking Technology-Based Entrepreneurship in the Charleston Region

By: David V. Gibson, James E. Jarrett, Michele Chesser, Mary Graham, Jacquelyn Warren, Frank L. Hefner, and Lloyd Brown

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Abstract:

A study of resources and opportunities for technology-based economic development in Charleston, South Carolina. The study draws on interviews and a survey of managers of technology-intensive enterprises and public-sector institutions in the Charleston area conducted in June 1996..

Keywords: economic development; Charleston, South Carolina; South Carolina

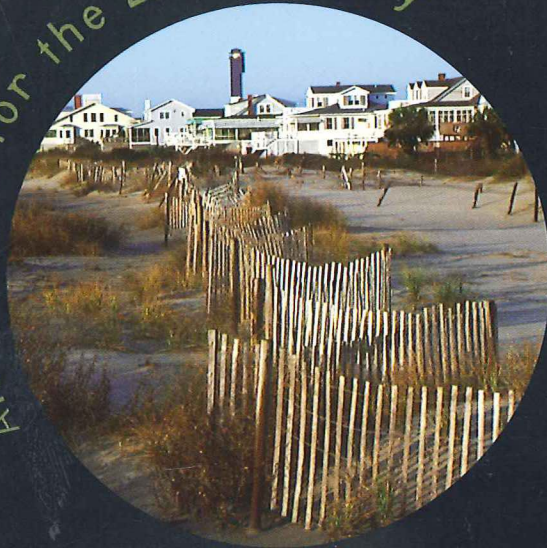


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CHARLESTON'S
CENTER FOR
TECHNOLOGICAL
INNOVATION

An Alliance for the 21st Century



BENCHMARKING TECHNOLOGY BASED
ENTREPRENEURSHIP IN THE CHARLESTON REGION

Benchmarking Technology-Based Entrepreneurship In The Charleston Region

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To meet tomorrow's economic and environmental challenges, the Nation and communities, as well as government agencies and corporations, must take creative action that will facilitate sustainable development and economic growth into the next century.

The National Oceanic and Atmospheric Administration (NOAA) is the world's leader in monitoring and predicting change in the Earth's environment. NOAA science and technology has been a key factor in America's superior performance in sustaining the health of coastal and marine resources and their habitats. Maintaining this leadership depends on a robust private sector to supply the needed technologies and related services.

Charleston, the surrounding region, and South Carolina are rich with amenities and a growing technology knowledge base. The NOAA Center for Technological Innovation (CTI), inspired by Charleston's entrepreneurial spirit and optimistic vision of the future, and made possible by an alliance between federal, state, and city governments as well as regional academic and business sectors, is being implemented to enhance technology-based wealth and job creation in the Lowcountry and South Carolina.

The CTI is modeled after the successful technology transfer and economic development initiatives of the Innovation, Creativity, and Capital (IC²) Institute of the University of Texas at Austin, NOAA's cooperator in this venture. The CTI is a designed to help create and grow technology-intensive businesses. It provides a reduced-risk and highly supportive environment for start-up companies to stimulate rapid growth, create high-value jobs, and attract investment capital to the region.

The CTI is the first stage of what we hope to see as an emerging smart infrastructure that reflects Charleston's and South Carolina's interest to expand its technology-based economy. *Technology-based Entrepreneurship in the Charleston Region*, provides an excellent in-depth report of key opportunities and challenges facing the region as it builds globally competitive technology intensive enterprises and high value jobs.

NOAA's vision is to be a major contributor to the Charleston region and South Carolina's development as a world center for coastal ecosystem, life science, information system, and other advanced technologies. We look forward to building new partnerships and undertaking creative actions to achieve this goal.

A handwritten signature in cursive script that reads "Earle N. Buckley".

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Executive Summary

Comprised of three counties -- the Charleston region is a highly diverse metropolitan area strategically located in the center of the Atlantic coast. A flourishing economy, coupled with a rich history and breathtaking environment, combine to offer an outstanding business climate and a quality of life that is second to none. However, as with many such up-and-coming communities, it is now confronted with a serious challenge — how to capitalize on its inherent potential, overcome its own obstacles, and build for the future to ensure continued growth.

Charleston currently relies on its robust tourist industry, with more than 7.4 million visitors each year, the Port of Charleston, the second largest containerized cargo port on the East Coast (second to the combined New York-New Jersey ports) and the sixth largest in the nation, and a growing health care community for its economic health. While these are important industries for the area, they alone cannot fuel the engine for continued economic growth.

Community leaders have identified technology as an important avenue for growth for the region, offering a high potential return on investment for the 21st Century and beyond. Through the development of technology-based industries, the Charleston region will create new high-value jobs, focus on improving education and building infrastructure, and attract new talent, resources and investment to the region. All of these contribute to a stronger, more prosperous future. While the region has a suitable base for building technology-intensive industries, it must expand its current technological climate and supporting infrastructure in order to successfully attract high-tech companies.

The opportunity now exists for investment in new technology to flourish as a result of the cooperative venture between the Coastal

Service Center (CSC) of the National Oceanographic and Atmospheric Administration (NOAA) and the IC² Institute, the world-renowned international research center for the study of Innovation, Creativity and Capital. Their joint mission is to lay the groundwork for the technology transfer, entrepreneurial enterprise and high-tech investment in the Charleston region. Their joint project is the NOAA Center for Technological Innovation (CTI), an innovative and entrepreneurial center for incubating new, regionally-relevant, high-tech businesses. CTI is a reduced-risk environment for early-stage technology-based companies designed to stimulate rapid growth, create new high-value jobs, and attract capital investment to the Charleston region. CTI focuses on coastal ecosystem, life science and information system technologies.

Charleston's Entrepreneurial Baseline

To gauge the current climate and better understand the challenges facing the region in developing technology-intensive industries, IC² Institute, in partnership with the Charleston Metro Chamber of Commerce and the College of Charleston, conducted a study of the region in June 1996. The study included fielding a survey to local business leaders from small, mid-sized and large organizations, those with first-hand knowledge in operating a business in region. The survey centered on assessing the key components necessary to support new businesses; accessibility of knowledge and expertise; availability of capital and financing; quality of education; and the current state of physical infrastructure in the region. The findings from the study and the survey are summarized below:

1. Charleston has a reasonable base from which to build, given the area's desirability, i.e. cultural and recreational

amenities, and local resources, i.e. universities and institutions;

2. Investment in education, infrastructure and the attraction of outside talent, resources and funding is necessary for the future growth of high-tech business; and
3. CTI can jump-start the technology development process by providing the necessary self-contained infrastructure for new businesses that currently does not exist within the Charleston region.

IC² Charleston Study Findings

The Region and Workforce

The Charleston region is the second largest metropolitan area in South Carolina (behind Greenville-Spartanburg-Anderson, pop. 879,000) with a population of 520,600, and ranks 96th in the nation by population. Total civilian employment in the region is 230,000 with Services, Trade and Government representing the three largest employment sectors, collectively employing 75 percent of the region's workforce.

In the Technology sector, there are currently six defined technology-intensive clusters in the region according to the Charleston Metro Chamber of Commerce's Center for Business Research:

- Electronic/Engineering/Computer Technologies
- Inorganic Chemicals
- Medical Technologies
- Environmental Technologies
- Plastics/Wovens/Nonwovens
- General Technologies

Among these categories in the region, there are 119 firms employing 12,006 total employees, or 5.2 percent of the region's total employment.

Education and Technology Base

Charleston has some strong assets with which to grow its technology sector.

The local universities and institutions support a broad range of technology-based research and development. Faculty resources at Charleston Southern University, the Citadel, the College of Charleston, The Medical University of South Carolina (MUSC) and Trident Technical College include over 1,400 full-time and 950 part-time professors and instructors. In addition, Clemson University and the University of South Carolina (USC), while both outside the immediate vicinity, also provide valuable resources to the Charleston region, with 2,133 combined full-time and 498 part-time faculty.

In addition, South Carolina's three higher education research institutions - MUSC, USC and Clemson - regularly invest significant levels of public and private sector funding toward technology-based R&D. Unfortunately, according to a 1995 study of university-industry technology transfer by the Southern Technology Council, technologies from the region are often exported to private sector licenses outside of the region. Consequently, South Carolina has not captured the full economic benefit of the region's research and development activities. By developing its technology sector, the Charleston region can be better positioned for technology transfer to capitalize on local R&D.

Charleston can also draw on a number of other sources of R&D or technology for commercial transfer in the region. These include the South Carolina Research Authority (SCRA), the Port of Charleston, the Naval In-Service Engineering East Coast Division (NISE-East), the South Carolina Department of Natural Resources, Marine Resources Division, the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center, and the South Carolina Sea Grant Consortium. The

Charleston region's public and private sectors can mutually benefit through enhanced regional technology transfer.

Survey Results

Respondents

Survey respondents were asked to evaluate the importance and current effectiveness of the local business support infrastructure in terms of accessibility to knowledge and expertise, availability of finance capital, the quality of education and the state of physical infrastructure. They were also asked to rate industries, economic development strategies and the role of local government for their importance and effectiveness in creating wealth and high-value jobs in the region over the next ten years. Finally, they were solicited as to what factors would facilitate or inhibit the growth of technology-based industries in the next ten years, and what "big" ideas might significantly improve the region's economy.

A total of 1,191 surveys were fielded with a response rate of 17 percent. The majority of respondents were from the private sector (77%), with public sector and educational institution respondents (17%) far fewer. The visitor and retirement industries were not included in the survey. Most respondents were owners of businesses or held high-level positions in their place of employment (79%).

The Charleston Infrastructure

While all respondents similarly indicated the need for improvement in all the areas addressed, the two areas of greatest concern are the quality of education and the state of the current physical infrastructure.

Respondents pointed to the area's education ranking, the limited availability of a trained and qualified workforce, and the lack of college and university programs in science and engineering as serious obstacles to economic growth. Comments indicate that the

"best and brightest" tend to leave the area and that the current education system does not and would not adequately support technological growth in the region. While local colleges and universities offer some relevant courses, there is a need for more specialized technology-based programs at an advanced level.

In terms of the physical infrastructure, many respondents indicated the need for improved roads and bridges, an improved mass transit system, more direct flights to and from the region, and a better highway system. Respondents believe that the region must improve its physical infrastructure if it is to continue to attract and retain large companies in the technology and manufacturing sectors.

Industries, Economic Development Strategies and the Role of Local Government

Respondents identified tourism/entertainment and the water transportation/cargo handling industries as the most important of the 24 industries listed in the survey for creating wealth and high-value jobs over the next ten years. The next most important industries were health-care, business and financial services, biomedicine/biotechnology, information technology and educational services. The apparel and textiles industry was considered to be least important. The region can further its competitive advantage in all of these industries by growing technology-based businesses in the area.

In response to questions about economic development strategies, respondents emphasized the need to both:

1. attract outside companies to the area, and
2. retain and expand local businesses, start-ups and expansions in order to grow the economic base of the region.

Respondents suggested the need for a Class "A" industrial park to attract outside com-

panies and the offering of improved business support systems such as easier access to capital, information networks among business owners and “one stop” business center for access to business-related assistance.

Respondents had mixed reactions as to the role of local government. However, there were two clear messages:

1. Local governments should work together rather than in competition to create meaningful economic development plans;
2. Local government should support growth and change in the region, i.e. the government should not be an obstacle to the region’s growth.

Charleston’s Technology Scorecard

Leading technology indicators, such as levels of federal R&D funding awards, show below average investment and performance for South Carolina and the Charleston region to date. South Carolina has received less than its share of federal Small Business Innovation Research (SBIR) funding, and no Small Business Technology Transfer Program (STTR) awards. SBIR funding is awarded by the government to applicant small businesses with promising new technologies. STTR funding is identical to SBIR with the exception that applicant companies must partner with a research institution.

South Carolina has received a total of 24 SBIR awards in 10 years, with only six of those in the Charleston region. In the first year of STTR competition, 1,950 STTR proposals were submitted to five participating federal agencies of which 198 were awarded. None of these were awarded to firms located in South Carolina.

This low level of funding awards indicates a below average focus on technology within the region.

The NOAA Center for Technological Innovation

The NOAA Center for Technological Innovation (CTI) was conceived to allow the Charleston region to begin building technology-intensive industries and invest in its future immediately. Modeled after the award-winning Austin Technology Incubator and other successful technology-transfer and economic development initiatives of the IC² Institute, CTI begins to provide the infrastructure that is necessary to stimulate the rapid growth of new technology-based businesses. It provides an efficient and effective mechanism for technology transfer, and nurtures new businesses. CTI operates as a partnership of NOAA and IC² working in alliance with local and state governments, plus the academic, entrepreneurial and business communities. CTI functions include business incubation, technology market assessment, capital formation and networking, community outreach, training, and business support services.

CTI is uniquely proactive. CTI technology and marketing experts work directly with inventors, scientists and researchers at NOAA and other federal laboratories, in academia, and in the private sector to identify the technologies that are the best targets for commercialization and then bring them to market through established or nascent businesses.

Business incubation is at the heart of the CTI concept. The incubator provides the entrepreneur with low overhead and access to an extensive “know-how” network of high-quality professional assistance and advice in such areas as accounting, law, marketing, finance, engineering and management. Businesses “incubate” as firms

develop and bring their products to market. Businesses “graduate” from the incubator when they are mature enough to continue their independent development as a viable enterprise.

Building for the Future

The NOAA CTI is intended to give the Charleston region a competitive advantage in developing new technology-based businesses, creating high-value jobs, and attracting new talent, resources and investment to the region.

Introduction

“The promises and expectations of R&D are increasing, but the resources needed to sustain the R&D effort are decreasing. In this environment, priorities not only need to be set, but knowledge and resources must be shared through wide-ranging collaborations involving companies, universities, and government agencies and laboratories.”

Council on Competitiveness

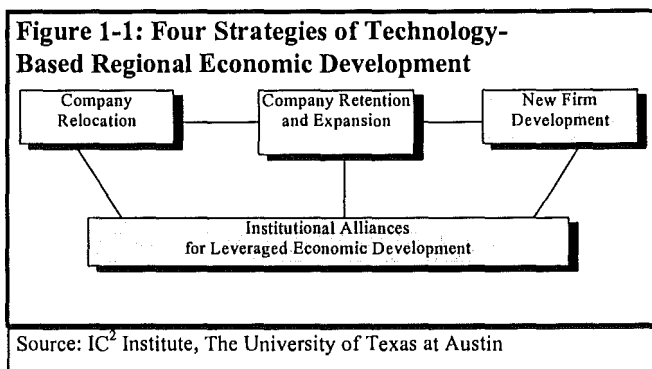
Endless Frontier, Limited Resources: U.S. R&D Policy for Competitiveness, April 1996.

Introduction

An important window of opportunity exists for Charleston, the surrounding region, and South Carolina. The area is rich with amenities; a growing technology knowledge base; and examples of successful, globally competitive entrepreneurial initiatives. The challenge is to more fully develop these resources and the capacity to exploit existing and new-to-the-world technologies to the benefit of the region’s small, mid-sized, and large companies. How Charleston and South Carolina organize to incubate, fund, and grow technology-intensive companies will, in large part, determine the region’s ability to create high value jobs and sustainable wealth creation into the 21st century.

The proposed course of action takes into account four strategies of technology-based regional economic development: company relocation; company retention and expansion; new firm development; and alliance building, Figure 1-1. The focus of this report is on technology-based entrepreneurship to enhance new firm development, and the building of institutional alliances for leveraged economic development in the Charleston region.¹

¹ This overall research and action oriented initiative, which was funded by the Coastal Services Center, National Oceanic and Atmospheric Administration (NOAA) and supported by the Charleston Metro Chamber of Commerce, has produced three separate and related reports all of which are



Wealth creation opportunities in the coming decades will be realized by meeting the challenges of a hypercompetitive global marketplace in the post-cold-war era. To prepare for the 21st century, communities as well as federal agencies and firms need to implement innovative technology commercialization strategies. The vision is for South Carolina and Charleston to benefit from a technologically diverse regional and globally competitive economy built on the core competencies of institutions that generate science and technology. This vision can be achieved by:

- Educating leaders and their respective institutions to the benefits of regional collaboration across academic, business, and government sectors, and

titled *Technology-Based Entrepreneurship in the Charleston Region*.

- Implementing regional, national, and global strategies and programs for building a technology-based economy that will create wealth and high-value jobs for a sustainable high quality of life.

Figure 1-2 shows critical components to achieving value-added technology commercialization through leveraging academic, government, and business resources at the regional level. Central to this process is the linking of four critical factors (1) talent — people, (2) technology — ideas, (3) capital — financial resources and (4) know-how — enterprise knowledge for new and rapidly growing firms to be competitive in national and global markets.

Entrepreneurial talent results from the perception, drive, tenacity, dedication, and hard work of special types of individuals—people who make things happen. Where there is a pool of such talent, there is opportunity for

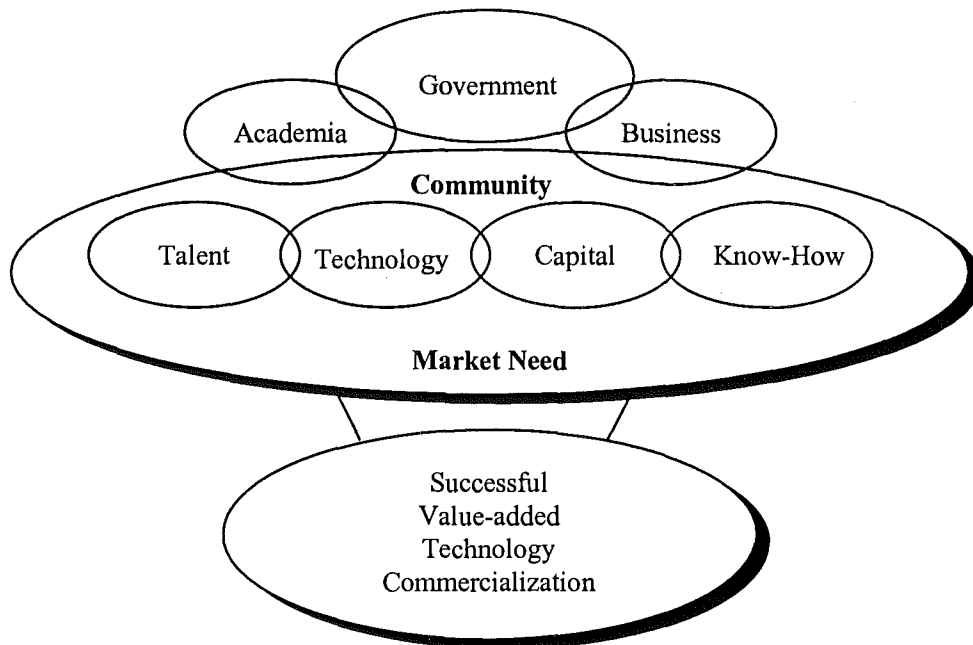
economic growth, diversification, and new business development.

Talent without ideas is like a seed without water. When talent is linked with technology, when people recognize and push and pull viable ideas to commercialization, the entrepreneurial process is underway. Every dynamic process needs to be fueled. The fuel here is capital. Capital is the catalyst in the technology venturing chain reaction.

Know-how is the ability to leverage business or scientific knowledge by linking talent, technology, and capital in emerging and expanding enterprises. It finds and applies expertise in a variety of areas, making the difference between success and failure. This expertise, or “smart infrastructure”, involves management, marketing, finance, accounting, production, and manufacturing, as well as legal, scientific and engineering skills.

Each of these critical factors needs to be

Figure 1-2: Value-Added Technology Commercialization Through Linking Public/Private Networks at the Regional Level



Source: IC² Institute, The University of Texas at Austin

nurtured and supported at the community level by creating conditions that build an environment that promotes innovation, such as:

- expanding the talent pool. These conditions include quality of education opportunities, quality of life, quality of “smart” and physical infrastructure, efficient access to needed resources domestically and internationally, recognition of successful role models, and development of a culture conducive to innovation as well as support for education and research.
- accelerating the development of technology. These conditions include innovative funding programs for R&D, technology transfer, science parks, incubators, R&D consortia, centers of excellence, and the protection of intellectual property.
- increasing the availability of capital. These conditions include creative regional programs, venture and private sector capital pools, tax advantages for investing in R&D and new companies, and small business research and development programs.
- improving availability of managerial, technical, and business know-how. These conditions include world-class education facilities; establishment of business and industry incubators; availability of programs for entrepreneurial training and assistance; and the development of organized networks of experienced people, local advisors and professional associations.
- establishing national and global networks that expand the flow of talent with links to the region’s know-how networks of management capital and business and technical professionals.

This report is designed to provide benchmarks to assist in the enacting of meaningful collaborative activities and to guide community-driven initiatives across the academic, government, and business sectors. The Charleston region could, and should, become a national model for successful economic transition to a more diversified, globally competitive, technologically-based economy while maintaining its strong tourism, port, and other industries.

Report Organization

Three types of data collected in Charleston and South Carolina during 1996 are emphasized in this report: (1) interviews with industry, academic, and government participants and leaders, (2) a survey on technology-based entrepreneurship in the Charleston region, and (3) previous economic development studies on Charleston and South Carolina and other published documents.

Interviews were conducted with managers and technicians in small, mid-sized, and large technology-intensive enterprises. The focus was on reasons for locating and choosing to remain in the Charleston region and management’s near and longer term challenges to growth and profitability. Interviews were also conducted with public sector organizations, such as NOAA, that are dedicated to fostering national R&D missions as well as agencies more focused on enterprise development and growth in Charleston and South Carolina. Interviews were conducted with faculty and administrators at Charleston area colleges and universities and at USC in Columbia and Clemson University. As one result of these interviews, short case profiles are reported for select entrepreneurial small, mid-sized, and large technology-intensive firms and public sector organizations.

The survey focused on the opinions of managers of small, mid-sized, and large tech-

nology-intensive firms located in the Charleston region including Berkeley, Charleston, and Dorchester Counties. The survey assesses the relative importance and effectiveness of:

- Twenty-four industries and a range of economic development strategies to creating wealth and high value jobs in the Charleston region over the next ten years;
- Educational infrastructure — K-12, college and university — with regards to quality of science/ technology/ mathematics instruction, regional partnering across academic institutions, apprentice programs, entrepreneurial education, and graduate degree programs;
- Needed business expertise for technology-based business expansions, spin-outs, and start-ups including accounting, marketing, legal, and manufacturing support; networking opportunities; entrepreneurial training; and technology incubators, Class A business parks, and light manufacturing space.
- Finance for technology-based business expansions, spin-outs, and start-ups including seed and venture capital; education and networking programs; new and creative funding mechanisms; risk reduction mechanisms; education of bankers to the needs of entrepreneurs; and venture fairs where potential investors are linked with select entrepreneurs.
- Access to research and development (R&D) locally, nationally, and globally.
- Physical infrastructure, quality of life, and other issues including the importance of natural and cultural assets, the role of local government, regional collaboration, and a can-do attitude.

After the Introduction (Section I), this report is organized into six additional sections.

Section II: Demographics and workforce characteristics of the Charleston region

briefly introduces Charleston's unique historical and cultural assets and amenities. It describes the region's key employment sectors and major employers, and compares Charleston's region's high technology employment with other cities of comparable size and that are located in the same geographic region.

It is important to understand and appreciate Charleston as a unique "living history, cultural, and environmental" center that attracts tourists worldwide. As a real and functioning city, it is different than many other tourist locations. As the region pursues technology-based entrepreneurship, a key challenge is to not only preserve but to improve these unique historical, cultural, and environmental assets.

Section III: Talent and R&D Base for Technology-Based Entrepreneurship

focuses on two critical components noted in Figure 1-2: talent and technology. The emphasis is on current assets and the growth of these resources in colleges and universities in the Charleston region as well as The University of South Carolina and Clemson University. While the focus of this report is on Technology-Based Entrepreneurship in the Charleston Region, a regional assessment of talent and technology resources is emphasized.

Profiles of select Charleston-based public and private sector R&D assets are also emphasized. To facilitate a "benchmarking" of these assets, comparisons are made with universities and other concentrations of R&D talent outside South Carolina. These

comparisons include data on intellectual property assessments, Small Business Innovation Research (SBIR) Awards, and The Small Business Technology Transfer Program.

Section IV: Survey on Technology-Based Entrepreneurship in the Charleston Region reports on the responses of mostly business leaders from small, mid-sized, and large technology-intensive firms. The data record the ratings of (1) the importance of particular assets or strategies for creating wealth and high-value jobs in the Charleston region over the next ten years, and (2) the effectiveness of the Charleston region in fostering these assets or in pursuing these strategies.

These assets and strategies including quality education; business expertise and know-how; finance; access to R&D; physical infrastructure; quality of life; and regional collaboration are all considered important for fostering technology-based entrepreneurship in the Charleston region. For example, quality education at all levels (K-12, college, and university) is centrally important for realizing each of the economic development strategies identified in Figure 1-1: company relocation, company retention and expansion, new firm development, and building institutional alliances for leveraged economic development. And, regional networking and collaboration is key to linking talent, technology, capital, and know-how as identified in Figure 1-2.

Section V: Scorecard of Technology-Intensive Industry Sectors presents data collected on the founding, location, and growth of 119 start-up (1-5 employees), small (6-10 employees), mid-sized (11-99 employees), and large (100+ employees) technology-intensive Charleston-based firms in the following industry clusters:

- Electronics/Engineering/Computer Technologies
- Inorganic Chemicals
- Medical Technologies
- Environmental Technologies
- Plastics/Wovens/NonWovens
- General Technologies

These data provide an indication of which of these clusters supports the most employment in small, mid-sized, and large firms; and they provide an overall view of technology growth in the Charleston region since 1950. Plotting the location of all 119 firms also illustrates technology corridors growing in the region.

Section VI: Where Opportunity Meets Necessity draws on all previous sections of the report:

- (1) to clarify barriers and facilitators to fostering technology-based wealth creation in the Charleston region, and
- (2) to introduce the NOAA sponsored Charleston-based Center for Technological Innovation (CTI).

The Center for Technological Innovation (CTI) is an important community resource for facilitating each of the four strategies of economic development — industrial relocation, industrial retention and expansion, new firm development, and alliance building — but the focus is on the latter two strategies and includes:

- fostering the linking of talent, technology, capital, and know-how.
- accelerating technology-based entrepreneurship leading to spin-outs from Charleston's academic, business, and government sectors.
- accelerating the growth of local company start-ups.
- attracting entrepreneurs and new technology firms to Charleston.

- serving as an education-based research facility and “experiential learning laboratory” on new company formation, technology transfer, and alliance building.
- being a catalyst for forming regional, national, and global alliances across academic, business, and government sectors.

Section II

Demographics and Workforce Characteristics of the Charleston region

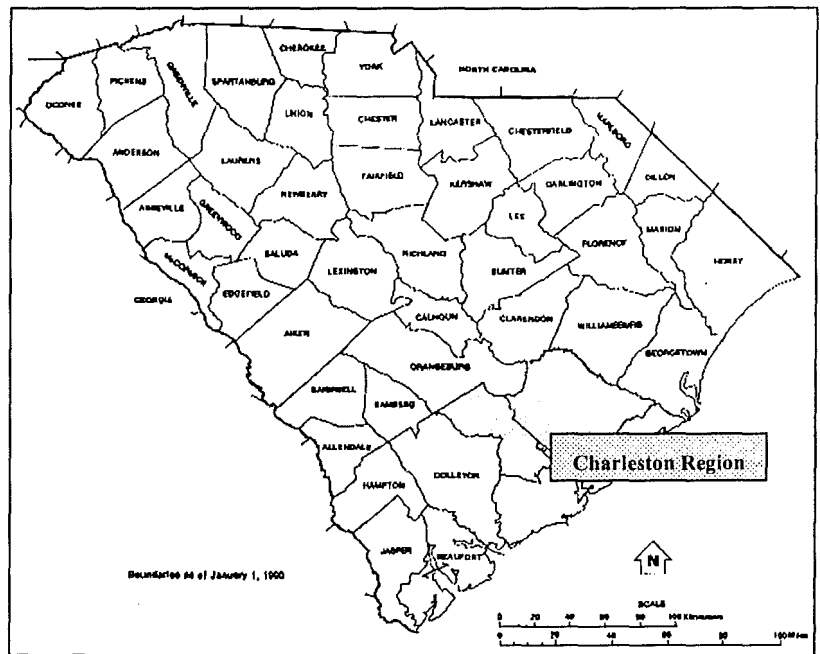
"As a region, concentrating on the prosperity of business in our community must be our primary goal. We must never become complacent but constantly strategize to cover economic development from every angle."

James D. Bradley
Chief Executive Officer
Charleston Metro Chamber of Commerce

Charleston is a unique living history, cultural, and environmental center. The city is known nationally and internationally for its Spoleto arts festival, Southeastern Wildlife Exposition, historic downtown district, and other amenities. It is a prime tourist destination, and increasingly, a destination of choice by international visitors, particularly from Europe. More than 7.4 million people visit Charleston's attractions each year. The true essence of Charleston combines the wisdom and confidence born of past experience with an optimistic vision of the future.

Three hundred years of a rich cultural and historical heritage have provided the City of Charleston and its inhabitants with a unique combination of charm, eloquence, and energy. Founded as a colony in 1670 with the name Charles Towne after King Charles of England, the city has survived wars, floods, earthquakes, and hurricanes to emerge as one of the most beautiful and livable cities in the U.S.

This high quality of life is central to the region's success in company relocation, company retention and expansion, new firm development, and forming national and global alliances. The challenge is to maintain and



enhance these historical, cultural, and environmental assets as the region strives to be economically competitive in the global economy of the 21st century.

In addition to being one of the oldest English colonies in the United States, Charleston boasts the oldest French Huguenot Church, America's first female artist, the famous Dock Street Theatre, the first reformed synagogue in the South, the oldest municipal college in America — the College of Charleston and the first Chamber of Commerce. These historical, cultural, recreational, and social amenities are

Table 2-1: Charleston Region Population and Comparable Metropolitan Areas, 1995

Metropolitan Area	Population (000)	Rank
Baton Rouge	560.6	90
Jersey City	552.2	91
Wilmington-Newark (DE)	541.8	92
Little Rock-North Little Rock	539.9	93
Stockton-Lodi (CA)	526.7	94
Sarasota-Bradenton	523.7	95
<u>CHARLESTON REGION</u>	<u>520.6</u>	<u>96</u>
Ann Arbor	518.2	97
Mobile	515.8	98
New Bedford-Fall River- Attleboro (MA)	511.4	99
Vallejo-Fairfield-Napa (CA)	495.2	100
Columbia	489.5	101
Wichita	476.0	102
Fort Wayne	470.4	103
McAllen-Edinburg-Mission (TX)	470.1	104
Colorado Springs	461.1	105
Johnson City-Kingsport-Bristol	451.8	106
Aiken-Augusta	450.8	107

Source: 1995 Demographics-County Edition, Market Statistics.

a major asset for Charleston to build upon as it emerges as an important national and international center for technology-based entrepreneurship.

The City of Charleston has about 80,000 residents, which ranks it between 275 and 300 nationally in city size, while the Charleston region's population, consisting of Charleston (297,000), Berkeley (139,000), and Dorchester (85,000) Counties, is 520,600, Figure 2-1.

Charleston is the second largest metropolitan area in South Carolina, behind the Greenville-Spartanburg-Anderson metro area whose population is 879,000. The Columbia, South Carolina metro area has about 490,000 residents. Nationally, the Charleston region is 96th, about the same size as the metropolitan areas shown in Table 2-1.

Total civilian employment in the Charleston region is about 230,000 in 1996. Approximately three-quarters of all employees in the region are working either in the service, trade, or government sectors, Figure 2-2. Each of these sectors has roughly 50,000 employees. The largest employers in the region are shown in Table 2-2.

The manufacturing sector of Charleston's economy, at roughly 10 percent, is lower than the national average. Yet manufacturing jobs are still an important barometer of a region, and comparing manufacturing employment in different regions can prove useful.

Employment in technology firms, as defined by SIC codes within manufacturing, were computed for specific metropolitan areas and compared with the Charleston region.

These metropolitan areas were selected by three criteria: (1) geographic proximity to the Charleston region, (2) population comparability with the Charleston region, and (3) metropolitan areas commonly cited as high technology benchmarks.

As noted in Table 2-2, much of the region's workforce is concentrated in fields which are NOT included in this high tech manufacturing measure, such as government, education, and health care. Furthermore, many other workers and managers are employed in tourist-related businesses.

As shown in Figure 2-3, the Charleston region is about in the middle by this measure of high technology employment in manufacturing firms. It is higher than Greenville-Spartanburg, Chattanooga, Wilmington-Newark, Jacksonville and other areas, but lower than eight others.

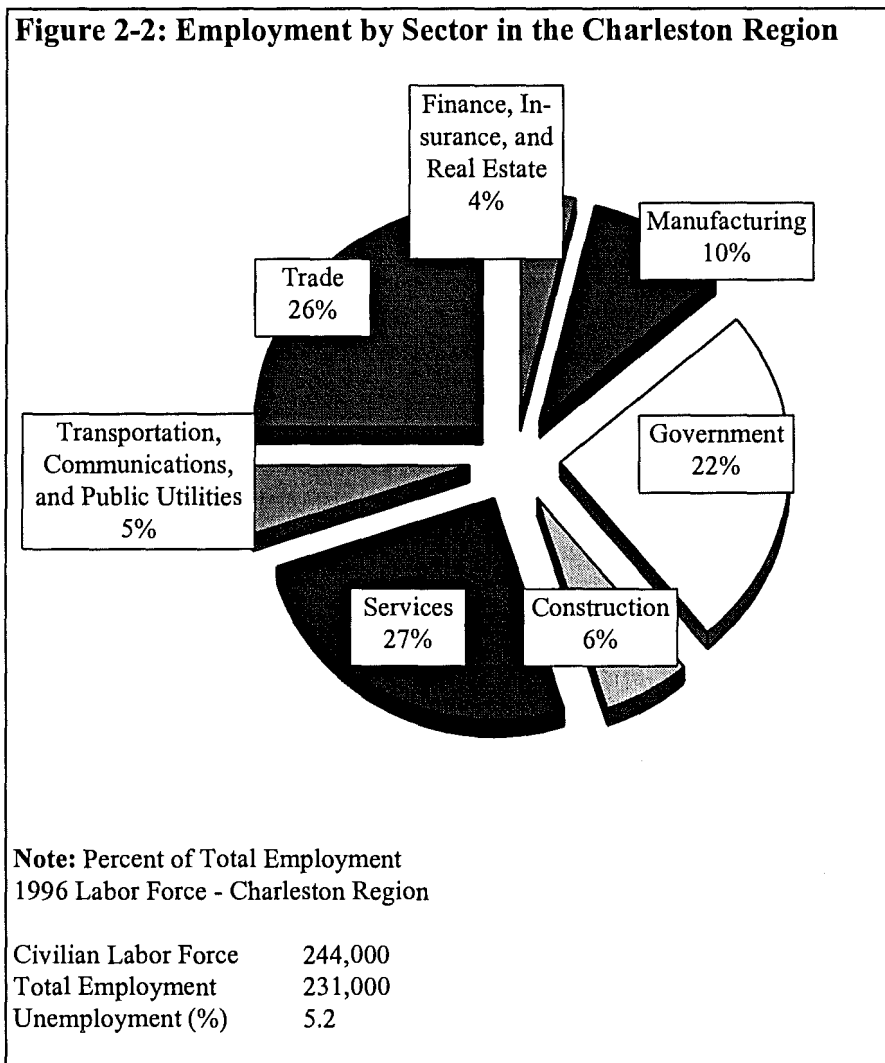
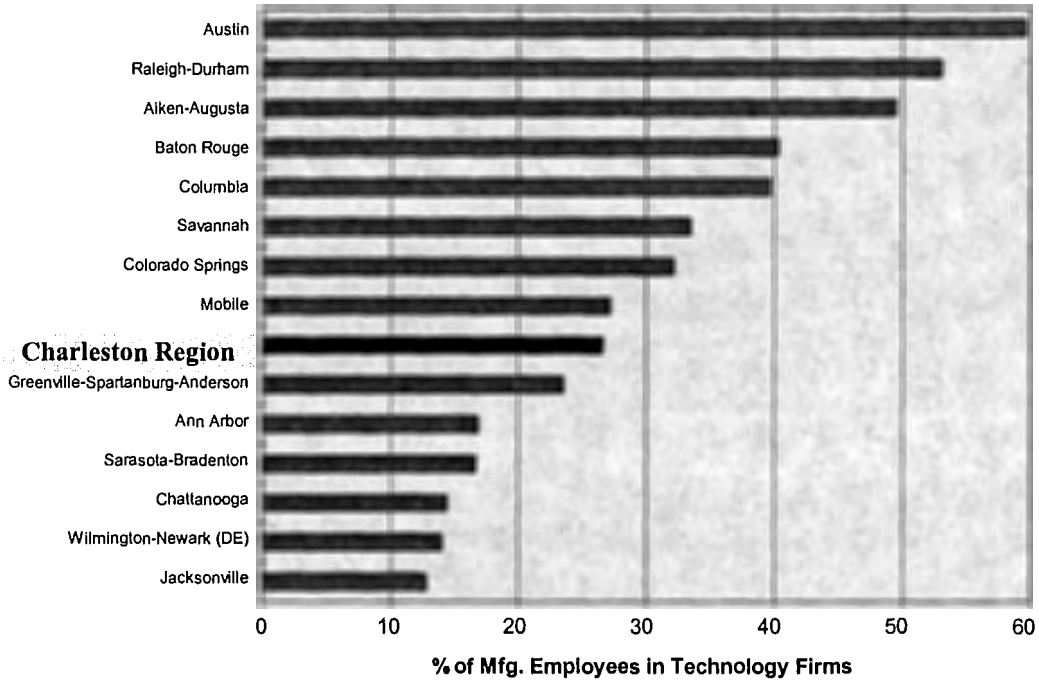


Table 2-2: Charleston Region's Major Employers

Company/Government Department	Number of Employees
US Navy, various commands	7,881
Medical University of South Carolina	7,528
Charleston Air Force Base	5,452
Charleston County School District	5,109
Berkeley County School District	2,945
Roper Hospital & Roper Hospital North	2,500
Charleston County Government	2,136
Westvaco Corporation (lumber, paper, chemicals)	2,110
U.S. Postal Service	1,965
Robert Bosch Corporation (fuel and braking systems)	1,926
Columbia/HCA Carolinas Div. HQ & Medical Centers, Columbia Trident & Summerville Medical Centers	1,880
Piggly Wiggly Carolina Co. Inc. (grocery HQ and area stores)	1,800
Dorchester County School District II	1,585
Wal Mart Stores	1,564
City of Charleston	1,312
Bi-Lo Inc. (grocery stores)	1,117
Santee Cooper (electric utility)	1,101
SC Electric & Gas Company	1,067
Bayer Corporation (dyes, pigments, fibers)	1,006
College of Charleston	1,000
R.H. Johnson Veterans Affairs Hospital	1,000
Bon Secours-St. Francis Xavier Hospital	875
City of North Charleston	808
Kmart Stores	803
Coastal Center (SC DMR facility)	720
Kiawah Island Resort	700
Main-Waters Management (restaurants)	651
Food Lion (grocery stores)	650
Alumax of South Carolina (aluminum ingots)	625
Publix Supermarkets (grocery stores)	622
Berkeley County government	619
Georgia-Pacific Divisions (lumber products)	618
Winn Dixie Stores (grocery stores)	612
The Post & Courier (newspaper/publishing)	610
East Cooper Regional Medical Center	610
E-H Enterprises (restaurants)	600
BellSouth (telecommunications)	587
Holiday Inn Hotels	586
The Citadel	560
Charleston Place Hotel	550

Source: Center for Business Research, Charleston Metro Chamber of Commerce, September 1996.

Figure 2-3: High Tech Manufacturing Employment by Metropolitan Area



Computed from raw data supplied by Dr. Elsie Echeverri-Carroll and Lynn Hunnicutt, Bureau of Business Research, Graduate School of Business, University of Texas at Austin. Original source data is Country Business Patterns, U.S. Census Bureau, 1993. Technology firms are those which employ above average percentages of scientists, engineers, and mathematicians.

Section III

Talent and R&D for Technology-Based Entrepreneurship

"America's future prosperity will depend on a continued commitment to producing new ideas and knowledge, and the people educated to apply them successfully. They will be central to our economic opportunity in the face of intense global competition, to our protection against renewed threats to our security and environment, and to ensuring the health of Americans."

Letter from 60 Nobel Prize Winners
to President Clinton, July 1996

Introduction

Section III of this report focuses on select college, university, and other public and private resources in the Charleston region to provide an overview of the talent - people and technology - ideas available to fuel technology-based entrepreneurship in the Charleston region. In addition a brief overview is provided of the talent and technology resources at the University of South Carolina and Clemson University. While these universities are somewhat distant from Charleston, they are considered very important educational and research resources for the Charleston region and the state in general and in terms of technology-based entrepreneurship in particular. In conclusion, comparisons are made between South Carolina's major research universities and other major universities in the U.S. and between South Carolina and the nation in terms of Small Business Innovation Research Awards and awards of the Small Business Technology Transfer Program.

There are a variety of ways to "benchmark" talent and technology. Common metrics, from the academic perspective, are the number and quality of publications, the number of faculty in prestigious professional organizations, the number and amount of research grants, the number and placement of graduated students, and the

number of endowed (i.e., privately funded) faculty positions. Other metrics more commonly used by business and increasingly by academic institutions include patents, licenses, and royalty income. A community such as Charleston is most commonly concerned with an increased number of high-value jobs that also support service professionals and other local businesses, new firm creation and growth, a larger tax base, and increased business diversification.

Section III documents that the Charleston region in particular and South Carolina in general, does have significant and growing talent and technology resources as judged from academic, business, and community perspectives. The primary metrics used are the amount of funding (federal, state, and corporate) for R&D in designated technology areas and the number of faculty resources and degreed professionals. The emphasis is on the identification of research priorities and potential. The region and state fare less well when compared to other locations in the U.S. in terms of the commercialization of these regionally-based science and technology resources.

Part I: The Charleston region

Section III begins with descriptions of the College of Charleston, The Citadel, Charleston Southern University and Trident Technical College. The Medical University of South Carolina (MUSC), is presented as

the region's premier graduate institution and one of the major doctorate-granting universities in South Carolina. Information is provided on MUSC's externally sponsored research and funding history, specific strengths in research, and intellectual property generated.

Three Charleston-based government agencies which conduct and fund an array of environmental research are used to illustrate beneficial partnerships between the public and private sectors: The South Carolina Department of Natural Resources' Marine Resources Division, the National Marine Fisheries Service's Charleston Laboratory, and the South Carolina Sea Grant Consortium.

The South Carolina Research Authority (SCRA) is described as a regional resource in terms of research park development and R&D in such areas as advanced manufacturing, health care information systems and distributed technology management.

Two other large public sector agencies which are located in Charleston and which have developed particularly interesting entrepreneurial cultures are then described: The Naval In-Service Engineering East Coast Division (NISE East) and The Port of Charleston.

Part I ends with a partial listing of manufacturers operating in the Charleston region that conduct R&D.

Part II: The University of South Carolina and Clemson University

To exemplify the importance of a state-wide perspective to fostering technology-based entrepreneurship in the Charleston region, talent and technology resources are reviewed at the University of South Carolina and at Clemson University. The focus is on the source of awards, large federal and industry sponsors, major research projects and technology-based research initiatives.

Part III: Comparisons with Other States

To provide additional perspectives on research and development at South Carolina's three major doctorate-granting institutions (The University of South Carolina, The Medical University of South Carolina, and Clemson University) a series of benchmark comparisons are made with other state institutions. Comparative data are also presented on Small Business Innovation Research Awards in South Carolina and information on the number of nonacademic scientists and engineers in other states.

Part I: The Charleston region

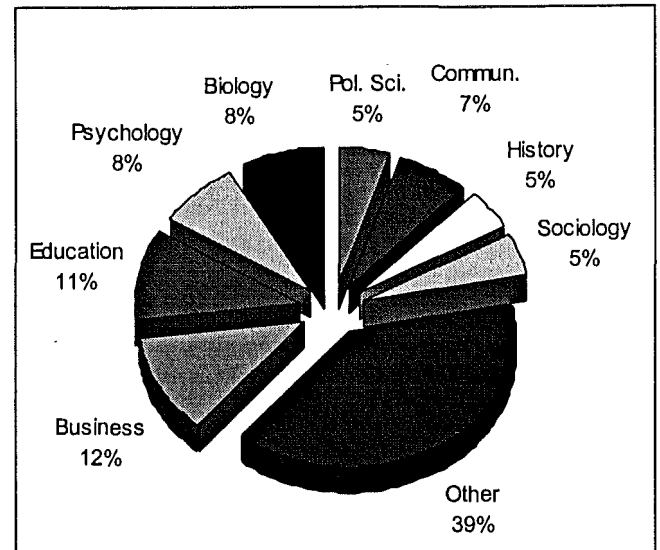
The College of Charleston

Founded in 1770, The College of Charleston is a state-supported institution whose central mission is to provide superior quality undergraduate education. In addition to a broad range of baccalaureate degree programs, the College provides masters' degrees in accountancy; bilingual legal interpreting (the only program of its kind in the country); marine biology; mathematics and early childhood education; elementary education; English, history, and special education (joint programs with the Citadel); environmental studies (a joint program with the Medical University of South Carolina), and public administration (a joint program with the University of South Carolina).

Current full-time undergraduate enrollment is approximately 7,500 with another 1,100 part-time undergraduates. There are 205 full-time and nearly 1,800 part-time graduate students. About three of every four students are from South Carolina. The College has 362 full-time faculty and 175 part-time faculty. Approximately 93% of the full-time faculty have doctorates.

The middle range for SAT scores for freshmen in 1995 was 920-1110. Slightly more than one-quarter of the freshmen were in the top 10 percent of their high school graduating class, and over 93 percent were in the top half of their graduating class. The most popular majors are business and education, Figure 3-1. Upon graduation, about three percent of graduates go to law school, three percent enter MBA programs, three percent enter medical school, and 21 percent go on to other graduate level training.

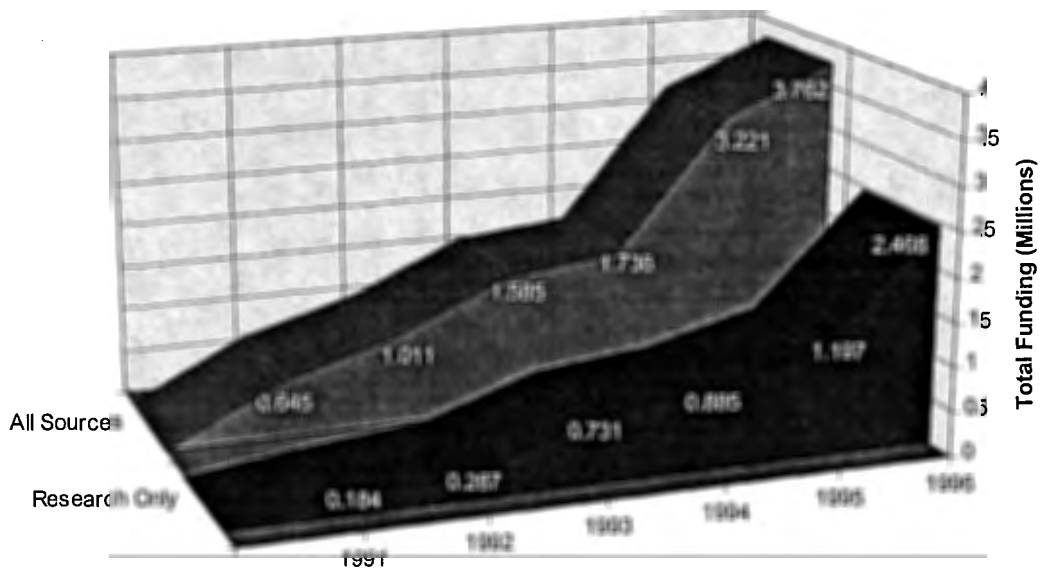
Figure 3-1: Majors at The College of Charleston, 1995



Funding for externally-supported research, public service, and for faculty and administrators has increased dramatically in the past five years, Figure 3-2. Research funding currently accounts for approximately 60% of all external support, whereas in 1991, the proportion was less than 30%. During this increase federal and federal flow-through funding has constituted around 86% of all funding. In 1994-1995, external financial support was concentrated in biology, environmental studies, and geology, Tables 3-1 and 3-2.

In addition to the externally funded research identified in Table 3-2, research is also being conducted in the areas of synthesizing novel bioactive chemicals, genetic marking (with the Medical University of South Carolina), computer image processing of health information, geochemistry, groundwater monitoring, and geographic information systems.

Figure 3-2: College of Charleston Outside Support - All Sources and Research Only



Source: "Report to the South Carolina Legislature, Fiscal Year 1994-1995," and 1995-1996 data provided by The College of Charleston, Office of Sponsored Projects. The fiscal years end on June 30; therefore the 1995 information covers expenditures during the period July 1, 1995 through June 30, 1996. Expenditures are funds actually spent during the fiscal year. Award data represents funds obligated to the institution, but not necessarily spent during that fiscal year.

Table 3-1: The College of Charleston Research, Training and Public Service Awards by Area, 1994-1995

	# of Awards	Total Support (000)
Department of Biology	31	\$ 818.8
Interdisciplinary, including Joint Master's Degree/ Environmental Studies	4	512.7
Department of Geology	15	450.4
Enrollment Management	4	444.0
Institute of Public Affairs and Policy Studies	11	369.5
Graduate Studies, Research, and Professional and Community Services	7	366.9
School of Education	17	365.4

Source: "Report to the South Carolina Legislature, Fiscal Year 1994-1995," The College of Charleston, Office of Sponsored

Table 3-2 College of Charleston Select Research Awards, 1994-1995 (000s)

Evaluation of Simulations in Developmental Disabilities* LaPlatte	NIH-NICHHD	\$109.000
River Watershed Phosphorous Allocation	Vermont Dept. of Envir. Pro.	108.800
Environmental Physiology of Fishes	Charleston Harbor Project	30.100
RUI: Photogenetic Analysis of the Cetacean...*	National Science Foundation	90.000
Effects of Light/Nitrogen on Prochlorococcus	National Science Foundation	86.600
RUI: Bacteriolysis in Deposit Feeders	National Science Foundation	65.000
Florida Keys Coral Monitoring	FL Dept. of Envir. Protection	80.000
Utility of Planktonic Foraminefera	National Science Foundation	33.100
SC Space Grant Consortium	NASA	170.000
Charleston County Hub	College of Charleston Foundation	262.600

*36 Month Awards

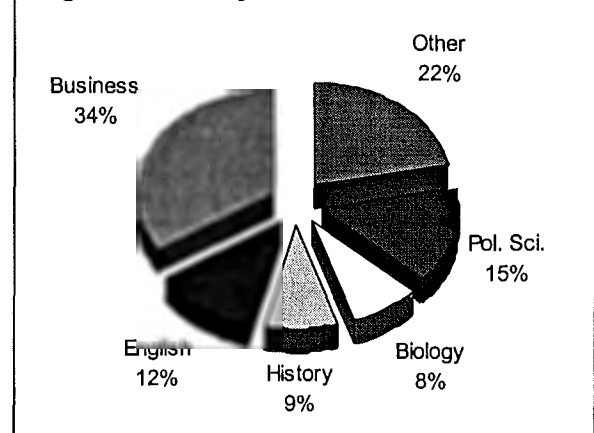
Source: "Report to the South Carolina Legislature, Fiscal Year 1994-1995," The College of Charleston, Office of Sponsored Projects.

The Citadel

Founded in 1842, The Citadel is a state-assisted liberal arts school that offers three distinct programs: the South Carolina Corps of Cadets, the College of Graduate and Professional Studies (co-educational), and Summer School. The Corps is comprised of about 2,000 young men and women in 17 companies within four battalions. The Corps began admitting young women to its ranks in Fall 1996. Enrollment in the College of Graduate and Professional Studies is about 2,200 students per semester and 1,300-1,500 during the summer. There are 153 full-time faculty and 50 part-time faculty.

Fully 90% of the full-time faculty have doctorates or the terminal degree in their profession.

Figure 3-3: Majors at The Citadel, 1995



The Citadel has received numerous accolades in recent years. The U.S. News and World Report on America's Best Colleges consistently ranks The Citadel highly. In 1996, the Citadel ranked tenth overall among Southern colleges, with a number three ranking in academic reputation and a number eight ranking in faculty resources. The Citadel also was ranked as the sixth best value in university education in the South. The Citadel has been recognized for having very high graduation rates.

The middle range for SAT scores for freshmen Cadets in the Corps in 1995 was 870-1050. Slightly more than ten percent of the freshmen were in the top 10 percent of their high school graduating class, and 75 percent were in the top half of their graduating class. Students came from 35 states and 11 foreign countries. The most popular majors are shown in Figure 3-3. About 30 percent of each graduating class enters military service, six percent goes to law school, six percent goes on to other graduate level training, four percent enter MBA programs, and two percent enter medical school.

Classes in the co-educational College of Graduate and Professional Studies are offered in late afternoon, evening, and summer. There are bachelor's programs in business administration, civil engineering, and

electrical engineering. There are graduate degree programs in biology, business administration, education, English, history, math, physical education, psychology, social sciences, and community counseling. Through an arrangement with Clemson University, graduate engineering courses are offered on The Citadel campus. The College also offers an increasing number of non-credit continuing education courses.

Research by Citadel faculty is conducted both with internal funds and with external sponsors. The Citadel has an annual competition for faculty called CDF Research Grants of around \$5,000. The amount of externally funded research has varied considerably, Table 3-3. The large majority of funding has come from federal agencies and departments. In the last three years, research support has concentrated in marine biology, astronomy, and genetic and forest biology, Table 3-4.

Charleston Southern University

Charleston Southern University (CSU) was founded in 1964 as the only Christian college in the South Carolina Lowcountry. CSU is the region's second largest privately accredited university, with approximately 2,150 (1535 full-time) students. Affiliated with the South Carolina Baptist Convention,

Table 3-4: The Citadel Research Support by Area, 1994-1996

	Number of Awards	Total Support (000)
Marine Biology Genetic	2	\$ 79.8
Marine Biology	5	70.2
Astronomy	7	69.7
Biology Genetic	2	68.5
Forest Biology	2	16.6
Early Childhood Psychology	1	6.5
Biology	2	5.0
Environmental Assessment	1	1.0

Source: Unpublished data, The Citadel, March 21, 1996.

CSU's 300-acre campus is located just outside of Charleston.

Charleston Southern offers 28 undergraduate degrees. The most popular majors are business and management (27%), education (17%), psychology (11%), computer science (10%), and criminal justice (6%). CSU also offers a Master's of Business Administration, a Master's of Education degree in elementary and secondary school education, and a Master's of Art in teaching and in English, social studies and sciences. CSU is currently conducting feasibility studies for environmental management (B.S.) and nursing (B.S.N.) degree programs. CSU's evening college enrolls approximately one-third of all matriculating students. There are 78 full-time and 70 part-time faculty. Approximately two-thirds of the full-time faculty hold doctorates.

Externally funded research, such as the master's teaching and curriculum grant of approximately \$100,000, has been limited due to CSU's emphasis on teaching. CSU's major externally funded project is a \$274,000 Department of Defense Economic Adjustment grant to the Center for Enterprise Development. Begun in February 1995, the grant provided business assistance services to prospective entrepreneurs at the Naval base. To date, 38 individuals have proceeded through the three-month program and established their own businesses.

Since 1991, the Center for Economic Forecasting has been providing annual and quarterly economic forecasts for the region in partnership with the Charleston Metro Chamber of Commerce's Center for Business Research. The Center also expanded its forecasting project to the Myrtle Beach area in 1995.

The Medical University of South Carolina

The Medical University of South Carolina (MUSC) has a full-time enrollment of 550 and about 90 percent of these students are native South Carolinians. There are 162 full-time faculty and 60 part-time faculty in the core sciences; 570 full-time faculty and 540 part-time faculty are in the clinical program. At the end of fiscal year 1995, approximately 425 of MUSC's faculty were supported by research funding. MUSC has approximately 100 postdoctorates.

"MUSC's primary missions are educating health professionals, discovering new knowledge, and providing outstanding health care for the people of South Carolina."

James B. Edwards, D.M.D.,
President, MUSC

Entrance to MUSC is very selective. The average MCAT score for freshmen is 9.0, and the average undergraduate grade point average is 3.5. The most popular majors are biological sciences (45%), social sciences (18%), and the physical sciences (15%). Approximately half of the graduates enter primary care specialties of family practice, general pediatrics, and general internal medicine.

MUSC is the second largest employer in the Charleston region with over 7,500 employees. Although a state-assisted institution, MUSC's budget is increasingly dependent on non-state funding. MUSC's budget increased 240 percent in the last five years from \$331 million in fiscal year 1989-1990 to \$796.2 million in fiscal year 1993-1994. Yet, MUSC's state appropriated funding has remained fairly constant at approximately

Table 3-5: MUSC Awards and Funding in Recent Years

	Number of Awards	Funding
1991	352	\$ 26.9 Million
1992	357	35.5
1993	461	38.7
1994	528	52.0
1995	537	66.1
1996	489	56.9

Source: *Annual Report of Research and Related Activities* FY 1995-1996; *Annual Report* 1994-1995, page 8; *Annual Report* 1993-1994, page 4; *Review of Extramural Funding 1987 Through 1993*, Table 2; *Review of Extramural Funding 1986 Through 1992*, Table 2. Medical University of South Carolina, Office of Research Administration, Charleston, South Carolina. The fiscal years end on June 30; therefore the 1996 information covers awards during the period July 1, 1995 through June 30, 1996. Multi-year awards are counted as being received entirely in one year. Also, the data are based on obligated amounts, not actual expenditures. Award amounts exclude those from Veteran's Affairs.

\$132.7 million annually, about one-sixth of the total budget.

Research Funding

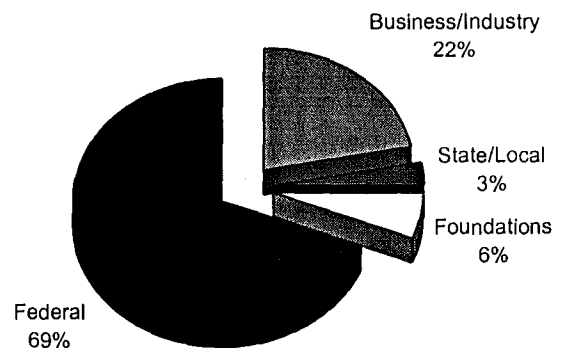
MUSC's research funding has increased every year during the past decade, prior to the most recent period, Table 3-5. According to an institutional profile from the Association of American Medical Colleges, MUSC's increase in research expenditures over 1992 through 1994 boosted MUSC from 71st to 59th among all participating medical colleges. The 59th place ranking is based on total research expenditures and is not adjusted for the number of faculty or size of institution.² This increase was surpassed by only four other medical colleges out of 126.

Federal research funding dominates other sources at MUSC, contributing approximately 69 percent of all research dollars, Figure 3-4. This proportion has remained fairly constant over the past five years. As

with many medical colleges, secondary research support comes from corporate sponsors (22 percent), foundations (6 percent), and state government and other sources (3 percent).

The largest federal sponsors in 1995 are listed in Table 3-6. Except for the U.S. Department of Energy and the National Science Foundation, federal research is principally derived from the National Institutes of Health. The three largest Department of Energy multi-year awards are:

Figure 3-4: Sources of Research Funding at MUSC



² See *Benchmarking University-Industry Technology Transfer In The South*, by Louis G. Tomatzky, Paul G. Waugaman, and Lucinda Casson, The Southern Technology Council, Southern Growth Policies Board, Raleigh, North Carolina, April 1995.

- Environmental Hazards Assessment Program--\$7.2 million.
- Enhancement of MUSC Cancer Research and Molecular Biology Programs--\$5.5 million.
- South Carolina Nuclear Waste and Spent Fuel Program--\$5.0 million.

Table 3-7 lists MUSC's largest corporate sponsors in 1995. Considering all sources of funding (that is, federal, corporate, foundation, and other sources), there were several MUSC departments that received at least \$1.0 million in 1995 to conduct research for outside sponsors, Table 3-8. Major grants not previously noted which exceed \$500,000 are listed in Table 3-9.

Table 3-6: MUSC's Largest Federal Sponsor, 1995

	Proportion of Total Funding
U.S. Department of Energy	28.0%
NIH-National Heart, Lung, and Blood Institute	7.3
NIH-National Institute on Drug Abuse	3.9
NIH-National Institute on Diabetes and Digestive and Kidney Diseases	3.6
NIH-National Cancer Institute	2.9
NIH-National Center for Research Resources	2.9
NIH-National Institute on Deafness and Other Communication Disorders	2.4
National Science Foundation	2.3
NIH-National Institute of Alcohol Abuse and Alcoholism	2.1
NIH-National Eye Institute	1.1
Total	56.6%

Source: Source: Computed from data on page 13, Annual Report 1994-1995, Medical University of South Carolina, Office of Research Administration, Charleston, South Carolina.

Table 3-7: MUSC's Research Support by Industry Partners, 1995

	Number of Awards	Funding (Millions)
Pfizer, Inc.	10	1.38
Eli Lilly	3	1.38
Glaxo, Inc.	6	.89
Organon, Inc.	2	.79
Solvay Pharmaceuticals	1	.67
University Hospital Consortium	1	.59
SmithKline Beecham Corporation	13	.59
Ciba Geigy Corporation	3	.56
Boehringer Ingelheim Pharmaceuticals	2	.39
Otuska America Pharmaceuticals, Inc.	4	.37

Source: Compiled from data on pages 11 and 12, Annual Report 1994-1995, Medical University of South Carolina, Office of Research Administration, Charleston, South Carolina

Table 3-8: MUSC's Research Support for University Departments, 1995 (All Sources)

	Number of Awards	Total Support (Millions)
Administration-Two DOE Awards	11	\$12.7
Psychiatry	86	11.9
Medicine	134	10.9
Experimental Oncology	8	6.0
Cell and Molecular Pharmacology	28	3.8
Cell Biology & Anatomy	17	2.7
Graduate Studies	13	2.7
Pediatrics	51	2.4
Otolaryngology	6	1.5
Ob/Gyn	10	1.5
Surgery	21	1.4
Biochemistry	13	1.3
Nursing	11	1.0

Source: Compiled from data in Table 1, Annual Report 1994-1995, Medical University of South Carolina, Office of Research Administration, Charleston, South Carolina.

Table 3-9: MUSC's Individual Grants Above \$500,000, by Department, 1995

Department/Title	Sponsor	Support (Millions)
<u>College of Graduate Studies</u>	NSF	\$1.1
BSB Biochemistry Laboratory Renovation		
<u>Cell & Molecular Pharmacology</u>	NIH-NCRR	1.4
General Clinical Research Center		
<u>Cell Biology & Anatomy</u>	NIH-NHLBI	1.1
Cardiac Valvuloseptal Morphogenesis		
<u>Medicine</u>	NIH-NHLBI	1.1
Load Induced Cardiac Hypertrophy in the Adult Mammal		
Pima Diabetes Genes Project	Glaxo	.6
<u>Obstetrics/Gynecology</u>	University Hospital	.6
Norplant Observational Cohort Study	Consortium	
<u>Otolaryngology</u>	NIH-NIDCD	1.1
Experimental and Clinical Studies of Presbycusis		
<u>Pediatrics</u>	NIH-NIDA	.7
Treatment Outcome with Substance Abusing Delinquents		
Augmenting MST Effects with Violent Chronic Delinquents	NIH-NIDA	.7
<u>Psychiatry</u>	Eli Lilly	1.0
Fluoxetine and Placebo in Treatment of Panic Disorder		
Flesinoxan vs. Diazepam vs. Placebo in the Treatment of Generalized Anxiety Disorder	Solvay Phar.	.7
Organon 4428 vs. Prozac vs. Placebo in Outpatients with Major Depression	Organon	.6

Source: Compiled from data in Annual Report 1994-1995, Medical University of South Carolina, Office of Research Administration, Charleston, South Carolina.

Intellectual Property

In recent years, MUSC has been actively developing its intellectual property. To date, royalties from licenses have been about \$1 million annually.³ As of February 1996, this intellectual property included the following:

Licenses	13
Confidentiality Agreements	6
Patents Issued	5
Patents Pending	9
Patent Applications Pending	2
Copyrights	4
Copyright Preparation Pending	4
At Attorney	3
Trademark Pending	1

³ For further information about these assets, see the series of profiles in "Technologies Available for Licensing," Medical University of South Carolina, Office of Research Administration.

Trident Technical College

Trident is a comprehensive, public two-year institution which provides quality education and promotes economic development in Berkeley, Charleston and Dorchester counties. The College offers over 80 programs of study on its three campuses and Charleston's Air Force Base. Trident is the second largest technical college in South Carolina and is among the state's five largest public colleges or universities.

In a recent fall semester, there were more than 9,000 students taking courses for credit, with approximately one-third of them being full-time. A large majority of Trident's graduates remain in the tri-county region, and about one-third of all students further their education after leaving Trident. Trident's Division of Continuing Education and Economic Development provides training annually to more than 20,000 Low country residents. In the past five years, nearly 400 regional companies with 48,000 employees have utilized the College's Continuing Education programs.

Trident Technical College opened the doors of its state-of-the-art Complex for Industrial and Economic Development in early 1997. The complex will feature executive-level corporate training suites designed for organizational skills training in areas such as supervision, total quality management and ISO standards. The facility will also house three computer labs designed for training in personal computer-based applications such as AutoCAD, Windows Applications, Geographic Information Systems and network training, and state-of-the-art telecommunications capability with uplink and downlink connectivity.

Programs of study at Trident College include: Allied Health Sciences, Arts and Sciences, Business Technology, Developmen-

tal Studies, Engineering Technology, Hospitality and Tourism, Industrial Technology Nursing, and Public Service.

Trident's Business Technology Division is designed to prepare the student for entry-level positions in business, industry and government. Associate degree programs are offered in accounting, general business, management, office systems technology and computer technology. All are accredited by the Association of Collegiate Business Schools and Programs. The Business Technology division offers programs with the University of South Carolina and The Citadel that allow students to complete the first two years of a four-year degree at Trident and then transfer to USC or The Citadel.

Trident's Engineering Technology Division offers an array of associate degrees and certificates designed to provide career opportunities in the highly technical and rapidly expanding area of engineering technology. The associate degree programs require two years of study. Programs are available in chemical engineering technology, civil engineering technology, electronics engineering technology, and mechanical engineering technology.

Certificate programs require two-to-four terms of study and are offered when sufficient interest is generated to support class-size groups.

As with the Business Technology division, Trident's Engineering Technology division offers programs with the University of South Carolina (USC) and The Citadel to provide students with the opportunity to complete the first two years of a four-year degree and then apply for admission to USC or The Citadel's Evening College to earn a bachelor of science degree in engineering.

In Industrial Technology, Trident offers associate degrees in aircraft maintenance technology, general technology (e.g. air

conditioning/refrigeration mechanics, automotive mechanics, engineering design graphics, environmental technology, and industrial electricity/electronics), horticulture technology, and machine tool technology. Diplomas and certificate programs are offered in such areas as advanced aircraft maintenance, arc welding, computer numerical control operations, industrial electricity/electronics, and machine tool technology.

Trident's Division of Continuing Education and Economic Development promotes economic development through customized company-sponsored training, occupational upgrading, and professional development programs. Continuing education classes are held on all three Trident campuses and at other sites throughout the Lowcountry, including on-site at individual businesses.

Recently, Trident's Division of Continuing Education and Economic Development received a grant from the Sloan Foundation to develop an asynchronous learning course on Manufacturing Resource Planning (MRP). A new CD-ROM will be developed to help students apply the concepts covered in their written text to "real-life" industrial situations.

Trident along with Alumax of South Carolina also recently received a grant from the South Carolina Department of Education - Office of Vocational and Adult Education to develop a basic skills curriculum for the workplace. The objectives of this national workplace literacy demonstration project include improving employees' basic skills and performance, developing a model curricula and providing information to replicate the program at other sites.

South Carolina Research Authority (SCRA)

Established in 1983 with state land grants, SCRA is a public non-profit corporation which receives no state appropriations. Besides developing several research parks within South Carolina, SCRA conducts research and development in advanced manufacturing, health care information systems, product data technology, and advanced metal casting. A core strength is in distributed technology management. SCRA has established alliances or teaming efforts in several areas such as for the American Metalcasting Consortium, a diverse team of metalcasting industry associations, universities, and foundries.

SCRA officials believe the Charleston region must enhance graduate engineering training if it is to become a competitive technology-based economy in the future. They also emphasize three major assets of the region: (1) a number of outstanding K-12 school districts; (2) high quality of life; and (3) superb talent and expertise among the growing retiree population in Charleston, Seabrook, and Kiawah.

In the fiscal year ending June 30, 1996, SCRA's revenues surpassed \$35 million, marking a five year revenue growth trend. The contract backlog increased during the year, with continued gains in advanced manufacturing and health care. The largest current contract is the Rapid Acquisition of Manufactured Parts (RAMP) program, which is designed to provide "on-demand" manufacture of non-standard parts for national defense and industrial applications. The major revenues in 1996 were derived from technology research and development programs in information technology (40%), advanced manufacturing (36%), electronic design (19%), and metals (5%).

SCRA teams with South Carolina's research universities and companies as well as with universities and corporations outside the state in pursuing national and international contracts. SCRA strategic teaming efforts include:

- PDES, Inc.--an international industry-government consortium to accelerate the development and implementation of ISO 10303 (STEP);
- Team InteGrated Electronic Response (TIGER)--to hasten deployment of electronic commerce;
- Enabling Next Generation Mechanical Design (ENGEN)--to improve engineering design and data exchange;
- Pre-Competitive Advanced Manufacturing Processes (PreAMP)--to advance U.S. electronic product development;
- RASSP Education and Facilitation--to provide methods and tools for electronic design;
- Health Care Information Infrastructure Tools (HIIT)--to improve the availability of health care information;
- Supply-chain Technologies for Affordable Missile Products (STAMP)-- to demonstrate distributed, collaborative design environments through the supply chain in product data management, workflow management and CAX in secure environments;
- Cast Metal Coalition (CMC)--to implement key R&D efforts in materials, energy, process and product research for the primary industry alloys of iron, steel, aluminum and diecastings; and
- Healthcare Information Technology (IT) Enabling Community Care (HITECC)-- to develop and implement robust IT

tools to improve healthcare information delivery, security and accessibility.

The Port of Charleston

According to a 1994 economic impact study on the operations of the Port of Charleston, there were 4,457 local residents transporting cargo through the Port. The same study estimated that more than 78,000 jobs in South Carolina were directly or indirectly tied to Port-related commerce. Almost \$22 billion of cargo was handled at the Port in 1995.

"The State Ports Authority is always going to be the main factor in our economy. It will attract industrial development. Compared to other cities with ports, Charleston is really growing by leaps and bounds--much faster than most ports."

Ben Cole, President and CEO
Charleston Regional Development Alliance

The Port of Charleston is the major organizational entity of the South Carolina State Ports Authority, and it is a shining example of a state agency structured as a private business. While the Port's 450 employees are state employees, unlike nearly all other ports in the United States, the Authority operates solely on its own revenues, without appropriations or subsidies from state, local, or special district governments. Operating revenue was approximately \$62 million in 1996, a 13 percent increase over 1995. Property and equipment (net) was valued at \$320.5 million in 1995, and long-term debt stood at \$87.3 million.

There are four terminals in the Charleston region. Union Pier, located on the eastern edge of the historic section of Charleston is the Port's dedicated roll-on, roll-off load

center. It also services LASH barges and breakbulk vessels which handle paper and lumber products, bulk metals, and minerals. The Columbus Street Intermodal Terminal is a combination container and breakbulk facility with shipside rail service. The Wando Welch Terminal is a world class facility with new technology, substantial storage capacity, administration and conference buildings, and outstanding highway access. The North Charleston terminal is a modern container intermodal facility.

In 1995, 64% of the tonnage through the Port was exported. Trade with Europe represents 40 percent, the Far East 35%, with the remainder from the Mediterranean, Latin America, the Middle East, and other regions. Major commodities include foodstuffs, woodpulp, paper products, heavy machinery, lumber and lumber products, metals, vehicles, chemicals, and clay prod-

ucts. In the Charleston region, the Port works with 50 steamship lines, 27 steamship agencies and line offices, 117 truck lines and 41 custom house brokers and freight forwarders.

The Port has been expanding as well as gaining market share. The number of vessel and barge calls increased 15 percent between 1994 and 1995 and containerized cargo tonnage increase about 17 percent. Exports to Europe have shown large gains, and trade with South America rose 34 percent. African trade, while still relatively small, tripled. The Port of Charleston now ranks first among container ports on the Southeast and Gulf Coasts, and is second only to the combined New York and New Jersey ports on the East Coast. Nationally, it is sixth, behind Long Beach, Los Angeles, New York, Seattle, and Oakland.

Orion

The Port of Charleston is among the most automated ports in the world, perhaps the most automated. Ninety percent of all containerized cargo is cleared within two hours, and 85 percent of all breakbulk cargo is cleared within a day. Key to this performance is ORION, the port's electronic data interchange (EDI) system which is a one-stop-source for document clearing and processing of all cargo-related information. ORION was developed by the Port's entrepreneurial information services staff.

An initial version of ORION became operational in 1982, and major improvements occurred in 1989 when the Port was selected as a pilot site by the U.S. Customs Service. Since 1989, continuous enhancements to ORION have been made and today, ORION transfers and provides information, as needed, across the U.S. Customs Automated Commercial System, shippers/importers, customs house brokers/freight forwarders, U.S. Department of Agriculture, shipping agents and steamship lines, and inland (rail and truck) carriers. Because each of the major types of businesses and governmental agencies requires different information, security and business confidentiality safeguards are important features within ORION.

"By having port staff enter import manifests into the system seven days prior to a ship arriving, government inspectors are able to choose which cargo to inspect before it arrives. Brokers can file necessary forms and pay custom duties prior to, or simultaneous with the ship's arrival."

ORION is regularly evaluated and assessed by an advisory panel of users. This group provides feedback about current service levels and the constantly changing waterfront industry. Future possible enhancements to ORION are putting the system on different computer platforms, including a global positioning system module, and adding a container yard management system. As part of its entrepreneurial orientation, the Ports Authority is offering ORION to a select number of non-competing ports on a revenue-generating basis.

Among the Port's competitive advantages are:

- Excellent intermodal facilities, including the best rail line characteristics of any U.S. Eastern port for double-stack cars, dimensional cargo, or high/wide shipments;
- More dedicated train service to Atlanta, Charlotte, Chicago, Mobile, and New Orleans than any other Southern Port;
- The ORION electronic data information system for expediting shipments (see case profile) and an entrepreneurial information technology group;
- A harbor protected by barrier islands on both sides of its wide entrance channel, with ships being able to assume sea speed approximately 30 minutes after leaving downtown terminals;
- Custom-built cranes, more than two miles of berthing space, and large quantities of warehouse space and open storage space for both containers on chassis and those grounded;
- The lowest pilferage and damage rate of any U.S. port and among the lowest in the world; and
- An operating structure which encourages entrepreneurial behavior within a governmental framework.

Naval In-Service Engineering East Coast Division (NISE East)

NISE East generates revenues solely through fees for services and equipment provided to Naval organizations and other defense clients outside the Navy. Revenues in fiscal year 1996 were approximately \$1.2 billion. NISE East considers itself a growth

organization within the Department of Defense. Nearly all of NISE East's contracts are obtained through competitive bidding. Staff members operate in a more entrepreneurial environment than scientists and engineers at other federal government facilities.

More than 965 NISE East employees are located in the Charleston region, and that number is expected to increase to more than 1300 by mid-1997, when NISE East will move into a new, 256,000 square foot custom-designed engineering center. The Naval Command will also occupy a 90,000 square foot engineering and lab facility, a 90,000 square foot integration/lab facility, and several smaller buildings in the region. In addition to the in-house work force, NISE East estimates that its contractors and vendors have 4-5 employees located in the Charleston region for each NISE East employee. There are between 15 and 20 Charleston-based technology firms currently serving as contractors to NISE East. Among the largest are Milcom Systems Corporation, TDS, Inc, Management Systems Applications, Scientific Research Corporation, and Allied Signal Technical Services.

Main business lines for NISE East are:

- Air traffic control and sensor systems (navigational systems, radiation detection, meteorologic sensor and display systems, electromagnetic effect analysis);
- Security systems (physical intrusion prevention and detection systems, communications security systems, signal emanation protection);
- Communications systems (line of sight and over the horizon, subs, ships, point-to-point);
- Command and control systems (tactical and non-tactical, decision aid program,

decision support systems, module maintenance and calibration);

- Cryptologic and intelligence systems (direction finding and signal acquisition, intercept and analysis, space surveillance, secondary imagery dissemination, and signal security).

NISE East engineers generally integrate commercial off-the-shelf components into systems to meet their customers' needs. NISE East considers many of its products to have both commercial and defense applications such as bandwidth sharing, CASE tools, acoustic and infra-red sensors, intelligent switching devices, and optical scanning. NISE East has been designated a naval center of excellence for video teleconferencing (VTC), and the organization is developing technical standards for Navy-wide VTC interoperability.

South Carolina Department of Natural Resources, Marine Resources Division

South Carolina Department of Natural Resources, Marine Resources Division is one of the largest marine research and management facilities on the east coast. Research and management activities focus on the condition of the commercial fishing industry and evaluation of the effects of fishery management efforts, new and promising fishing technologies, the potential for new and expanded fisheries and developments in seafood production.

The Marine Resources Division's Charleston research facility consists of three laboratory buildings and boat slips for research vessels at Fort Johnson on James Island.

The main laboratory is equipped with a recirculation seawater and freshwater system and a substantial library. Research vessels include a 110-foot steel hull ocean research vessel, a 73-foot St. Augustine trawler, a 51-foot fiberglass trawler, and a 52-foot wooden hull inshore research vessel.

Currently there are approximately 100 research staff, most housed within the Division's Marine Resources Research Institute. About 20 of the staff hold doctorates and another 30 have master's degrees. The remaining research staff have undergraduate science degrees. Many Division scientists hold full or adjunct faculty appointments at either Clemson University, College of Charleston, Medical University of South Carolina, or the University of South Carolina. Staff frequently serve as research advisors and committee members for students in the joint master's degree program between the College of Charleston's Marine Biology Program and MUSC's Marine Biomedical and Environmental Sciences program. The Research Institute's Environmental Research Section assesses the consequences of various human-related activities on South Carolina's marine and estuarine resources.

National Marine Fisheries Service, Southeast Fisheries Science Center, Charleston Laboratory

The National Marine Fisheries Service (NMFS) Charleston Laboratory at Fort Johnson has significant research and development programs in marine biotechnology and seafood safety. Other program research activities are conducted in marine forensics, and managed and protected resources.

Potential Commercial Products from the NMFS Charleston Laboratory:

- *NMFS' fish oil facility has been supplying the National Institutes of Health with a refined fish oil for experiments and been selling fish oil overseas.*
- *The University of Southern Mississippi in Hattiesburg is developing a "dipstick" assay designed to detect three chemicals in fish which are spoiled. The assay will help in determining appropriate shelf life.*
- *NMFS is in the early stages of developing a prototype test kit which can be used by commercial fishermen on their boats to check for biotoxins. The test will enable fishermen to decide whether to bring their catch to the dock.*

Marine biotechnology projects involve the application of molecular and cellular biology to a variety of questions in ecology, environmental health, and marine and fisheries biology. In addition to using genetic research to improve seafood safety and fisheries management decisions, this research also entails developing biomarkers to assess resource and ecosystem health. In the most recent fiscal year, marine biotechnology projects were funded at approximately \$1.8 million.

Major seafood safety projects, funded at \$1.36 million in fiscal year 1996, are being undertaken in:

Marine biotoxins--developing quantitative dockside testing and production of toxin standards; identification of biomarkers of toxin exposure; role of bacterial-algal interactions and genetic markers for harmful algal blooms.

Marine ecotoxicology--identifying and quantifying chemical and bacterial contaminants and effects associated with anthropogenic inputs from agriculture, dredging operations, industrial discharges, and urbanization on marine and estuarine ecosystems.

Risk assessment--research on the accumulation in marine biota of chemical contaminants and microbial pathogens; determining exposure of populations to toxic and infective agents.

The Laboratory provides purified, quality assured test materials from fish oil for biomedical research into the therapeutic and preventative effects of the oil in a variety of human diseases. Other research in managed fisheries and protected resources, marine forensics and the dissemination of seafood safety and fishery resource health information through a wide range of scientific, regulatory and public forums were budgeted at about \$1.66 million.

The Lab's full-time research staff is 53. Fourteen of the scientists have doctorates and another dozen have masters' degrees. An additional seven scientists with doctorates are working at the Lab under programs with other institutions. Over and above the full-time research scientists and technicians, there are administrative support and computer support personnel. Also, at any one time, there are normally 15-20 students working at the Lab. Nearly all are involved in research projects while pursuing their advanced degrees most at colleges and universities in The Charleston region.

South Carolina Sea Grant Consortium

The South Carolina Sea Grant Consortium was formally created by the South Carolina General Assembly in 1978. It is committed to maximizing the economic, social and environmental potential of the state's

coastal and marine resources through re-
search and community outreach activities.

This consortium generally funds other insti-
tutions' R&D rather than conducting re-
search internally. In 1996, approximately
\$775,000 was allocated for extramural re-
search. Among the larger projects being
funded were:

- Mesoscale Modeling of Sediment
Transport and Morphologic Changes at
Tidal Inlets--USC/Clemson; \$74,000
- Wind Effects on Coastal Structures--
Clemson; \$53,000
- Development of Bioassay for Com-
munity-Level Effects of Contaminated
Estuarine Sediments--USC; \$55,000
- Proteins from Oyster Shell for Biode-
gradable Water Treatment and Super-
Absorbent Polymers--Clemson; \$80,000
- Development of Models for Environ-
mentally Mediated Signal Transduction
in Marine Species--MUSC; \$59,000
- Improvement of Hybrid Striped Bass
Aquaculture--S.C. Department of Natu-
ral Resources; \$90,000

Charleston Area Manufacturers Conducting Research and Develop- ment

Over 400 manufacturing firms operate in
the Charleston region. According to a re-
cent survey conducted by the Charleston
Metro Chamber of Commerce's Center for
Business Research, a great deal of the R&D
occurring in the Charleston region is being
conducted by manufacturing companies.
Following is a partial listing of select com-
panies and their primary areas of research:

Abrasives-South, Inc.

Abrasives specialties

Albright & Wilson Americas, Inc.

*Organo phosphorus chemicals,
phosphoric acid, phosphorus hal-
ides*

American Sail, Inc.

Small sailboats, dinghies

American Skiff, Inc.

Small fiberglass boats

Applied Industrial Automation, Inc.

*Design and fabricate custom con-
trol panels*

Asten, Inc.

*Monofilament for paper machine
clothing*

Atlantic Littleneck Clamfarms

*Hard shell clams, sea scallops,
specialty sauces*

Baker Material Handling, Corp.

Industrial and narrow aisle forklifts

Bellwright Industries, Inc.

*CNC machining, product manufac-
turing, research and design, as-
sembly*

Berle Manufacturing Co., Inc.

*Men's and boy's trousers and
slacks*

Capital Imaging Co., Inc.

*Typewriter, word processing and
data processing ribbons*

Carolina Equipment & Supply Co., Inc.

High pressure water blaster

- Casselman Metal Contractors
Industrial equipment, trailers
- Charleston Enterprises, Inc.
Water saving devices-toilet tanks, shower heads
- Charleston Marine Manufacturing Corporation
Ship repair, conversion and structural manufacturing
- Con-Vel
Constant velocity universal joints
- Cummins Marine Center
B&C Engines for marine applications
- Curd Enterprises, Inc.
Custom vacuum formed plastic and fabrication
- Dock and Marine Construction
Prefabricated dock sections
- Endosafe, Inc.
Limulus Amebocyte Lysate (LAL)
- Envirometrics Products, Inc.
Industrial hygiene devices and research/development
- Evans Rule, Co.
Steel measuring tapes, hand tools, woodrules, plating
- GS Roofing Products Co., Inc.
Asphalt roofing shingles, glassmats, fiberglass, roofing granules
- Gates Rubber Co.
Timing belts
- General Engineering Laboratories
Environmental consulting and laboratories
- Georgia-Pacific Corp.-IWPD Plant
Particleboard
- Georgia-Pacific Corp.-Plywood Division
Veneer and plywood
- Giant Cement Co.
Portland and masonry cements
- Haarmann and Reimer Corp.
L-Menthol, aroma esters, sunscreen agents
- Harbor & Lake, Inc.
Fiberglass boats, electric powered boats
- ITT-Conoflow
Pressure regulators, transducers, valve activators and positioners, diaphragm seals
- Industrial Acoustics Co. SC, Inc.
Noise control equipment
- InnerLogic, Inc.
Plasma cutting equipment, power supplies, torch height controls
- Innovative Technology Systems
Builds computers, develops software, and performs management consulting
- JW Aluminum
Aluminum foil and sheet products
- LINO Industrial Fabrics, Inc.
Woven polypropelene fabric, packing materials, geo and agritextile
- Life Cycle Fabricators, Inc.
Metal fabrication, precision laser cutting
- Marble Plus, Inc.
Cultured marble lavatories, shower bases, tubs and whirlpools
- Mearl Corp.
Pearlescent pigments
- Mi-Tech, Inc.
Marine industrial machinery
- Micronics, Inc.
Industrial and military electronics, metal fabrications
- Moore Drums, Inc.
Reconditioned steel drums
- Motion Devices Technology, Inc.
Synchros and resolvers
- Nitta Corp. of America
Nylon flat belts
- Ontko & Young Co., Inc.
Pipe organs (musical instruments)
- Perfect Shirt Co./Passport International, Inc.
Screen printing and custom embroidery
- RM Engineered Products, Inc.
Rubber, elastomer, packing and sealing products, industrial coating
- The Richards Group, Inc.
Polyethylene liners
- Sasib Beverage & Food, North America
Scaffolding and bottling equipment

Scientific Research Corporation

Communications and monitoring systems and equipment

Scotts Co., The

Controlled release fertilizer

Sealoflex, Inc.

Waterproofing materials, roof paint, caulking compounds

Showa Denko Carbon, Inc.

Graphite electrodes, electric arc furnace

Siebe North, Inc.

Industrial safety products

South Carolina Research Authority

Computer integrated manufacturing, metal parts, printed circuits

Summit Rubber Co.

Gaskets, seals and rubber-to-metal

Syn Strand, Inc.

Monofilament, nylon and polyester

Trident Forest Products

Hardwood lumber for export

Van Bergen Bellfoundries, Inc.

Electronic bell instruments, cast bronze bells, tower clocks

Victoria Carolina, Inc.

Manufacture and distribute proprietary giftware and specialty items

Westvaco Corporation

Lumber, paper products, chemicals, etc.

Williams Technologies

Remanufacture automobile transmissions

Yancy Co., Inc.

Wind chimes and candles

Part II: The University of South Carolina and Clemson University

The University of South Carolina-Columbia

The University of South Carolina-Columbia (USC) has 1,060 full-time and 350 part-time faculty. Approximately 90% of the full-time faculty have doctorates. The university has a full-time undergraduate enrollment of 12,410. Another 3,660 students are part-time. About 80 percent of the students are native South Carolinians. The most popular majors are business and management (17%), social sciences (13%), interdisciplinary studies (8%), health sciences (8%), and engineering (5%). Biology, psychology, and nursing attract high numbers of students, and there is a challenging honors program. About 20 percent of each class enter graduate school within a year after graduation.

USC's international business program has been ranked the best nationally for five consecutive years. The marine science program is ranked fourth. Top ten program ratings also were achieved in accounting and advertising. There are approximately 10,000 graduate students in the 175 master's degree programs, 68 doctorate fields, and in 24 professional fields, including law and medicine. USC was recently ranked the ninth largest graduate institution in the United States with 1,142 full-time and 518 part-time graduate students in science and engineering fields. There were also 62 science and engineering postdoctorates.

The University of South Carolina has set a goal of doubling external research support over the next five years. The university has 54 centers and institutes which are conducting externally sponsored research.

Notable research achievements among USC's more than 1,000 current projects include:

- A process discovered by two university chemists to detect impurities in pharmaceuticals, which reduces production costs, was named one of the top 100 significant, new technological products and processes in 1993 by *R&D Magazine*.
- Forty-two research studies are underway on some aspect of coastal resources.
- A faculty member in geography is a pioneer in developing current geographic information systems.
- A university computer scientist invented a computer which can read aloud in foreign languages. This technology has benefited both foreign language instruction and individuals with sight impairments.
- The USC School of Medicine received a national research award designed to improve the health and educational development of children up to three years of age. This award may eventually exceed \$16 million in support.

Research Funding

Over the past six years, funding for research, public service, and instruction at USC has grown consistently, Table 3-10. In 1995, research represented 63.4 percent of external funding at USC. Public service and equipment represented nearly 25 percent, while training represented 12 percent.

Table 3-10: USC (All Campuses) Awards and Funding, 1991-1996

	Number of Awards	Funding (Millions)
1991	826	\$50.4
1992	909	58.1
1993	1133	60.7
1994	1140	61.8
1995	1272	73.8
1996	1342	77.1

Source: USC Annual Report of Sponsored Program Activity, Fiscal Years 1994-95, 1993-94, 1992-93, 1991-92, and 1990-91 with 1996 data from the University of South Carolina-Columbia, Office of Sponsored Programs and Research. The fiscal years end on June 30; therefore the 1996 information covers awards during the period July 1, 1995 through June 30, 1996. Multi-year awards are counted as being received entirely in one year.

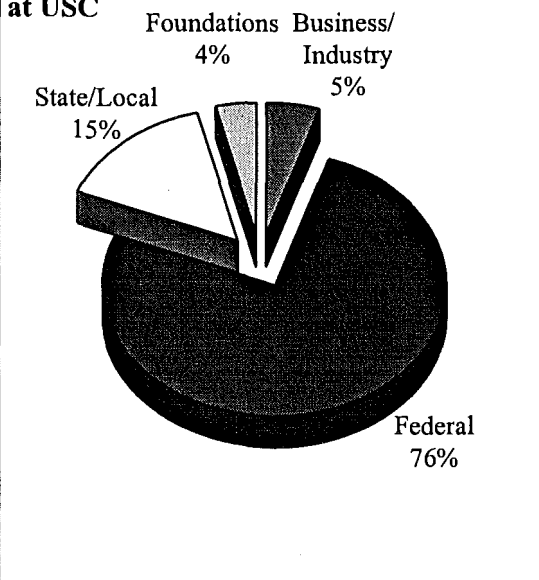
Research funding is fairly concentrated, with the seven largest sponsors in 1995 providing nearly two-thirds (63%) of all funding. All of the sponsors are federal or state government, Table 3-11.

Federal research funding dominates other sources at USC, contributing roughly 75 percent of all research dollars. As with many other major state-supported universities, secondary research support comes from state and local government (roughly 15 per-

cent), business and industry (5 percent), and nonprofit foundations and organizations (4 percent), Table 3-12 lists USC's largest industry sponsors in 1995. Among the largest industry sponsors in 1994 were Intel Corporation, Mobil Corporation, Occidental Petroleum, and Burroughs Wellcome Company.

Considering all sources of funding (federal, state, local, industry, and nonprofit sources), there were numerous university units that received about \$2.5 million funding in 1995

Figure 3-5: Sources of Research Funding at USC



Faculty Fly Free

To assist in securing federal research support, the University of South Carolina Research Foundation sponsors a direct flight twice-a-week from Columbia to Washington, D.C. Faculty members wishing to pursue funding opportunities make reservations for the 80-minute flight with the Office of Sponsored Programs and Research. A minimum of three faculty are needed, otherwise the flight is canceled. There are normally five passengers on a flight. Surveys of faculty have documented cases in which the flights have been crucial in uncovering research opportunities and in concluding successfully agreements which had been pending.

Table 3-11: USC (All Campuses) Largest Sponsors, 1995

	Proportion of Total Funding
U.S. Department of Energy	11.5%
National Science Foundation	11.4
National Institutes of Health	11.1
State/Local Government Agencies	9.4
U.S. Department of Commerce	7.0
U.S. Department of Education	6.2
U.S. Department of Defense	6.0
Total	62.6%

Source: Source: Computed from data in Table 8, USC Annual Report of Sponsored Program Activity, Fiscal Years 1994-95, University of South Carolina-Columbia, Office of Sponsored Programs and Research, Columbia, South Carolina.

Table 3-12: USC's (All Campuses) Research Support by Industry Partners, 1995

	Number of Awards	Funding (000s)
Exxon	3	239
General Motors	1	194
Medical Enzymes Ltd.	6	183
Edison Gas	2	128
AT&T Global Information	2	121
Avery Dennison	2	113
Westinghouse Savannah River Co.	3	105
Unisys Corporation	1	104
Amgen Company	2	99
Amoco Production Company	2	96
Bridas	1	90
Quaker Oats	1	80
Pfizer Laboratories	11	79
Unocal, Inc.	2	77
Various Petroleum Companies	4	140

Source: Compiled from data in Table 9, USC Annual Report of Sponsored Program Activity, Fiscal Years 1994-95, University of South Carolina-Columbia, Office of Sponsored Programs and Research, Columbia, South Carolina.

Table 3-13: USC (All Campuses) External Support by University Unit, 1995 (All Sources)

	Total Support (Millions)
College of Science and Math	\$17.2
College of Engineering	8.5
School of Medicine	8.2
School of Public Health	5.7
College of Liberal Arts	5.6
College of Social Work	5.4
College of Education	3.7
Earth Sciences and Resources Institute	3.0

Source: Compiled from data in Table 4, *USC Annual Report of Sponsored Program Activity, Fiscal Years 1994-95*, University of South Carolina-Columbia, Office of Sponsored Programs and Research, Columbia, South Carolina.

to conduct research for outside sponsors, Table 3-13. A more detailed description of funding by research/technology area is provided in Table 3-14. While the categories are somewhat general, they do provide an initial indication of concentrations of research support.

Intellectual Property

The University of South Carolina has been actively developing its intellectual property for about three years. Results include in about 150 patent disclosures, 30 patents,

and six licenses. Negotiations are in process on another five licenses: medication for diabetics, a software exercise program to be marketed through a large retail chain, prostate inhibitors, modeling for testing alloys in nickel metal hydride batteries, and an attractant which induces certain types of fish to eat more food. Twenty-two faculty, staff, and graduate students who reported inventions or discoveries during 1995 were recognized in an "Excellence in Research" ceremony at USC.

USC's Venture Fund

USC's Research Foundation allocates approximately \$100,000 annually to support high-risk research by faculty members which is deemed promising, but unlikely to be supported by traditional sponsors without further development. Frequently, faculty use funds, usually less than \$20,000, to accumulate data for a more competitive proposal.

The main awards in 1995 were granted for:

- 1) "Smart Concrete;" 2) "Expression of the FTR Chloride Channel in *Xenopus Oocytes*;" 3) "Genetic Engineering of Heavy Metal Processing to Develop a Remediating *Spartina* Plant for Salt Marshes;" 4) "Hollow Semiconductor Particles: Towards New Optical Materials;" and 5) "Transgenic Zebrafish: Development of a Transient Expression Assay to Directly Characterize Regulation of Odor Receptor Gene Expression."

UNIVERSITY OF SOUTH CAROLINA BARUCH INSTITUTE AWARDS, 1995

New research awards over \$20,000 in 1995 at USC's Baruch Institute include:

1. "Population Genetic Structure of *P. Marinus*," National Oceanic & Atmospheric Administration (NOAA); \$20,075.
 2. "Georges Bank Food Web Studies Using Polyclonal Antibodies," SC Sea Grant Consortium/NOAA; \$26,388.
 3. "The Dynamics and Evolution of a Coastal Water-Table Aquifer Under a Regime of Slowly Rising Sea Level," National Science Foundation; \$82,270.
 4. "Salt Marsh Geomorphology and Ecological Development," SC Sea Grant Consortium/NOAA; \$39,440.
 5. "Analysis of Hydrological Time Series Data from the Charleston Estuarine Project System," SC Department of Health and Environmental Control/NOAA; \$51,989.
 6. "The Role of Alternative Respiration in Marine Phytoplankton," National Science Foundation; \$86,623.
 7. "Long Term Studies of Salt Marsh Primary Production," National Science Foundation; \$51,324.
 8. "Predicting the Toxicity and Biodegradability of Quadricyclane, Fluorocarbon Ethers and Their Analogs," University of Minnesota/U.S. AFOSR; \$72,660.
 9. "Experimental Analysis of Waterborne Chemical Cues as Agents Regulation Larval Settlement and Metamorphosis," National Science Foundation; \$110,000.
-

Clemson University

Clemson University, located in the north-west region of South Carolina, has 1,073 full-time faculty and 148 part-time faculty. Approximately 96% have doctorates or masters' degrees. Clemson has a full-time undergraduate enrollment of 11,695, with 847 part-time undergraduates. Nearly a third of all entering freshman were in the top 10 percent of their high school graduating class. Clemson has five colleges:

- College of Agriculture, Forestry, and Life Sciences (AFLS)
- College of Architecture, Arts, and Humanities (ARHM)
- College of Business and Public Affairs (BUSN)
- College of Health, Education, and Human Development (HEHD)
- College of Engineering and Science (ENSC)

Clemson has 3,775 graduate students enrolled in these five colleges, half are full-time. There are 312 graduate students enrolled in masters' degree programs and 232 in doctoral programs in the College of Agriculture, Forestry, and Life Sciences. There are 391 graduate students enrolled in masters' degree programs and 26 in doctoral programs in the College of Business and Public Affairs. There are 635 graduate students enrolled in masters' degree programs and 316 in doctoral programs in the College of Engineering and Science.

Research Funding

Over past five years, the number of research grant and contract awards to Clemson have declined, although the amount of funding has fluctuated, Table 3-15.⁴

⁴ Funding figures do not include donated software and equipment (\$1.8 million in fiscal year 1996), funds retained

Table 3-15: Clemson University Awards and Funding, 1992-1996

	Number of Awards	Funding (Millions)
1992	1253	\$58.7
1993	1236	44.7
1994	1200	36.4
1995	1149	48.9
1996	907	37.5

Source: Research and Sponsored Program Activity, Year Ended June 30, 1996, Office for Sponsored Programs, Clemson University.⁵

Federal research funding dominates other sources at Clemson, contributing slightly more than two of every three research dollars. As with many other major state-supported universities, secondary research support comes from state and local government (roughly 15 percent), business and industry (13 percent), and foundations and associations (4 percent), Figure 3-6.

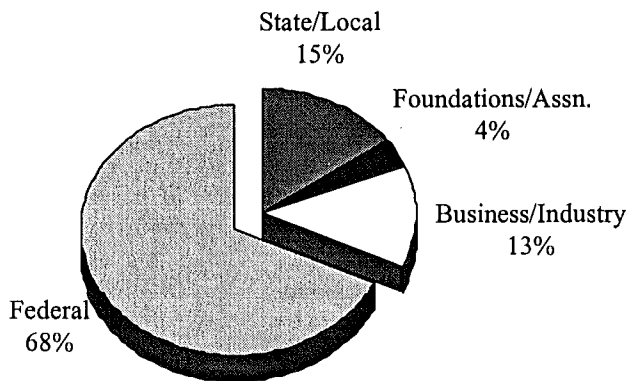
Research funding is fairly concentrated, with the seven largest sponsors in 1996 providing about two-thirds of all funding. The Department of Defense is the largest sponsor of research at Clemson, Table 3-16. Table 3-17 lists the largest industry sponsors in 1996.

Table 3-18 shows that sponsored research from all sources (federal, state, local, industry, and nonprofit), has been led by the

from Clemson University Performance Agreements of the Clemson University Research Foundation (\$3.6 million in fiscal year 1996), or the funding (\$5.5 million in fiscal year 1996) from the National Textile Center Research Program in which the Clemson University Research Foundation acts as fiscal agent for the National Textile Consortium Award.

⁵ The data are for grants and contracts only and do not include awards and funding for equipment and software, The National Textile Center Research Program/Consortium, the Advanced Gas Turbine Systems Research, or funds retained from Clemson University Performance Agreements by the Clemson University Research Foundation.

Figure 3-6: Sources of Research Support at Clemson



College of Engineering and Science (\$18.9 million) and the College of Agriculture, Forestry, and Life Sciences (\$9 million).

A more detailed description of funding by research and technology area is provided in Table 3-19. While the categories are given by academic groupings and are somewhat general, they do provide an initial indication of concentrations of research support. A select listing of environmental and companion technology grants is provided at the end of this section.

Intellectual Property

During the past five years, Clemson faculty and staff have produced 41 invention disclosures, 29 patents, and two software copyrights. Recent successes include licenses for a power quality device, a multi-purpose agricultural tractor, a surface texturing technology for improved catheters, a new femur fracture fixation method, and a hybrid seed production process. Clemson's intellectual property income last year was 14th among U. S. universities, and fifth with medical schools excluded. Three start-up companies have been formed to commercialize faculty and staff inventions. MBA graduate students are used by Clemson's

Table 3-16: Clemson University, Largest Sponsors, 1996

		Proportion of Total Funding
Department of Defense		21.1%
U.S. Army	(9.2)	
U.S. Navy	(7.4)	
Other DOD	(4.5)	
South Carolina Department of Health and Human Services		10.2
U.S. Department of Agriculture		9.7
South Carolina Universities Research and Education Foundation (SCUREF)		9.6
National Science Foundation		7.9
U.S. Department of Energy*		4.7
Greenville Hospital System		2.9
Total		66.1%

*Includes funding from several federal laboratories.

Source: Please refer to source note for Table 3-15.

Table 3-17: Clemson University Research Support by Industry Partners in FY 1996

Awards Totaling More Than \$75,000	
Greenville Hospital System	\$1,100
Angelica Uniform Group	272
AT&T	260
Proctor and Gamble Company	145
Duke Power Company	134
Olin Corporation	120
CIBA-Geigy	111
General Electric	110
Klein-Baker, Inc.	106
International Business Machines	100
Westinghouse Electric Corporation	95
Cyrovac	90
Alexander O'Neill, Haas & Martin	83
Philbril Corp.	79
Construction Industry Institute	79
Various Miscellaneous Grants	825

Source: Please refer to source note for Table 3-15.

Special Projects Office to market technologies available for licensing.⁶ Royalty income from intellectual property has grown:

Royalty income from intellectual property	
FY 1990-1991	\$ 1,507,423
FY 1991-1992	1,648,757
FY 1992-1993	1,679,308
FY 1993-1994	4,400,000
FY 1994-1995	4,400,000

A recent study of university-industry technology transfer at 40 universities in 14 southern states ranked Clemson highly, particularly in the amount of royalties received in relation to the size of its research budget.⁷

One technology developed at Clemson improves orthopedic implantation of prostheses by increasing the chemical bond between the prosthesis and human bone. This is the most widely used technique in artificial hip, knee, and elbow replacements.

⁶ A Complete listing of patents and intellectual property being marketed under confidential disclosure agreements in the life sciences and physical sciences appears later in this section.

⁷ See *Benchmarking University-Industry Technology Transfer In The South*, by Louis G. Tornatsky, Paul G. Waugaman, and Lucinda Casson, The Southern Technology Council, Southern Growth Policies Board, Raleigh, North Carolina, April 1995. While the study did not specifically identify the score for each university on each measure, there was a state-by-state summary of scores. Since Clemson, MUSC, and USC were the only universities chosen from South Carolina, there were three entries for each of the seven measures in the state-by-state summary. Only when all universities were in the same quartile on a measure or when explanatory material in the text made it clear which institution was rated highly, was it possible to specifically identify university rankings.

Table 3-18: Clemson University Research Support for Organizational Unit/department in FY 1996 (All Sources)

	Total Support (Millions)
College of Engineering and Science	\$18.9
College of Agriculture, Forestry and Life Sciences	9.0
Provost and VP Academic Affairs	6.5
College of Health, Education & Human Development	1.4
College of Architecture, Arts & Humanities	.8
College of Business & Public Affairs	.6

Source: Please refer to source note for Table 3-15.

Select research awards in 1996 at Clemson University include:

Coastal Research and Education Center

"USDA-ARS-SAA-US Vegetable Lab," B.M. Shepard, \$123,001.

"Potential of Sludge from Coastal Aquaculture Farms for Use as a Fertilizer," R.J. Dufault, \$14,000.

Environmental Systems Engineering

"Evaluation of Biodegradationates of Toxic Organic Chemicals," C.P. Grady, \$145,486.

"NYI: Advance Oxidation Processes for Water and Wastewater Treatment," G.T. Daigger, \$125,000.

Physics and Astronomy

"A Plan to Develop Predictive and Warning Capability for Equatorial Scintillation Storms by the Northeast ONR Consortium," D.L. Hy-sell, \$68,365.

"Multi-Instrument Studies of Equatorial Thermosphere Aeronomy (MISETA): Continued Measurements of Equatorial Upper-Atmosphere Winds," J.W. Meriwether, \$118,902.

"Sounding Rocket Investigations of Eddy and Molecular Diffusivities," M.F. Larsen, \$97,000.

TIWET

"Wildlife Biomarkers Applications to Remediation Decision Making," M.J. Hooper, \$136,797.

"Rapid Bioassessment Methods: Vegetation Studies," S.J. Klaine, \$64,000.

"Optimizing the Use of Juvenile Mussels as a Standardized Toxicity Testing Organism," S.J. Klaine, \$54,073.

"Development of a Basic Ecologic Risk Assessment for Assessment of Estrogenic and Antiestrogenic Effects in Wildlife Exposed to Environmental Chemicals," R.L. Dickerson, \$116,078.

Water Resources Research Institute

Various grants, E.J. Hayter, \$61,500.

Table 3-19: Clemson University Major Funding by Research Area, 1996*

	Total Support (Millions)
College of Engineering and Science	
Electrical and Computer Eng.	\$5.4
Chemical Engineering	2.3
Mechanical Engineering	2.2
Environmental Systems Eng.	1.3
Ceramic Engineering	1.3
Geologic Sciences	1.0
Civil Engineering	1.0
Chemistry	.8
Plant Pathology & Physiology	.5
Horticulture	.5
College of Agriculture, Forestry & Life Sciences	
Livestock and Poultry Health	1.2
Biologic Sciences	.9
Agricultural & Biological Eng.	.6
Provost and VP Academic Affairs	
Computer Center	2.4
Information Systems Development	2.0
Greenville Hospital System	1.0
College of Architecture, Arts & Humanities	
Dean of Architecture	.5
College of Business & Public Affairs	
Small Business Development Center	.5
Total:\$	\$25.4

* The compilation is limited to units with at least \$500,000 in support and whose funding is not for primarily administrative functions. The order of presentation is by college and then by unit within the college.

Source: Please refer to source note for Table 3-15.

"Clemson University, with a royalty ROI (return-on-investment) of 4.31 percent, tied for fourth among participating institutions. Roughly 40 percent of its royalties are derived from a software program used to operate automated tape data storage and retrieval systems. Clemson has developed one of the more diversified portfolios among the benchmark institutions with two significant royalty-producing licenses."⁸

⁸ Please refer to footnote 7.

Part III: Comparisons with Other States

"...South Carolina [is] a major player in the global economy. NationsBank economists report that our exports have doubled the national average since 1987. For the third quarter... Everen Securities ranked us third-strongest in the country. ...The Census Bureau ranked South Carolina third in the nation in percentage increase of black-owned businesses and first in reducing poverty. ...[In] 1995, new investments broke all-time records, international and rural investment reached historic levels while new jobs hit a 30-year high. ...The figures are mind-boggling: \$5.4 billion in capital investment; 24,000 jobs, paying 27 percent better than the average for all industries; rural investment breaking the billion-dollar mark for only the second time in history."

Governor David Beasley,
State of the State,
January 24, 1996.

Clemson, MUSC, and USC

Over time comparisons generally show a favorable pattern for South Carolina as all three major universities exceeded the rate of increase in research and development expenditures between 1986 and 1993 when compared with the nation's 200 largest universities, Figure 3-7. USC and Clemson also surpassed the overall rate of increase in support from industry sponsors, Table 3-20. Table 3-21 shows changes in funding over 1990 to 1993 for select areas of science expenditures. When compared to the sample of 200 U.S. major research institutions, MUSC had a considerably greater increase for R&D expenditures in the life sciences, medical sciences, and biological sciences.

A more sobering observation is offered in a 1995 study of university-industry technology transfer by The Southern Technology Council. South Carolina's three higher education research institutions (Clemson, MUSC, USC) were compared with other research universities in 14 southern states.⁹

⁹ See *Benchmarking University-Industry Technology Transfer In The South*, by Louis G. Tomatsky, Paul G. Waugaman, and Lucinda Casson, The Southern Technology Council, Southern Growth Policies Board, Raleigh, North Carolina, April 1995. While the study did not specifically identify the score for each university on each measure, there

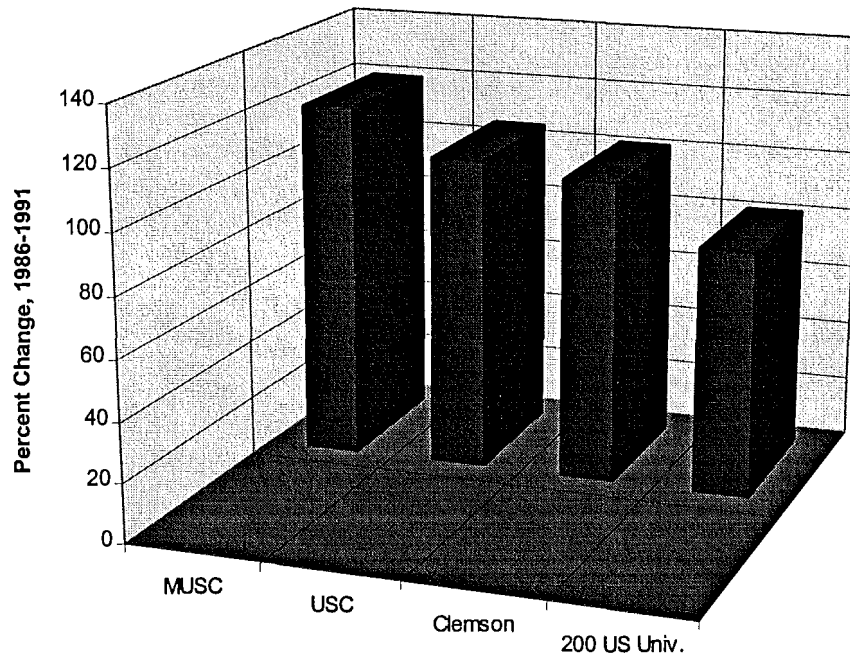
All three universities rank in the lowest quartile for the measure: Active Licenses per \$10 million Expenditure. More favorably, Clemson University ranked in the top quartile, in fact, fourth among all the 40 institutions surveyed, on the measure: Royalty Return-On-Investment, a particularly important measure as noted by the study's authors:

"Royalties are an excellent benchmark of the "bottom line" commercial value of faculty inventions. Since the magnitude of royalties is usually directly tied to the volume of sales, real or expected, of products derived from university technologies, royalties represent a market validation of the invention's worth."

On percentage of royalties from in-state licensees, the University of South Carolina ranks in the top quartile. It was also noted in the study that "Over 40 percent of this uni

was a state-by-state summary of scores. Since Clemson, MUSC, and USC were the only universities chosen from South Carolina, there were three entries for each of the seven measures in the state-by-state summary. Only when all universities were in the same quartile on a measure or when explanatory material in the text made it clear which institution was rated highly, was it possible to specifically identify university rankings.

Figure 3-7: Rate of Increase in R&D Expenditures from 1986 to 1993 for All Types of Sponsors Comparing MUSC, USC, and Clemson with the 200 Largest Universities in the U.S.



iversity's small royalty flow comes from licenses to firms founded by former faculty members."

The entire southern region was faulted for exporting its technologies to private sector licensees outside the 14-state area. The re-

port's authors noted that if this export trend continues, the region will not be accruing the value-added high skill jobs as rapidly as possible or desirable. In short, South Carolina, and the entire South, is not capturing the full economic benefit of the region's research and development activities.

Table 3-20: Research and Development Expenditures at 200 Major Doctorate-Granting Institutions in South Carolina and The United States, 1986-1993 (Industrial Sponsors Only)

	1986 Funding	1993 Funding (Millions)	Change % (Millions)
MUSC	\$1.379	\$1.793	30%
USC	1.566	6.414	310%
Clemson	2.963	6.035	104%
US	699.7	1,374.0	100%

Source: Computed from data in Table B-38, *Academic Science and Engineering R&D Expenditures: Fiscal Year 1993*, National Science Foundation, NSF 95-332 (Arlington, VA, 1995). Note data for US is all universities and colleges.

Table 3-21: Research and Development Expenditures by Science Area at Major Institutions in South Carolina and the US, 1990 to 1993

Area	Institution	Change %
Life Sciences	MUSC	83.9%
	Clemson	6.9
	USC	7.9
	US Institutions	24.2
Environmental Sciences	USC	27.6%
	US Institutions	24.6
Biological Sciences	MUSC	59.7%
	Clemson	12.1
	US Institutions	25.3
Medical Sciences	MUSC	74.4%
	US Institutions	28.1

Sources: Computed from data in Table B-58 Life Sciences; Table B-54 Environmental Sciences; Table B-61 Biological Sciences; and Table B-62 Medical Sciences in *Academic Science and Engineering R&D Expenditures: Fiscal Year 1993*, National Science Foundation, NSF 95-332 (Arlington, VA, 1995). US data for life sciences is top 150 universities and colleges. US data for biological sciences, environmental sciences, and medical sciences are for top 100 institutions in each field.

Small Business Innovation Research Awards in South Carolina

The Small Business Innovation Research (SBIR) program requires most larger federal departments and agencies to set aside a specified amount of their R&D budgets to be awarded to small business concerns. The SBIR program consists of two phases which involve federal research support and a third phase, which normally does not include federal funding.¹⁰

¹⁰ Phase I awards are given to determine the scientific, technical, and commercial merit and feasibility of a proposed research or R&D undertaking. From the beginning of the SBIR program in 1983 through federal fiscal year 1993, Phase I awards could not exceed \$50,000 for direct costs, indirect costs, and other fees for a period usually of no more than six months. In 1994, the maximum Phase I award was increased to \$100,000.

Phase II awards are designed to continue the most promising research efforts funded in Phase I projects. Until 1994, the maximum Phase II award was \$500,000. That was increased

Companies from South Carolina received 24 Phase I and Phase II awards since the program's inception in 1983, Table 3-22. In the Charleston region there have been six awards. Charleston region companies that have received SBIR funding over the past decade are shown in Table 3-23.

The South Carolina company which has received the most SBIR funding is Doty Scientific, Inc. of Columbia. The company received four awards, totaling \$457,000.

to \$750,000 in federal fiscal year 1994 which ended on September 30, 1994. Both Phase I and Phase II awards were restricted to small business concerns with fewer than 500 employees.

Table 3-22: SBIR Awards in South Carolina and the Charleston Region

	Number of Awards Charleston Region	Number of Awards Elsewhere in South Carolina	Total
1983	0	0	0
1984	1	1	2
1985	1	2	3
1986	0	2	2
1987	1	3	4
1988	0	4	4
1989	1	1	2
1990	1	1	2
1991	0	1	1
1992	0	0	0
1993	0	0	0
1994	1	3	4
Totals:	6	18	24

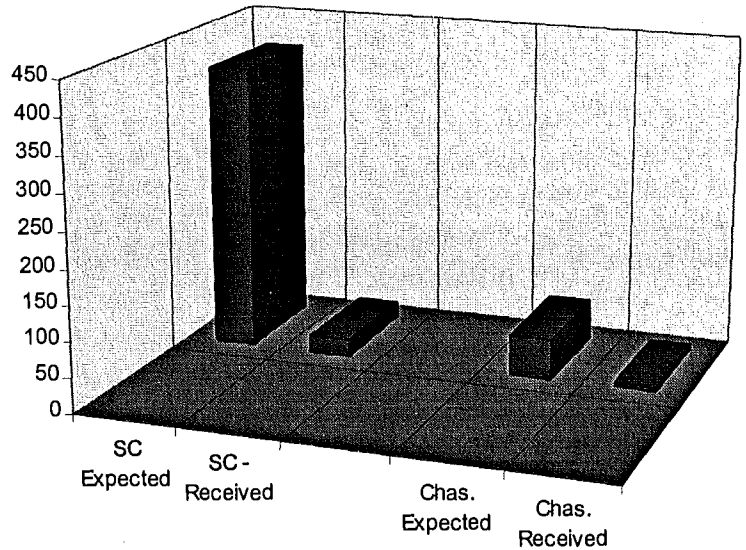
Source: Computed from source data provided by the U.S. Small Business Administration. Phase I and Phase II awards are counted as two awards.

Table 3-23: SBIR Awards in the Charleston Region by Company, 1983 through 1994

	Number of Awards	Amount of Awards
Amtron, Inc. (Antigen/organism specific transfer factors with application for immunoprophylaxis and immunotherapy of human veterinarian diseases)	1	\$50,000
Amtron, Inc. (new biologics to prevent swine transmissible gastroenteritis and pseudorabies)	2	383,000
Atlantic Littelneck Clamfarms (Development of cryopreservation techniques for bivalve larvae)	1	50,000
Hadley Company (Microcomputer-based water quality monitoring and control system)	2	91,276

Source: Compiled from source data provided by the U.S. Small Business Administration. All the data are based on obligated amounts, not actual expenditures which may be less. For each award, the total was rounded to the nearest thousand dollars.

Figure 3-8: Expected and Received SBIR Awards: Charleston, South Carolina, 1983-1994*



*Expected number of awards is based on the populations of South Carolina and Charleston when compared with other regions in the U.S.

Two rough measures suggest that South Carolina and Charleston firms have not received their proportionate share of SBIR awards: (1) South Carolina companies have received roughly one-seventeenth or 6% of what should be expected on the basis of population size, and (2) Charleston received only 0.2 of every 1000 awards, or ten percent of what should be expected on the basis of population size, Figure 3-8.

The Small Business Technology Transfer Program

The Small Business Technology Transfer (STTR) program is designed to:

- stimulate and foster scientific and technological innovation through cooperative research and development carried out between small business concerns and research institutions;
- foster technology transfer between small business concerns and research institutions; and
- increase private sector commercialization of innovations derived from Federal research and development.

The STTR program is identical to the SBIR program in terms of its phases and funding limits. There are two major differences in that the STTR program requires that the applicant (small business) “team” with a research institution and that a STTR principal investigator may have his/her primary employment with a research institution, rather than the small business.

In the first year of STTR competition, 1,950 STTR proposals were submitted to the five participating federal agencies. One hundred and ninety-eight Phase I awards were made to a total of 181 firms. None of the firms was located in South Carolina.

Summary and Conclusion

Section III focuses on training talent and conducting technology-based R&D at selected colleges, universities, and other public and private institutions that are considered key to fostering nationally and globally competitive technology-based entrepreneurship in the Charleston region.

Faculty resources at the College of Charleston, The Citadel, Charleston Southern University, Trident Technical College, and The Medical University of South Carolina include over 1,400 full-time and 950 part-time professors and instructors.

The College of Charleston, The Citadel, and Charleston Southern University (CSU) provide a total of 12,800 undergraduate students (full and part-time) training in the areas including entrepreneurship and enterprise development; environmental studies; physical sciences; marine biology and biology sciences; social sciences; electrical engineering; computer science; and information technologies.

In addition, Trident Technical College has about 9,000 taking courses for credit with about one-third of these full-time students.

Nearly 400 regional businesses with 48,000 employees have utilized Trident’s Continuing Education Programs. The divisions of Continuing Education and Economic Development; Business Technology; and Engineering Technology offer courses in such areas as health sciences, computers and information systems, environmental compliance, finance, geographic information systems, manufacturing/engineering, and quality improvement.

Graduate training is provided by The College of Charleston (about 2,000 full and part-time students) and The Citadel (about 2,000 full and part-time students) in the areas of accountancy and business administration, bilingual legal interpreting, environmental studies, marine biology, mathematics, biology, and engineering.

The Medical University of South Carolina (MUSC) with 732 full-time and 600 part-time faculty has 550 full-time graduate students and 100 Post-Doctoral students studying and conducting research in the areas of biology, social and physical sciences, medicine, and chemistry.

The University of South Carolina (USC) in Columbia has 12,500 full-time and 3,660 part-time students and around 10,000 full and part-time graduate students. USC has approximately 1,060 full-time and 350 part-time faculty. Areas of research and teaching emphasis and excellence at USC include international business, marine science, business know-how (especially accounting and advertising), law, medicine, and the full range of science and engineering fields which includes over 60 post doctorates.

Clemson University has 11,695 full-time and 850 part-time undergraduate students and approximately 3,780 full and part-time graduate students. The university has 1,073 full-time and 148 part-time faculty. Areas of research and teaching emphasis and excellence include health, education, and human

development; business and public affairs including small business development; agriculture, forestry and life sciences; and the full range of engineering and science studies.

Other Public and Private Institutions

When considering the training of talent in the Charleston region, it is also important to emphasize the important role played by the area's small, mid-sized, and large businesses. Selected examples of these training and educational resources are described in case profiles included in all sections of this report. Section III especially targets the contributions of other public institutions such as The South Carolina Research Authority (SCRA); The Port of Charleston; The Naval In-Service Engineering East Coast Division (NISE East); South Carolina Department of Natural Resources, Marine Resources Division; and the National Marine Fisheries Service, South-East Fisheries Science Center, Charleston, Laboratory.

Research and Development base for technology-based entrepreneurship focused on funding amounts and particular areas of expertise. The following are the selected institutions and selected areas of technological expertise.

College of Charleston: biology, environmental studies

The Citadel: biology, astronomy

The Medical University of South Carolina: environmental studies, medicine and health care, molecular biology, biochemistry

The Port of Charleston: software, information technology, information systems management

Naval In-Service Engineering East Coast Division (NISE East): electronics, information systems, intelligence and security sys-

tems, electrical engineering, and information technologies

The South Carolina Department of Natural Resources, Marine Resources Division: marine and environmental sciences including medical and biomedical

The South Carolina Research Authority (SCRA): advanced manufacturing, health care information systems, product data technology, and advanced metal casting
National Marine Fisheries, South-East Fisheries Science Center: marine biotechnology, marine forensics, genetics, molecular and cellular biology, ecology, and environmental health

The University of South Carolina offers the full range of graduate student and faculty research opportunities with an emphasis on the following technology areas: marine sciences; medicine in the areas of developmental biology and anatomy, internal medicine, and microbiology and immunology; chemistry; pharmaceuticals; biological sciences, geological sciences, mathematics, and physics; and chemical, electrical, computer, and mechanical engineering.

Clemson University offers the full range of graduate student and faculty research opportunities with an emphasis on the following technology areas: electrical and computer engineering; chemical, mechanical, environmental, and ceramic engineering; geological sciences; chemistry; plant pathology and physiology; life and biologic sciences; agricultural and biological engineering, and information systems development.

The Medical University of South Carolina, The University of South Carolina, and Clemson University compare favorably with the nation's other leading research universities in terms of the rate of increase in R&D funding.

The main challenge for South Carolina in general and Charleston in particular is to obtain and retain return on investment (ROI) for the investments in the talent and the technology resources described in Section III. Indicators that the full economic development potential of these resources is

not being realized is provided by data from The Southern Technology Council, Small Business Innovation Research Awards, and Small Business Technology Transfer Program awards.

Section IV

Survey on Technology-Based Entrepreneurship in the Charleston Region

"The only infrastructure that really matters is between the ears."

William M. Youngblood, Chair
Charleston Metro Chamber of Commerce Education Foundation

Introduction

Section IV provides survey data on technology-based entrepreneurship in the Charleston region. During Summer 1996, 1,000 surveys were mailed to managers, technicians, and researchers in small, mid-sized, and large technology-intensive organizations located in the Charleston region. A smaller set of surveys, about 200, were also mailed to community leaders in the public sector and in Charleston's educational institutions.¹

¹ The names and addresses for the survey mailing to industry were provided by the Charleston Metro Chamber of Commerce with additional respondents coming from The Medical University of South Carolina and The College of Charleston. Two hundred and ten surveys, out of a total of 1,191, were completed and returned for a response rate of about 17 percent. This modest rate of return is considered acceptable since the survey is not attempting to generalize to the entire Charleston community. Rather, the objective is a focused study of a targeted group of respondents---business and community leaders most interested in technology-based development and entrepreneurship. Furthermore, after data were analyzed for the two survey mailings in May and June of 1996, an additional sample of about 20 surveys from business and other respondents was returned and analyzed. This second group of responses re-affirmed the initial conclusions drawn from the initial data analyses.

Section IV first presents survey data on 24 of Charleston's industries and a range of economic development strategies for creating wealth and high value jobs in the Charleston region over the next 10 years. Section IV then presents survey data on the importance and effectiveness in Charleston of :

- 14 educational initiatives
- 12 strategies for facilitating finance for technology-based business expansions, spin-outs, and start-ups (i.e., capital)
- expertise or "smart infrastructure" resources for technology-based business expansions, spin-outs, and start-ups (i.e., know-how)
- access to R&D resources local, national, and global (i.e., technology)
- Charleston's physical infrastructure, quality of life, regional planning, and local government (i.e., community issues)

Written-in survey responses are also presented which focus on:

- (1) the most important factors that would facilitate and/or inhibit the growth of technology-based industries in the

Charleston region over the next 10 years, and

- (2) what one “big idea” or large-scale project could or should the Charleston region undertake to significantly improve the area’s economy?

By obtaining and assessing data on a key group of Charleston respondents, the survey provides important ideas, opinions, and concerns for designing effective and doable strategies to foster the growth of technology-based entrepreneurship and regional “smart” infrastructure in the Charleston region.

Demographic Profile of Respondents

The great majority of respondents (76%) work in the private sector, Figure 4-1. This group of respondents was the primary target of the survey — managers, technicians, and entrepreneurs who work in small, mid-sized, and large Charleston-based technology-intensive firms. Seventeen percent of the respondents work in the public sector and educational institutions in the Charleston region. The survey did not target tourist or retirement related industries. Most respondents were either owners of a business or held a high-level position in their place of

Figure 4-1: Employment Sector of Respondents

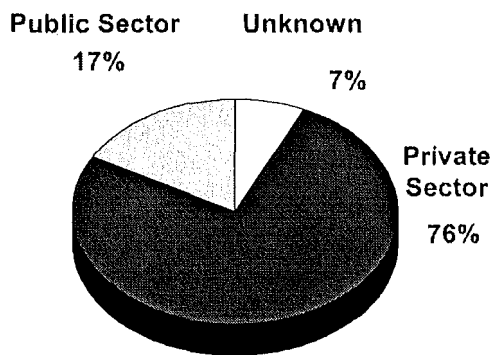
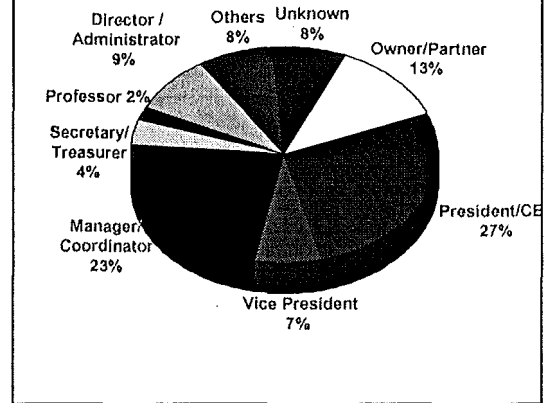


Figure 4-2: Work Positions of Respondents



employment (79 percent), Figure 4-2.

A large majority of the respondents live in Charleston county (75%), 11.4 percent live in Dorchester county, and 9 percent reside in Berkeley county. Of those individuals who live in Charleston county, most live in the cities of Charleston (47.9%) or Mount Pleasant (46.2%). Six percent live in North Charleston. A significant majority of the respondents work in Charleston county (72.6%) while 8% work in Berkeley and 8.5% in Dorchester counties. Most respondents indicated that they work and live in the same county. Of the large percentage who work in Charleston county, most are employed either in the city of Charleston or North Charleston.

Survey Results

Importance of the Charleston region’s Industries

The tourism/entertainment and the water transportation/cargo handling industries were considered to be the most important of twenty-four industries for creating wealth and high value jobs in the Charleston region over the next ten years. The next most important industries were health care, business and financial services, biomedicine/biotechnology, information technology and educational services. The apparel and textiles industry was considered to be the least important, Figure 4-3.

Table 4-1: Number of Respondents Living/Working in Each County Area

	Live	Work
Berkeley County	18	16
Dorchester County	23	17
Charleston County	150	146
<i>Charleston</i>	57	55
<i>Mt. Pleasant</i>	55	18
<i>North Charleston</i>	7	41

“The most important factor that will inhibit the economic growth of technology-based industries in the Charleston region is to keep the focus on tourism and not focus on other industries as well.”

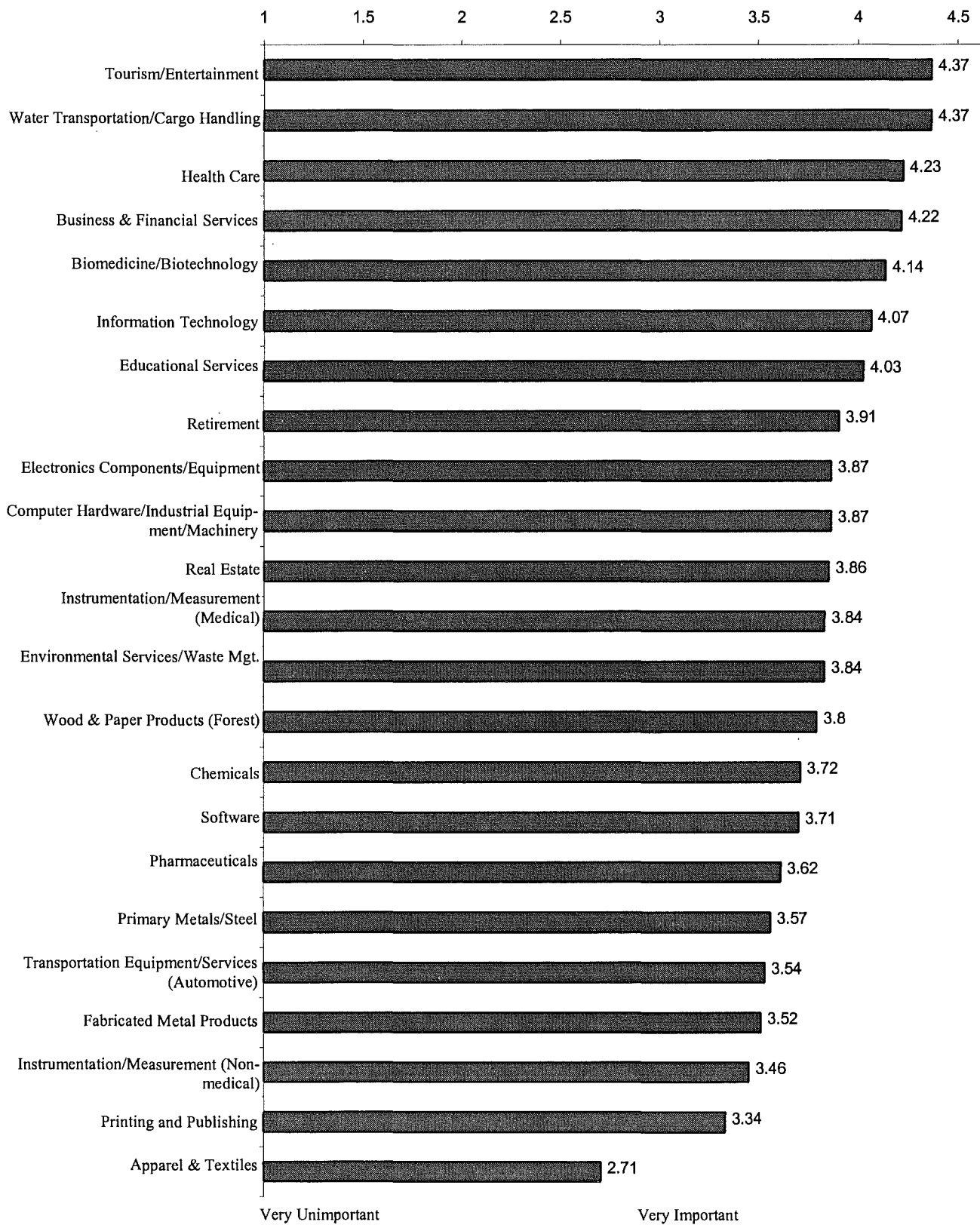
“Redevelop the Charleston Naval shipyard/Navy base so that it is the premiere location for technology-based industries.”

Each of these industries was included in the survey because of their perceived importance to the Charleston region. And while technology and related talent concerns were not emphasized here, it is important to note that nineteen of these twenty-four industries are directly driven by or face increased global competitiveness through technology advances. While the five other industries (e.g., tourism/entertainment, business and financial services, educational services, retirement services, and real estate) also rely on technology advances and skilled employees to be state-of-the-art in such key areas as quality and customer satisfaction.

Of the six industries rated as being the most important in the Charleston region, only the tourism/entertainment industry currently has sector employment shares larger than the national average (U.S. Bureau of Census, County Business Patterns, plus selected BLS reports and GSO estimates). The other five industries that were rated highly by the respondents are somewhat below the national standards in terms of the number of people employed.

Respondents’ written-in comments emphasize the need to strengthen and increase manufacturing and technology-intensive industries in the Charleston region. Two major themes expressed through written-in comments are exemplified by the following quotes of selected respondents:

Figure 4-3: Importance of Select Charleston Region Industries for Creating Wealth and High-Value Jobs Over the Next Ten Years*



*Mean scores are based on all survey respondents.

Regional Economic Development Strategies

"Charleston should focus on attracting entrepreneurial firms from all industries and should be marketed as an 'entrepreneur's paradise.'"

— Survey Respondent

Respondents were asked to rate the **importance** in the Charleston region of eleven different economic development strategies, each of which is linked to the four fundamental economic development strategies listed in Section I of this report: relocation, retention and expansion, new company formation, and alliance building. The three strategies considered most important, by the survey respondents, for creating wealth and high-value jobs in the Charleston region over the next ten years were (Figure 4-4):

- (1) the development of existing public assets (e.g., Port of Charleston and the airport) in the Charleston region;
- (2) the relocation/expansion of established companies from other regions in the U.S.; and
- (3) the retention/expansion of established/start-up companies in the Charleston region.

Both the quantitative ratings and the written-in comments indicate that highly favored economic development strategies also include the redevelopment of the Charleston Naval base/shipyard into an industrial complex and the encouragement of companies from other regions to relocate to or expand in the Charleston region. Following are representative comments.

"Make it easier for industry to enter the Charleston region—more attractive benefits to bring in out-of-town businesses."

"Redevelop the Charleston Naval shipyard/Navy base so that it is the premiere location for technology-based industries."

"Encouraging large companies to move satellite offices down to Charleston is the first step."

"Increasing awareness of the Charleston name is crucial."

Respondents were also asked to rate the current level of **effectiveness** of the eleven economic development strategies. All but two of the ratings were above the 'neutral' rating of 3.00 indicating that respondents consider most of the strategies to be somewhat effective. The relocation/expansion of established companies from other regions was noted as being the most effective strategy and the retention of government programs and facilities was considered to be the least effective as well as least important economic development strategy in the Charleston region.

These findings are congruent with the proposed economic development strategy put forth by the Growth Strategies Organization which observed that the Charleston region is unusually reliant upon the civilian government and the military for employment opportunities. As the GSO report states, (Boyle, 1994):

"With the recent closure of the Naval base, Charleston must identify new opportunities for economic growth. Considering that Charleston's high-wage service sector is small in size, it cannot rely solely on the expansion of current Charleston companies to produce growth...Instead, Charleston should identify ways to attract high-wage manufacturing and service companies to broaden the economic base."

In terms of the focus of this report (1) new firm creation and (2) alliance building, respondents emphasized the importance of retaining and expanding start-up companies, the relocation of entrepreneurs, new spin-out companies, and relocating start-up companies to the Charleston region. These strategies were closely followed by the importance of providing mechanisms for assessing and commercializing home-grown technologies and the development of home-grown entrepreneurs, spin-outs, and start-ups in the Charleston region.

Cooperative alliances across the public and private sectors regionally and globally were considered somewhat less important.

Again, and in terms of the focus of this report, while the following economic development strategies were all considered important, respondents emphasized the region's lack of effectiveness in:

1. the retention and expansion of established and start-up companies,
2. the relocation of entrepreneurs, new spin-outs and start-ups,
3. providing mechanisms for accessing and commercializing home grown technologies,
4. the development of home-grown entrepreneurs, new spin-outs and start-ups,
5. providing mechanisms to enhance the globalization of local and mid-sized firms,
6. forming cooperative alliances across small and larger firms, and
7. forming public/private economic development alliances with other regions in South Carolina.

"If through education we can prove to the upcoming generation that there is a future for them, not only will it help the economy, but also the crime and drug problem and many facets of the quality of life."

— Survey Respondent

Education Infrastructure

In their analysis of Charleston's MSA Economic Development strategy, the Growth Strategies Organization rated the educational attainment of the Charleston region and its nearest competitors (Nashville, Atlanta, Raleigh, Charlotte, Norfolk, Birmingham, Jacksonville, Greenville, and Savannah) and found that "Charleston is about average when compared to the other nine communities," (Boyle, 1994). However, this analysis was based on the quantity of school degrees awarded. The findings of the cur-

"[The most important factor for growth] is the effective education of a local future work force prepared to meet the technological challenge of future industry."

— Survey Respondent

rent survey stress the mismatch of the rated importance and current effectiveness of a range of education initiatives in the Charleston region. Of all the issues addressed in the survey, education was considered the most important for creating wealth and high-value jobs through technology-based entrepreneurship in the Charleston region over the next ten years. It was also the most frequently mentioned area of concern.

Figure 4-5 provides the mean scores for the degree of importance and effectiveness of fourteen action/policy recommendations for Charleston's education infrastructure. All but one of the 14 reported education strategies were considered important with a mean score of greater than or equal to 4.0. The effectiveness scores for each of these strategies ranged from low (mean score of 2.5) to moderately effective (3.16).

The highest mean scores are for the importance of quality sci-

ence/technology/mathematics education in area high schools and area colleges. At this same time, the Charleston region was considered to be least effective in providing such educational opportunities in area high schools followed by entrepreneurship education also in area high schools.

Communication and partnering among Charleston’s educational institutions and quality entrepreneurship education in area colleges are also considered to be highly important for creating wealth and high-value jobs in the Charleston region. When asked how effective each of these action/policy recommendations was in the Charleston region, the scores were low--most falling between ‘somewhat ineffective’ and ‘neutral’.

Of the 174 respondents who provided written comments on the survey, 67% mentioned education as a crucial area which

needs to be improved. Most of the comments (53.4%) were concerned about K-12 education and about the quality of education in regards to the availability of a trained and qualified work force (29.3%). An additional 17.2% complained of a lack of college and university programs in science and engineering and suggested that there is a need for more specialized technology-based advanced education programs.

Following are comments made by respondents regarding the current quality of education and the types of educational programs needed in the Charleston region.

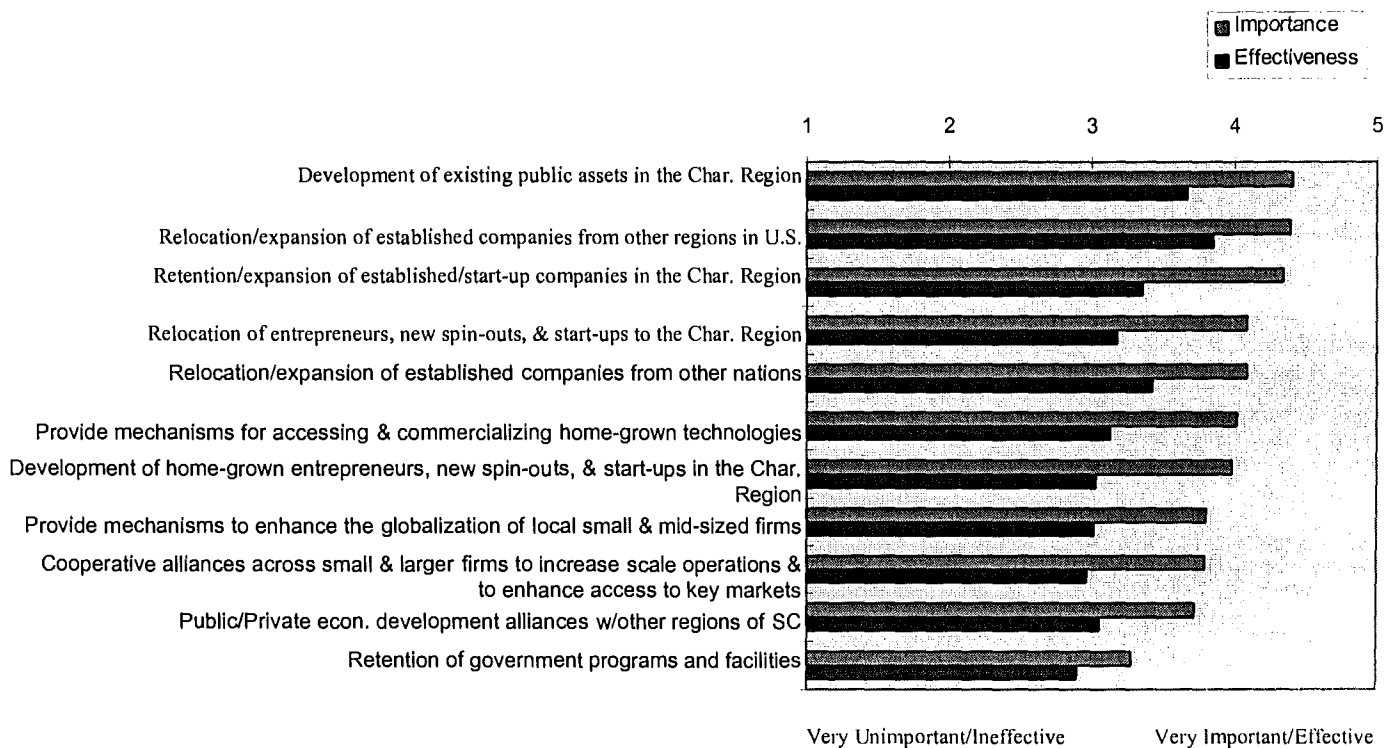
“Improving the public school system...will attract new jobs/families.”

“Lack of a major university, graduate level education, in the area--even in the state.”

“Education is the key to skilled people, kudos to Trident Technical College.”

“Creatively fund the educational system by

Figure 4-4: Economic Development Strategies for Creating Wealth and High-Value Jobs in the Charleston Region Over the Next Ten Years



lottery or any means to upgrade the current level of education.”

“Education partnering with the business community is essential.”

“Educate children about career choices.”

“Just getting school-to-work up and running—the jury is still out.”

“Best and brightest’ generally leave area. We lack broad range of high quality programs.”

“Merge three small colleges to form a larger university that can partner with and provide needed research support for the desired technology industries.”

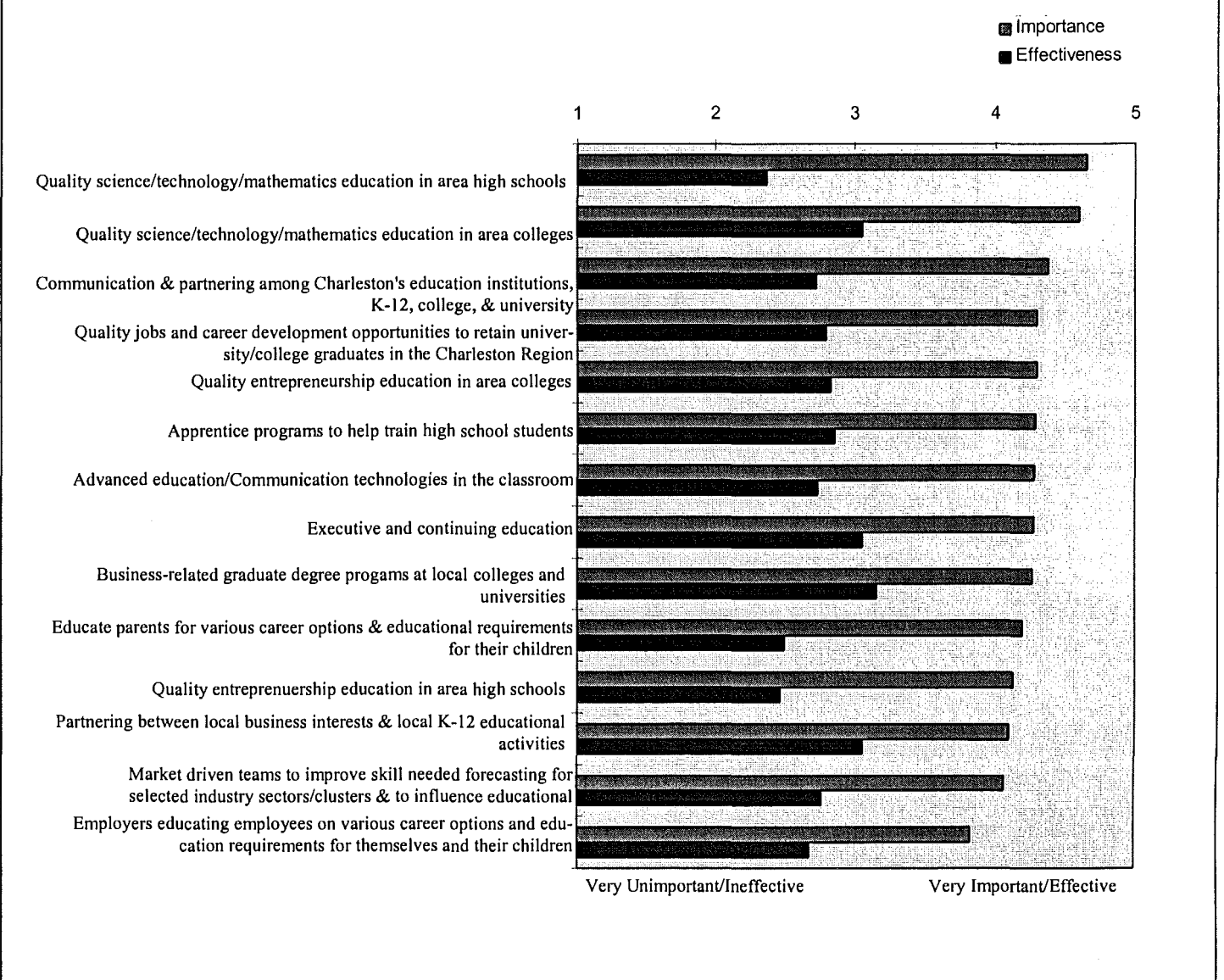
“Expand science programs in local universities.”

“Good technical education is available; good technological education is not.”

“The teaching of economics and the free enterprise system needs to be greatly improved.”

“With the exception of the Medical University, Charleston lacks higher education resources in engineering and science. There is little opportunity for engineers and science related undergraduates to gain Masters and PhD’s in their field.”

Figure 4-5: Education Infrastructure for Creating Wealth and High-Value Jobs Through Technology-Based Entrepreneurship in the Charleston Region Over the Next Ten Years.



Math and Science Education: A Foundation for the Future

The National Science Foundation in 1993 selected the State of South Carolina to formulate a comprehensive statewide plan for math and science education reform. The goal is for all children in South Carolina to be mathematically, scientifically, and technologically literate. The reform effort represents a partnership among local school districts, higher education, and the business community. Thirteen regional resource centers or Hubs, have been established to serve teachers and schools throughout South Carolina.

One of these regional resource centers, or Hubs, is located in Charleston and a second serves Berkeley and Dorchester Counties. In addition to providing state-of-the-art instructional materials to teachers, the Charleston Hub offers an annual **Curriculum Leadership Institute (CLI)** for teachers. The CLI brings together the very best teachers of mathematics and science to share their proven methods with other teachers. Teachers conduct demonstration lessons, research and reading assignments, and discuss topics such as student assessment and school-based reform. At the recent CLI session held at the South Carolina Department of Natural Resources, Marine Resources Division, classroom work was supplemented by laboratory tours and opportunities to assist marine scientists with their research.

Business leaders who participate actively in the Hub advisory boards see the Hubs as vehicles for shaping mathematics and science to meet the current and future needs of businesses.

“Our needs in business are changing quickly when it comes to the math, science, and technological skills of the work force. We must relay these needs back to the education community, and the Hubs provide a great avenue by which to do this.”

Anita Zucker, The InterTech Group,
and Chair of the Charleston Math and
Science Hub Advisory Board

Quality Education as Key Resource

The Charleston region has four public school districts serving a total of 88,000 students in grades K-12 and 132 schools. In addition, over 25 private and parochial schools provide K-12 education to approximately 10,000 students. All four of the region's public school districts face the challenge of meeting the demands of providing a quality, individualized education to a diverse student body.

The 1993 Early Childhood Development and Academic Assistance Act enacted by the South Carolina General Assembly, is a major reform initiative designed to ensure that all students in the state graduate with their peers. Both on the state and local level, South Carolina's leaders recognize that significant educational improvement is needed if South Carolina students are to be adequately and appropriately prepared for the twenty-first century.

In the Charleston region, the challenge of preparing students for the future workforce is a challenge the business community recognizes as one in which it must be involved. A number of innovative programs which partner the schools with businesses have been established to address the many challenges facing the area's public school districts.

In 1994, Ross Boyle, noted economic development strategist, issued a report on the Charleston region's competitiveness related to job creation. His report stated that the perception of inadequate public education in the region is one of the most urgent problems that must be addressed by the business community. This report served as a wake-up call to the region's business leaders. Boyle told the business community that no public school district is doing everything right, however, the competitive edge goes to the community that is seeking creative approaches to the challenges posed in public education. Since the issuing of the Boyle's report, a number of workforce development initiatives involving business and education have been established.

Charleston Education Foundation

The Charleston Metro Chamber of Commerce Education Foundation was formed in 1995 to build the coalitions, mobilize the resources and advocate the changes necessary in the community to prepare the workforce for the 21st century. Governed by a 22-member board of directors, the Foundation is comprised of business leaders from across the region, parents and the superintendents of the four public school districts working together to improve the learning and achievement of all students.

Each year, the Education Foundation holds a summit that brings together educators and business leaders to seek creative approaches in the development of a globally competitive workforce for the 21st century. Wide-spread support for South Carolina's School-to-Work Transition Act was established at the first Summit. The Second Annual Summit provided a forum for local schools to showcase unique approaches to technology and job preparation.

School-To-Work: Educational Pathways to the World

The School-to-Work Transition Act of 1994 allows each local school district within South Carolina to establish a system to prepare all students for the world of work. A critical component of the School-to-Work Transition is the creation of meaningful partnerships between education and business.

School-to-Work focuses on providing elementary students with increased awareness about the variety of occupations available; middle school students with career guidance for the coming decades; high school students with mentor and apprentice opportunities and post-secondary educational opportunities. The emphasis is on real life experience in four career clusters: Business and Information Systems; Health, Human and Public Services; Communications and The Arts; and Engineering, Industrial and Environmental Technology.

Through School-to-Work, businesses provide meaningful work-based learning opportunities for students and teachers. Work-based learning activities cover the spectrum from simple techniques like "shadowing" where a student observes an employee to full-scale youth apprenticeships where students receive credentials in a certified program of work and study. In the Charleston region, the goal is for all students to experience some type of work-based learning before graduating high school. Hundreds of businesses through the three-county area have committed to hosting students and teachers, serving as classroom speakers and working with the school districts through the Chamber's School-to-Work Office to develop region-wide guidelines and procedures.

Smart Infrastructure for Technology-Based Business Expansions, Spin-Outs, and Start-Ups

"The most important factor for growth is the Center for Technological Innovation. CTI will be a 'one stop shop'--a highly coordinated effort to grow a particular type of business."

— Survey Respondent

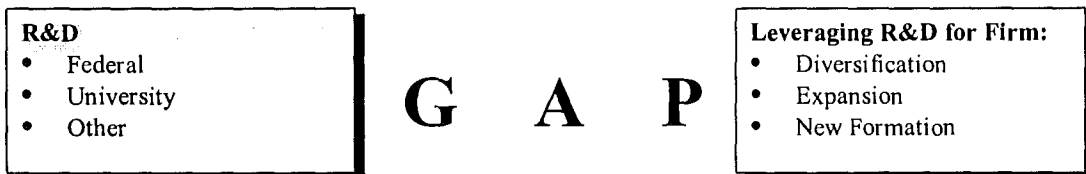
Section III of this report provides a targeted overview of the science and technology resources in Charleston and South Carolina. However, for these considerable resources to create wealth and high-value jobs, it is necessary to use business know-how (e.g., market research, finance, production, sales and distribution) to transfer this technology or "R&D" to leverage business diversification, expansion, and new firm creation, Figure 4-6.

One of the themes stressed in this section of survey results is the need for greater overall support for local businesses, start-ups, and expansions, Figure 4-7. In specific, respondents considered it most important to:

- have accessible support from local business expertise for Charleston's entrepreneurs
- have business-related networks for entrepreneurs
- create Class 'A' technology/industry parks and specialized office/light manufacturing space for start-up activity
- provide entrepreneurial training in area high schools, colleges, and universities
- provide entrepreneurial training and initiatives for the inner cities and rural areas
- provide a technology business incubator and one-stop business services center

The effectiveness rating on these same issues was lowest for providing entrepreneurial training for inner city and rural areas and the lack of a technology business incubator/technology commercialization center.

Figure 4-6: The Technology Transfer Gap



Transferring "R&D" with

- Market Research know-how
- Financial know-how
- Legal know-how
- Production know-how
- Distribution, sales, and service know-how

Written-in comments provided by the respondents support the responses recorded in Figure 4-7 and emphasized: the creation of a Class 'A' industrial park utilizing the Naval base area, wide support for better networking systems among business owners, and a 'one stop' information center, accessible to all, which would simplify the process of starting a business.

Specific written-in comments follow:

- “Consolidate all business services in the tri-county area into one location.”
- “Business knows no boundaries--make it easy and user friendly!”
- “[Provide] more organizations or mechanisms for business owners to network.”
- “Develop and fund a technology transfer incubator using Navy resources at NISE East.”

Finance for Technology-Based Business Expansions, Spin-Outs, and Start-Ups

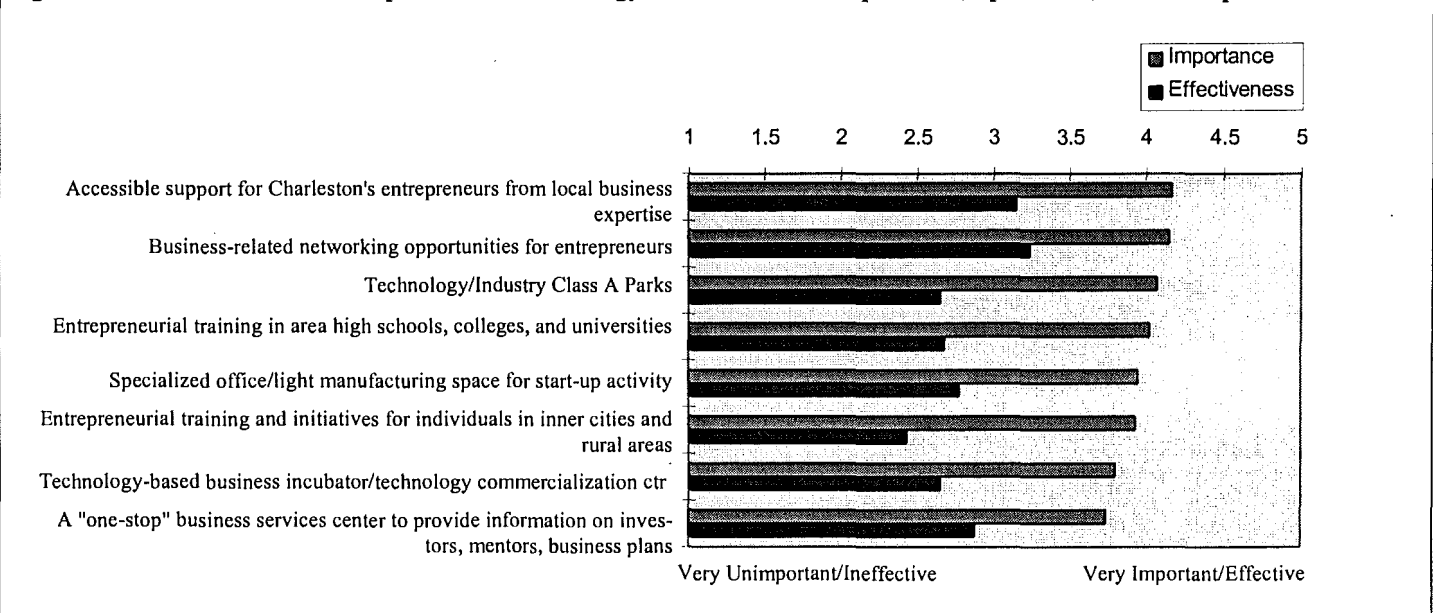
Respondents were asked to rate the importance and perceived current level of effectiveness of twelve recommendations for financing technology-based expansions,

spin-outs, and start-ups. The findings indicate that a significant number of individuals are frustrated with the current level of and accessibility to financing for start-up and small to mid-sized businesses, Figure 4-8.

Respondents considered venture/business expansion capital to be the most important finance issue followed by 'seed' capital, new and creative funding mechanisms for locally-based businesses, education of entrepreneurs about how to raise early stage capital, and the education of local bankers on the special needs of small and mid-sized firms. The overall discontent with the financing process is evidenced by the low ratings of effectiveness in the Charleston region and by the written-in comments as exemplified below:

- “No money = no business.”
- “[There is] no venture capital for R&D companies.”
- “With our limited capital base, area investors are few.”
- “Venture fairs and trade fairs attract many entrepreneurs, almost no true investors.”
- “Nationally controlled banks have removed local source of funding for all except those

Figure 4-7: Charleston-Based Expertise for Technology-Based Business Expansions, Spin-Outs, & Start-Ups



already financed by private funds.”
 “Small businesses must do it alone.”
 “From a financial point of view, Charleston is very conservative.”
 “The Charleston area needs a combination of all these [finance] ideas [noted in the survey] to prosper in the high tech arena. Unfortunately, the current timid and rigid climate is not conducive to capital investment and formation.”

Access to Research and Development (R&D) and Technology

The survey contained four policy/action recommendations regarding business access to R&D and technology which the respondents rated in terms of importance and ef-

fectiveness for creating wealth and high-value jobs, Figure 4-9. While each of these recommendations received a high rating of importance, all are also considered to be quite ineffective in the Charleston region. The two ideas considered to be the most important for R&D and technology access are:

- 1) technology transfer linkages with nationally-based technology resources and markets
- 2) technology transfer linkages with local sources of R&D

Written-in comments provided by the respondents suggest that while access to research and development and technology is

Figure 4-8: Charleston-Based Financing for Technology-Based Expansions, Spin-Outs, & Start-Ups

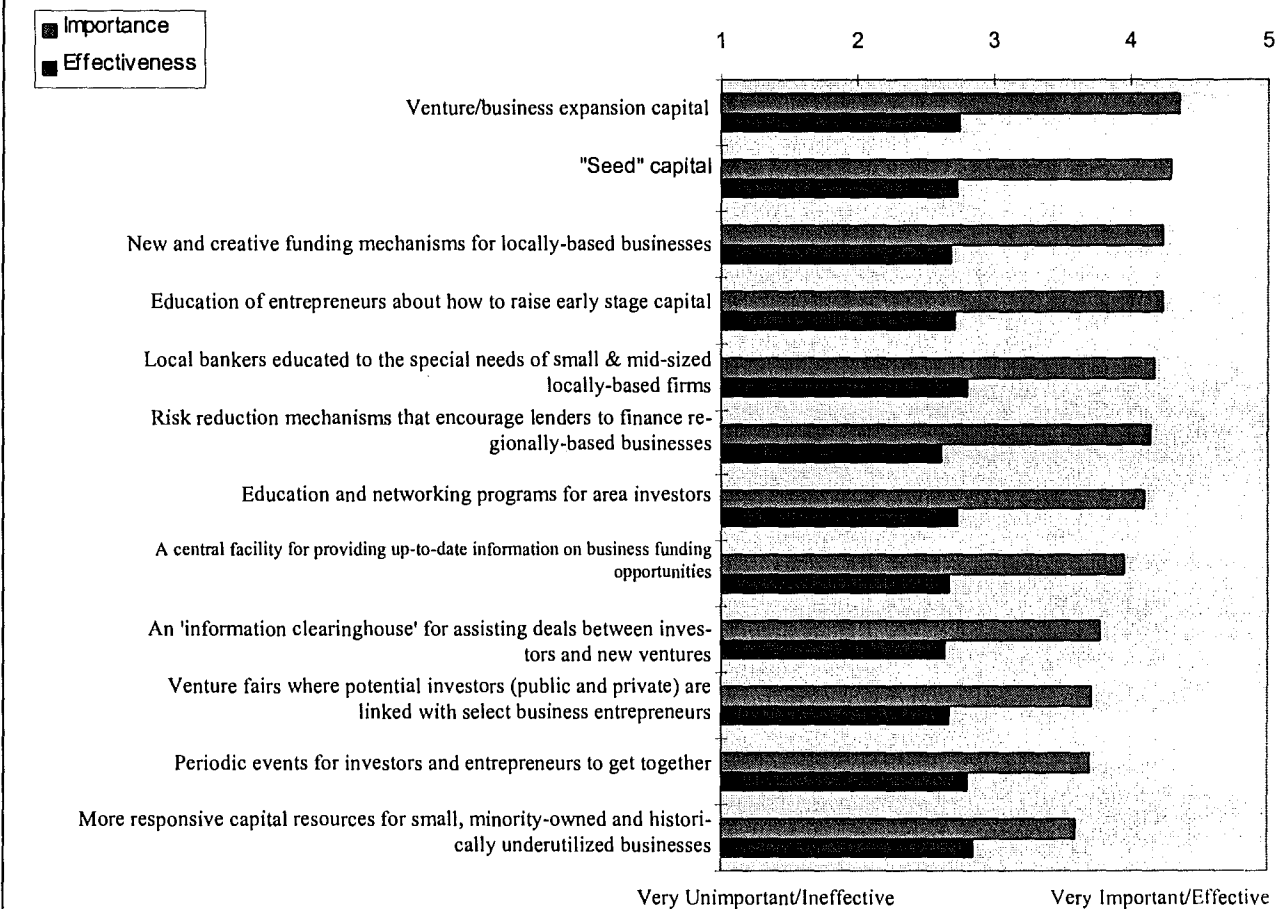
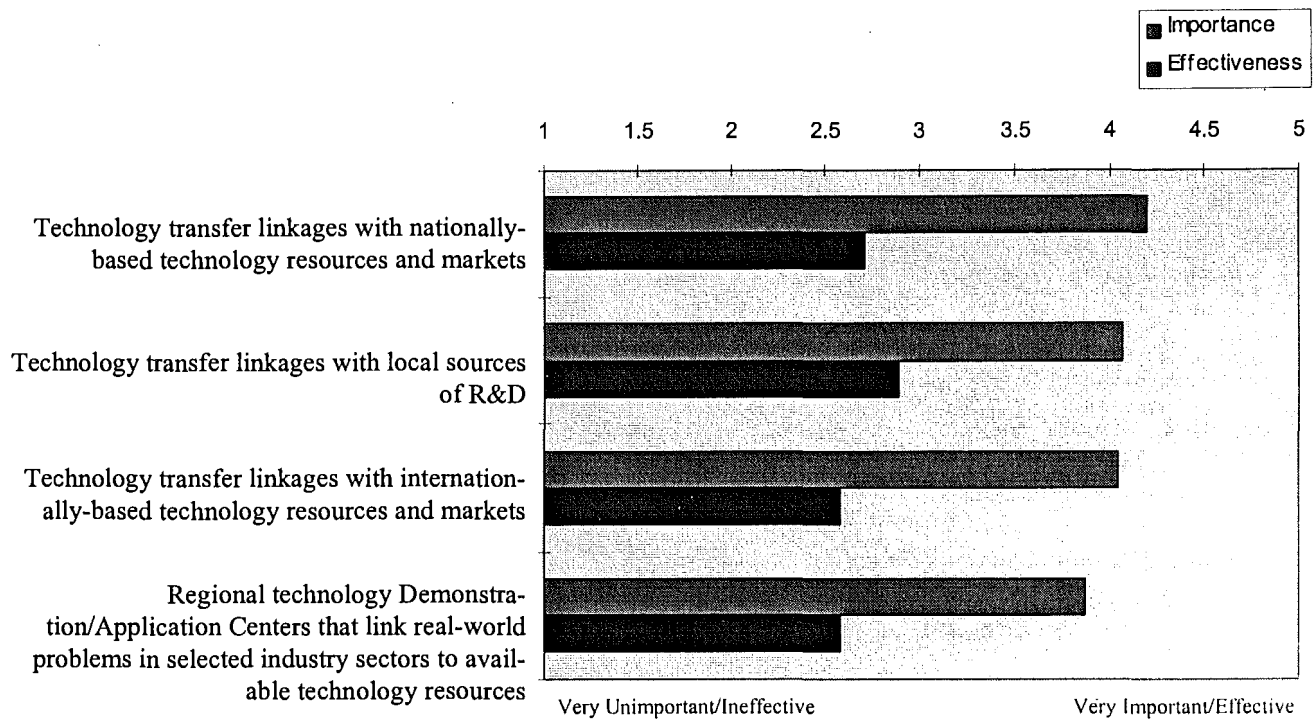


Figure 4-9: Access to R&D and Technology in the Charleston Region



considered to be valuable, it is currently limited due to the lack of research/business alliances and technological knowledge resources in the area. A significant number of respondents indicated that local universities

“Work to provide a true research facility to educate and utilize the best minds. This would be a catalyst for bringing in clean high tech industry.”
 “Link closer with U.S. Navy resources at NISE East and supporting contractors.”

“Encourage the current plans for promoting a good transportation system for the entire Tri-county area.”

— Survey Respondent

do not have adequate advanced degree programs in science and engineering, while others mentioned the importance of Trident Technical College. Below are other comments provided by the respondents regarding these issues.

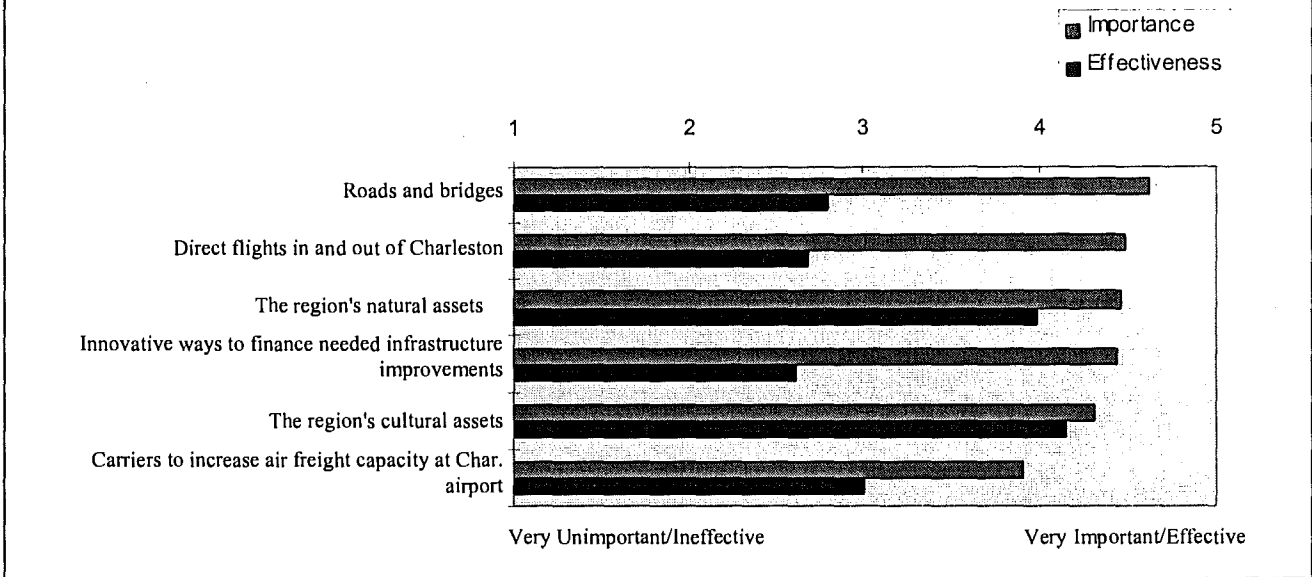
“Develop an environment which promotes innovation through organized think tanks, technology transfer, etc.”
 “Attract a major R&D or technology-based program which must rely on the input and contribution of private sector companies.”

Physical Infrastructure and Quality of Life

While Charleston’s quality of life (the region’s cultural and natural assets) is considered by many to be its greatest asset, the condition of the region’s physical infrastructure seems to be one of Charleston’s greatest challenges, Figure 4-10. At the same time, physical infrastructure, along with education, is considered to be one of the most important factors for creating wealth and high-value jobs in the region.

Seeking innovative ways to finance infrastructure improvements was rated very important, while effective strategies in this regard received the lowest score for this set of questions. Of the 174 respondents who

Figure 4-10: Physical Infrastructure and Quality of Life In the Charleston Region



provided written comments on the survey, 30.5% mentioned the poor condition of Charleston’s physical infrastructure. A significant number of individuals expressed concern over the condition of local roads and bridges. Other issues mentioned were the need for a mass transit system, more direct flights to and from Charleston, and the need for a better highway system.

The overlying message presented by the respondents is that Charleston cannot attract and retain large companies in the technology and manufacturing industries until the physical infrastructure is improved. Selected written-in comments from survey respondents follow:

- “The Cooper bridge should move ahead.”
- “Provide a transit system that would reach out to everyone.”
- “Improve the highway system! Expand water and sewer systems to create industrial areas.”
- “Our roads cannot handle the traffic now and no one seems to be looking for answers.”

“Seek larger corporations for their headquarters here; however, transportation by air in and out of Charleston is not conducive.”

“Major infrastructure problems to be solved--with no realistic funding source!”

“Convenient, safe, and fast transportation will have a positive influence on industrial decision makers.”

“Have one strategy plan by the tri-county area that all counties are committed to and actively participate in.”

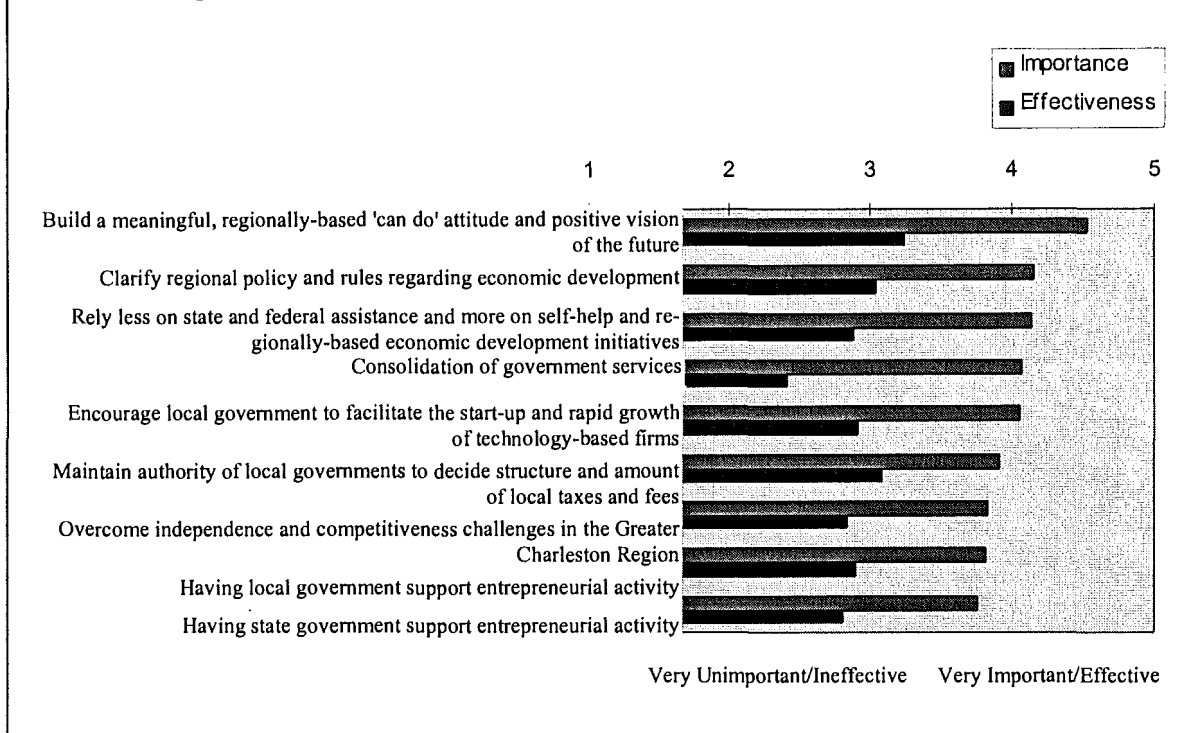
— *Survey Respondent*

“Why hasn’t the Cooper river bridge issue ever been resolved?”

Importance of Local Government and Other Issues for Economic Growth

Respondents were asked to rate the importance and level of effectiveness in the Charleston region of nine recommendations regarding the role of government in entrepreneurial activity and other issues which

Figure 4-11: Importance of Regional Issues in the Charleston Area



could facilitate economic development and the growth of technology-based firms, Figure 4-11.

Rated most important was the need to build a meaningful, regionally-based 'can do' attitude and positive vision of the future, followed by the need to clarify regional policy and rules regarding economic development; relying less on federal and state assistance and more on self-help; and the consolidation of government services. Of the four issues considered to be the most important for economic growth, the building of a meaningful, regionally-based 'can do' attitude and positive vision of the future received the highest rating of current effectiveness in the Charleston region (3.24).

Respondents also made reference to these issues in the written-in comment sections of the survey, as exemplified below:

"Reduce government interference and agency control and economy and business will be successful."

"Charleston, Columbia, and Greenville coming together politically to form a strong state is very important!"

"The most important factor to inhibit growth is political fighting between municipalities and local governments."

"Too much government. Too many entities to deal with in negotiations."

"Need a consortium of industry education and governmental resources to support new/expanding/healthy businesses."

"Tri-county government cooperation."

"The region's various economic development institutions--i.e. chambers, governments, Alliance, small business community, MUSC, SCRA, and colleges--should come together in commitment to the importance of all economic development activities."

"Government interference inhibits growth."

On the one hand, both the ratings of importance and the written comments indicate a desire among many of the respondents for the reduction of infighting so that public and private sectors can work together to create strong and comprehensive economic development plans.

On the other hand, there is a lack of consensus over the role of the local and state governments in the planning of economic development and overall entrepreneurial activity. Some respondents view regional government as a ‘good ole boy’ network which inhibits change and growth while other individuals indicate the need for government involvement in entrepreneurial planning.

In short, there is support for the inclusion of local and state government in the development of an overall economic strategy, while there also is strong support for no government intrusion in business activity.

Important Factors that will Facilitate or Inhibit Economic Growth of Technology-Based Industries

In an open-ended section of the survey, respondents were asked two questions:

- 1) What do you think is the most important factor or condition that will facilitate the economic growth of technology-based industries in the Charleston region during the next ten years?
- 2) What do you think is the most important factor or condition that will inhibit the economic growth of technology-based industries in the Charleston region during the next ten years?

The large majority of respondents reported the same factor or condition as being potentially a facilitator or an inhibitor of growth depending how the challenge is met. Education was reported as being the most important factor in both facilitating or inhibiting economic growth—depending on whether improvements were made or not. Of all written-in responses, approximately 40% emphasized the importance of quality education. Most respondents referred to either the lack of skill among the work force

due to poor education or the importance of improving elementary and secondary public education. Illustrative comments include:

- “Improve the local educational system--especially the public schools.”
- “Improvements in the education of available workers.”
- “Lack of quality education and skilled labor.”

Following education, the creation of regional cooperation and organizational partnerships were reported as being most important for facilitating growth and most likely to inhibit growth if cooperation does not occur. Comments indicative of this sentiment include:

- “Political fighting between municipalities and local governments will inhibit growth.”
- “Important for growth is a plan that gets the local tri-county officials working together.”
- “Regional adoption of a comprehensive strategy which; confirms the relative importance of the mission; spells out institutional roles; and outlines time tables, necessary resources, and potential funding sources.”

The relocation of companies from other regions was also emphasized as being important for the growth of technology-based industries in the Charleston region. More specifically, many respondents suggested the need to provide tax breaks and other incentives in order to lure industry into the area. Select respondents’ comments are:

- “The first company or two brought in are critical and will set the stage--innovative lures should be used!”
- “A major technology company coming to Charleston from which other businesses will grow and spin-off [will facilitate growth].”
- “Active pursuit of technology-based industries along with improvements to infrastructure, educated work force, and quality of life.”

“Make it easier for industry to enter the Charleston region--more attractive benefits to bring out-of-town businesses.”

The other categories receiving multiple responses include: 1) improvement of physical infrastructure; 2) quality of life as a facilitator of growth; 3) development of port and Naval base as a facilitator of growth; 4) business networks and information centers as a facilitator of growth; 5) Lack of available financing seen as an inhibitor of growth; and 6) the establishment of class ‘A’ industrial parks seen as a facilitator of growth.

“Big Ideas” to Significantly Improve the Area’s Economy

The last open-ended question asked respondents, “What one ‘big idea’ or large-scale project could/should the Charleston region undertake to significantly improve the area’s economy?” Again, improvements in the education infrastructure was identified as being the most important ‘big idea’ for improving the area’s economy. The topic of education received the greatest amount of response to this question. More specifically, respondents suggested either improving the overall performance of the public education system or improving the skills of the local work force through specialized or advanced-degree education. Some of the suggested ideas were:

“Create a strong Masters and Doctoral program in Charleston--especially engineering.”

“Develop a branch campus with Clemson University at the College of Charleston to provide advanced degree courses for math, science, and engineering. I’m afraid technology-based companies are reluctant to come to Charleston because of the lack of educational opportunities for their work force.”

“Enhance the total educational environment: 1) Expand and improve school-to-work; 2) Expand availability of advanced degrees; 3) Advanced technical training; and 4) Make every parent and kid expect and demand excellence in education.”

“Improve education--to year-round schools with tech. classes available in junior and high schools.”

“Charleston should stop comparing itself to other southern regions when assessing educational quality. If you want a national/international business base, then you must look beyond this region. I would suggest that education innovators from the North and West be brought in to present their strategies to private and public school leaders in this area. There is too much emphasis on a ‘tradition’ of mediocrity in education. The recent struggles concerning accelerated classes in middle school and the site for the academic magnet school underscore attitude problems in the area.”

“Learn a lesson from Georgia--creatively fund the educational system by lottery or any means to upgrade the current level of education.”

Suggestions for improving Charleston’s physical infrastructure were second highest in frequency with 22 respondents commenting. The following is a selection of ‘big ideas’ representative of the comments made regarding infrastructure.

“New Cooper River bridge--8 lanes.

A monorail system linking all major areas that is reliable and inexpensive.”

“Have a limited access highway from Charleston to Augusta to link up with I-20 and Atlanta, and a limited access highway going up SC 41 to connect with I-95.”

“Create a master plan to coordinate rail, land, sea, and air transport through Charleston’s port area. We need a plan to merge these capabilities to obtain maximum potential through synergy as opposed to individual efforts.”

“Light rail links to suburban areas.

“Improved roads and bridges--clean up roadsides--stricter rules for trucks carrying loose material.”

Comments regarding the creation of industrial parks were also specified frequently. Most would like to see the development of a class ‘A’ industrial park, and many of the respondents commenting on industrial parks suggested using the Naval base as a prime location. The following are some of the suggestions made.

“Build a very large research park similar to Research Triangle Park in North Carolina, and encourage capital from national and international sources to invest in this park and locate high technology R&D programs here. Must make the banking and venture capital funds more accessible to start-up companies that participate in this enterprise.”

“Develop major joint Tri-county industrial and technology park including spec buildings with appropriate educational and conference facilities located in the park.”

“World class industrial complexes: well defined, close to major transportation, close to ‘technical education’ resources, well supported by community and local governments.”

“Regional industrial park with appropriate connections to port, railroads, highways, and airport.”

“A large regional business/ corporate/technology business park with direct access to rail and highways (I-26)--Class A.”

“Using existing property and buildings from Charleston Naval base for center for technology-based industry.”

The relocation of established companies from other regions in the U.S. received considerable mention as an idea to improve the economy of the Charleston area. While most of the respondents simply suggested the recruitment of large technology or manufacturing companies to the area, a few

respondents specifically outlined how this might be accomplished.

“A full-time, focused task force working on targeting industries to relocate to the region.”

“Target Fortune 100 and 500 companies throughout the U.S. with a survey asking the CEO’s and CFO’s what attracts them to an area to build a new facility or to relocate. Include a wide variety of topics (such as this survey has done). Then use this information to target and recruit these and other similar industries that fit into the Charleston environment and also use results to improve, change, or develop important issues to make us more attractive.”

“Executive Management Conference -- Invite top level executives of existing and prospective large employers to meet here and discuss in detail the factors needed to put Charleston at the top of the ‘areas to grow in’ list. Meeting here would allow the group to experience our quality of life, as well as see firsthand some of our benefits like lower wages than other metropolitan areas and special schools.”

“Big ideas” were also mentioned for regional cooperation in developing an economic strategy for the region (11 comments); the consolidation of city/county governments (7 comments); forms of assistance to businesses (6 comments); and tourism as a means of increasing growth (6 comments). The overall comments from the open-ended questions of the survey indicate that the improvement of the educational system is viewed as being most important for economic growth, followed by the creation of regional cooperation and organizational partnerships and physical infrastructure challenges.

Summary and Conclusion

The overall ratings of importance from the survey on technology-based entrepreneur-

ship indicate that the most important issues facing the Charleston region are the improvement of the educational system; physical infrastructure challenges; access to R&D and technology; and financing for technology-based business expansions, spin-outs, and start-ups.

More specifically, respondents indicate that the most important areas are quality science/technology/mathematics education in area high schools; improving the conditions of roads and bridges; the development of existing public assets in the Charleston region; building a regionally-based supportive attitude; venture/business expansion capital; technology transfer linkages with nationally-based technology resources and markets; and accessible support for Charleston's entrepreneurs. The area that is considered to be the least effective in the Charleston region at the current time is access to research and development (R&D) and technology.

The written-in comments substantiate these findings. A significant majority of individuals mentioned education and physical infrastructure as being the greatest challenges faced by the Charleston community. Emphasis was placed on making a renewed commitment to the quality of education at both the K-12 and advanced levels. Many respondents were concerned that the educational system is not producing the skilled employees needed to attract technology-based companies to the region.

Roads, bridges, highways, and mass transit systems were all considered to be the most important issues regarding physical infrastructure. Many of the respondents stressed the need for the Cooper River bridge to be

rebuilt and transportation problems addressed so that companies from outside of the region would relocate or expand into the area. Finally, there were suggestions that the Tri-county region needs to be linked more effectively through the construction of a few key connecting highways.

The creation of regional cooperation and organizational partnerships was also considered to be important for the creation of a successful economic development strategy. A large number of respondents commented that economic development institutions in the Tri-county area are not working together as a unified group. Although there was no straight forward consensus regarding the role that the state and local governments should play in the strategic planning process, most respondents recognized the need for government cooperation with business, research, and the other key institutions involved.

Finally, respondents indicated the need to encourage the relocation and expansion of outside companies in order to increase the economic base of the region. Respondents suggested converting the Naval base to a class 'A' industrial park as a means of encouraging large companies to locate in Charleston and as a way to increase the manufacturing and technology industries. While relocation of companies was considered to be very important, a number of respondents also stressed the need to help local businesses, start-ups, and expansions through easier access to capital, information networks among business owners, and 'one stop' business centers to provide information on investors, mentors, and business plans.

Section V

Scorecard of Charleston-Based Technology-Intensive Industry Clusters

"We all know that science is not simply about the future. It is the future."

Dr. Neal Lane, Director
National Science Foundation
Oak Ridge Summit on Science, Environment, and Technology
June 1, 1995

Section V of this report provides a benchmark or "scorecard" of small, mid-sized, and large firms in six technology-intensive industry clusters in the Charleston region. Within each of these clusters are examples of the four economic development strategies described in Section I: company relocation, company retention and expansion, new firm development, and building institutional alliances across public and private sectors, (see Figure 1-1).

As Section II of this report described the great percentage of job and wealth creation in the Charleston region is currently in the public sector (i.e., government and education), services and tourism. Section V focuses on an important and growing segment of the Charleston and South Carolina economy---technology-intensive industry clusters. These clusters were defined and enumerated by The Charleston Metro Chamber of Commerce. They are:

- Electronics/Engineering/Computer Technologies
- Inorganic Chemicals
- Medical Technologies
- Environmental Technologies
- Plastics/Wovens/Nonwovens
- General Technologies

Using Standard Industrial Classification (SIC) codes, 119 firms, in the Charleston region, were selected as being in one of these six clusters. Each of these industry clusters and the designated companies with

date of founding, current size, and main product/service lines is listed in Appendix C. Each firm is categorized, within the appropriate cluster, as to whether it is small (1 to 9 employees), mid-sized (10 to 99), or large (over 100 employees).

This enumeration of technology-intensive firms is intended to provide a realistic indication of important and emerging areas of current and potential industrial growth for high value jobs and wealth creation in the Charleston region.¹

The two technology clusters with the greatest number of firms in the Charleston region are electronics/engineering/computer technologies (with 39 firms) and general technologies with 38 firms. There are also 16 environmental firms, 11 medical firms, 10 plastics/wovens/nonwovens firms, and 5 chemical firms identified, Figure 5-1.

As the data within Table 5-1 indicate, the greatest amount of current entrepreneurial and start-up activity (e.g., firms with 1 to 9 employees) is in the electron-

¹ While the objective is to present as complete an enumeration as possible, in the Charleston region, for all small, mid-sized, and large technology-intensive firms in each of the six clusters, this is a challenging task. The count changes daily as new firms are launched, some grow, some decrease in size, and some die. Furthermore it is often difficult to place particular firms in one designated cluster. The analysis in Section V is based on trends of over 50 years and is not limited to specific firms at any one period of time. In our data collection efforts we especially acknowledge the key role played by Mary Graham and Jacki Warren, Charleston Metro Chamber of Commerce.

Table 5-1: Industry Cluster by Number of Firms and Number of Employees

Industry Cluster	Number of Employees			Total Number of Firms
	1 to 9	10 to 99	100+	
Electronics/Computer	9	19	10	39
Inorganic Chemicals	0	1	4	5
Environmental	8	3	4	16
Medical	3	5	3	11
Plastics/Wovens/Nonwovens	0	5	4	10
General Technologies	7	17	14	38
Totals	27	50	39	119

ics/engineering/computer, environmental, and general technologies industry clusters. Mid-sized and large firms are most heavily represented in the electronics/ engineering/computer technology and general technology industry clusters.

As shown in Table 5-2, general technologies is the industry cluster with the largest employment, 3837 employees, followed by electronics/ engineering/computer technologies (2699 employees), inorganic chemicals (1960 employees), plastics/ wovens/ nonwovens (1506 employees), medical technologies (1112 employees), and environmental technologies (890 employees). Total employment across all six clusters is 12,004 which represents about five percent of the total civilian employment in the Charleston region as of Fall 1996.

As noted in Figure 5-2, 20 (about 17%) of the total sample of 119 technology-intensive firms are start-up or small firms with five or fewer employees. Eight firms (about 7%) have six-to-ten employees. Fifty-one firms (about 44%) are mid-sized with 11 to 100 employees, and 37 firms (about 32%) are large with over 100 employees.

Research on regional economic development throughout the U.S. emphasizes the importance of having different sized firms cooperating and competing within a dy-

amic high tech region. Small and mid-sized technology-intensive companies are important to regional economic development for:

- their potential for rapid growth
- the acceleration of technology commercialization of new to-the-world technologies and services
- the fostering of new and emerging industries

Large technology-intensive companies are important to regional economic development for:

- tax income
- entry level jobs and employee training
- technology/ideas for spin-out companies and as a source of trained personnel for new company formation
- being magnets for sub-contractors and service providers in related industries
- providing expertise and funding for innovative programs and state-of-the-art technologies for colleges, universities, and K-12

It is important to remember three crucial points when reviewing the employment numbers for technology-intensive companies (Table 5-2) and comparing them with the larger employment numbers of

Charleston's more traditional and service industries (Table 2-2).

First, technology-intensive jobs are high value jobs with the potential for rapid career development and comparatively high salaries.

Second, for each technology-based job it is estimated that 6 to 8 additional jobs are created in the surrounding region in services, education, and the professions.

Third, select small and mid-sized firms in emerging technology industries are capable of impressive growth and they have great wealth generating potential.²

Table 5-2: Number of Employees by Size of Firm for Each of Six Industry Clusters

<u>Electronics/Engineering/Computer Technologies</u>			<u>Inorganic Chemicals</u>		
Size of Firm	Employees	% of Elec/Comp.	Size of Firm	Employees	% Chemical
1 to 10	27	1.10%	1 to 10	0	0.00%
11 to 50	468	18.30%	11 to 50	0	0.00%
51 to 100	305	11.90%	51 to 100	62	3.20%
100+	1899	68.70%	100+	1898	96.80%
Total	2699	100%	Total	1960	100%
<u>Medical Technologies</u>			<u>Environmental Technologies</u>		
Size of Firm	Employees	% of Medical	Size of Firm	Employees	% of Environmental
1 to 10	18	1.60%	1 to 10	27	3.03%
11 to 50	140	12.60%	11 to 50	45	5.06%
51 to 100	0	0.00%	51 to 100	83	9.32%
100+	954	85.80%	100+	735	82.59%
Total	1112	100%	Total	890	100%
<u>Plastics/Wovens/NonWovens</u>			<u>General Technologies</u>		
Size of Firm	Employees	% of Plastics	Size of Firm	Employees	% of General
1 to 10	0	0.00%	1 to 10	46	1.20%
11 to 50	82	5.40%	11 to 50	202	5.30%
51 to 100	75	5.00%	51 to 100	505	13.20%
100+	1349	89.60%	100+	3084	80.40%
Total	1506	100%	Total	3837	100%
Grand Total employees in all six clusters = 12,003					

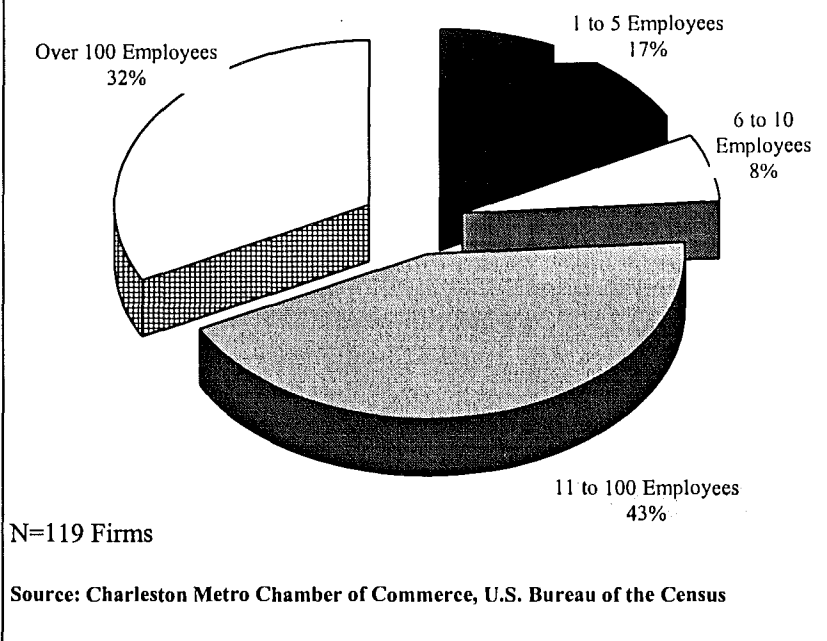
According to the address and location of each of the 119 technology-intensive companies (see Table 5-3), there is an emerging high tech corridor in the Charleston region: developing to the northwest of Charleston in the I-26/I-526 corridor. It is likely that companies are concentrating in this area because of access to interstates and main thoroughfares as well as proximity to the International Airport. Additionally, this area includes the region's largest concentration of suburban office space.

Using the founding dates of the 119 firms, Figure 5-4 shows the "peaks" and "valleys" for firm relocations and foundings (spin-outs and start-ups) of technology-intensive firms from 1951 to 1995. Such activity has been generally increasing from the 1970s through the 1980s and into the 1990s.

Figure 5-5 shows that the cumulative growth of technology firms was relatively flat from 1950 to 1961 with 10 to 17 firms. While there was slight growth in the 1960s it was in the 1970s and during the 1980s, continuing into the 1990s when Charleston began to show its potential as an emerging area for technology-intensive firms.

It is interesting to compare the stages of preconditions for takeoff, pre-takeoff, and sustainable growth as noted in Figure 5-5 with similar analyses in Austin, Texas from 1945 to 1992 (Figure 5-6) and East Tennessee from 1960 to 1994 (Figure 5-7). Professor Walt Rostow (Senior Research Fellow, IC² Institute and Professor at Lyndon B. Johnson School of Public Affairs, University of Texas at Austin), who has written extensively on the history and future of regional economic development, provides the following explanation.

Figure 5-2: Technology-Intensive Companies by Size of Firm



"The sequence of economic development consists of three periods: a long period (up to a century or, conceivably, more) when the preconditions for take-off are established; the takeoff itself; and a long period when growth becomes normal and relatively automatic.³ Take-off is defined as the interval during which the rate of investment increases in such a way that real output per capita rises and this initial increase carries with it radical changes in production techniques.

³ Rostow, W.W., "The Take-Off into Self-Sustained Growth", *Economic Journal*, Vol. LXVI, No. 26 (March 1956), pp.25-48.

Technology Intensive Companies Charleston Metropolitan Area

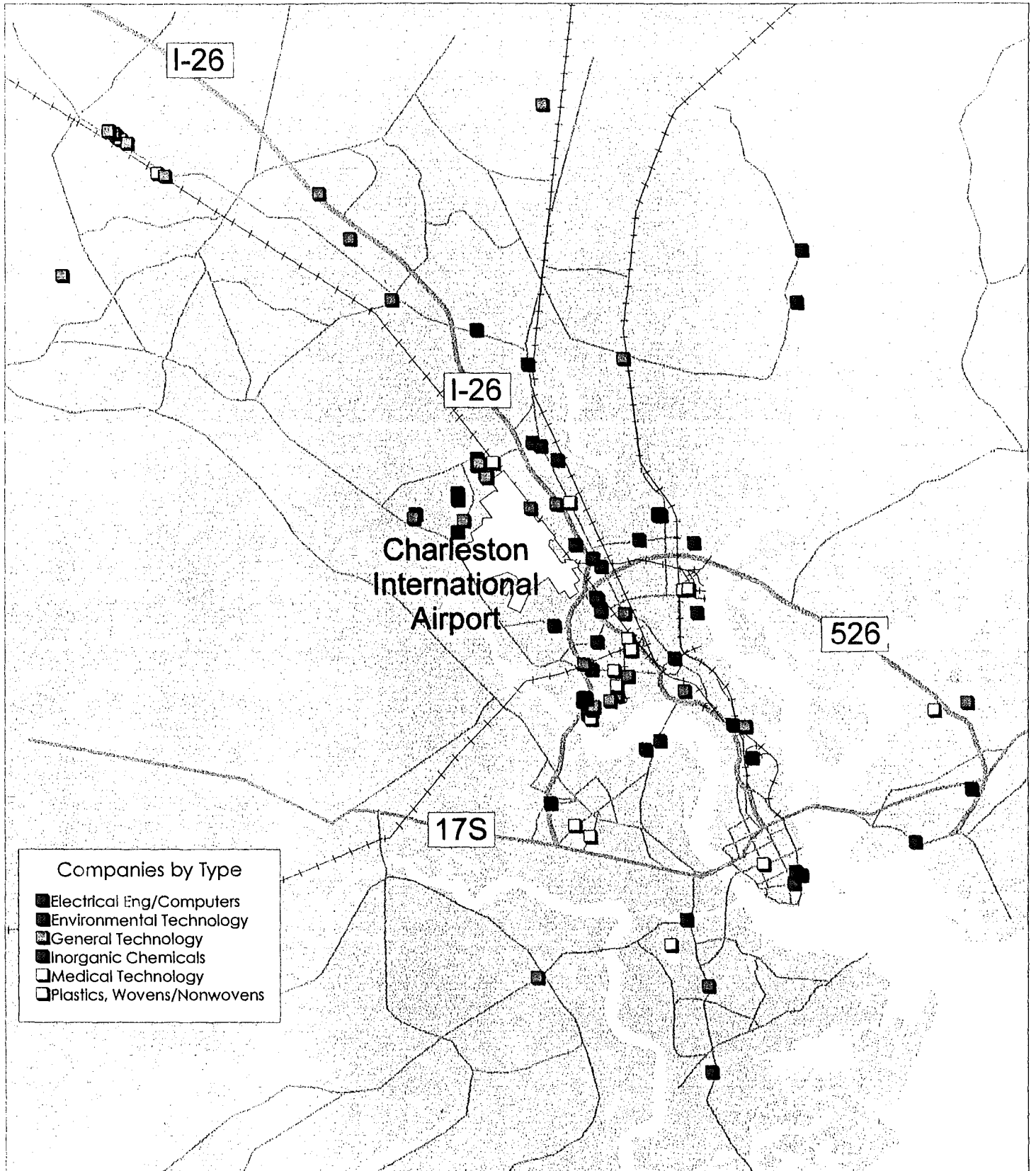
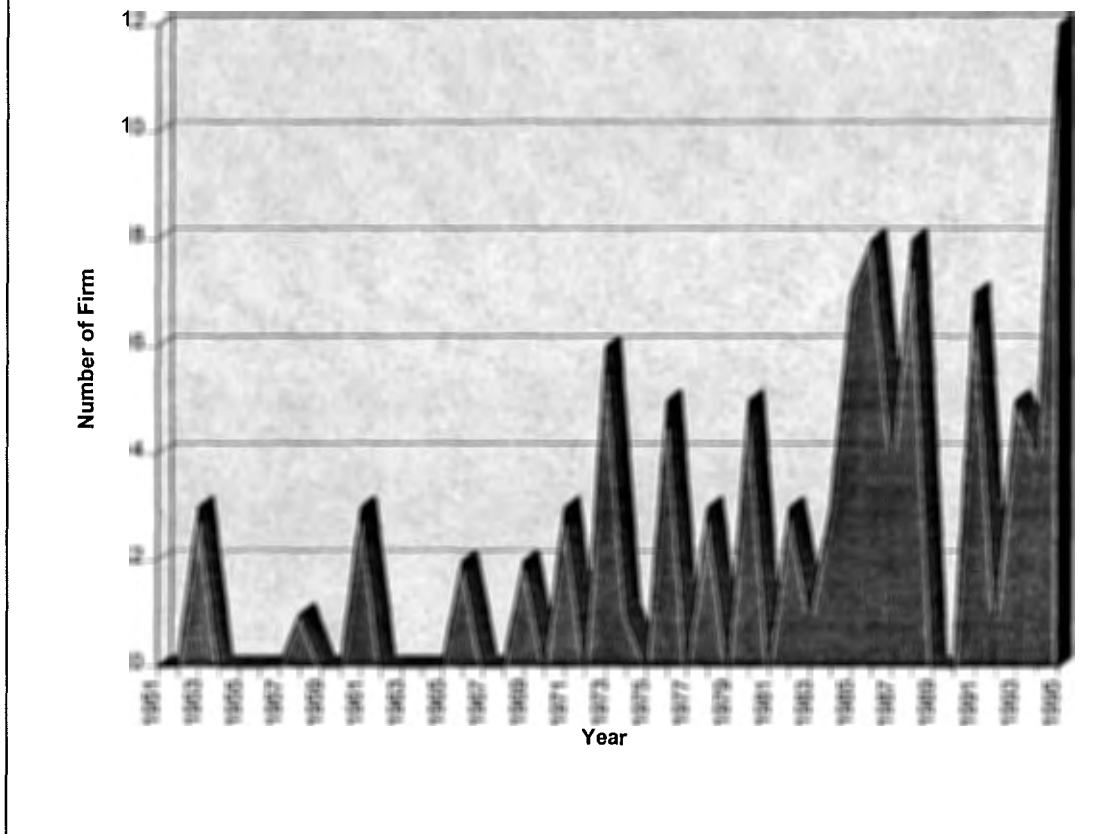


Figure 5-4: Technology-Intensive Firm Relocations and Foundings by Year in the Charleston Region from 1951-1995.



Takeoff requires a society prepared to respond actively to new possibilities for productive enterprise; and it is likely to require political, social, and institutional changes which will both perpetuate an initial increase in the scale of investment and result in the regular acceptance and absorption of innovations.¹

The essentially nonacademic process permitting the drive to technological maturity to happen is a progressive increase in technological absorptive capacity; that is, the buildup within the society of scientists and engineers, workers and entrepreneurs, and foremen and managers capable of absorbing the backlog of relevant, increas-

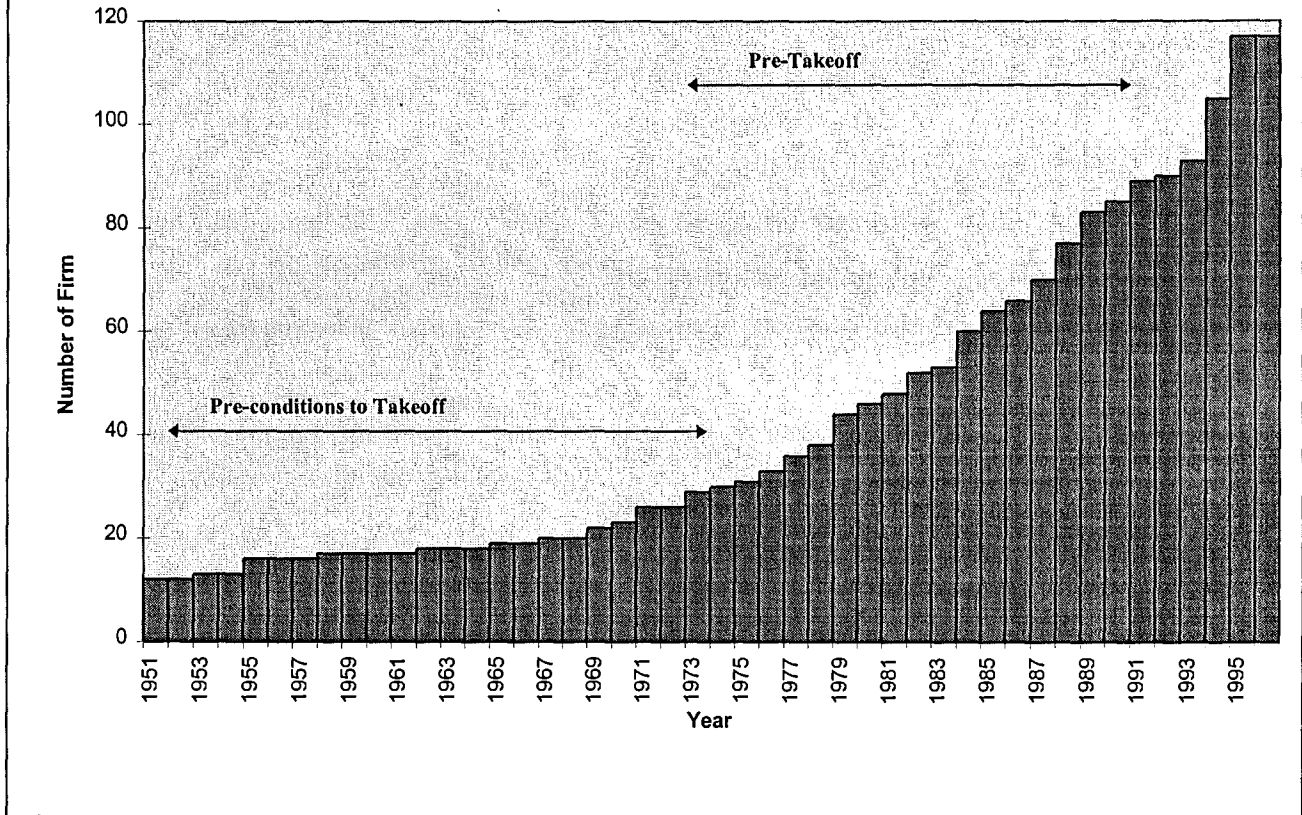
ingly sophisticated, hitherto unapplied technologies. This implies not only an extension of education at every level and the emergence of modernized institutions encouraging the process, but also a succession of generations each born into and taking for granted a technologically more complex and diversified world.²

Austin is known worldwide as a dynamic and rapidly growing “technopolis”. Yet at its pre-takeoff stage, which began around 1985, Austin had about 150 high technology firms, Figure 5-6. This number is only slightly more than the Charleston region

¹ Rostow, W.W., *The Process of Economic Growth*, New York: W.W. Norton & Company, 1962, pp. 274-275.

² Rostow, W.W., *Theorists of Economic Growth from David Hume to the Present*, New York; Oxford University Press, 1990.

Figure 5-5: Cumulative Total of Technology-Intensive Firms in the Charleston Region, 1951 to 1996.



records in 1996.³ East Tennessee, which is home to Oak Ridge National Laboratories and related federally supported R&D activities funded at over \$1 billion per year, is identified for potential “pre-takeoff” in the early 1990s with a count of about 220 regionally-based technology-intensive firms, Figure 5-7.

Despite East Tennessee’s massive federally funded R&D, which is significantly greater than exists in Austin and the large number of technology firms, it is Austin, Texas that is the growing, nationally and internationally recognized technopolis. One major dif-

ference between these two areas has been Austin’s greater success in building regional alliances across academic, business, and government sectors to facilitate the linking of talent, technology, capital, and know-how at the community level (see Figure 1-2) to foster value-added technology commercialization and economic development (Gibson and Rogers, 1994).

While it is somewhat encouraging to show the numbers and growth of small, mid-sized, and large technology intensive firms in the Charleston region, it is perhaps more important to analyze each cluster in terms of two important characteristics: (1) whether the firms are service or product oriented, and (2) whether or not these firms are part of the Fourth Industrial Revolution, Table 5-4.

³ Techno reflects an emphasis on technology; polis is the Greek word for city-state that emphasizes collaboration between the public and private sectors. The modern technopolis fosters technology commercialization through collaboration between the public and private sectors to spur regional economic development and to promote technology diversification and the creation of high-value jobs, see Smilor, et al 1988; Gibson, et al 1992.

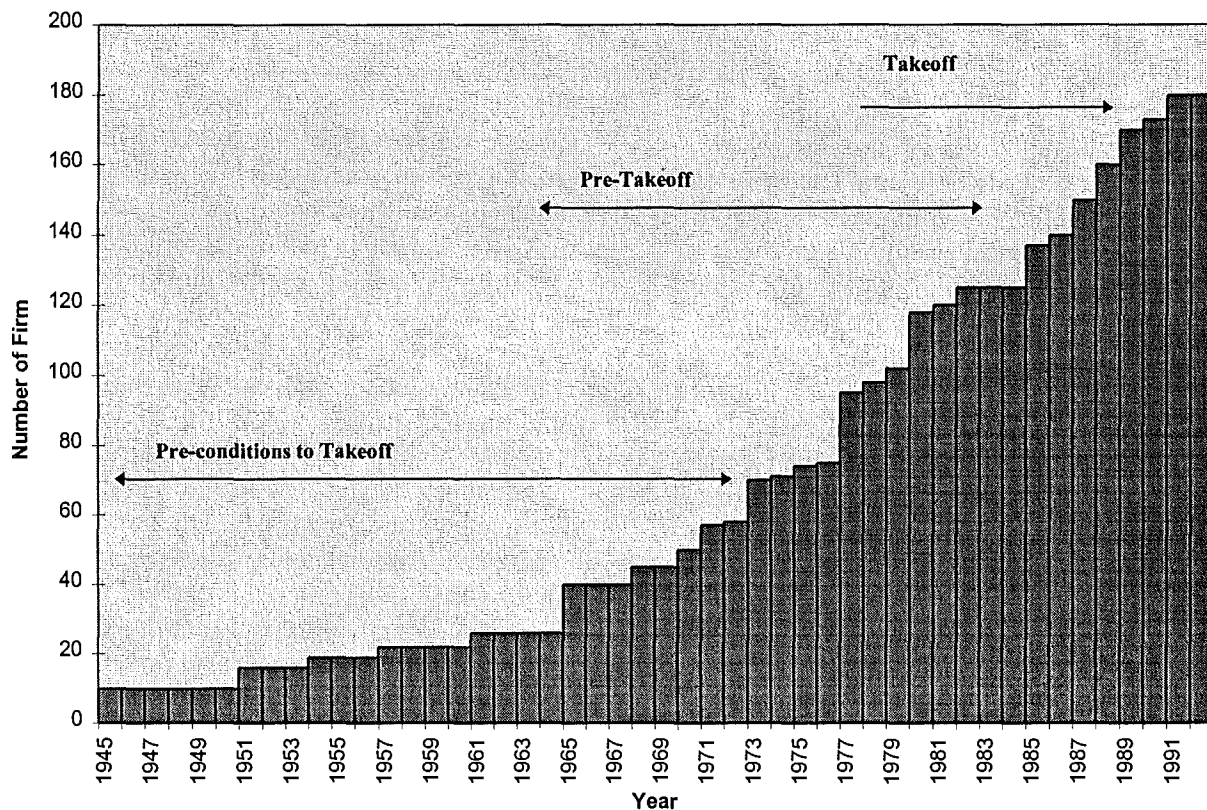
Core, high value technology jobs are in product oriented firms. It is these firms that export technology/products to create wealth at home and it is these firms that support the service sector. While regionally-based service firms also create wealth through exporting their services, nationally and globally, their sustainability and growth is often dependent on the wealth generating potential of product oriented firms.

The Fourth Industrial Revolution, which began asserting itself in the mid-1970s, has four major dimensions — microelectronics, genetic engineering, new industrial materials, and lasers. All of these technologies are subject to global competition and discontinuous new developments as well as sustained incremental progress. According

to Rostow, The Fourth Industrial Revolution will suffuse virtually all the major challenges the global community will confront in the 21st Century.

While the Charleston-Based Electronics/Engineering/Computer Technology Cluster is among the largest, of the sample of firms, 23 are service oriented while 15 are product oriented. However, all 15 of the product oriented firms could be considered part of the Fourth Industrial Revolution. Of the 38 firms listed in the General Technologies Cluster, all 38 are product oriented; however, only about 13 of these firms are part of the Fourth Industrial Revolution. Firms not part of the most recent industrial revolution produce such products as forklifts, particleboard, cement, engines, wind

Figure 5-6: Cumulative Total Technology-Intensive Firms in Austin, Texas, 1945 to 1992.



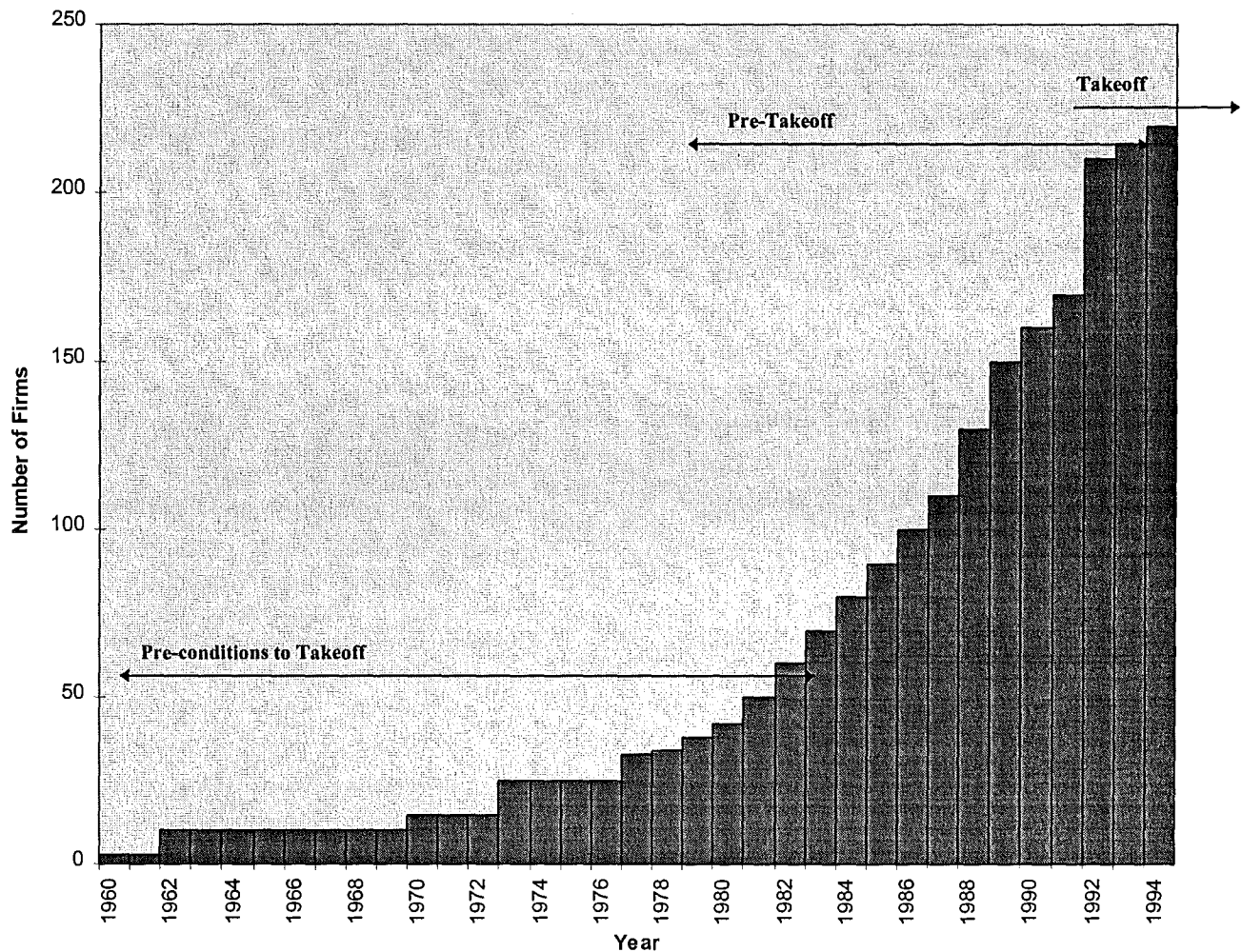
Source: *Austin Technology-Based Industry Report*, Gibson, et al, 1991.

chimes, lumber, and musical instruments. While all of these firms are important and all provide jobs and create wealth, it is the Fourth Industrial Revolution technologies that will shape the future of Charleston and determine the global competitiveness of the region.

Within the Environmental Technologies Cluster there are 9 service firms and 7 product oriented firms; however, all 7 product oriented firms are part of the Fourth Industrial Revolution. The Medical Technologies cluster has only 11 firms listed, but 9 of

these firms are product oriented and most of these are central to the Fourth Industrial Revolution. There are only 10 firms listed in the Plastics/Wovens/Nonwovens Cluster but all 10 are product based and all 10 are part of the Fourth Industrial Revolution. Finally, five firms are listed as part of Charleston-based firms in the Inorganic Chemicals Cluster; however, once again, all these firms are product oriented and are part of the Fourth Industrial Revolution. In short, while the Environmental, Medical, Plastics/Wovens/Nonwovens, and Inorganic Chemical industry clusters have fewer firms

Figure 5-7: Cumulative Total Technology-Intensive Firms in East Tennessee, 1960-1994.



Source: East Tennessee's 21st Century Jobs Initiative: Creating Wealth for a Sustainable Economy, Gibson, et al, 1996.

Table 5-4: The Four Industrial Revolutions

Industrial Revolution	Key Technologies	Managerial Issues
First	Textile, iron from coke, steam engine	One man or one family affair
Second	Railroads and steel making	Exploitation of scale and investments in production, marketing, and management
Third	Electricity, batch elements and combustion engine	Exploitation of R&D, mass production, and scope (more than one product)
Fourth	Microelectronics, bio-technology, genetic engineering, new materials, robots, environmental technology	Global markets, niche markets, flexible manufacturing and linking of science, innovation and management for rapid change

Source: Rostow 1990; Kozmetsky, 1994.

and employees than the Electronics/Engineering/Computer Technology and General Technologies Clusters, their product and technology orientation suggests that they deserve special consideration in terms of regional economic development. For example, the economic growth strategy of firm relocation for each of these industry clusters might benefit from targeting specific product oriented firms in Fourth Industrial Revolution technologies. Certainly the economic development strategies of new firm creation and alliance building would do well to focus resources on firms and strategies that enhance product development in creative and innovative technologies to the

general benefit of established firms and new industries.

Case profiles of representative examples of Charleston-based small, mid-sized, and large technology-intensive firms are now presented:

- To emphasize important “first hand” reasons why these firms chose to locate and remain in Charleston
- To enumerate barriers and facilitators to their growth
- To share lessons learned to the benefit of current and future entrepreneurs
- To celebrate successful “role model” individuals and firms

General Engineering Laboratories Inc.

GEL was launched in Charleston in 1981 by Molly and George Greene. Dr. Greene earned a Ph.D. in Chemical Engineering from Tulane University and Mrs. Greene has a liberal arts degree from Mississippi University for Women. Over the years their diverse educational backgrounds have served to complement their business challenges. Growing up in the South, the Greene's were anxious to return "home" and establish "roots" for their two young children. Dr. Greene was working for Exxon Research and Engineering in New Jersey and Mrs. Greene was establishing a Spanish program in a private school. They both loved to sail, and they both knew that they wanted to own their own business. On one particularly cold and snowy February day in Morristown, New Jersey, after two years of looking around for a business opportunity, they decided to drive south one more time. As Mrs. Greene remembered,

"Although we fell in love with Charleston, we couldn't find a marine related business that we could afford to buy. However, we did locate a small waste water lab that was for sale. We figured George had the technical background and I enjoyed the people aspect of business. Our first major challenge was raising capital. Instrumentation needed to modernize the lab was expensive [\$15,000 to 100,000 for each instrument at that time] and capital was difficult to come by so we took out a second mortgage on our Jersey home and sold our sailboat. While we had no fear of failure, we were extremely lucky, it was the right place and the right time to establish a hazardous waste business.

Fortunately, Charleston's business community, especially Jerry Zucker, kept opening doors for us and encouraging us. When we were first located in an old dry cleaning company down the street from here, we could not get any money from the Small Business Administration. However, we found one bank, First National Bank of Charleston, where Betty Mouzon, the manager provided the necessary seed capital [interest rates at the time, 1983, were 18%] for our entrepreneurial venture. We credit her 'faith in our abilities' as a turning point. Our ability to service our debt and grow was beyond belief. Most of the banks who turned us away in the early days have by now beaten on our doors to have another chance. The expectation at the time was that 'our' testing lab would earn about \$30,000/year, much less than George's income at Exxon. We weren't looking for big incomes, we were looking to be part of a community---to make a contribution."

General Engineering Laboratories' (GEL) initial operating philosophy was, "If anybody calls, tell them we can do it. Often we had to figure out 'how' after we got the work. But, there was never fear of failure although times were difficult." The environmental industry exploded in the mid 1980s. Average growth was 20 percent, GEL grew at 40 percent. Demand was great and the supply was limited. GEL doubled in people and facilities every two years. In 1991, the company grew 67 percent which motivated another turning point.

"We needed help. We lacked systems to handle the growth. Employee morale was at an all-time low and turnover was high. We were no longer just the 'Mom and Pop Lab.' We hired a management consultant to help us identify issues and develop implementation plans. She worked with us throughout the year and assisted us in turning things around. We had grown so quickly that we had lost sight of our vision. Our

mission was unclear to most of the people working with us. We were doing everything possible just to get the work out."

Nine vision groups were formed within the company, and each employee was assigned to one of the groups. Each group articulated GEL's corporate vision: "To Be the Environmental Firm of First Choice." The groups also identified objectives the company would have to meet to attain the vision - such as to respond "with technical competence and personal concern to clients' needs and to provide superior consulting services based on a thorough understanding of the regulations and sound engineering and scientific principles and to ensure that employees will work in an atmosphere of trust and open communication where good ideas can be quickly implemented, where they can grow in their careers, and where compensation and benefits will be attractive."

GEL also sought guidance from some of the "best run" companies. The Greene's were invited to visit Hewlett-Packard in Palo Alto, CA and meet with their leadership group and go through their strategic planning process as well as how to better meet the needs of internal and external customers. Along with 12 to 16 hour work days, six days a week, the Greene's built a corporate culture that included oyster roasts, raft races, and parties at their home.

The environmental industry has gone through its fast growth stage and is in a maturing stage. There is tremendous over-capacity and price erosion. Many competitors are consolidating, downsizing, or going out of business. As Molly Greene emphasized,

"The U.S. has the reputation of being the leader in the environmental industries. We are the largest, privately owned, single site environmental laboratory in the country---Battelle, the National Labs, DOE [Department of Energy] are our clients. However, testing companies, worldwide, are currently undergoing difficult times---competition is intense, equipment and personnel are costly, and profits are shrinking. Currently we are in a shake out period in the environmental industry. A good lab in Research Triangle Park just declared Chapter 11. There is so much competition. We need to tighten our belt and watch our expenses. We are back to working 12 hour days. We have to do more with less. As of now, we are doing very nicely and have a stable and sound balance sheet. Our strategy is to be pro-active and to develop global markets while cutting costs."

Currently around 200 highly trained General Engineering Laboratories (GEL) personnel are using some of the world's most advanced, high performance instrumentation in a sophisticated, state-of-the-art facility to provide quality environmental data quickly and economically. GEL is providing world competitive environmental consulting and analytical services using organic and inorganic chemistry laboratories, a radiochemistry laboratory, a general chemistry laboratory, and specialized computer software.

NCGS and Associates, Inc.

NCGS and Associates Inc., which was launched in Florence, South Carolina in 1984, moved to Charleston in 1993, "because it is a charming place to recruit people." Charleston's amenities: historical charm, coastal location, proximity of world class golf courses, and fine dining make the area a very desirable location for NCGS to attract quality employees.

"...clients enjoy visiting Charleston for on-site consultations with company staff," stated Nancy C.G. Snowden, founder. Furthermore, "the Medical University of South Carolina provides NCGS with a pool of quality employees as does the College of Charleston and the Citadel."

NCGS is a contract research organization that provides services nationally for the pharmaceutical and diagnostic industry. The company's primary service is to expedite FDA submissions for drug, device, biologic and diagnostic procedures. For example, if a pharmaceutical company wishes to test a new product, it may contract with NCGS to design the clinical study, identify medical centers where the appropriate research may be conducted, construct the forms for data entry, monitor the research, and finally evaluate the data. NCGS compares new products to the competition or other currently available products to ascertain if the product is as safe and effective. Clients include Johnson & Johnson, Bayer, Genentech, Amgen and Becton Dickinson.

From 1984 until 1995, NCGS averaged 84 percent annual growth in sales. By 1994, Ms. Snowden had hired 20 full-time and 40 part-time employees, and by 1996, the company expanded to 40 full-time employees and a network of 40 contract workers across the country. In 1996, NCGS received the 1996 Blue Chip Enterprise Initiative, an award sponsored by Connecticut Mutual Life Insurance Co. and the U.S. Chamber of Commerce which recognizes small businesses that have prospered despite past adversities. The current challenge for NCGS is expanding to a bi-coastal operation in response to a growing West Coast business. NCGS has several major clients in the San Francisco area and is considering opening a satellite office in the Bay Area.

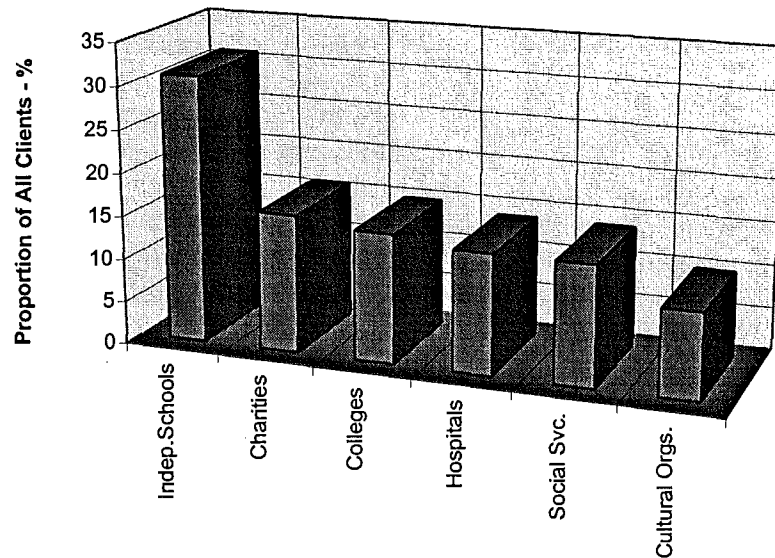
Blackbaud, Inc.

Blackbaud was founded in 1981 in New York City, moved to Long Island in 1986, and moved from there in 1989 because of that area's climate, high tax rates, and high salaries. After biking around Charleston's historic area, the founder and current president, Anthony Bakker, chose Charleston to grow his company mainly for the area's attractive lifestyle. He had considered Atlanta, Charlotte, Savannah, and Research Triangle.

Headquartered in Charleston, Blackbaud develops, markets, and supports fund-raising and gift-giving software packages used by preparatory schools and non-profit institutions throughout the country and internationally. In addition to its principal software package, The Raiser's Edge for Windows, Blackbaud has products for fund accounting, admissions, and student registration. The firm is among the premier companies in this growing market. Blackbaud's more than 6,000 clients can be classified into six major categories as shown below.

Blackbaud's internal growth is strong, and the firm recently acquired a number of smaller software companies around the country. The firm's employment was at 170 in 1994, increased to 230 in 1995, and was 301 as of November 1996.

Blackbaud's Client Base (By Type of Organization)



Key Challenges to Growth

While Blackbaud has found Charleston to be attractive to recruits in terms of overall lifestyle and the area's appeal as a relatively low cost region in which to live, this growing company has been unable to meet its need locally for trained software programmers. As a result, most programmers, about one-third of Blackbaud's employees, are hired from outside the Charleston region.

Blackbaud experienced difficulty in obtaining a commercial bank account with traditional borrowing arrangements because the company had few plant and equipment assets. As a result, for several months, the firm operated on the personal credit accounts of the senior officers. As one senior Blackbaud officer noted:

“...unless you have a smokestack and there are widgets coming out the end, they don't understand you in Charleston or South Carolina.”

Other barriers to Blackbaud's growth include a lack of continuing education opportunities for its key technical staff and the availability and quality of some key local support services, particularly specialized legal expertise and employee benefits planning.

Despite these challenges, Blackbaud is pleased to be located in Charleston and the company welcomes other software firms to the region and believes they “...will not only add to the labor pool, but also increase the visibility and acceptance of information age firms in the region.”

SMARTech Stations

Located between a propeller factory, a bug spray operation, and a metal fabrication plant just off Signal Point Road is SMARTech Stations™, one of Charleston's globally competitive technology-based start-up firms. SMARTech was launched by three partners in 1989. The company's founders were initially recruited from out-of-state by the National Oceanic and Atmospheric Administration. NOAA's Charleston-based operations were seen as an attractive place to live and pursue their professional careers. However, with time these public sector entrepreneurs began to think about starting their own company.

SMARTech's founders initially used off-the-shelf locally developed technology in innovative ways to provide turn-key computer/software solutions for real-time acquisition, processing and interpretation of data transmitted from NOAA and other imaging satellites. Their products are currently sold mostly to educational and research professionals worldwide in marine, terrestrial, and atmospheric applications. The cost of each SMARTech system ranges from \$25,000 to \$90,000.

Eight-five percent of SMARTech's sales are international---sixteen countries including Japan, South Korea, Taiwan, India, Chile, Brazil, and Egypt. Advanced information technology allows SMARTech to provide global customer support and computer-based diagnostics from the firm's Charleston headquarters. SMARTech also trains, in Charleston, employees from the firm's 20 international distributors. Currently, SMARTech's most significant worldwide competition comes from companies located in LaJolla, CA; Scotland; and England. Because of the lack of local airfreight facilities, the firm's products are trucked for international shipping to airports in Atlanta and Charlotte.

While receiving initial and crucial support from Hawthorn Investments, the start-ups biggest continuing challenge is raising capital for business expansion. As stated by one of SMARTech's founders,

"We fall between the cracks - we're too successful for State and Federal assistance programs and too small for V.C.'s [venture capitalists] and banks. Furthermore, they [the banks] have trouble understanding our competitive urgency as well as the international business challenges we face daily. Charleston's lending institutions generally don't understand technology companies. If we were a dry cleaning business then there are lots of government assistance programs.

At times we've asked ourselves, 'Did we start SMARTech in the wrong state?' We've had recruitment offers from Massachusetts and Hawaii, but we prefer to live and work in Charleston."

With each year of operation, SMARTech develops more of its own proprietary computer and software technologies providing additional employment opportunities for trained personnel. However, a second important challenge to SMARTech's growth is being able to hire (1) locally trained machinists, for part fabrication, and (2) software programmers who understand the company's technologies and markets. Fortunately one of SMARTech's competitive strengths is the firm's ability to recruit quality, trained employees. Key to such recruitment success is Charleston's high quality of life and local research and educational opportunities.

As stated by Leslie Davis, Vice President, International Marketing,

“It’s easy for us to recruit and retain talent. Unbelievable talent comes through the area because of the region’s amenities and the marine programs offered at NOAA and the College of Charleston.”

SMARTech’s President, Kevin Davis states:

“Charleston has been a challenging place to develop a technology-based firm. NOAA’s planned Center for Technology Innovation (CTI) would provide a valuable place to share ‘lessons learned.’ Entrepreneurs often don’t know what they don’t know and we would welcome support and advice as we ramp up production and attempt to secure additional capital.”

Westvaco

With paper and specialty chemical manufacturing facilities located in Charleston, Westvaco Corporation (listed 180 on the Fortune 500 list with sales of \$3 billion) is one of Charleston's largest technology-based employers. New product development, patents, and technology licensing are all a very important part of Westvaco's competitive strategy. Since 1980, the company has been honored nearly 50 times with environmental awards including forestry management, wildlife and wildlife habitat enhancement, and environmental education.

Quality education, at all levels, is very important to Westvaco's success in the globally competitive marketplace. The company's Charleston operations have a learning center to assist new and experienced employees and their families in expanding their skills as well as refreshing basic skills. Company employees mentor students in area high schools and volunteer for local education initiatives.

Westvaco is currently building a \$20 million Technology Center at its Charleston location. With a rapidly growing R&D department, the Charleston-based Technical Center is an important resource for the region. As stated by Research Director, Ben F. Ward, Jr., "The company interviews all over the U.S. to hire the most qualified PhDs to bring to the Charleston facility. We are hiring 10 to 20 new research employees each year." The Research Center currently employs about 50 PhDs. Most are chemists or chemical engineers. While new hires with bachelor degrees in technical disciplines from the Charleston area excel as analysts, Dr. Ward believes Westvaco in particular and Charleston in general would benefit from more quality graduate chemistry and engineering programs in the region, so employees could continue their formal education. Many advanced degree prospects are married to scientists or engineers, so finding both a job in the area is at times a problem. "A major challenge is to find quality, technology/business related jobs or educational opportunities for spouses," says Dr. Ward. "More technology-based firms and more advanced degree programs in the area would enhance our recruiting efforts by increasing the desirable options for dual career families."

Section VI

Where Opportunity Meets Necessity

"No matter what field you are talking about -- electronics, medical, education, the environment, entertainment -- the global marketplace opens up more opportunities than I've seen in my lifetime. Very few generations in history, perhaps not since the Renaissance, have been accorded the opportunities this period provides. It is a profoundly different world."

Dr. George Kozmetsky
Chairman of the Board
IC² Institute, The University of Texas at Austin
quoted in *Inc. Magazine*, August 1996

As previous sections of this report have shown, Charleston is poised for technology-based growth. Now is the time when opportunity must meet necessity.

Opportunity is to:

- Build on the region's emerging technological base and internationally recognized high quality of life.
- Target key industrial sectors for expansion through entrepreneurial and technology transfer initiatives for small, medium-sized, and large firms.
- Strive toward world-class excellence in key areas of R&D which contribute to the growth of key industry clusters.
- Leverage NOAA's Center for Technological Innovation to:

- ◊ *foster regional cooperation across academic, business, and government sectors*
- ◊ *enhance entrepreneurial educational initiatives*
- ◊ *foster new firms and industries*

- ◊ *enhance job creation*
- ◊ *enhance national and international economic collaboration*

Necessity is to:

- Develop a shared vision across academic, business and government sectors for regional technological development.
- Leverage and enhance educational resources (K-12, college, and university) through cooperative initiatives with industry and local government.
- Strive toward world-class excellence in "smart" infrastructure development including:
 - ◊ seed and venture capital resources
 - ◊ national and international marketing
 - ◊ world class production facilities
 - ◊ global sales and distribution
- Attract and retain entrepreneurs and keep wealth creating tech-

nology and jobs in the Charleston region and in South Carolina.

Opportunity and necessity do not come together under conditions of benign neglect. Prioritization of action initiatives and collaboration across academic, government, and business sectors is required for the Charleston region and South Carolina to realize the full potential of job and wealth creation.

NOAA's Center for Technological Innovation: An Alliance for the 21st Century

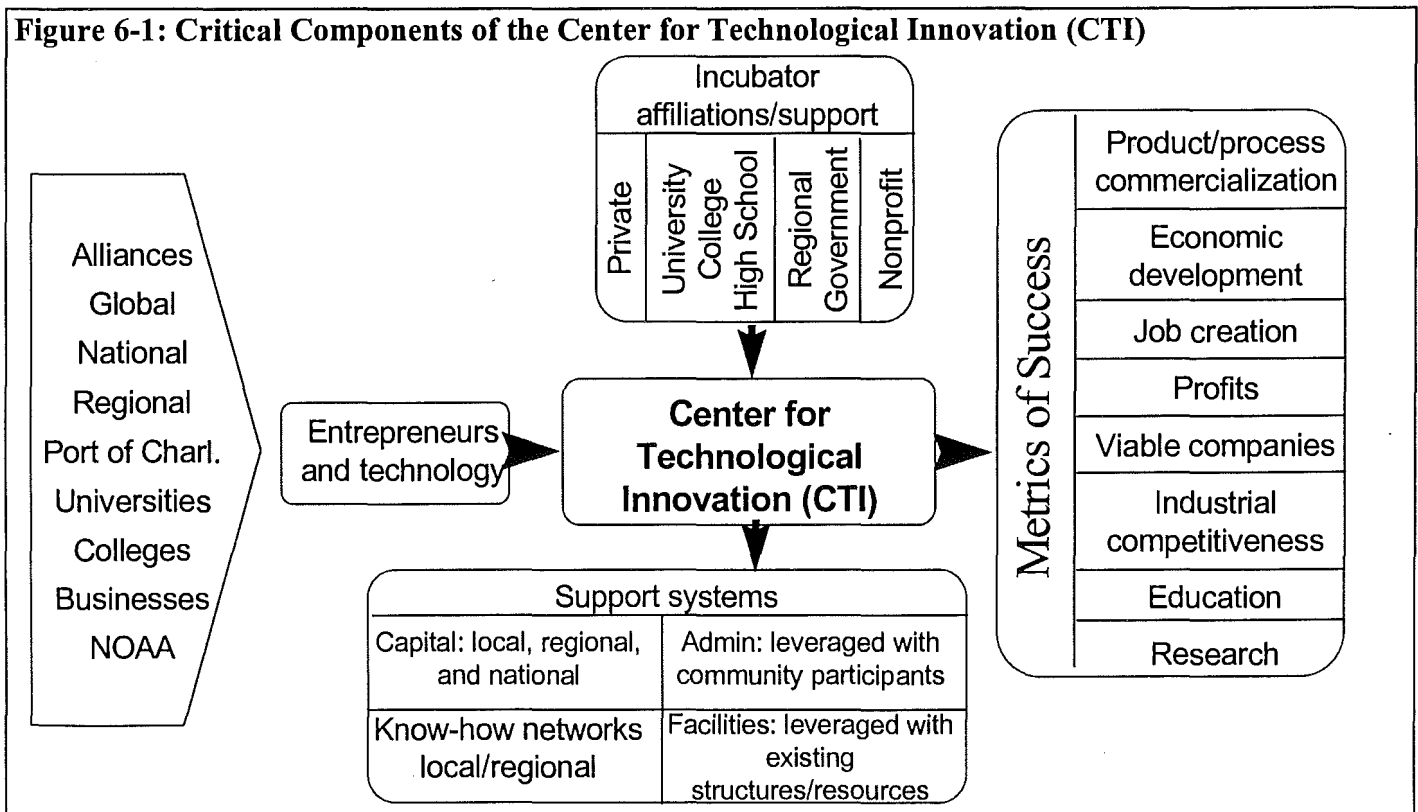
NOAA's Center for Technological Innovation (CTI) is designed to be a catalyst in the Charleston region and in South Carolina for new firm development and for building institutional alliances (across academic, business, and government sectors) for leveraged economic development. Moving technology from creativity (an idea/technology) to an

innovation (an actual product) to market success requires mechanisms for transfer, efficient processes (public/private know-how involvement), and metrics for success (product process commercialization, viable company formation, job creation, educational opportunities), Figure 6-1.

Inspired and made possible by an alliance between federal, state, and city government representatives as well as regional academic and business sectors, CTI is being implemented in the city of Charleston to enhance technology-based wealth and job creation in the Charleston region and South Carolina by:

- Accelerating the commercialization of technologies researched in the region's R&D laboratories.
- Fostering links with national and international R&D resources.
- Facilitating the linkage of public sector institutions and for-profit, market-

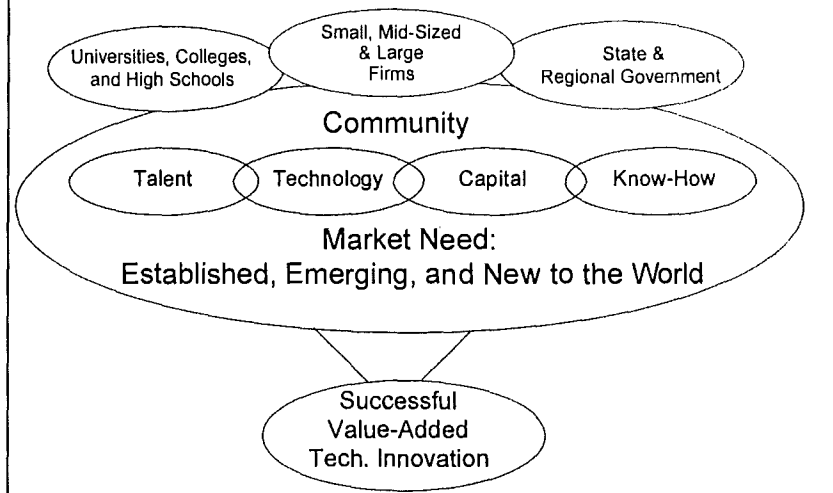
Figure 6-1: Critical Components of the Center for Technological Innovation (CTI)



driven entities to help sustain and enhance research and education funding.

- Providing unique educational and workforce training opportunities on advanced technologies in such fields as environmental research, chemistry, waste treatment, medical, electronics, and communications.
- Encouraging regionally based networking among existing and new organizations concerned with entrepreneurship and finance.
- Attracting and retaining private sector partners and entrepreneurs for wealth creation through regional, national, and international alliance building.

Figure 6-2: Critical Success Factors for Technology-Based Entrepreneurship in the Charleston Region and South Carolina



In short, CTI will promote positive government-academic-business alliances; transfer and commercialize technology through innovative and collaborative efforts; and enhance the competitiveness of the region's technology-intensive companies through the linking of: (1) talent — people, (2) technology — ideas, (3) capital — resources, and (4) know-how — knowledge to catalyze technology innovation, Figure 6-2.

In terms of technology-based entrepreneurship, the challenge for the Charleston region as it prepares for the 21st Century during the next five years is to improve incrementally in the following five sectors:

Talent

- Enhance the quality of regionally-based educational facilities and opportunities.
- Continue to expand mathematics and science courses at all educational levels.
- Enhance entrepreneurial and business training at all educational levels.
- Allocate more regional funds and acquire additional state funding for executive and continuing educational courses at the graduate levels in technological fields.

- Facilitate partnering among Charleston's and South Carolina's education institutions (K-12, college, university) and business interests.
- Bring advanced communication technologies into the classroom.
- Establish more technology and business related graduate degree programs in the Charleston region.

Technology

- Better leverage for commercial application of R&D resources at regional universities, colleges, and the public and private sectors.
- Improve technology transfer linkages with national and international sources of R&D.
- Establish technology demonstration/application centers that link real world problems, in selected industry sectors, to available technology resources.

Capital

- Establish new and creative funding mechanisms for locally-based technology-intensive businesses.
- Augment sources of venture capital and seed capital for small and mid-sized technology-intensive businesses.
- Chart a more proactive approach for the submission of federal small business applications by the region's small technology firms and academic institutions.
- Educate local bankers, and their national headquarters, to the special needs of small and mid-sized locally-based technology firms.
- Establish an "information clearing-house" for providing up-to-date information on business funding opportunities.
- Establish "venture fairs" to assist in putting together deals between investors and new ventures.

Know-How

- Achieve more involved access of key business and technological expertise in the Charleston region: with local entrepreneurs.
- Establish more pro-active links with national and international business expertise.
- Foster network ties with the talent and other resources of the populations of Hilton Head, Seabrook, and Kiawah.
- Strengthen national and international collaborations to foster regionally-based entrepreneurship.
- Foster business related networking opportunities for entrepreneurs.

CTI's Emerging Know How Network

A critical gap in technology transfer from an R&D source to a real world problem, growth market, and ROI (Return on Investment) is business know-how---the linking of talent (entrepreneurs/champions), technology, and capital with a market need. Know How expertise centers on such areas as quality manufacturing, marketing, legal, finance, sales and distribution. This Know How is key to leveraging technology/knowledge by new enterprise creation. Such regionally-based Know How is critical to the success of such established high tech areas as Silicon Valley, California and Austin, Texas.

The technology transfer gap, or 'Valley of Death' as it is often called, needs to be crossed as fast and efficiently as possible for a technology-based start-up company to survive and grow. Technology life cycles are growing increasingly short as the world is growing increasingly competitive. At the other side of the valley is the wealth creation that can fuel an enhanced quality of life for individuals and the community, educational initiatives, further research, and jobs.

CTI will act as a catalyst to foster the creation of a regional Know How Network in the Charleston region and link it to other high tech regions nationally and globally. CTI's Know How Network will serve as an effective **Experiential Learning Laboratory** for Charleston's students, entrepreneurs, professionals, and service providers. The objective is to leverage and enhance existing educational and business resources to the benefit of the creation and expansion of small and mid-sized technology-based enterprises ---to enhance the excellence of **Charleston's Smart Infrastructure**.

Community

- Continue to build and support a meaningful “can do” attitude and positive vision of the future that encompasses the entire region.
- Develop a region-wide strategic economic development plan.
- Examine approaches to the rationalization of government service delivery.
- Establish more technology/industry Class A parks and light manufacturing facilities.
- Foster innovative ways to finance needed infrastructure improvements.
- Encourage more direct flights and air freight capacity at Charleston’s airport.
- Encourage local government to facilitate the start-up and rapid growth of technology-based firms.
- Consolidate government services.
- Maintain authority of local government to decide structure and amount of local taxes and fees.
- Overcome independence and competitiveness challenges in the Charleston region and South Carolina.

Technology-based entrepreneurship involves the commercialization of science and technology through newer institutional arrangements. It concentrates on technology alliances for competitiveness. It is based on creative and innovative ways of linking public-sector initiatives and private-sector resources within and across national boundaries for promoting economic growth.

To be effective, the technology-based entrepreneurship must foster positive government-academic-business relationships. These new types of organizational alliances incorporate a dynamic private sector; a creative role for government through technology policies, initiatives, and development programs; and innovative academic relationships. Science and technology policies that promote and flow from these technology alliances are redefining the role and scope of the wide variety of institutions involved in advancing economic growth through technology.

Policies to accelerate science and technology commercialization must enhance links among key institutions to build a viable public/private infrastructure, a strong financial environment, a vibrant entrepreneurial spirit, and a commitment and dedication to risk-taking and risk-sharing.

“Technology continues to shrink the world. There is no choice other than to participate in the global community. Science and technology is too precious a resource to be restricted from drawing the world together. That is what the 21st Century is all about.”

*Dr. George Kozmetsky
Remarks to company graduation at the
Austin Technology Incubator
September 6, 1996*

APPENDIX A

Data Sources

Survey

A mail survey on Technology-Based Entrepreneurship in the Charleston region was administered in June and July 1996. Two hundred and eight respondents provided their views on the importance of facilitators and inhibitors to the creation of wealth and high-value jobs in the Charleston region over the next ten years. More than 60 percent of the survey respondents were either owners or senior executives of private firms. About 75 percent were from Charleston County, and nearly four of every five respondents were from the private sector. Most of the public sector respondents were from one of the educational institutions in the region. The survey was not meant to be representative of the entire Charleston population. Rather, it was intended to obtain the views of business community leaders on technology-based economic development in the region.

Respondents were asked to comment on how effective the Charleston region is doing with respect to technology-based wealth creation in terms of:

- The relative importance of 24 industries for creating wealth and high-value jobs in the Charleston region over the next ten years;
- Economic development strategies for the coming decade;
- Educational infrastructure to support economic growth;
- Business expertise, finance, and entrepreneurial assistance mechanisms; and
- Physical infrastructure, regulatory climate, governmental institutions, and

quality of life issues affecting entrepreneurs and new job creation.

A final set of questions asked leaders to identify (1) the single most important factor or condition that will **facilitate** the growth of technology-based industries in the region during the next decade; (2) the single most important factor that will **inhibit** growth of technology-based industries; and (3) one “big idea” or large-scale project which should be undertaken to significantly improve the region’s economy.

University Based Research in the Charleston Region

The data on the number of external awards and the level of funding for the Medical University of South Carolina (MUSC) was drawn from annual reports prepared by MUSC’s Office of Research Administration. The sources of the awards, by category of sponsor for 1995-1996, was given in Annual Report of Research and Related Activities, Fiscal Year 1995-1996. MUSC’s fiscal years end on June 30; therefore the 1996 information covers awards during the period July 1, 1995 through June 30, 1996. Multi-year awards are counted as being received entirely in one year. The data are based on obligated amounts, not actual expenditures which may be less. Award amounts exclude those from Veteran’s Affairs.

For the College of Charleston, most data was drawn from “Report to the South Carolina Legislature, Fiscal Year 1994-1995,” The College of Charleston, Office of

Sponsored Projects. The 1996 data was provided in a spreadsheet (Grant and Contract Expenditures) from the Office of Sponsored Projects, dated July 1996. Similarly to MUSC, The College's fiscal year ends on June 30. Expenditures are funds actually spent during the fiscal year. All funding includes research, instruction, and public service.

Non-University Based Research in the Charleston Region

Information about the South Carolina Research Authority (SCRA) came from its 1995 annual report and from SCRA officials. Data about scientists and research activities of the Marine Resources Division of the South Carolina Department of Natural Resources appeared in the 1995 annual report and was augmented based on conversations with senior researchers. The National Marine Fisheries Service's information was provided by NMFS officials in the summer of 1996 and was based on internal documents. Data on research and development underway at firms in the Charleston region was provided by the Charleston Metro Chamber of Commerce and was drawn from its annual survey early in the calendar year 1996.

University Research Elsewhere in South Carolina

Awards and funding data for the University of South Carolina (USC) are based on information from USC Annual Report of Sponsored Program Activity, Fiscal Years 1994-1995, 1993-1994, 1992-1993, 1991-1992, and 1990-1991. These annual reports are published by the University of South Carolina-Columbia, Office of Sponsored Programs and Research. The data for fiscal year 1996 was provided by a senior research administration official. The fiscal years end on June 30. Multi-year awards are counted as being received entirely in one year. The data are based on obligated amounts, not

actual expenditures which may be less. The combined funding level data include research awards, training awards, service awards, and equipment awards. Both funding and awards are for all campuses of the University of South Carolina. Additional data was based on research-oriented publications from the University of South Carolina-Columbia.

Data on awards, funding, and sources of awards for Clemson University are drawn from Research and Sponsored Program Activity, Year Ended June 30, 1996, Office for Sponsored Programs, Clemson University. The data are for grants and contracts only and do not include awards and funding for equipment and software, The National Textile Center Research Program/Consortium, the Advanced Gas Turbine Systems Research, or funds retained from Clemson University Performance Agreements by the Clemson University Research Foundation.

Intellectual property information was drawn from the Clemson University internet site, from information provided by a senior technology transfer university official, and from the Southern Growth Policies Board's report, Benchmarking University-Industry Technology Transfer in the South, by Louis G. Tornatsky, Paul Waugaman and Lucinda Casson.

Information for the comparisons of research and development expenditure increases from all sources, and from industrial sponsors only, at USC, Clemson, MUSC, and all U.S. universities and colleges, were computed from Academic Science and Engineering R&D Expenditures: Fiscal Year 1993, National Science Foundation, NSF 95-332, 1995. Note data for U.S. is all universities and colleges, not only doctorate-granting institutions.

Non-Academic Research and Development

The Small Business Innovation Research (SBIR) award data was provided by the U.S. Small Business Administration. Phase I and Phase II awards are counted as two awards. The number of business establishments was obtained from the U.S. Bureau of the Census, County Business Patterns, State of South Carolina, 1995.

Data on the ranking of non-academic scientists (those with doctorate, with bachelors' degrees and above, and change in number of scientists with bachelors' degrees and above from 1980-1990) was computed from Nonacademic Scientists and Engineers: Trends From the 1980 and 1990 Censuses, NSF 95-306, 1995. State population data is for January 1, 1995 as given in Demographics USA-County Edition 1995, published by Market Statistics.

Technology-Intensive Companies

Original data for Charleston region technology intensive companies was obtained by searching for predefined standard Industrial Classification codes for companies in a database of the Charleston Metro Chamber of Commerce's Center for Business Research. The clusters were sorted by the SIC codes. The size and founding date information for each firm also was obtained from the same database and used for computing graphs.

Company and Organization Profiles

The case profiles were prepared after interviews with officials and executives of each firm and organization noted. Interview information was supplemented with original source materials of the respective firms and organizations.

APPENDIX B

Survey on Technology-Based Entrepreneurship

CHARLESTON

Metro

CHAMBER OF COMMERCE

May 15, 1996

Dear Business Leader:

Please take a few minutes to complete the enclosed survey on Technology-Based Entrepreneurship in the Charleston region. This survey is being conducted by the IC2 Institute of the University of Texas at Austin in cooperation with the Charleston Metro Chamber of Commerce. The survey is part of a broader effort by the Charleston-based Coastal Services Center of the National Oceanic and Atmospheric Administration to enhance the transfer of coastal environmental technology to the commercial marketplace.

The specific purposes of this survey are to obtain your views about:

1. the relative importance of different industries for creating technology-based jobs in the Charleston region;
2. economic development strategies which should be undertaken for creating technology-based jobs in the region;
3. various infrastructure, finance, education, and government issues affecting technology locally; and
4. specific actions to help generate more technology jobs in the next several years.

The survey is being sent to a sample of businesses and major employers in the Charleston region. Please mail your completed survey to the IC2 Institute using the enclosed addressed envelope by May 29, 1996. If you so indicate on the survey, the IC2 staff will send you a summary of the survey results. Survey responses and comments will not be attributed to specific individuals. If you have any questions, please call me at 577-2510, extension 3043.

Thank you for your time and contribution to Charleston's future.

Sincerely,



Mary Graham
Senior Vice President
Charleston Metro Chamber of Commerce

81 MARY STREET • P.O. BOX 975 • CHARLESTON, SC 29402.0975 • FAX 803.723.4853

CHARLESTON METRO
CHAMBER OF COMMERCE
803.577.2510

ECONOMIC
DEVELOPMENT
803.720.5674

CHARLESTON AREA
CONVENTION & VISITORS BUREAU
803.853.8000

CHARLESTON

Metro
CHAMBER OF COMMERCE

Monday, June 24, 1996

Dear Charleston Business Leader:

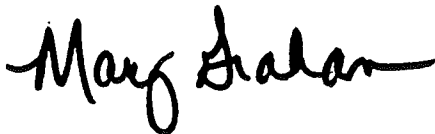
In mid-May, I wrote asking you to complete a survey on Technology-Based Entrepreneurship in the Charleston Region. As noted in my previous letter, this survey is being conducted by the IC² Institute of The University of Texas at Austin in cooperation with the Chamber. The survey is part of a broader effort by the Charleston-based Coastal Services Center of the National Oceanic and Atmospheric Administration to enhance the transfer of coastal environmental technology to the commercial marketplace.

We have received a strong response to the initial survey request, but before we do a final tabulation of the data, we hope that you might find time to complete your survey and return it to the IC² Institute. Your views are important, and we want to include them so we have an accurate picture of what actions businesses and major employers feel are necessary to create additional technology-based jobs in the Charleston region. If you have already mailed your completed survey, thank you, and please ignore this request.

Please take a few minutes to complete the survey and mail it as soon as possible in the enclosed self-addressed envelope. If you so indicate on the survey, we will send you a summary of the survey results. Survey responses and comments will not be attributed to specific individuals.

Thank you again for your time and contribution to Charleston's future.

Sincerely,



Mary Graham
Senior Vice President
Charleston Metro Chamber of Commerce

81 MARY STREET • P.O. Box 975 • CHARLESTON, SC 29402.0975 • FAX 803.723.4853

CHARLESTON METRO
CHAMBER OF COMMERCE
803.577.2510

ECONOMIC
DEVELOPMENT
803.720.5674

CHARLESTON AREA
CONVENTION & VISITORS BUREAU
803.853.8000

SURVEY ON TECHNOLOGY-BASED ENTREPRENEURSHIP IN THE CHARLESTON REGION

This survey is part of a long-term effort, supported by the Charleston-based Coastal Services Center of the National Oceanic and Atmospheric Administration, to enhance the transfer of environmental technology to the commercial marketplace and to stimulate new business formation and job creation in Charleston. NOAA and the IC² (Innovation, Creativity and Capital) Institute, The University of Texas at Austin, are working in alliance with the state and local governments, as well as the academic, entrepreneurial, and business communities, to establish a technology innovation center that links technology with entrepreneurs and provides access to resources to nurture new businesses in the Charleston region. Functions of the Center for Technological Innovation (CTI) will include business incubation, technology market assessment, capital formation and networking, community outreach, training and business support services. The Associate Director for Coastal Technology Services, Dr. Earle Buckley (974-6226), would be pleased to provide more information about the overall project. Specific questions about the survey should be directed to Mary Graham at the Chamber (577-2510).

I. INFORMATION ABOUT RESPONDENT

Place of work _____

Public

Private

Your position _____

County/area where you

Live

Work

Berkely County

Dorchester County

Charleston County

Charleston

Mount Pleasant

North Charleston

Please print your name and address if you would like us to send you a summary of the survey results. The data will be summarized and not attributed to specific individuals.

II. OVERVIEW

- A. Please indicate the extent to which you believe each of the following industries will be important in creating wealth and high-value jobs in the Charleston Region over the next ten years. (PLEASE CIRCLE ONE NUMBER IN EACH ROW.)

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	Don't Know
Apparel and Textiles	1	2	3	4	5	6
Biomedicine/Biotechnology.....	1	2	3	4	5	6
Business and Financial Services.....	1	2	3	4	5	6
Chemicals	1	2	3	4	5	6
Computers Hardware/Industrial						
Equipment/Machinery	1	2	3	4	5	6
Educational Services	1	2	3	4	5	6
Electronics Components/Equipment ..	1	2	3	4	5	6
Environmental Services/Waste Mgt. ..	1	2	3	4	5	6
Fabricated Metal Products.....	1	2	3	4	5	6
Health Care.....	1	2	3	4	5	6
Information Technology	1	2	3	4	5	6
Instrumentation/Measurement						
(Medical)	1	2	3	4	5	6
(Non-medical).....	1	2	3	4	5	6
Pharmaceuticals	1	2	3	4	5	6
Primary Metals/Steel	1	2	3	4	5	6
Printing and Publishing.....	1	2	3	4	5	6
Real Estate.....	1	2	3	4	5	6
Retirement	1	2	3	4	5	6
Software	1	2	3	4	5	6
Telecommunications Equipment/						
Services	1	2	3	4	5	6
Tourism/Entertainment.....	1	2	3	4	5	6
Transportation Equipment/						
Services (automotive)	1	2	3	4	5	6
Water Transportation/ Cargo						
Handling	1	2	3	4	5	6
Wood and Paper Products (forest) ...	1	2	3	4	5	6
Other _____	1	2	3	4	5	6
Other _____	1	2	3	4	5	6

B. Please indicate the importance of each of the following economic development strategies for creating wealth and high-value jobs in the Charleston Region over the next ten years. (PLEASE CIRCLE ONE NUMBER IN EACH ROW.)

Also, in the last column, please rate the effectiveness of the Charleston region in the given activity on the following scale: 1=very ineffective, 2=somewhat ineffective, 3=neutral, 4=somewhat effective, 5=very effective.

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
The relocation/expansion of established companies from other regions in the U.S.....	1.....	2.....	3.....	4.....	5.....	[]
The relocation/expansion of established companies from other nations	1.....	2.....	3.....	4.....	5.....	[]
The retention/expansion of established/start-up companies in the Charleston region	1.....	2.....	3.....	4.....	5.....	[]
The retention of government programs & facilities.....	1.....	2.....	3.....	4.....	5.....	[]
The relocation of entrepreneurs, new company spin-outs, & start-ups to the Charleston region.....	1.....	2.....	3.....	4.....	5.....	[]
Development of home-grown entrepreneurs, new company spin-outs, & start-ups within the Charleston region	1.....	2.....	3.....	4.....	5.....	[]
Public/private economic development alliances with other regions of South Carolina.....	1.....	2.....	3.....	4.....	5.....	[]
Cooperative alliances across small & larger firms to increase scale of operations & to enhance access to key markets.....	1.....	2.....	3.....	4.....	5.....	[]
Development of existing public assets in the Charleston Region (e.g., Port of Charleston, airport).....	1.....	2.....	3.....	4.....	5.....	[]
Provide mechanisms to enhance the globalization of local small & mid-sized firms ..	1.....	2.....	3.....	4.....	5.....	[]
Provide mechanisms for accessing & commercializing home-grown technologies (e.g., Medical University of South Carolina & other regionally-based R&D activities).....	1.....	2.....	3.....	4.....	5.....	[]

Your Comments _____

In the following sections of this survey, we ask questions about education, business expertise, finance, research and development (R&D) and technology, physical infrastructure, and quality of life. Please indicate your views about the relative importance of the suggested actions/ policy recommendations in these topic areas for creating wealth and high-value jobs through technology-based entrepreneurship in the Charleston region over the next ten years by circling one number in each row. In the last column, please rate the effectiveness of the Charleston region in the given activity on the following scale: 1=very ineffective, 2=somewhat ineffective, 3=neutral, 4=somewhat effective, 5=very effective.

III. EDUCATION INFRASTRUCTURE

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
Communication & partnering among Charleston's educational institutions, K-12, college, and university	1	2	3	4	5	[]
Market-driven teams to improve skill need forecasting for selected industry sectors/ clusters & to influence educational curriculum.....	1	2	3	4	5	[]
Educate parents on various career options & educational requirements for their children.	1	2	3	4	5	[]
Employers educating employees on various career options and education requirements for themselves and their children	1	2	3	4	5	[]
Apprentice programs to help train high school students.....	1	2	3	4	5	[]
Quality science/technology/mathematics education in area high schools.	1	2	3	4	5	[]
Quality science/technology/mathematics education in area colleges.	1	2	3	4	5	[]
Quality entrepreneurship education in area high schools.....	1	2	3	4	5	[]
Quality entrepreneurship education in area colleges.....	1	2	3	4	5	[]
Quality jobs & career development opportunities to retain university/college graduates in the Charleston region.	1	2	3	4	5	[]
Partnering between local business interests & local K-12 educational activities (e.g., the school-to-work program).....	1	2	3	4	5	[]
Business-related graduate degree programs at local colleges & universities in the Charleston region.....	1	2	3	4	5	[]
Executive & continuing education	1	2	3	4	5	[]
Advanced education/communication technologies in the classroom.....	1	2	3	4	5	[]

Your Comments _____

IV. EXPERTISE FOR TECHNOLOGY-BASED BUSINESS EXPANSIONS, SPIN-OUTS, AND START-UPS

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
Accessible support for Charleston's entrepreneurs from local business expertise (e.g., accounting, finance, marketing, manufacturing, legal, public relations/advertising)	1	2	3	4	5	[]
Business-related networking opportunities for entrepreneurs	1	2	3	4	5	[]
A one-stop business services center to provide information on investors, mentors, business plans	1	2	3	4	5	[]
Entrepreneurial training in area high schools, colleges and universities.....	1	2	3	4	5	[]
Entrepreneurial training and initiatives for individuals in inner cities and rural areas.....	1	2	3	4	5	[]
Technology-based business incubator/ technology commercialization center	1	2	3	4	5	[]
Technology/industry Class A parks	1	2	3	4	5	[]
Specialized office/light manufacturing space for start-up activity.	1	2	3	4	5	[]
Your Comments _____						

V. FINANCE FOR TECHNOLOGY-BASED BUSINESS EXPANSIONS, SPIN-OUTS, AND START-UPS

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
"Seed" capital	1	2	3	4	5	[]
Venture/business expansion capital	1	2	3	4	5	[]
Education of entrepreneurs about how to raise early stage capital.	1	2	3	4	5	[]
Education and networking programs for area investors.....	1	2	3	4	5	[]
New and creative funding mechanisms for locally-based businesses.	1	2	3	4	5	[]
Risk reduction mechanisms that encourage lenders to finance regionally-based businesses.....	1	2	3	4	5	[]

V. continued

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
Venture fairs where potential investors (public and private) are linked with select business entrepreneurs	1	2	3	4	5	[]
An "information clearinghouse" for assisting deals between investors and new ventures	1	2	3	4	5	[]
More responsive capital resources for small, minority-owned and historically underutilized businesses	1	2	3	4	5	[]
Local bankers educated to the special needs of small and mid-sized locally-based firms.	1	2	3	4	5	[]
Periodic events (e.g., venture fairs, conferences, seminars) for investors and entrepreneurs to get together	1	2	3	4	5	[]
A central facility for providing up-to-date information on business funding opportunities.	1	2	3	4	5	[]
Your Comments _____						

VI. ACCESS TO RESEARCH AND DEVELOPMENT (R&D) AND TECHNOLOGY

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
Technology transfer linkages with <i>local</i> sources of R&D (e.g., MUSC, industry).....	1	2	3	4	5	[]
Technology transfer linkages with <i>nationally-based</i> technology resources and markets.	1	2	3	4	5	[]
Technology transfer linkages with <i>internationally-</i> <i>based</i> technology resources and markets.	1	2	3	4	5	[]
Regional technology Demonstration/Application Centers that link real-world problems in selected industry sectors to available technology resources.	1	2	3	4	5	[]
Your Comments _____						

VII. PHYSICAL INFRASTRUCTURE AND QUALITY OF LIFE

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
Roads and bridges.....	1	2	3	4	5	[]
Direct flights in and out of Charleston	1	2	3	4	5	[]
Carriers to increase air freight capacity at Charleston's airport.....	1	2	3	4	5	[]
The region's natural assets (e.g., coast line, parks, wildlife).	1	2	3	4	5	[]
The region's culture assets (e.g., music, theater) ..	1	2	3	4	5	[]
Innovative ways to finance needed infrastructure improvements	1	2	3	4	5	[]
Your Comments _____						

VIII. OTHER ISSUES

	Very Unimportant	Somewhat Unimportant	Neutral	Somewhat Important	Very Important	How Effective in Charleston Region?
Having state government support entrepreneurial activity	1	2	3	4	5	[]
Having local government support entrepreneurial activity	1	2	3	4	5	[]
Overcome independence and competitiveness challenges in the greater Charleston region.....	1	2	3	4	5	[]
Consolidation of government services	1	2	3	4	5	[]
Rely less on federal and state assistance and more on self-help and regionally-based economic development initiatives.....	1	2	3	4	5	[]
Maintain authority of local governments to decide structure and amount of local taxes and fees.....	1	2	3	4	5	[]
Clarify regional policy and rules regarding economic development.....	1	2	3	4	5	[]
Encourage local government to facilitate the start- up and rapid growth of technology-based firms. ..	1	2	3	4	5	[]
Build a meaningful, regionally-based "can do" attitude and positive vision of the future.....	1	2	3	4	5	[]
Your Comments _____						

XI. OPEN-ENDED QUESTIONS

A. What do you think is the most important factor or condition that will *facilitate* the economic growth of **technology-based industries in the Charleston Region** during the next ten years?

B. What do you think is the most important factor or condition that will *inhibit* the economic growth of **technology-based industries in the Charleston Region** during the next ten years?

C. What one "big idea" or large-scale project could/should the Charleston Region undertake to significantly improve the area's economy?

**Thank you for providing your insights and comments about
Technology-Based Entrepreneurship in the Charleston Region**

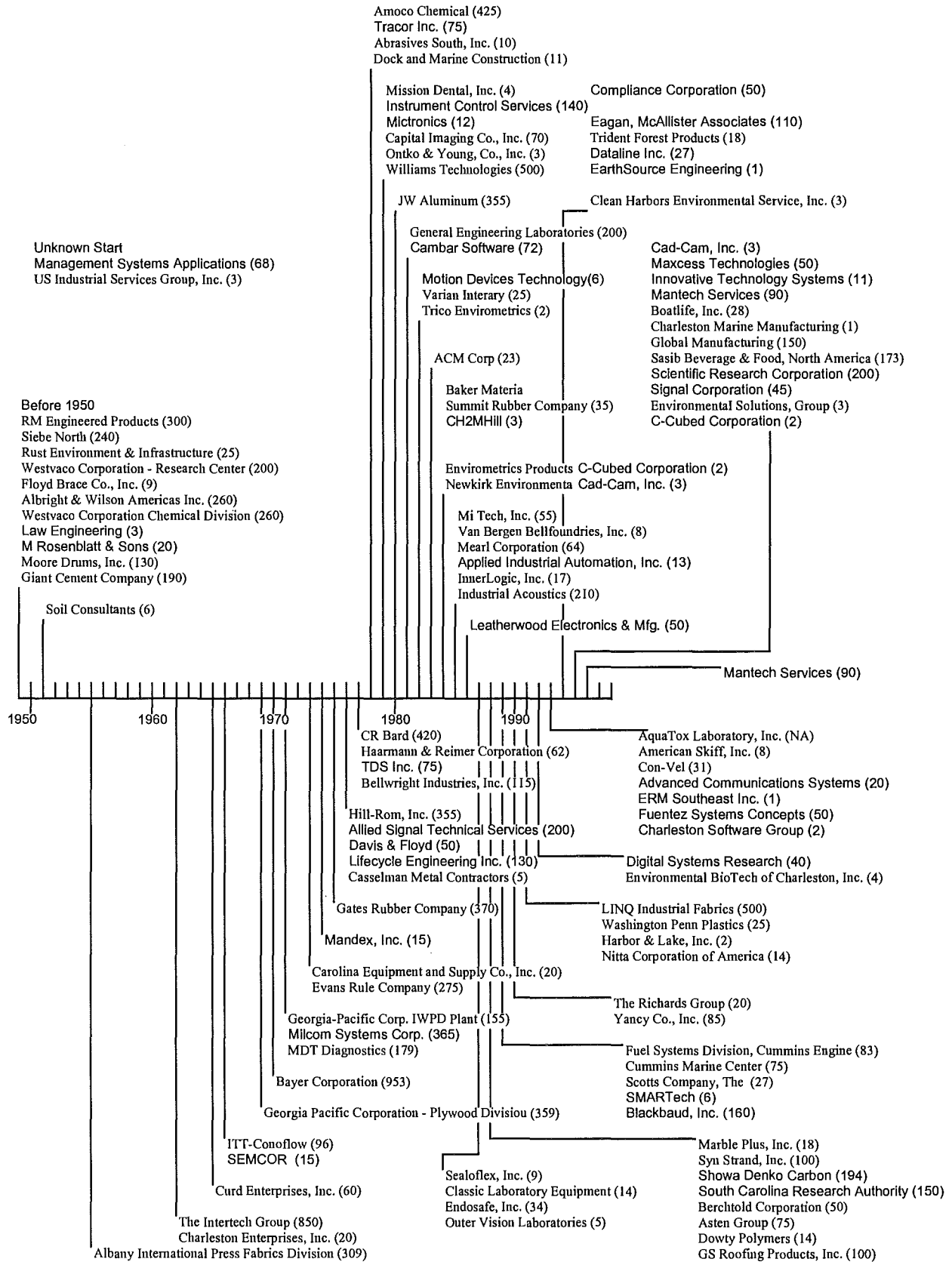
Please mail this survey in the pre-addressed envelope or fax it to:

Dr. David Gibson
IC² Institute
The University of Texas at Austin
2815 San Gabriel
Austin, TX 78705
Telephone: (512) 475-8900
Fax: (512) 475-8901

APPENDIX C

Technology-Intensive Industry Clusters in the Charleston Region and SIC Code Classification

Summary Chart of Company Foundings: General Technologies Companies in the Charleston Area



Technology-Intensive Industry Sectors - Greater Charleston Region

<i>Company</i>	<i>Description</i>
<u>Electronics/Engineering/Computer Technology</u>	
Advanced Communications Systems	Radiac and meteorology electronics
Allied Signal Technical Services	Engineering services
Applied Industrial Automation, Inc.	Design and fabricate custom control panels
Blackbaud, Inc.	Computer software
C-Cubed Corporation	Engineering services
Cad-Cam, Inc.	Cad-Cam design services
Cambar Software	Computer software and services
CH2Mhill	Engineering services
Charleston Software Group	Programming, computer services
Compliance Corporation	Communications and facilities systems
Dataline Inc.	Engineering network systems
Davis & Floyd	Engineering services
Digital Systems Research	Software engineering
Eagan, McAllister Associates	Engineering and technical support
EarthSource Engineering	Engineering services
ERM Southeast Inc.	Engineering services
Fuentez Systems Concepts	Engineering services
Innovative Technology Systems	Computer and data processing services
Instrument Control Services	Patch panel and patch cards/radiac services
Law Engineering	Engineering services
Leatherwood Electronics & Mfg.	Communications/electronics mfg.
Lifecycle Engineering Inc.	Engineering services
Management Systems Applications	Engineering install systems
Mandex, Inc.	Imagery engineering and technical services
Mantech Services	Engineering services
Maxcess Technologies	Computer flooring
Mictronics	Industrial and military electronics
Milcom Systems Corp.	Engineering services
Motion Devices Technology	Synchros and resolvers
M. Rosenblatt & Sons	ILS services
Scientific Research Corporation	Engineering and technical services
SEMCOR	Communications and support services
Showa Denko Carbon	Graphic electrodes
Signal Corporation	Computer equipment/engineering services
SMF Systems Corporation	Monitor and control equipment
SMARTech	Designs and builds satellite mapping systems
South Carolina Research Authority	Computer integrated mfg.
TDS Inc.	Engineering services
Tracor Inc.	Supersonic flight services, IDS design
<u>General Technologies (Manufacturing Firms not otherwise listed that have R&D activities)</u>	
Abrasives South, Inc.	Abrasive specialties
American Skiff, Inc.	Small fiberglass boats
Baker Material Handling Corporation	Industrial and narrow aisle forklifts

Bellwright Industries, Inc.
Boatlife, Inc.
Capital Imaging Co., Inc.
Carolina Equipment and Supply Co., Inc.
Casselman Metal Contractors
Charleston Marine Manufacturing
Con-Vel
Cummins Marine Center
Curd Enterprises, Inc.
Dock and Marine Construction
Evans Rule Company
Gates Rubber Company
Georgia Pacific Corporation - Plywood Division
Georgia-Pacific Corp. IWPD Plant
Giant Cement Company
Global Manufacturing
GS Roofing Products, Inc.
Harbor and Lake, Inc.
ITT-Conoflow
JW Aluminum
Marble Plus, Inc.
Mearl Corporation
Mi Tech, Inc.
Moore Drums, Inc.
Nitta Corporation of America
Ontko & Young Co., Inc.
Sasib Beverage & Food, North America
Sealoflex, Inc.
Summit Rubber Company
Syn Strand, Inc.
Scotts Company, The
Trident Forest Products
Van Bergen Bellfoundries, Inc.
Williams Technologies
Yancy Co., Inc.

Environmental Technologies

Albrecht & Associates
AquaTox Laboratory, Inc.
Charleston Enterprises, Inc.
Clean Harbors Environmental Service, Inc.
Environmental BioTech of Charleston, Inc.
Envirometrics Products, Inc.
Environmental Solutions, Group
Fuel Systems Division, Cummins Engine
General Engineering Laboratories
Industrial Acoustics
Newkirk Environmental Services
Rust Environment & Infrastructure
Soil Consultants
Trico Envirometrics
US Industrial Services Group, Inc.
Westvaco Corporation - Research Center

CNC Machining
Chemical manufacturing
Word processing, data processing ribbons
High pressure water blasters
Industrial equipment, trailers
Ship repair, conversion
Constant velocity universal joints
B&C engines for marine applications
Custom vacuum formed plastic & fab.
Prefabricated dock sections
Steel measuring tapes
Automotive timing belts
Veneer and plywood
Particleboard
Portland and masonry cements
Global mining and technology equipment
Asphalt roofing shingles
Fiberglass boats
Pressure regulators
Aluminum products
Cultured marble laboratories
Pearlescent pigments
Marine industrial machinery
Reconditioned steel drums
Nylon flat belts
Musical instruments
Scaffolding and bottling equipment
Waterproofing materials
Gaskets, seals, and rubber-to-metal
Monofilament, nylon, polyester
Controlled release fertilizer
Hardwood lumber for export
Electronic bell instruments
Remanufactured auto transmissions
Wind chimes

Engineering services
Water pollution control systems
Water saving devices
Air, water, and solid waste management
Air, water, and solid waste management
Industrial hygiene devices, Research
Air, water, and solid waste management
Commercial physical research
Commercial physical research
Noise control equipment
Air, water, and solid waste management
Engineering services
Soil services
Engineering services
Industrial supplies
Commercial non-physical research

Medical Technologies

Berchtold Corporation
Classic Laboratory Equipment
CR Bard
Endosafe, Inc.
Floyd Brace Co., Inc.
Hill-Rom, Inc.
InnerLogic, Inc.
MDT Diagnostics
Mission Dental, Inc.
Outer Vision Laboratories
Varian Interary

Surgical lighting
Laboratory apparatus and furniture
Catheters, tubing
Surgical and medical instruments
Orthopedic and prosthetic appliances
Surgical appliances and supplies
Plasma cutting equipment
Surgical and medical instruments
Dental equipment and supplies
Optical lenses
X-ray tube reloading stations

Plastics/Wovens/Nonwovens

ACM Corp.
Albany International Press Fabrics Division
Asten Group
Dowty Polymers
LINQ Industrial Fabrics
RM Engineered Products
Siebe North
The Intertech Group
The Richards Group
Washington Penn Plastics

Rubber, rubber recycling
Paper machine felts
Monofilament for paper machine
Rubber polymers
Polypropylene fabric
Rubber, elastomer
Rubber gloves
Corporate headquarters - Nonwoven mfg.
Polyethylene liners
Recycle polypropylene

Inorganic Chemicals

Albright & Wilson Americas Inc.
Amoco Chemical
Bayer Corporation
Haarmann & Reimer Corporation
Westvaco Corporation Chemical Division

Organic phosphorous chemicals
Purified terephthalic acid
Dyestuffs, pigments, organic intermediates
L-Menthol
Tall oil products, dispersants, surfactants

Source: Center for Business Research, Charleston Metro Chamber of Commerce, 9/96

Standard Industrial Classification (SIC) Codes Used to Determine Technology-Intensive Companies in the Greater Charleston Region

2221	3531
2231	3532
2426	3537
2435	3548
2493	3565
2800-2899	3568
2952	3599
3052	3600-3699
3053	3731
3069	3732
3089	3800-3873
3200	3931
3241	3955
3281	3999
3291	4800-4899
3353	7371-7376
3412	7378
3423	8711
3431	8731
3444	8732
3448	8734
3499	9511
3519	9512

APPENDIX D

Small Business Information & Assistance Providers in The Charleston region

The Charleston Metropolitan area has many public and private organizations and agencies that can assist a small business owner with opening and operating a business.

The Charleston Metro Chamber of Commerce
Business Development Division
Post Office Box 975
Charleston, SC 29402
803-577-2510

- ◆ *The Chamber's Business Development Division offers a comprehensive program focusing on five areas: business expansion and retention; business recruitment; small business development; the Charleston Metro Film Liaison Office, and the Center for Business Research.*

South Carolina World Trade Center - Charleston
Post Office Box 975
Charleston, SC 29402
803-805-3029

- ◆ *An official affiliate of the Charleston Metro Chamber of Commerce, the center is a one-stop shop for international trade and business services focusing on five main areas: programs; seminars; education (through the SC World Trade Institute); international market research; and international visitors (through the Council of International Visitors.)*

South Carolina Small Business Resource Center
284 King Street
Charleston, SC 29401
803-853-3900

- ◆ *A cooperative agreement among Nations-Bank, U.S. Small Business Administration, U.S. Department of Commerce/Minority Business Development Agency, BellSouth Small Business Services and the College of Charleston. The center provides a multi-level, multi-dimensional approach to management assistance by providing resources and self-help training opportunities.*

Service Corps of Retired Executives (SCORE)
284 King Street
Charleston, SC 29401
803-727-4778

- ◆ *A resource partner of the U.S. Small Business Administration that provides confidential counseling, training and workshops in all aspects of starting and operating a small business. Counselors' offices are located in the Small Business Resource Center.*

Charleston Minority Business Development Center
284 King Street
Charleston, SC 29401
803-937-0011

- ◆ *The center provides counseling on small business topics for current and potential minority small business owners. Also provides assistance with loan packaging, business plan writing and procurement opportunities. Offices are located in the Small Business Resource Center.*

University of South Carolina Small Business
Development Center (SBDC)
5900 Core Drive
North Charleston, SC 29406
803-740-6160

- ◆ *A resource partner of the U.S. Small Business Administration that provides confidential counseling and seminars to current and potential small business owners.*

Berkeley, Charleston, Dorchester (BCD) Council
of Governments
5290 Rivers Avenue, Suite 400
North Charleston, SC 29406
803-529-0400

- ◆ *A tri-county public agency involved in comprehensive planning programs for the region. The agency is a source for information on population, housing and socio-economic characteristics of the Tri-county area. Research information is available on transportation issues, environmental concerns and land use. The agency can also provide traffic counts for certain locations.*

Center for Entrepreneurship
College of Charleston
66 George Street
Charleston, SC 29401
803-973-6700

- ◆ *This center offers current and prospective business owners a broad range of business support services including seminars, short courses and lectures. Assistance is provided in the areas of market research, locating sources of financing and developing business plans. The center can act as a facilitator between capital seekers and potential investors.*

Department of Economic Development
Trident Technical College
7000 Rivers Avenue
Post Office Box 118067
North Charleston, SC 29423-8067
803-572-6328

- ◆ *The center provides training and consulting services to assist local firms and individuals in improving their operational processes and productivity. The three departments of the division are: Occupational and Vocational Training; Industrial and Apprenticeship Training; and Economic Development.*

Southeast Manufacturing Technology Center
121 Surrey Drive
Summerville, SC 29483
803-821-1400

- ◆ *The center helps small and medium sized manufacturing firms improve competitiveness, productivity, and technology. Assistance is offered through demonstration, training and consulting services.*

Trident Area Community of Excellence (TACE)
Post Office Box 40306
Charleston, SC 29423-0306
803-572-6297

- ◆ *TACE is a non-profit organization whose mission is to promote continuous improvement in the quality of goods and services delivered by business, industry and government throughout Berkeley, Charleston and Dorchester counties. The organization is a co-sponsor of the Trident Area Quality Award Program. Membership in TACE requires no financial commitment.*

Center for International and Regional Development
The Citadel
171 Moultrie Street
Charleston, SC 29409
803-953-7089

- ◆ *This center works with businesses, schools and other community organizations to provide customized research studies. Assistance includes: planning and producing economic impact studies; developing business activity forecasts; conducting surveys; analyzing and reporting data; and assisting with related economic development needs.*

U.S. Department of Commerce
International Trade Administration
Post Office Box 975
Charleston, SC 29402
803-727-4051

- ◆ *The Charleston Branch Office, as part of the world-wide network of U.S. Department of Commerce offices, assists exporters of U.S. manufactured goods and services in the Lowcountry area. Such programs and services include, but are not limited to: identification of viable markets through market research, foreign agent/distribution identification, export trade leads, advertising, export financing, and basic export counseling.*

Charleston Citywide Local Development Corporation
75 Calhoun Street, 3rd Floor
Charleston, SC 29401
803-724-3796

- ◆ *The organization provides financial assistance to small businesses within the Charleston city limits. Currently, the agency administers the following programs: SBA Microloan; Corner Store; Facade Loan; Small Business Collateral Assistance; and Peer lending. The agency can also help businesses with gap financing opportunities.*

SC Sea Grant Consortium
287 Meeting Street
Charleston, SC 29401
803-727-2078

- ◆ *The consortium offers a variety of outreach business-assistance activities especially to groups whose operations impact directly on the coastal environments: fisheries, aquaculture, nature-based tourism, etc. They also offer access to research data, limited counseling services (dealing mainly with technical and environmental matters) and coastal resource information. In addition, the consortium is the parent organization of the Coastal Community Economic Development Partnership (CCEDP), a group whose purpose is to help small Lowcountry communities and their businesses adapt in environmentally sound ways to major changes in coastal economics. CCEDP publishes a comprehensive directory of service organizations that assist businesses.*

Greater Summerville/Dorchester County Chamber of Commerce
Post Office Box 670
Summerville, SC 29484
803-873-2931

- ◆ *A member organization with a mission to protect and promote the quality of life in the local community with specific emphasis on improving its economic vitality and providing a favorable business operating climate.*

Berkeley County Chamber of Commerce
Post Office Box 905
Moncks Corner, SC 29461
803-761-8238 or 803-577-9549

- ◆ *A member organization that promotes the business, commercial, manufacturing and civic interests of Berkeley County.*

Charleston County Library
Reference Department
404 King Street
Charleston, SC 29403
803-723-1645

- ◆ *County libraries offer many business resources for the potential or current small business person. Information is available in different forms such as: pamphlets, books, computer databases, videos and microfiche.*

Berkeley County Library
100 Library Street
Moncks Corner, SC 29461
803-761-8082

- ◆ *Libraries throughout the county provide a variety of management information and training resources for use by small business owners. These materials are in print and electronic formats, and they are catalogued in the library's own small business resource guide.*

Dorchester County Library
76 Old Trolley Road
Summerville, SC 29485
803-871-5075

- ◆ *The Dorchester County Library system provides a wealth of resource information for small business owners. Their collection includes print materials for planning, starting and managing many types of small companies. These materials are catalogued in a resource directory.*

APPENDIX E

Source Documents

SOURCE DOCUMENTS

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APPENDIX F

About the Institutional Contributors

National Oceanic and Atmosphere Administration (NOAA)

NOAA's Coastal Services Center (CSC) is a coastal science and resource advisory center that draws on the expertise of NOAA and its partners to address critical coastal resource issues. CSC was established in 1994 to identify, develop and facilitate the use of technologies and information that support the sustainable use and management of coastal resources. CSC will bridge the gap between coastal scientists and resource managers by bringing staff, technologies, and outside partner expertise to bear on national problems of coastal ecosystem health.

All projects undertaken must be:

- client driven — responding directly to the explicit needs of the primary user groups;
- results oriented — activities of the various service areas achieve viable conclusions;
- relevant — to local, state, and regional issues throughout the country;
- aligned with partners — engaging managers, scientists, and private sector organizations.

The goal of CSC is to build capabilities around the nation which simultaneously address pressing issues of coastal health and change by:

- conserving coastal environments including coastal wetlands, riparian

forested wetlands, maritime forests, fisheries/shellfisheries, and other living marine resources;

- promoting efficient and sustainable industry, farming, commercial and residential development, urban redevelopment, and tourism.

The Coastal Services Center:

- serves as a solution platform and catalyst for managers, scientists, professionals, and citizens to exchange innovative methods of addressing coastal management issues;
- provides tools designed to assist coastal managers in their decision-making process (including information, techniques, and technologies used in effectively addressing coastal issues);
- catalyzes and facilitates strategic alliances between government agencies, non-governmental organizations, and the private sector.

Contact Information:

NOAA Coastal Services Center
2234 South Hobson Avenue
Charleston, South Carolina 29405-2413

Telephone: (800) 789-2234

Fax: (803) 974-6224

Web: <http://www.csc.noaa.gov>

For further information, contact Gale Moody,
Contract Outreach Specialist at (803) 974-6231,
(800) 789-2234; gmoody@csc.noaa.gov

Charleston Metro Chamber of Commerce

Established in 1773, the Charleston Metro Chamber of Commerce is the oldest municipal chamber in continuous operation in the United States. Since its inception, the Chamber has represented the business community in advancing economic development for the quality growth of the Charleston region.

The Chamber works to accomplish its mission by concentrating on four priority areas:

- **Business Development**
Through the Business Development Division, the Chamber works with both existing business expansion and the attraction and development of new business to the three county metropolitan region.
- **Workforce Development**
By working closely to link the business and education communities, the division is working to ensure the region has a skilled and quality workforce both now and in the future.
- **Regional Affairs**
Concentrates on issues that affect the region's business climate and advocating for solutions that will balance the quality growth of the region with its quality of life.
- **Charleston Area Convention & Visitors Bureau (CVB)**
The CVB markets the Charleston area as a vacation, convention and group tour destination to both domestic and international markets.

Contact Information:

Charleston Metro Chamber of Commerce
PO Box 975
Charleston, South Carolina

Telephone: 803-577-2510
Fax: 803-723-4853
Web: <http://www.charleston.chamber.net>

IC² Institute

The University of Texas at Austin

The mission of the IC² (Innovation, Creativity, and Capital) Institute is to enhance understanding of the process of economic wealth creation and prosperity sharing. The IC² Institute accomplishes its mission through

- defining and conducting an integrated and interdisciplinary program of research and education on the enterprise system;
- identifying and employing unique and improved research and learning methods for investigating the enterprise system;
- developing a synthesis of research, education, and practice that mutually reinforce and enhance each other;
- disseminating knowledge through a systematic program including classes and a full curriculum for a Masters' Degree in Science and Technology Commercialization, publications, workshops, seminars, and conferences; and
- engaging The University of Texas and other progressive universities around the world in dialogue and initiatives directed at maximally contributing to society's economic, social, and cultural well-being.

The key areas of research and study concentration of IC² include

- the commercialization of science and technology,
- technology in education,
- creative and innovative management,
- dynamic business development and entrepreneurship, and
- econometrics, economic analysis and management sciences.

The results of work conducted by more than ninety IC² research fellows are published through special reports, monographs, policy papers, technical working papers, research articles, and five major series of books.

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