**Forces for Change — An Economy in Transition**

VISION 2030
DRIVING THE NEW ECONOMY
SCIENCE & TECHNOLOGY

# Vision 2030

## Science and Technology Driving North Carolina's New Economy

*Sponsored by:*

**The North Carolina Board of Science and Technology**

# TABLE OF CONTENTS

# TABLE OF CONTENTS – TABLES AND FIGURES

*Tables:*



*Figures:*

*Figures:*

# The Vision 2030 Project – *Adding Value through Product and Process*

The *Vision 2030* Project is a "real-options" planning effort undertaken to strengthen the competitiveness of North Carolina's workforce and industry by taking advantage of science and technology-driven economic development opportunities. *Vision 2030* was initiated by Governor Jim Hunt and is being led by the North Carolina Board of Science and Technology, the North Carolina Department of Commerce, and the North Carolina House and Senate Technology Committees. Throughout the nine-month *Vision 2030* Project, North Carolina leaders from industry, education, and government will investigate the science and technology innovations that will drive the global economy over the next thirty years. They will work through Task Forces comprised of individuals from all regions of the state to create the policies that will keep North Carolina's workforce and industry competitive in the New Economy. The goals of the *Vision 2030* Project include:

- **Identifying** future trends in science and technology;
- **Developing and Disseminating** a sense of what will be required of each organization in North Carolina to ensure a competitive future for all of North Carolina's citizens and organizations; and
- **Creating** short-term and long-term policies that will use science and technology to ensure North Carolina's future competitiveness.

## The *Vision 2030* Project is built upon several major components:

### Regional Focus Groups—August 1999

Researchers from the Kenan Institute's Office of Economic Development (OED) are assessing each of North Carolina's seven Economic Development Partnership region's strengths relevant to the knowledge economy. They have created regional profiles and have met with key public officials, corporate executives, and education leaders in each region to solicit regional visions and priorities. These regional economic development goals will be analyzed in conjunction with the research and development activities of the universities, institutes, and corporations in each region to identify congruencies, potential linkages, and gaps. Suggestions for addressing any gaps will be forthcoming.

### Statewide Science and Technology Survey—August 1999

Researchers from the Regional Development Service of East Carolina University have conducted a statewide telephone survey to assess public perceptions of the importance of science and technology to each region's economy and to North Carolina's economy as a whole. Results will be disseminated at the Vision 2030 Leadership Conference and the Vision 2030 Regional Conferences.

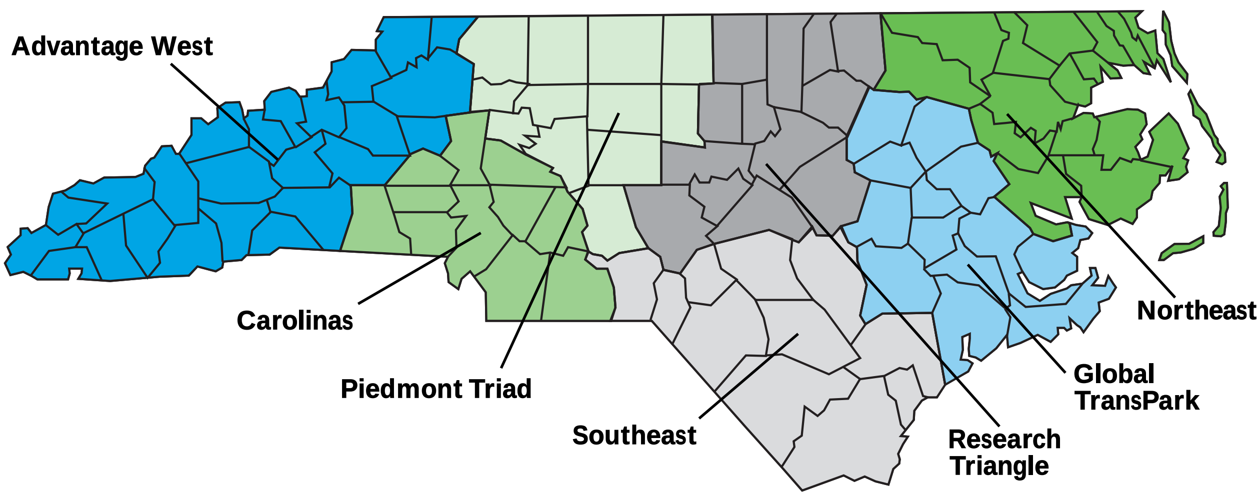
### Benchmarking Study—September 1999 release

The *Vision 2030* Benchmarking Study presented in the following report examines the results of North Carolina's past public investments in science and technology infrastructure. The study presents a retrospective analysis of the role that science and technology investments have played in the growth of North Carolina's economy over the past twenty years. It also examines the current status of science and technology investment in North Carolina benchmarked against selected states to present an accurate picture of North Carolina's competitive position in the knowledge economy.

### Leadership Conference—September 1999

Leaders in industry, education, and government from throughout North Carolina will participate in a 24-hour conference to consider the role science and technology will play in the future quality of life for North Carolina's citizens and in the state's economic competitiveness. The Vision 2030 Leadership Conference will mark the public commencement of the *Vision 2030* Project.

**Economic Development Regions in North Carolina**




### Regional Conferences—November 1999 - January 2000

Regional Conferences will be held in each of the seven Economic Development Partnership regions of North Carolina between November 1999 and January 2000. These conferences will focus on the integration of regional goals for science and technology-driven economic development with the academic and industrial strengths of each region.

### Task Forces—Fall 1999 - Spring 2000

Five Vision 2030 Task Forces will be created in order to develop policy options to ensure that North Carolina's industry and workforce is on the cutting-edge of science and technology. The Task Forces will be staffed by different organizations throughout North Carolina. In the Spring of 2000, the Task Force recommendations will be presented to the Governor, members of the General Assembly, and candidates for statewide office.

### Sciences and Technology Roundtables—Fall 1999 and ongoing

Science and Technology Roundtables will be established in each of North Carolina's seven Economic Development Partnership regions. The roundtables will meet three to four times per year. The Roundtables will be used to inform regional leaders about innovations in science and technology and will provide a forum for regional dialogue on science and technology-driven economic development.

### Economic Cluster Analysis Update—Fall 1999

Researchers at UNC-Chapel Hill will identify major manufacturing and service industry clusters in each of the North Carolina's Economic Development Partnership regions to update and expand on the economic cluster analysis completed for the North Carolina Alliance for Competitive Technologies in 1994. Their report will describe the clusters, examine trends in cluster development over the 1989 to 1998 period, and describe connections among North Carolina's industry clusters, universities, colleges, non-profit institutions, and government agencies.

### North Carolina Innovation Index—Winter 2000

Researchers will create a North Carolina Innovation Index that will assemble over 35 indicators of innovation and technology for North Carolina and several comparable states. Each indicator will be analyzed in terms of its connection to economic development outcomes and its relative quality or reliability for understanding science and technology trends. The North Carolina Innovation Index will be updated annually.

### Final Report and Recommendations—Spring 2000

The *Vision 2030* Project will issue its final report and policy recommendations in the Spring of 2000. This report may recommend statutory, regulatory or administrative changes that will need to be effected by various entities in the state to ensure that North Carolina maintains a leadership position in science and technology-driven economic development.

### Dissemination of Vision 2030 Project Findings—Spring 2000

The Chairs of the North Carolina House and Senate Technology Committees will present the *Vision 2030* Project's final report and policy recommendations to the North Carolina General Assembly. The Project will also sponsor a final briefing for persons who have participated in the process and will disseminate the report and policy recommendations to the various communities of interest in North Carolina.

# ACKNOWLEDGEMENTS


The North Carolina Board of Science and Technology is deeply indebted to Deborah T. Watts of Technology Development Group for her outstanding research and development of this written report on benchmarking of North Carolina's science and technology infrastructure.

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We would like to recognize and thank the many individuals that helped shape this report. Their willingness to share information, advice and editorial comments contributed enormously to both the accuracy and relevance of this document. These individuals exemplify the spirit of commitment to a common purpose that has helped make North Carolina a leader among states in science and technology today. Their continued interest and committed involvement will help ensure North Carolina's competitiveness in the emerging, science and technology-based New Economy.

- Alan Blatecky – MCNC
- David Brown – Wake Forest University
- Douglas Darr – NC Biotechnology Center
- Julie Cole – Wake Forest University
- Mark Crowell – NC State University, Office of Technology Transfer and Industry Programs
- Scott Daugherty – Small Business and Technology Development Center
- Tom Feldbush – East Carolina University
- William Glaze – UNC-Chapel Hill, Environmental Program
- Andrew Grubbs – Venture First
- Ed Holmes – Duke University
- Martin Lancaster – NC Community College System
- Brent Lane – NC Center for Entrepreneurship and Technology
- Harry Leamy – UNC-Charlotte, C.C. Cameron Applied Research Center
- Quentin Lindsey – Former Science Advisor to the Governor of North Carolina
- Richard Linton – UNC General Administration
- Fran Meyer – UNC-Chapel Hill, Office of Technology Development
- Charles Moreland – NC State University
- Kathy Neal – TechKnowledge Communications
- Walter Plosila – Batelle Institute
- Ernestine Psalmonds – NC A&T State University
- Leslie Stewart – Kenan Institute, Office of Economic Development
- John Summers – Brookmont Management, Ltd.

- Margie Boccieri – NC Board of Science and Technology
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# A Context for Change - An Economy in Transition

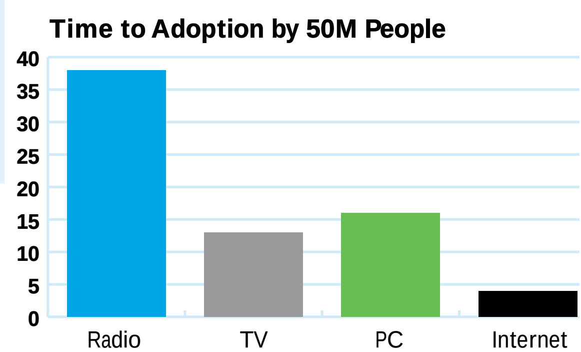
A fundamental global transformation is underway that is redefining the basis of economic competitiveness at every level — from individual firms to industrial sectors; from regions to states to nations (Table 1). During this extended transition from the Industrial Economy that characterized the twentieth century to the knowledge-based New Economy which specifies the upcoming millenium, innovation is the watchword. The future will belong to those states and nations that proactively seize the opportunity to assess the future and adapt to support the innovators among their population. Winners will implement mechanisms and strategies to ensure that their academic institutions and industries are equipped to harness the science and technologies that are the foundation of innovation. North Carolina must be prepared to systematically support continuous innovation to be a winner in the New Economy.

Driven by ever-more intense competition, rapidly evolving technologies are being introduced into the economy and culture at a pace that challenges the absorptive capacity of firms, communities and individuals (Figure 1).[1]

*Figure 1:* **Accelerating Pace of Technology Adoption**

***Technology is growth –*** technology, innovation and knowledge are critical factors in economic growth. Research and technological innovations account for more than two-thirds of U.S per capita economic growth.

***Competition is growing exponentially –*** IBM's competitors have grown from 2,500 in 1965 to more than 50,000 today.




***Product development cycles are compressing –*** one-half of products on the market in 1998 were new introductions.

***Speed is becoming standard –*** along with rapid obsolescence and customization. Movements supported by Internet technologies are changing more than ten times faster than any previous technology.

[1] William M. Daley, U.S. Secretary of Commerce. 1998. *The Emerging Digital Economy*.

*Table 1:* **Keys to the Old and New Economies**

| ISSUE | OLD ECONOMY | NEW ECONOMY |
|---|---|---|
| **Economy-Wide Characteristics:** | | |
| Markets | Stable | Dynamic |
| Scope of Competition | National | Global |
| Organizational Form | Hierarchical, Bureaucratic | Networked |
| **Industry:** | | |
| Organization of Production | Mass Production | Flexible, Agile Production |
| Key Drivers of Growth | Capital/Labor | Innovation/Knowledge |
| Key Technology Driver | Mechanization | Digitization |
| Source of Competitive Advantage | Lowering Cost Through Economies of Scale | Innovation, Quality, Time-to-Market and Cost |
| Importance of Research/Innovation | Low-Moderate | High |
| Relations with Other Firms | Individualistic, Competitive | Alliances and Collaborations |
| **Workforce:** | | |
| Policy Goal | Full Employment | Higher Real Wages/Incomes |
| Skills | Job-Specific Skills | Broad Skills and Cross-Training |
| Labor-Management Relations | Adversarial | Collaborative |
| Nature of Employment | Stable | Market by Risk and Opportunity |
| **Government:** | | |
| Business-Government Relations | Impose Requirements, Autonomous | Encourage Growth Opportunities, Partnerships |
| Regulation | Command and Control | Market Tools and Flexibility |
| Infrastructure Focus | Bricks and Mortar | Virtual and Scalable |

*Source: Progressive Policy Institute (modified)1998*[2]

# Innovation – The Key to Competitiveness in the New Economy

The 1990s have seen the roll-out of thousands of new technologies from laboratory applications to consumer appliances. The seemingly sudden re-emergence of technological progress is the culmination of years of largely publicly-funded research in disparate fields finally reaching critical mass. Beyond this, parts of different innovation waves are starting to feed-on and reinforce one another. For example, the Internet is the culmination of investments of public funds by Department of Defense (DOD) in the Advanced Research Projects Agency (ARPA) network in the 1960s. Gene splicing technologies developed with funding from National Science Foundation (NSF), the National Institutes of Health (NIH) and other agencies underpin the explosive growth of the biotechnology industry today. Combined, biotechnologies and super-fast networked computers are enabling the collaborative effort to map the DNA sequence of the human genome. Global partnerships and competition are amplifying the resulting innovation wave, with the human genome project a prime example of collaboration on a global scale.

The private sector clearly appreciates the power of innovation to fuel economic growth. Eighty-four

[2] Progressive Policy Institute. 1998. *The New Economy Index – Understanding America's Economic Transformation*. (by Robert D. Atkinson and Randolph H. Court). Washington, DC.

percent of global executives cited innovation as the most critical business success factor.[3] Their actions make tangible this faith in innovation. U.S. firms have doubled their research and development (R&D) intensity[4] over the past 15 years. Many of today's innovations have a better chance of succeeding in the market exactly because they are being developed by the private sector in response to the profit motive.

The emerging paradigm of the innovation cycle marks a significant departure from the more deterministic, linear model that framed the structure of federal and state R&D investment of previous decades (see Figure 2). The earlier model depicted R&D and deployment as a pipeline that had ideas and some funds entering at the intake end. Information flows were uni-directional, moving from basic research through applied research and onto prototype development. Commercialization was an endpoint that yielded products and returns on the funds that were invested all along the R&D process. Market forces were not an explicit part of the earliest stages of the process. Public-private partnerships did not have a significant role in joint support of various stages of the process in this model.

A new research, development and technology deployment model captures the current understanding of how this multi-dimensional process evolves (Figure 3). This systemic model reflects a more sophisticated understanding of innovation as a system of relationships and information flows. We now view the innovation process as:

- Non-linear
- Interactive
- Incremental
- Expensive
- Market Driven

*Figure 2:* **The Innovation Process, A Linear Model**

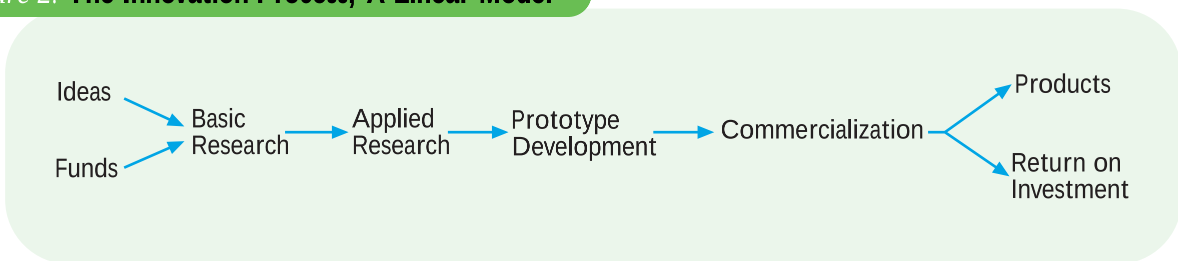
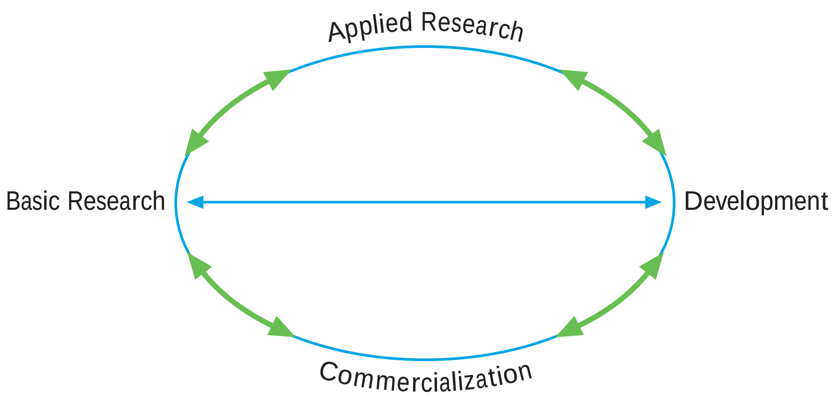



*Figure 3:* **The Innovation Cycle, A Systemic Model**




[3] Arthur Little survey.

[4] R&D intensity is defined as: 1) R&D investment as a percent of sales (in the case of a commercial operation); or 2) R&D investment as a percent of Gross State (or National ) Product (in the case of the public sector).

# State Government Roles in the Knowledge and Information Economy

*Since the 1980s, more than 250 programs related to the use of technology for economic development have been started around the U.S., with total annual funding of over $500 M.*

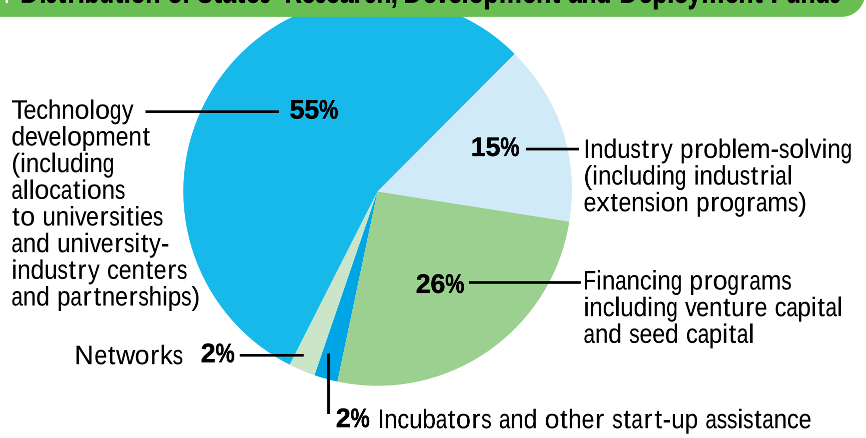
Today's economy is knowledge and idea based, driven by the ability of firms to create and develop new products and processes. State economic development policies and practices are not immune to this paradigm shift, as they likewise become more innovative and entrepreneurial. Historically, states have emphasized infrastructure development and the recruitment of large, established firms. In the New Economy, more states are recognizing the value of experimentation and entrepreneurship. **Emerging themes are those of collaboration, leverage, connectivity and strategic investment in the identification and support of areas of technical strength.**

Technology, and the science that underpins it, are the driving forces in the emerging economy, affecting almost everything we do and how we do it. States' efforts to promote economic growth increasingly have to focus on bringing technology to their industries and communities. States must facilitate the creation of new technology-based firms and industries. And states must ensure that all regions and people are able to participate in this new economy.

In line with the vision of state governments as "Laboratories of Democracy"[5], **all 50 states are engaged in a number of different experiments and approaches for advancing science and technology**. Increasingly the emphasis of these efforts is on the deployment side of the innovation equation. State efforts tend to focus on creating high technology firms and using advanced technologies in the traditional manufacturing and service sectors.[6] The distribution of states' funds applied to research, development and deployment of science and technology are seen in Figure 4.[7]

At least thirteen states have adopted a formal science and technology component to their statewide

*Figure 4:* **Distribution of States' Research, Development and Deployment Funds**




*Source: States Research Institute of the National Science Foundation*

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[5] David Osborne. 1988. Laboratories of Democracy: A New Breed of Governor Creates Models for National Growth. Harvard Business School Press, Boston, MA.

[6] National Science Foundation, Division of Science Resource Studies. 1999. *What is the State Government Role in the R&D Enterprise?* NSF 99-348. (by: John E. Jankowski) U.S. Government Printing Office, Washington, DC.

[7] Walter H. Plosila. 1997. State Technology Programs and the Federal Government. In Albert H. Teich, Stephen D. Nelson, and Celia McEnaney (eds), American Association for the Advancement of Science' AAAS Science and Technology Policy Yearbook 1996-1997. U.S. Government Printing Office, Washington, DC.

economic development plans. These plans share four tenets in common:

- Maintaining and strengthening the R&D capacity of the state's colleges and universities.
- Encouraging home-grown business by providing support to entrepreneurs and small technology-based firms rather than focusing exclusively on recruiting technology firms.
- Facilitating the incorporation of new technology into processes and products through up-skilling of the workforce and capacity-building of established firms.
- Fostering university-industry partnerships.

# North Carolina — An Economy at a Crossroads

And where does North Carolina fit in this picture? As recently as 1996 North Carolina ranked number one in the nation in its investment in programs to support science and technology.[8] This is no longer the case. While many of the state's earlier investments have paid off well, the impact of those investments are not as widespread as we would wish.

The N.C. Board of Science and Technology recently sponsored two separate efforts aimed at gauging public understanding and appreciation of the role of science and technology play in North Carolina's economic health. The results of these efforts paint a fairly clear picture.[9] North Carolinians generally appreciate the important role science and technology have in the state's current and future economic competitiveness. Regional leaders recognize the value of building local R&D capacity that supports the needs of industry in their areas. They also acknowledge vast differences in the current status of R&D capacity across these regions (and even within regions). Beyond this, not everyone believes that the rising economic performance in the urban centers lifts the boat throughout the state. The picture is, in short, one of contradictions, concerns and opportunities (See Table 2).

Science and technology is powering structural changes and competitive advances in certain North Carolina industries and in the state's economy as a whole. Likewise, science and technology are among the most effective tools available to leaders seeking to ensure growth and prosperity for all North Carolinians. Leaders from every sector and geographic region must join in this effort to ensure that the return on public investment in research, development and deployment is maximized and equitably beneficial to all the citizens of the state.

*Table 2:* **The North Carolina Economy – A Story of Contradictions and Opportunities**

| Challenges: | Strengths: |
|---|---|
| Predominance of traditional manufacturing | Expanding high-tech sector |
| Low wage, low skilled, but productive workforce | Regional concentration of highly skilled research and professional workers in both biotechnology and information technologies |
| Below average volume of R&D in industry (NC #9 of 10 top manufacturing states) | Rapid R&D growth in universities and hospitals |
| 85 rural counties with limited R&D resources | Internationally recognized research parks in urban areas |
| Relatively low Internet and computer access statewide | Recognition as a strong R&D center for telecommunications and computers and manufacturing, coupled with the NC Information Highway high-speed telecommunications backbone |
| Relatively low dependence on federal R&D funds | Top-rated academic programs |
| Limited venture and seed capital | Strong technology transfer programs and emerging critical mass of university spin-offs and commercialization activity |

[8] U.S. Economic Development Administration of the U.S. Department of Commerce. 1999. *Science and Technology Strategic Planning — Creating Economic Opportunity.* A report prepared by the State Science and Technology Institution. Westerville, OH.

[9] The NC Board of Science and Technology sponsored a series of focus groups in each of the seven regional economic partnerships to examine the roles local academic institutions and other technology service delivery organizations have in shaping regional economies. The Board also sponsored a statewide survey of public perceptions of the importance of technology in the NC economy. Results of both projects are being prepared for dissemination.

# North Carolina at the Forefront of Science and Technology

Innovation, science and technology have a rich history in the Tar Heel State. Many of the traditional industries underpinning the state's economic and regional growth in this century have their origins in North Carolina research settings — from transportation to biomedicine to telecommunications. The national and world leadership positions held by NC firms and industries today are tied directly to initially unproven innovations and entrepreneurial R&D efforts that transpired in the state in earlier periods.[10]

- **First Research Lab in North America** – ***Roanoke Island, Dare County*** – Two early scientists, Hariot and Gans, on the *1585* Sir Walter Raleigh expedition conducted metallurgical research to explore the commercial potential of indigenous gold and silver ores.
- **Alamance Plaid Textiles** – ***Alamance, Alamance County*** – Innovative textile dyeing process resulted in production of first colored cotton woven on a power loom in the South in *1853*.
- **Pioneering Pharmaceutical** – ***Lincolnton, Lincoln County*** – North Carolina's prominence in pharmaceuticals began in *1862* with the conversion of a textile mill into a drug manufacturing facility for Confederate soldiers.
- **Invention of Automatic Cigarette Maker** – ***Durham, Durham County*** – Mechanization of cigarette production by the American Tobacco Company in *1882* elevated tobacco from a raw material to the state's highest value-added product.
- **Chemical Production** – ***Spray, Rockingham County*** – The state's fast-growing chemical production industry has its roots in the serendipitous discovery of a commercial production method for acetylene gas in *1892* that led to the creation of Union Carbide Corporation.
- **First Forestry School** – ***Pisgah, Transylvania County*** – Established in *1898* by Dr. C.A. Schenke, the Biltmore Forest School developed the forest management practices that underpin North Carolina's wood products and furniture industries and their 40,000 plus employees.
- **First Musical Radio Transmission** – ***Buxton, Dare County*** – Pioneering telecommunications breakthroughs in *1902* by Fessenden for the U.S. Weather Bureau resulted in the world's first transmission of music.
- **First Powered Flight** – ***Kitty Hawk, Dare County*** Three years of on-site experimentation culminated in man's first successful powered flight by Wilber and Orville Wright in *1903*.
- **First Major Regional Airline in the United States** – Piedmont Airlines was developed by business leaders in Winston-Salem and had its inaugural flight from Wilmington in *1948*.
- **Leader in Digital Economy**, Including the first statewide digital network *1983*, the first Gigapop connection in the nation *1997*, and the first one millionth transistor on a chip *1998*.
- **First Broadband Statewide Network** – The North Carolina Information Highway (NCIH), inaugurated in *1994*, enabled follow-on advances in establishing the NC Research and Education Network (NCREN) and other linkages to institutions throughout North Carolina.

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[10] North Carolina Technological Development Authority. 1996. Innovation North Carolina – TDA and North Carolina's Heritage of Innovation. Research Triangle Park, NC.

*Table 3:* **Initiatives in Innovation – Science and Technology at Work in North Carolina**

| PROGRAM | EST. | FOCUS | IMPACT |
|---|---|---|---|
| **Industrial Extension Service** | 1955 | Manufacturing modernization, first industrial extension service in the U.S. | Expansion to nine distributed offices to better serve all of NC's geographic and industrial sectors |
| **Research Triangle Institute** | 1958 | Contract research services to industry and government | Annual revenues in excess of $100 M and 1,400+ employees |
| **NC Community College System Customized Industry Training** | 1958 | Pioneered company-specific, customized training | Up-skilling of more than 4,000 NC workers annually |
| **Research Triangle Park** | 1959 | Economic development linking areas academic institutions and private sector | Prime catalyst for growth of region as leading U.S. technology centers |
| **NC Board of Science and Technology** | 1962 | 1st state science and technology program in U.S., 1st competitive state grants program | Progenitor of a network of science and technology assistance initiatives |
| **University Research Park** | 1966 | Non-profit established by Charlotte Chamber of Commerce to develop a research park for businesses | Catalyzed economic development in Charlotte and infrastructure supportive of UNC-Charlotte development |
| **University of North Carolina System consolidation** | 1971 | Administration of statewide 16 campus system | Leveraged university resources to ensure equitable distribution of education opportunities in NC |
| **NC School of Science and Mathematics** | 1978 | 1st residential school of science and math | Electronic delivery of science/math courses throughout NC |
| **NC Biotechnology Center** | 1979 | First state biotechnology center in the U.S. | Facilitated growth and presence of biotechnology in North Carolina |
| **MCNC** (formerly Microelectronics Center of North Carolina) | 1980 | Microelectronics, telecommunications, and high-performance computing research and support to NC industry, government and universities | Contributed to NC leadership in U.S. telecommunications industry; National Next Generation Internet initiative; seedbed for spin-off companies |
| **NC Technological Development Authority (TDA)** | 1982 | Seed capital to technology start-ups; System of incubators | Invested in 70 NC firms, 26 incubators, and entrepreneurial education network |
| **NC Networking Initiative** | 1983 | 1st digital (T-1) statewide network | 1st state to have statewide connectivity so that all state agencies were interoperably connected |
| **NC Centennial Campus** | 1984 | Research and advanced technology campus devoted to cooperative R&D involving industry, government and NCSU | Model of innovative partnerships with industry/government. 500+ industry/government employees, 700+ university personnel and 1,300+ students |
| **NC Small Business and Technology Development Center (SBTDC)** | 1984 | Inter-institutional program of UNC providing business and technology extension services | Only SBA-small business development group with technology as a focus; 15 offices across the state |

*continued*

*Table 3:* **Initiatives in Innovation – Science and Technology at Work in North Carolina** *continued*

| PROGRAM | EST. | FOCUS | IMPACT |
|---|---|---|---|
| **NC Information Highway** | 1984 | Establish first statewide switched broadband network in the U.S. | First statewide digital broadband network in the U.S., setting the foundation for follow-on linkages, and the state's role in the federal Next Generation Internet Initiative; NC ranks 6th in U.S. in school connections |
| **Global Transpark** | 1990 | Just-in-time global distribution center | Development ongoing |
| **NC Alliance for Competitive Technologies** | 1993 | Strategic technology planning and manufacturing competitiveness | 1st statewide technology strategic plan. Industry sector technology roadmaps, coordination of interagency responses to federal funding initiatives |
| **Piedmont Triad Research Park** | 1994 | Economic development based on regional strengths in science/technology | First urban science park in Southeast, catalyst for regional development efforts |
| **Non-profit venture funds involving NCSU, NC Biotechnology Center, UNC-C, WFU and TDA** | 1998 - 1999 | Investment in university spin-offs and biosciences startups | $10 M Centennial, $30 M NC Biosciences, and $10 M Longleaf Venture Funds |
| **NC Center for Entrepreneurship and Technology** | 1999 | Oversight of NC Department of Commerce efforts in support of entrepreneurship and small business initiatives | Assumed duties of NCACTS, targeting technology and small business initiatives to rural counties and disadvantaged populations and addressing the need for start-up capital in the state |

# Common Threads – Innovative Programs Supporting Innovation

**These initiatives share more than geography in common — they can be characterized, collectively and individually, as an innovative, experimental portfolio of efforts to capture and channel the power of R&D for economic development purposes.** Both the impetus and early stage funding for many of these initiatives came from the North Carolina Board of Science and Technology. Collectively, these initiatives are points of convergence for the industry, university and government stakeholders that constitute North Carolina's innovation triangle. Each of these initiatives could be called ambitious for its time and place.

Another, less constructive aspect of this set of efforts is the **documented lack of integration that has historically characterized their overlapping interests.**[11 12] This may be beginning to change. Examples of more recent collaborative efforts to leverage resources and coordinate activities include the following:

- **Centennial Venture Partners** — a collaborative effort between NC State University (NCSU) and the NC Technological Development Authority.
- **Polymers Extension Center** — a NCSU, UNC-Charlotte, and National Institute of Standards and Technology (NIST) partnership.

[11] NC State Legislature. 1993. *Government Performance Audit Committee Report (KPGM)*. Raleigh , NC.

[12] NC Alliance for Competitive Technologies. 1995 *Making Manufacturing and Technology Work for North Carolina — Strategies for a Competitive Future*. Raleigh, NC.

- **Ergonomic Resource Center** — a partnership between NC Department of Labor and NCSU.
- **Small Business and Technology Development Center and NC Biotechnology Center** — a collaboration to more effectively serve emerging biotechnology firms across the state.
- **Mechatronics degree** offered at UNC-Asheville via the Internet from NCSU in response to industry-identified needs.
- **Hosiery Technology Program** — a partnership involving Catawba Valley Community College, Randolph Community College, MEP and Hosiery Manufacturers Association.
- **Long Leaf Fund** — an alliance between public and private parties to develop a seed-stage venture fund to support technology investments in the Triad and Charlotte areas.

# Homeruns, Hits and Foul Balls — NC's Science and Technology Investments Today

## Research Triangle Park *— Precursor to Technology-Based Economic Development in North Carolina*

There is no better example of successful, far-sighted and progressive application of science and technology policy for economic development at the state level than the Research Triangle Park. Innovative from the outset, the Park has continued to evolve to meet the demands of resident and prospective tenant firms that are drawn from and active in the global arena. Accomplishments include:[13]

- Prestige — RTP ranks in the top three U.S. science and technology centers.
- International Visibility — 16 foreign firms from 9 countries.
- Economic Development — Approximately 100 companies, federal labs and other R&D-related initiatives occupy over 15 million square feet, employ 40,000 permanent and 10,000 contract employees, and generate a payroll in excess of $2.7 B annually.
- University Support — Over $150 M in research funding awarded annually by RTP organizations to North Carolina's academic institutions.
- Entrepreneurial Hotspot — At least 226 technology firms employing almost 14,000 have started in the RTP region since 1960, including 136 since 1990. 28 percent are in the Park itself and another 17 percent are in the immediate vicinity.
- Statewide impact — $300 M invested in 10 counties for RTP-affiliated production plants.

## Charlotte's University Research Park

- Established in 1966 at the juncture of a new interstate highway and a newly established University of North Carolina at Charlotte.
- University Research Park has spurred economic development in Charlotte.
- Early anchor tenants in the telecommunications and information industries supported the growth of the local financial services industry to a position of national leadership.
- Currently, technology intensive firms employ 22,000 people and occupy 8.2 million square feet of built space on 3,200 acres, making it the tenth largest science park in the country.

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[13] Research Triangle Foundation. 1999. *Research Triangle Park: The First Forty Years — An assessment of the Impact on the Region and the State of the Development and Operation of One of the Nation's Most Important Technology Centers.* (by: Hamer, Siler George Associates, Silver Springs, MD). Research Triangle Park, NC.

## Centennial Campus — Raleigh

- Established in 1984 as a research and advanced technology community premised on the value of industry-university-government partnerships in support of innovation.
- Centennial Campus continues to evolve as one of the country's most innovative undertakings — the development of the campus of the future.
- Deliberate attention to design in support of research and education, business and technology transfer, sustainable development and a culture of innovation are being integrated on the 1,000-acre campus.
- 760,000 square feet in 12 buildings house 500 corporate and government employees, 700+ university faculty, staff and post-docs, and 1,200 students. Centennial Campus is the nexus of a constellation of collaborations, leading edge technologies, technology transfer and entrepreneurial support needed to fully realize the potential of NC State University as a force for economic development in the state and nation.

## Winston Salem's Piedmont Triad Research Park (PTRP)

- Established in 1994, the Piedmont Triad Research Park is one of the newest research parks in North Carolina and the 1st urban research park in the Southeast.
- This masterplanned, urban-designed park is linked to university research, financial networks and government to form a critical mass of intellectual capital for technology development in the New Economy.
- PRTP is based on a strategy that promotes access to people in biotechnology, pharmaceuticals, nutrition, medical devices, imaging and information systems.
- The park continues to expand beyond its two existing buildings with construction of Technology Way, an 88,000 square foot facility along with the development of design schematics for a central courtyard plaza.
- Sites within the park are available for up to 300,000 square feet of new construction.

## Eastern Carolina Technology Center (ECTC)— Greenville

- A particularly vivid example of the transition from the old line to new line industries in Eastern North Carolina is found in Greenville. There East Carolina University, with assistance from the NC Biotechnology Center, is converting a former apparel plant to a technology business incubator.
- ECTC will offer laboratories and offices for firms spinning off from ECU's science and technology programs and firms working with the university.
- Increased university focus on technology transfer and a growing number of technology-based firms in the region combine with entrepreneurial support efforts to encourage the retention of technology startups in the region.

## MCNC

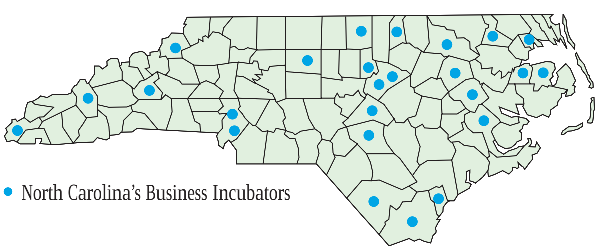
- MCNC provides research and development services in advanced electronic and information technologies for businesses, for state and federal government agencies, and for North Carolina's education communities.
- MCNC operates a statewide network, providing Internet access, data sharing and videoconferencing through the NC Research and Education Network (NCREN).
- A second service center operates a world-class supercomputing facility.

- Contract prototyping and development services speed the commercialization process for new and established electronics and telecommunications firms.
- Aggressive technology transfer practices have resulted in six joint ventures and spin offs from MCNC.
- MCNC will be the technology center for the national Abilene (Internet 2) project.

## NC Technological Development Authority (TDA)

From its inception in 1982, the TDA has taken a statewide perspective in carrying out its mission.

- TDA has invested, on a matching basis with local partners, in a network of 30 full-service business incubators totaling a half million square feet. The North Carolina Incubator System spans North Carolina from Waynesville to Ahoskie and includes 20 operating incubators, six under development and four approved last year.



• North Carolina's Business Incubators

- Six of these sites are on-line as part of a USDA-TDA joint effort to develop and transmit entrepreneurial distance learning programs to rural communities. Long term, all TDA-supported incubators will be part of this Entrepreneurial Education Network (EEN).
- The Rural Loan Program teams TDA with the U.S. Department of Agriculture (USDA) to provide flexible debt options to rural firms and incubator projects.
- TDA's Innovation Research Fund (IRF) has provided seed capital to a portfolio 70 companies which span the state. These investments involve a broad range of industries, including agriculture, biotechnology, genomics, medical devices, and information technologies.

## NC Biotechnology Center

In retrospect, biotechnology was a natural for a state that draws its economic strengths from industries that increasingly depend on biotech innovations – pharmaceuticals, textiles, chemicals and forestry.

- North Carolina's biotechnology industry ranks in the top 10 nationwide and first in the Southeast. From a small base of 12 biotech companies employing 5,000 people in 1988, the state's biotechnology industry has grown to include more than 100 established and start-up firms with sales in excess of $1.5 B.
- Biotech firms employ over 28,000 people in 27 counties in all regions of the state.
- North Carolina ranked 4th in 1998 in venture capital invested in biotech deals.

**NC Biotechnology Center concentrates its efforts on four fronts:**

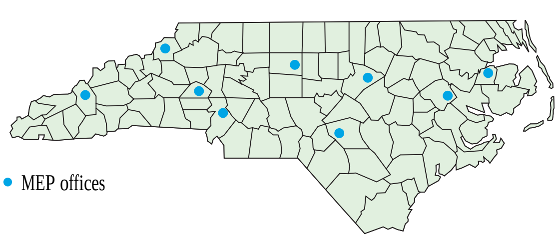
- The Science and Technology Development Program helps universities recruit and hire world-class scientists. These researchers are magnets for exceptional graduate students and industrial and federal support. They elevate programs at area institutions to global prominence.
- The Business and Technology Development Program focuses on moving the output of R&D into the commercialization arena, providing seed investments of $6 M to more than 50 companies which was leveraged with $330 M of additional investment. Six of these firms are now publicly traded.

- The North Carolina Bioscience Venture Fund, a $30 M bioscience-focused venture fund managed by Eno River Capital, LLC was established in 1998.
- Education and Training Programs span the spectrum from public information to K-12 science education. The NC Biotechnology Center partnered with the NC Community College System and industry to develop training programs for workers for the state's growing biomanufacturing, pharmaceutical and chemicals industries.

## NC Industrial Extension Service(IES) – Manufacturing Extension Program (MEP)

Since its establishment as the first industrial extension service in the nation, the North Carolina IES has had historically the mandate, but not the resources, to assist the state's full spectrum of industries and geographic regions. Headquarters at the NC State University College of Engineering facilitated access to the R&D resources of the university, but the lack of a physical presence outside of the Triangle limited the practical value of the IES' university ties. Beginning in 1993, an award from the National Institute of Standards and Technology (NIST) led to the creation of the North Carolina Manufacturing Extension Partnership (MEP) Program.

- MEP is a partnership among state universities and community colleges designed to expand modernization assistance to small and medium-sized manufacturers through field engineering assistance.
- MEP has since grown to include 9 professionally staffed offices across the state.




- Resources are leveraged through MEP's active links to 24 partners and subcontractors throughout North Carolina.
- Through the NIST network and National Technological University, MEP links the state's manufacturers to more than 1,000 engineering and technical experts throughout the country.
- Recognition of the added value that MEP brings to the state's manufacturers led to the North Carolina legislature, including the MEP in the state's recurring budget in 1999.

## NC Community College System (NCCCS)

As both the products and processes of North Carolina's industries become more technology intensive, the state's workforce must become likewise more adept at the use and understanding of technologies. The North Carolina Community College System (NCCCS) will be a critical element in the State's efforts to use technology to enhance its competitiveness. The need for specialized technology training at the community colleges is documented in an examination of the workforce training needs of North Carolina's bioprocessing industry.[14]

The NCCCS is in the planning stages for 8-10 centers to meet the specialized training needs of strategic technology-based industries which will dominate North Carolina's economic future.

***System Highlights***

- Nation's oldest and third largest community college system.
- Accessibility — 59 institutions and their satellite facilities put the NCCCS within 30 miles of nearly every North Carolinian.
- Focus on workforce preparedness, with more than 25 percent of its students enrolled in curriculum programs.

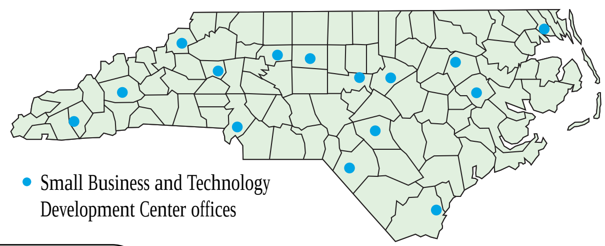
- One of every six adults in North Carolina enrolls in the NCCCS.
- Additional 1999 funding will increase some salaries as much as 12 percent, moving the system closer to the national average and enabling the acqusition of much-needed technology.

***Hurdles to Meeting the State's Need for High-Tech Training***

- The NCCCS has operated under antiquated funding formulas that provided far fewer dollars for students pursuing technical training than for students engaged in BA-transfer programs. This has detracted from the NCCCS's ability to address future workforce needs and changing market conditions and technologies. The Governor's Commission on Workforce Preparedness has recommended a revised formula that encourages innovative programs to meet the needs of a growing technology-based economy.[14]
- Faculty salaries are well below the national average.
- Technological resources can be obsolete or unavailable.

## Small Business and Technology Development Center (SBTDC)

Since its formation in 1984 by the University of North Carolina System, the SBTDC has had a specific role in support of technology development and commercialization in North Carolina. Now the largest inter-institutional program in the University System, the SBTDC has 17 offices and serves over 12,000 clients annually across the state. Its Technology Group works with universities and small firms to support commercialization efforts and the successful growth of technology-based companies.




### NC Community College System
**(1996-1997 performance data)**

- ***38,000 trainees from >900 new, expanding or existing companies.***
- ***297,000 adults trained in occupational extension classes or in-plant training courses.***
- ***58 small business centers served more than 62,000 clients***
- ***Almost 19,000 students enrolled in 19 high-tech related curriculums throughout the system.***

- The SBTDC is the state's partner for the Federal Small Business Development Center program, the Procurement Technical Assistance Program, and the Export-Import Bank.
- With NC Department of Commerce support beginning in 1998, the SBTDC was designated as the lead agency to support improvements in SBIR/STTR participation.
- The SBTDC has funded partnerships with the NC Biotechnology Center and the TDA.
- A recent grant from the U.S. Small Business Administration will support the SBTDC's establishment of a national training and demonstration program for organizations interested in establishing cost-effective technology development programs.

[14] North Carolina Biotechnology Center. 1997. *Window on the Workplace — Workforce Training Needs for North Carolina's Bioprocessing Industry*. Research Triangle Park, NC.

[15] Governor's Commission on Workforce Preparedness. 1995. *Building a High Performance Workforce: 1995-1997 Strategic Directions for North Carolina*. Office of the Governor, State of North Carolina.

# A Snapshot of the North Carolina Economy in 1999 Reveals a State in Transition:

- Manufacturing remains strong, but no longer dominates the North Carolina economy. The state's service sector industries now employ more people than any other sector.
- In North Carolina, technology plays an ever-increasing role in determining winners and losers, powering the transition from low-wage, labor-intensive industries to those that are focused on higher value-added products and processes.
- Traditional manufacturing firms in North Carolina are faced with two choices — retreat or modernize.
- Even as the North American Free Trade Agreement (NAFTA) and the General Agreement on Tariffs and Trade (GATT) cost some jobs, they create others as more NC firms enter the global market and the value of state exports continues to rise.
- Plant closings continue to plague NC workers, costing almost 23,000 workers their jobs in 1998 in 41 rural and urban counties across the state.
- Emergent manufacturing industries, such as electronics, communications equipment, plastics and biotechnology are increasingly supplementing NC's traditional manufacturing powerhouses of textiles/apparel, lumber, furniture and metalworking.
- Innovation characterizes both the fastest growing startups in urban areas and established but entrepreneurial firms that are having profound effects on the economies of rural counties.

From a public policy perspective, the question becomes one of where, and how, to best apply resources to create and sustain an environment that supports innovation. In North Carolina, a logical place to begin is with the backbone of the State's economy, the manufacturing sector, where technologies are being created and applied to ensure on-going competitiveness.

# The State of Manufacturing

In North Carolina, manufacturing matters! For more than two decades, manufacturing has provided the largest share of North Carolina's gross state product, exceeding more than $68 billion in 1998. Manufacturing employs more than 836,000 people across North Carolina, and exceeds the national average in its share of total employment in 83 of the state's 100 counties. While manufacturing accounts for only seven percent of the state's private companies, it accounts for 29 percent of all wages. North Carolina will fight its battle for global prominence on the manufacturing front. The road to success in manufacturing, and other sectors, is well defined; to compete in the next millenium North Carolina must:

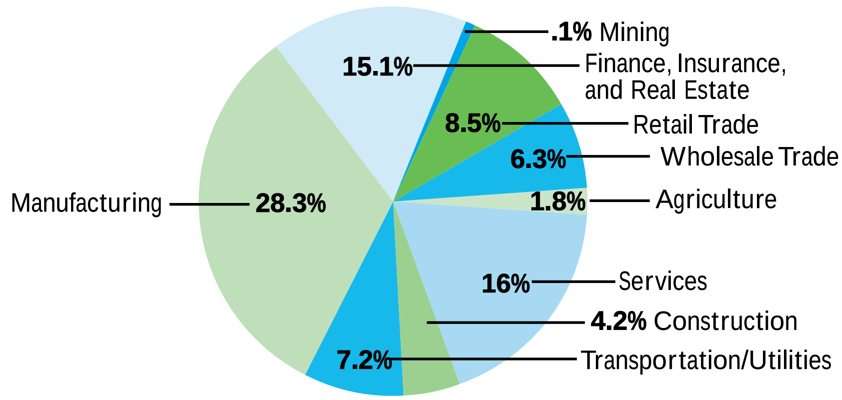
- Assist existing and traditional manufacturers to modernize and adopt critical technologies.
- Develop policies, infrastructure and the highly-skilled, flexible workforce needed to attract and retain leading-edge new technology firms.
- Create the intellectual and investment environment that supports new and innovative technology-based firms.

## Manufacturing Strength through Diversity

Manufacturing jobs in North Carolina continue to track a ten-year national decline in manufacturing employment. Offsetting this negative pattern is the increasing value of the various manufacturing sectors in the state. Between 1989 and 1995 the state's manufacturers in all but two Standard Industrial Classification (SIC) categories improved their national rank (Figure 6). North Carolina firms rank in the top sixteen nationwide in all but four of the twenty-one SIC-based manufacturing sectors.

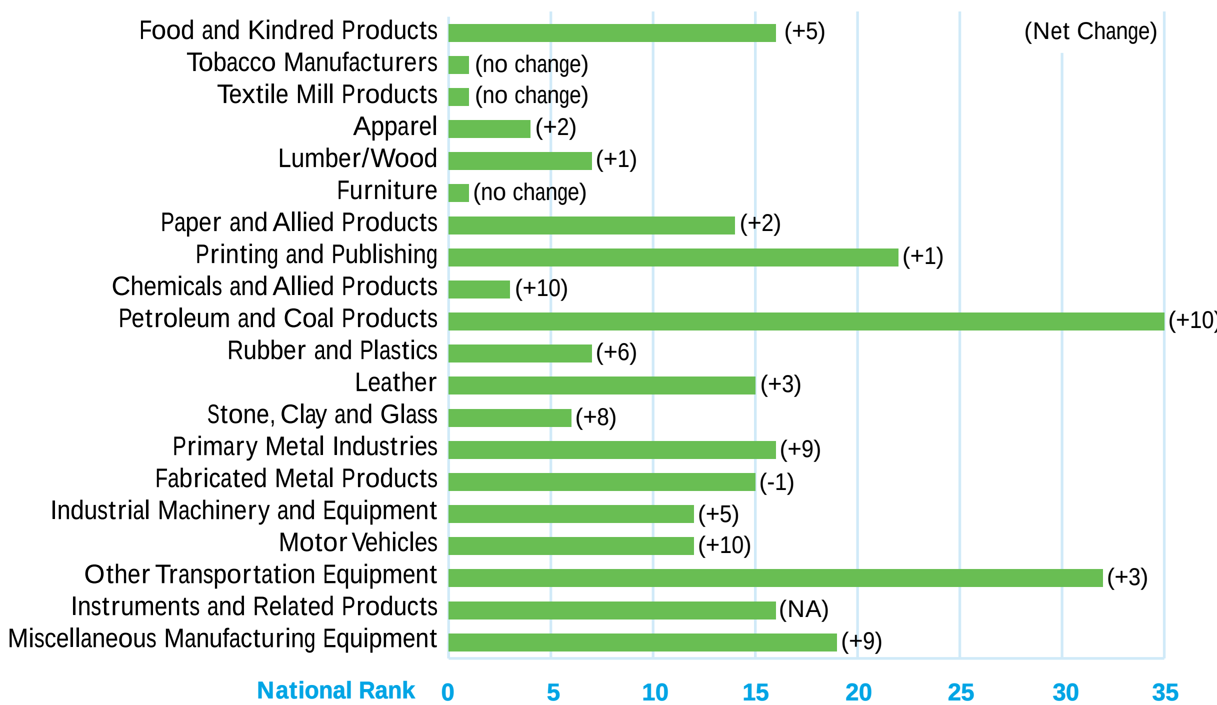
The sectors experiencing the greatest change in their relative national position are part of a cluster of related industry sectors with strong growth potential. These sectors warrant special consideration in technology support initiatives.

*Figure 5:* **North Carolina's $240 Billion Gross State Product**




*Source: UNC-Charlotte – Economic Forecast – Fourth Quarter 1998*

*Figure 6:* **National Rank of Value of North Carolina Manufacturing Sectors**




*Source: U.S. Bureau of Economic Statistics 1995*

### Potential Barriers to Continued Economic Growth

While forecasts for 1999 anticipate net growth across all sectors of manufacturing in North Carolina except mining[16], there are concerns, many of which relate to technology:[17]

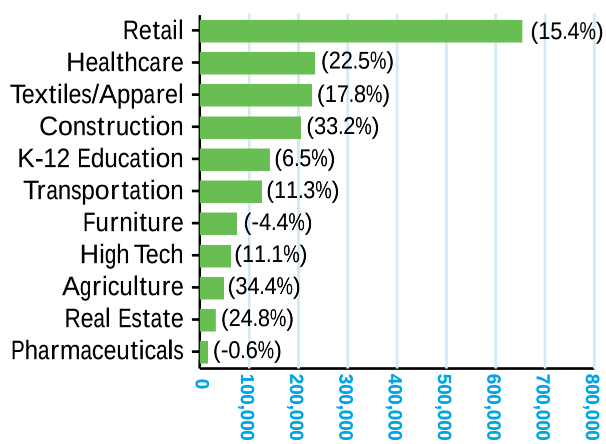
- At $11.41 per hour, manufacturing wages exceed the state average by 14 percent, but still compare poorly with manufacturing wages in both the region and the country, ranking 43rd nationwide.[18]
- North Carolina ranks 48th in the nation in number of engineers in the work force.
- 50 percent of NC firms do not have either a degreed engineer or an engineering technician on staff to facilitate modernization.
- Only 27 percent of NC firms conduct research to commercialize new technologies.
- Only six percent of NC firms have implemented the ISO 9000 quality standards needed to compete in international markets.
- North Carolina ranks 44th in manufacturing capital investments.
- In the face of growing demand for highly skilled workers, NC ranks 40th nationally in its high school graduation rate.[19]
- North Carolina is the state most negatively affected by NAFTA and GATT, seeing its historic advantage of low labor costs evaporate.

# High-Tech Firms in North Carolina

### High-Tech Firms Impact on Employment Statistics

While technology clearly is an important force for improved economic performance, the past significance of high-tech firms on job creation may be exaggerated. High technology[20] employees currently represent only a small share of North Carolina's total workforce, and the 11 percent growth rate over the 1989-95 period is only good, not stellar (Figure 7). While the absolute number of people employed in high-tech firms is still relatively small, these individuals have substantially higher annual wages (Figure 8) and have realized the greatest increase in annual wages since 1989 (Figure 9).

*Figure 7:* **NC Employment, By Select Industry Sector – 1997**




(%)= Net growth or decline in employment over the period from 1993-1997.

*Source: 1999 PricewaterhouseCoopers, LLP – data from* NC Business *1999 and US Department of Education 1999.*

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[16] UNC-Charlotte. 1998. *North Carolina Economic Forecast. Vol. 17, No.4* Charlotte, NC.

[17] Data from NC IES/NCMEP publications and annual manufacturing survey data. 1998.

[18] Data from U.S. Bureau of Labor Statistics (1997 data).

[19] NC Department of Commerce State Profiles (1997 data).

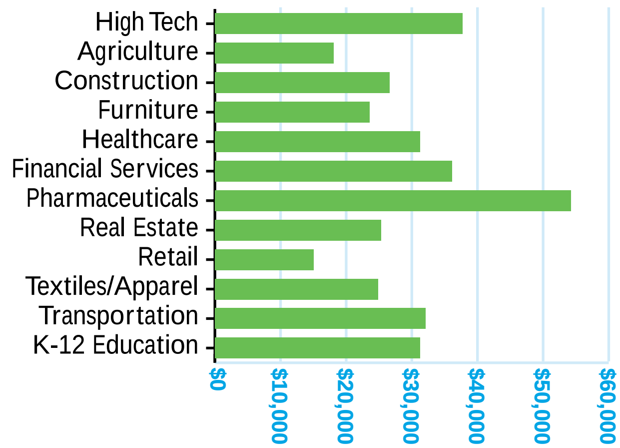
[20] The definition of "high tech" in this report is consistent with that utilized by the NC Department of Commerce, the NC Alliance for Competitive Technologies and the Office of Economic Development in their reports related to high-tech employment in the state. It corresponds to the definition used by the NC Employment Security Commission and other states. High-tech firms are those involved in the production of a high technology good, that make significant use of high technology production equipment and/or employ significant numbers of highly skilled R&D personnel.

## Technology Ripple Effects

This raises the issue of critical mass. High technology jobs have transformed the economy of the Research Triangle region over the past twenty years. Highly skilled people from all over the country and the world have been attracted by the high quality jobs (Figure 9) in a growing number of technology-producing industries (Figure 10). The Research Triangle Park has had ripple effects throughout North Carolina, particularly in other technology-rich urban centers with strong research universities. The net result has been that the gap between the level of technology employment in the state versus that of the nation has narrowed from 55 percent in 1956 to 19 percent in 1996.[21]

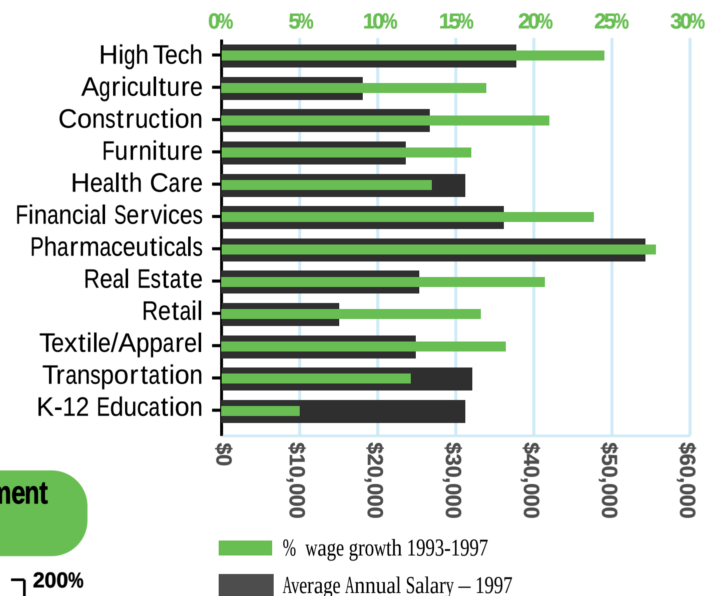
**However, high-tech employment in North Carolina as a whole still does not equal either the National or Southeastern U.S. average.**

*Figure 8:* **Average Annual Salaries for Key NC Industries**



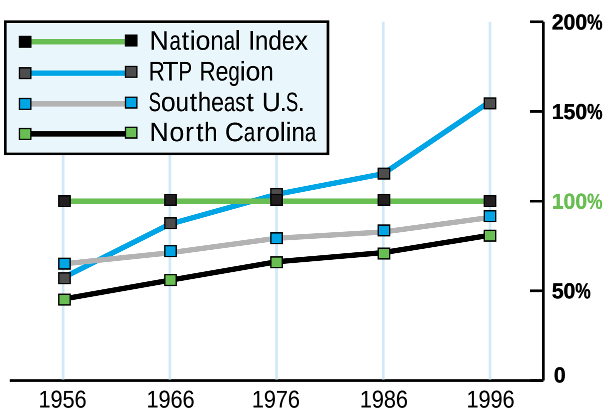

*Source: NC Employment Security Commission*

*Figure 9:* **Wage Growth in Select North Carolina Industries – 1993-1997**




*Source: PricewaterhouseCoopers 1997*

*Figure 10:* **Benchmark Technology Employment in the Years since RTP Founded**



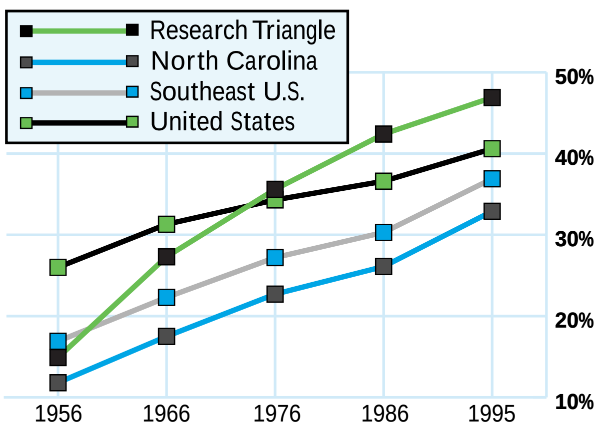

*Source: Hammer Siler George Associates*

[21] Research Triangle Foundation. 1999. *The Research Triangle Park: the First Forth Years* (by Hammer, Siler and George Associates, Silver Springs, MD). Research Triangle Park, NC.

## High-Tech Employment Throughout North Carolina

Technology-based firms are found in every region of the state (Figure 11), although in vastly different concentrations. Regions with relatively low numbers of technology firms are working to both recruit and develop indigenous high-tech enterprises. Representative of such efforts is the recruitment of Nucor Steel to Northeastern North Carolina. Nucor is noted for its use of innovative production process technologies that allow small-scale steel production to be competitive.

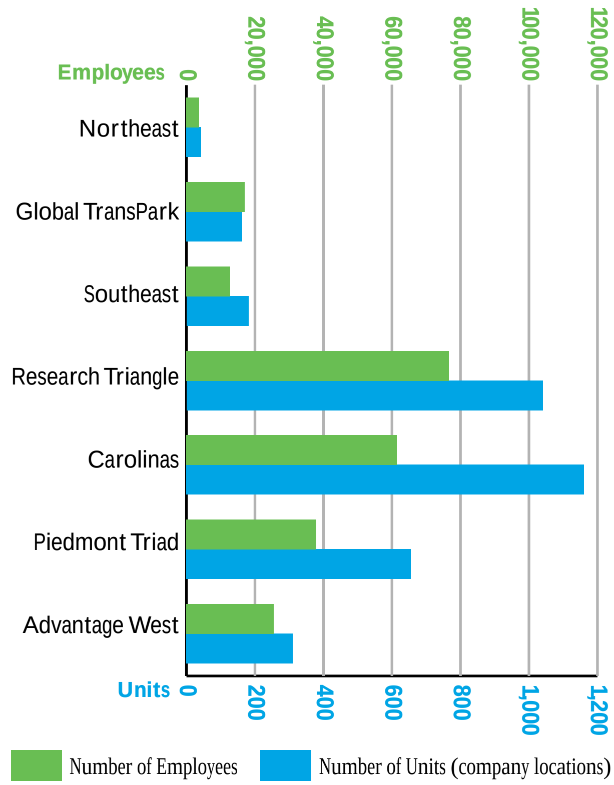
*Figure 11:* **Emergence of High-Tech Industries as a Force for Economic Development**




*Source: Hammer Siler George Associates*

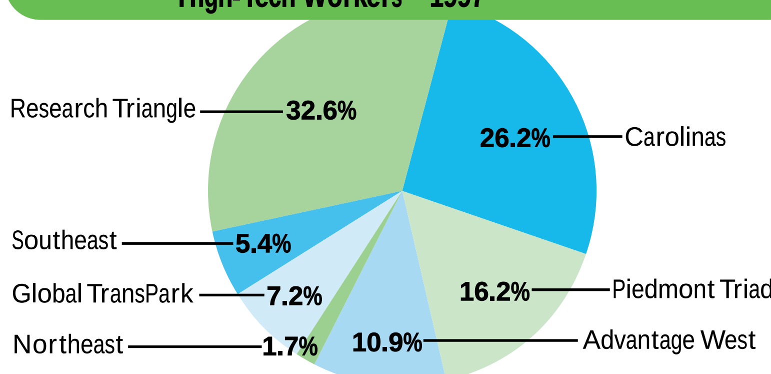
According to the Milken Institute, Rocky Mount ranked 38th nationally in terms of total high-tech output in 1998. Other North Carolina metro areas ranking high in specific high-tech industrial sector output were Wilmington (7th in Research and Testing Services), Goldsboro (6th in Medical Instruments) and the RTP area (13th overall and 22nd in high-tech services real output).[22]

*Figure 12:* **High-Tech Employment in North Carolina by Economic Development Region – 1997**




*Source: NC Employment Security Commission – Labor Market Division*

*Figure 13:* **North Carolina Regional Distribution of High-Tech Workers – 1997**




Percent of Total High Tech Employment in NC

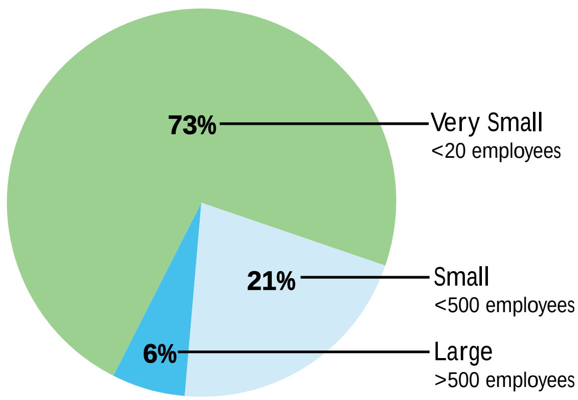
*Source: NC Department of Commerce*

[22] Milken Institute. 1999. *America's High-Tech Economy* (by Ross C. DeVol). Santa Monica, CA.

## Innovation and the Small High-Tech Businesses in North Carolina

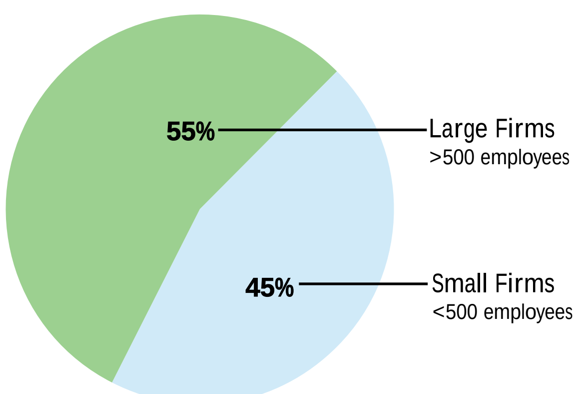
Collectively, Figures 14-17 paint a picture of North Carolina's high-tech sector as one of small to medium-size enterprises (SMEs) that are expected to experience dynamic growth. Although the SMEs lack the depth of research resources and receive less than one-half the federal R&D support of larger high-tech firms, they still account for nearly half of all innovations. Among SMEs everywhere, the need for start-up and pre-commercialization support and other sorts of technology transfer assistance are very important. In North Carolina, SMEs may have a particularly difficult time obtaining appropriate assistance from federal programs; for example, through the Small Business Innovative Research (SBIR), Small Business

*Figure 14:* **High-Tech Firm Size in NC**



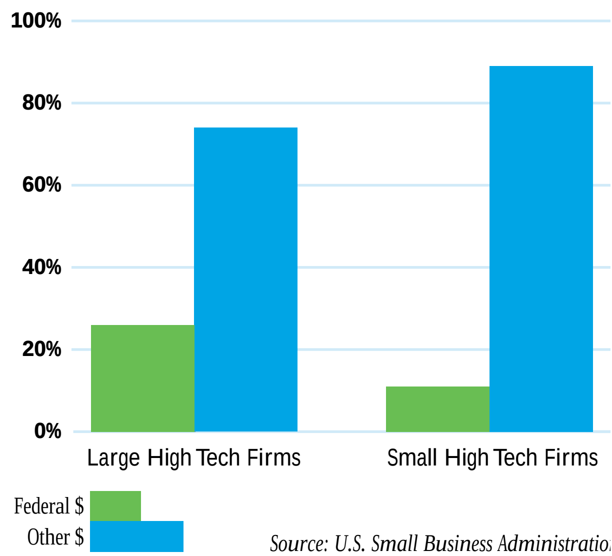

Proportion of High Tech Firms
*Source: U.S. Small Business Administration*

*Figure 15:* **Sources of High-Tech Innovations**



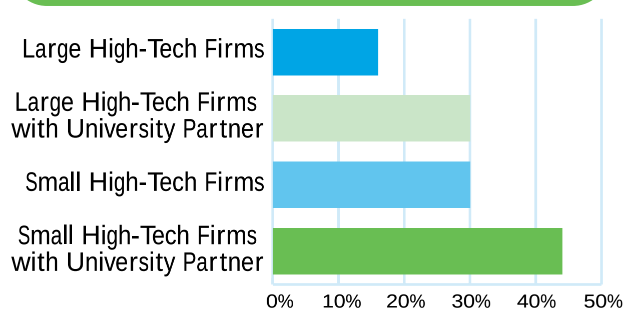

Percent of Innovations
*Source: U.S. Small Business Administration*

*Figure 16:* **Source of High-Tech R&D Funds**




*Source: U.S. Small Business Administratio*

*Figure 17:* **Rates of Return and University Partnerships and Alliances**




*Source: U.S. Small Business Administration*

Technology Transfer Program (STTR) and Advanced Technology Program (ATP) programs. It appears critical that North Carolina's SMEs are afforded every opportunity through:

- Facilitated partnerships and alliances with university researchers to enhance the firm's return on R&D investment.
- Improved accessibility to other university-based R&D resources.
- Seamless, coordinated delivery of the full spectrum of technology development, deployment and commercialization services, including targeted identification and application assistance for federal support.
- Creative funding assistance through existing technology-targeted seed and venture funds.

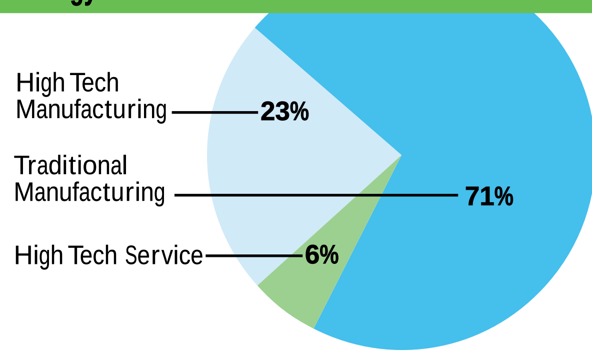
## Technology and the Growth of the Service Sector

Technology is fueling much of the growth in North Carolina's employment, pushing services' share of the gross state product to 23.8 percent in 1997 surpassing manufacturing's share of 22.8 percent for the first time ever. North Carolina has the 43rd largest service economy in the United States, up from 48th in 1994. North Carolina's service firms constitute at least eight percent of North Carolina's high-tech firms.

## The Changing Nature of High-Tech Employment

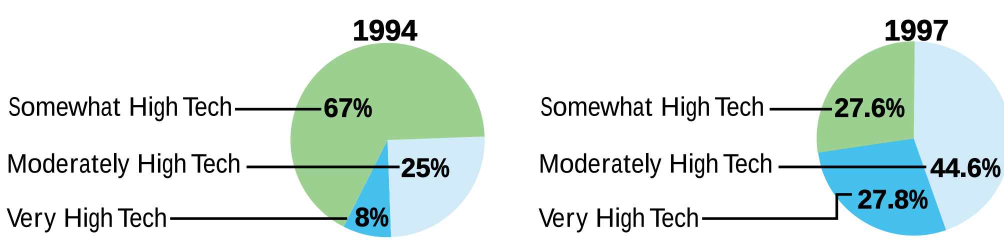
Across the economy, the technology content of jobs in all industry sectors and the number of technology-based firms is increasing. Within the set of industries defined as high-tech, there has been a shift towards a growing share of employment at the more technology intensive end of the spectrum.

*Figure 18:* **High-Technology and the Service Sector in North Carolina**




*Source: NC Employment Security Commission*

*Figure 19:* **Shifts in High-Tech Employment – 1994-1997**




*Source: NC Employment Security Commission 1999*

# Key Manufacturing Industry Clusters

Technology development, commercialization and deployment services can be important elements of strategic economic development plans. It is particularly important that these tools be applied to the economic sectors with the greatest potential impact on the state's competitiveness. Industrial Cluster Analysis has emerged as a method of choice for identifying these sectors.

State economic sectors do not operate in isolation. Rather it is the comprehensive network of extended relationships (input-output, buyer-supplier) and the strength of the relationships (primary or secondary) that determines the relative importance of a given cluster. Clusters suggest industries among which the transfer of intermediate goods, advanced production technologies, formal and informal information about new methods and innovations, and skilled production workers and technical personnel is likely to occur.

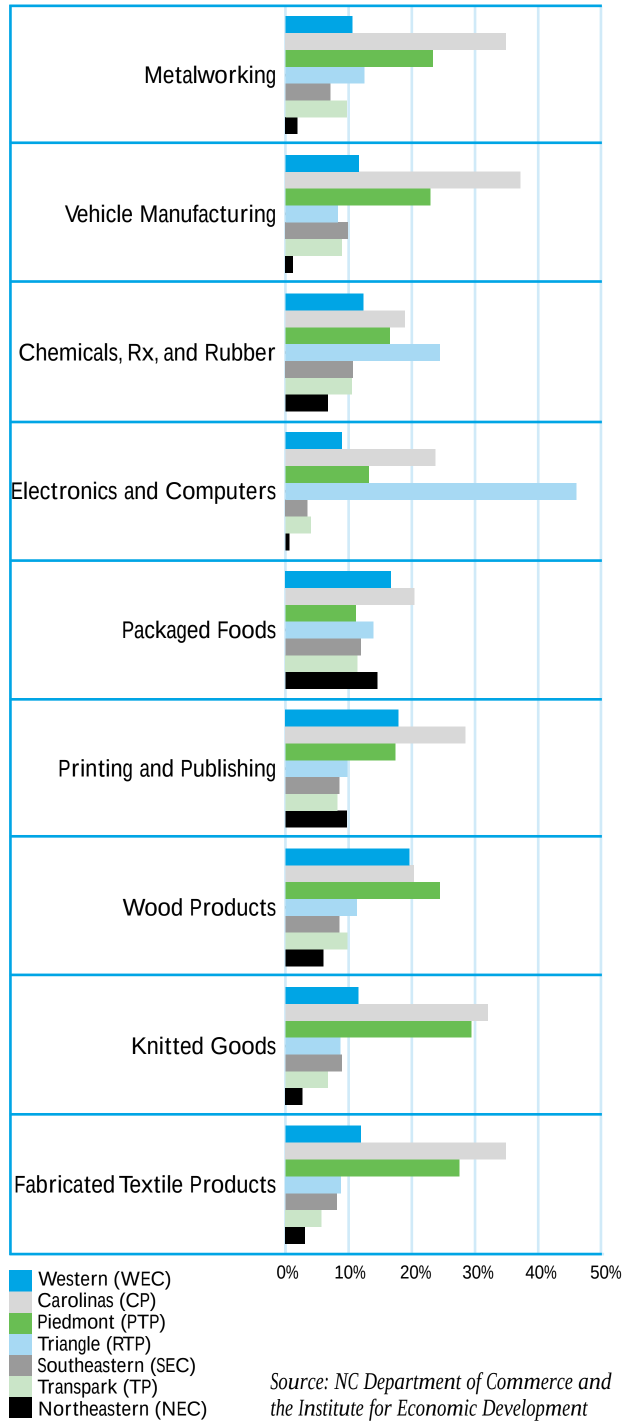
Clusters help characterize the manufacturing economy in terms of concentrations in major product chains, thereby revealing relative specializations in the economy by groups of interdependent, rather than independent sectors.

Nine clusters in which North Carolina has strong potential for competitive advantage have been identified[23] (Figure 20). In 1994, these sectors accounted for:

- 90 percent of all manufacturing establishments in NC
- 84 percent of total manufacturing employment
- 72 percent of estimated output

Findings from the 1994 cluster analysis are listed in Figure 20. An updated analysis is underway that will include North Carolina's large service sector. Significant variations from the 1994 findings are not expected.

*Figure 20:* **Regional Share of Statewide Estimated Cluster Output – 1994**

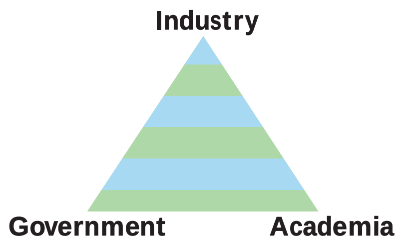



*Source: NC Department of Commerce and the Institute for Economic Development*

[23] Institute for Economic Development. 1996. *Targeting North Carolina Manufacturing — Understanding the State's Economy Through Industrial Cluster Analysis. Vol. 1: Summary.* (Project conducted for the North Carolina Alliance for Competitive Technologies). Chapel Hill, NC.

# Benchmarking Investments Relevant to the Innovation Pyramid

*Figure 21:* **Innovation Pyramid**




State efforts to utilize science and technology to improve the quality of its citizens' lives and to support the state's economic competitiveness have intrinsic value — they can be used to provide better jobs and to improve the quality of life. They also convey to the world at large the state's ability and intent to participate in the new innovation-based global economic arena. Key investments in core technology areas in the past have name-branded North Carolina as a leader in the growth industries of biotechnology and information and communications technologies.

**Innovation:** *The situationally new development and introduction of knowledge-derived tools, artifacts, and devices by which people extend and interact with their environment.*

**Leaders in these industries know that complacency can be fatal in their fast-paced, highly competitive markets. North Carolina's leaders need to avoid the same pitfall.** Frequent, rigorous evaluation of North Carolina's performance relative to others on a number of metrics relevant to innovation are required to aggressively support and improve the state's competitive position in the new economy. Benchmarking North Carolina's performance in its support of innovation against that of other innovation-focused states is a critical step in deciding where, and how, North Carolina's innovation-support efforts can best be directed in the future.[24]

States were selected as benchmarks based on one or more of the following parameters:

- **Widespread recognition** among practitioners as an innovator in technology development and deployment efforts. (Kansas, Utah, Georgia)
- **Common geographic borders** with North Carolina. (Virginia, South Carolina)
- **Common reliance on traditional industries and history** as an early adopter of technology and innovation as a focus for economic development efforts. (New Jersey, Pennsylvania)

When available, comparisons are made with regional performance as defined by the measures averaged across member states of the Southern Growth Policies Board (SGPB) and Southern Technology Council (STC).[25]

**Benchmarking:** *a continuous, systematic process for evaluating the products services and work processes of organization that are recognized as representing best practices for the purposes of organizational improvement.*

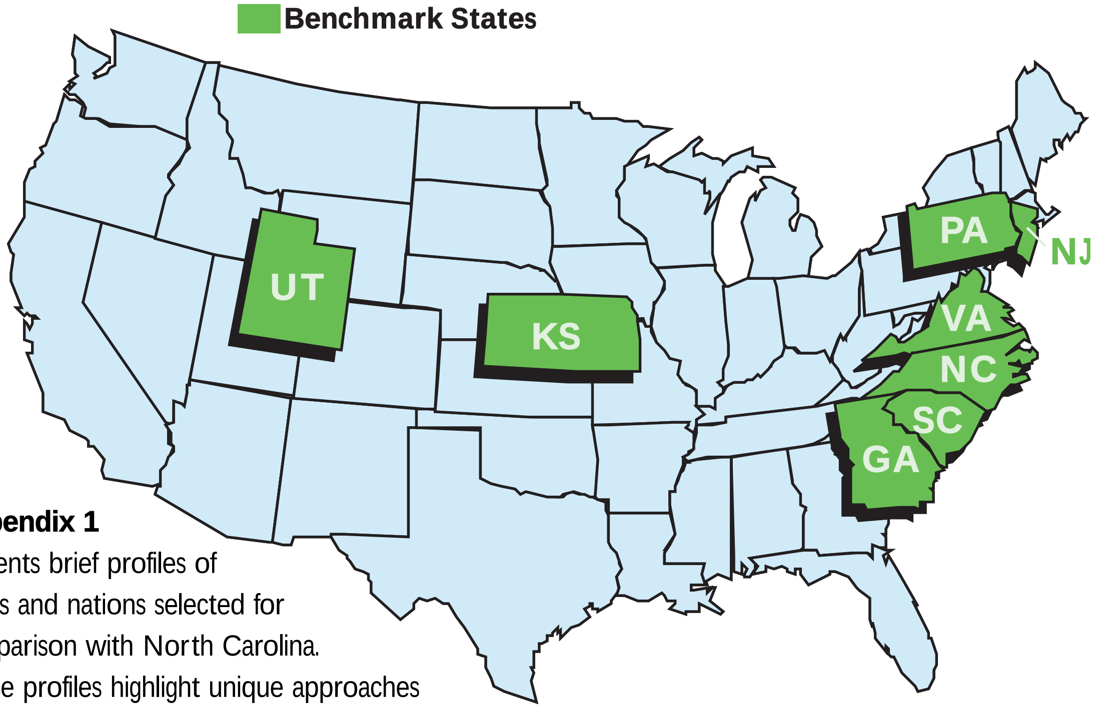
While direct comparisons of science and technology initiatives at state and national levels may not be appropriate, there are models executed on the national level that may be relevant to the North Carolina context. Singapore and Israel are profiled in Appendix 1 to highlight their public sector efforts to establish their nations as technology-elite states.[26]

[24] M Spendolini. 1992. *The Benchmarking Book*. New York: The American Management Association.

[25] SPGB/STC member states include: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisianna, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, West Virginia, and Virginia.

[26] Kenan Institute Office of Economic Development. 1999. *Best Practices in Science and Technology – Based Economic Development Policy: U.S. and Global.* Chapel Hill, NC.

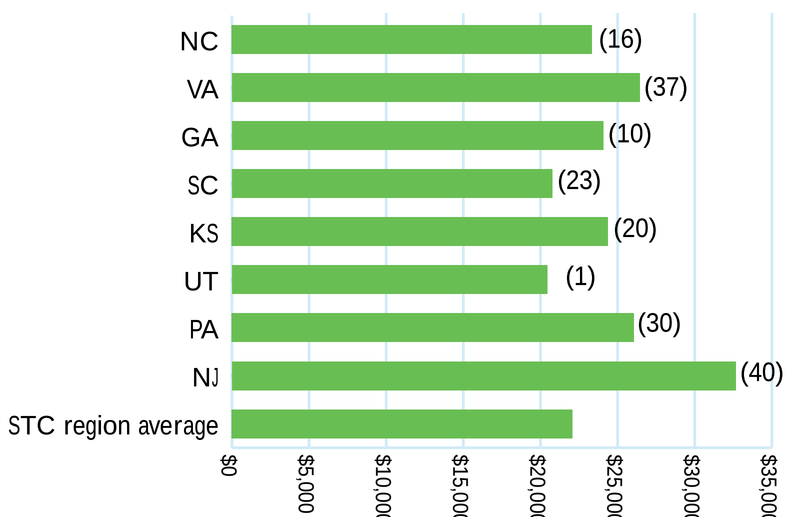
*Figure 22:* **States Selected as Benchmarks**




**Appendix 1**
presents brief profiles of states and nations selected for comparison with North Carolina. These profiles highlight unique approaches to the use of science and technology as a basis for economic development.

# Income Benchmarks

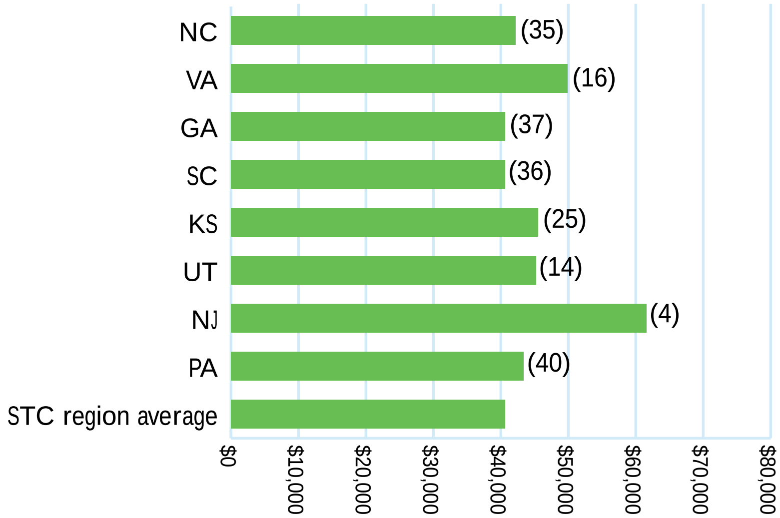
*Figure 23:* **Benchmarked 1997 Per Capita Income**




( ) = National Rank of % change – 1993-1997

*Source: NC Department of Commerce State Profiles*

*Figure 24:* **Benchmarked Median Household Income – 1998**




( ) = National Rank in % increase – 1990-1998

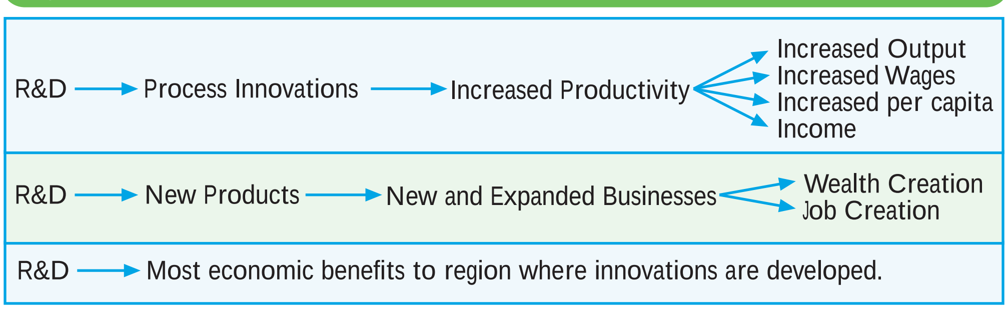
*Source: NC Department of Commerce State Profiles*

# North Carolina's Innovation System

## Innovation and Economic Growth

Innovation – the ability to develop and commercialize new products, processes and services – is increasingly recognized as the key to global competitiveness. While a number of factors contribute to economic competitiveness (including policies related to the treatment of intellectual property rights, antitrust practices and regulatory rules, and other technology transfer considerations) it is R&D that is seen as the foundation of innovation success for companies, industries, states and nations.

*Figure 25:* **Outcomes of Innovation**




## Best Practices in Science and Technology Strategic Planning

Today's economy is driven by knowledge and powered by innovation. Economic restructuring and the recognition that previous economic development strategies are no longer appropriate to compete for the agile, information intensive firms of tomorrow are causing a growing number of states to develop explicit science and technology strategic plans. Many states are developing economic development strategies that clearly define the role that science and technology will play in the emerging new economy. In this new economy, the key to wealth and job creation depends largely on the extent to which ideas, innovation and technology are embedded into services, manufactured products and government and educational practices.

A nationwide best practices assessment of technology strategic planning practices identified 29 economic and 13 science and technology strategic plans created between 1991 and 1995.[27] North Carolina was cited as one of seven states that had both an economic development[28] and a science and technology strategic plan[29], both of which were drawn on liberally as models of good planning. A discrete set of factors common to successful state science and technology strategic planning processes was identified.

### Key Factors in Successful State Science and Technology Strategic Planning

**The strategic planning process:**

- Had a champion
- Was structured to obtain a wide range of viewpoints

**The strategy:**

- Articulated a vision for the state's future
- Sought to benefit all areas of the state, including distressed areas
- Was based on a thorough understanding of the state's industry and technology resources
- Was built on existing delivery systems
- Addressed the key elements needed to support technology based development
- Included performance measures

**The implementation plan:**

- Identified specific action, assigned responsibilities and established timelines
- Was tied to the state's appropriations process
- Had strong leadership committed to implementation of the strategy over the long term

## North Carolina's 1995 Strategic Technology Plan — Successful or Not?

**Planning is only one element of exceptional science and technology policy — at least equal in importance are implementation and performance assessment.** The North Carolina Alliance for Competitive Technologies (NCACTS) was established by Executive Order in 1994 to "apply innovation, technology and technical resources to promote economic growth in the state". NCACTS was specifically designed to coordinate existing resources and to leverage investment in technology. NCACTS developed a model strategic plan that was the catalyst for several positive joint efforts among North Carolina's technology service delivery system. In the more ambitious area of coordination of the service delivery system there has been less progress. Neither NCACTS nor any other administrative organization has sufficient leverage to effect the degree of integration needed to implement the full spectrum of cooperative and coordinated activities outlined in the1995 plan.

Incremental improvements represented by an increased number of partnerships and alliances among members of the state's technology service delivery system have resulted in equally incremental improvements in the system's outreach efforts. NC ACTS has transformed into the NC Center for Entrepreneurship and Technology (NCCET), which is undertaking efforts to improve on the availability of technology development and delivery services to rural and disadvantaged urban areas of North Carolina. Wholesale improvements of the sort needed to qualitatively impact the less urban areas of the state require the deliberate application of resources in innovative programs that can only be effected by a coordinating entity that has leverage

[27] U.S. Economic Development Administration of the U.S. Department of Commerce. 1999. *Science and Technology Strategic Planning — Creating Economic Opportunity.* A report prepared by the State Science and Technology Institution. Westerville, OH.

[28] NC Economic Development Board. 1994. *Making North Carolina a High-Performance State.* Raleigh, NC.

[29] NC Alliance for Competitive Technologies. 1995. *North Carolina: Strategies for a Competitive Future.* Research Triangle Park, NC.

over the funds available to the service organizations. Such an entity does not presently exist. Both the Kansas Technology Enterprise Corporation (KTEC) and the New Jersey Commission on Science and Technology are often cited as successful approaches to using an external (non-profit) entity to encourage system synergies through the strategic application of funds.

## Components and Characterization of NC's Innovation System

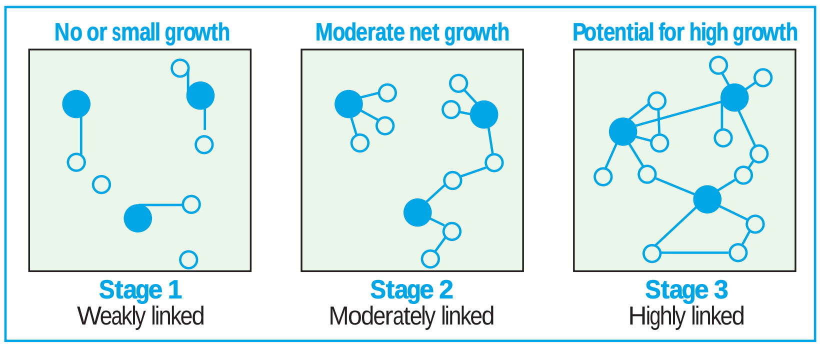
Innovation systems include:

- Firms at different levels of development
- Institutions such as universities, research centers and laboratories that perform and support aspects of R&D, knowledge generation and innovation
- Technology transfer agencies
- Government programs and actions
- Education and training institutions, art, design and cultural organizations
- Business and labor organizations
- Financial support system, such as venture capitalists, equity issuers, and banks
- The science and technology infrastructure — testing facilities, standards and regulations and methods for protecting intellectual property
- Networks that facilitate the exchange and transfer of business, trade, technology and technical information
- Telecommunications infrastructure

Innovation systems evolve through three stages from weak to moderate to high linkages. The challenge is to understand the current stage and to create an environment that supports and stimulates evolution to a more highly integrated and efficient stage.

A realistic assessment of North Carolina's innovation system on the model depicted in Figure 26 would place it in the second stage of development, with moderately linked system elements. The recent growth in the number and innovative nature of partnerships and strategic alliances among different elements of the state's innovation system is a cause for some optimism.

*Figure 26:* **Evolution of Innovation Systems**[30]

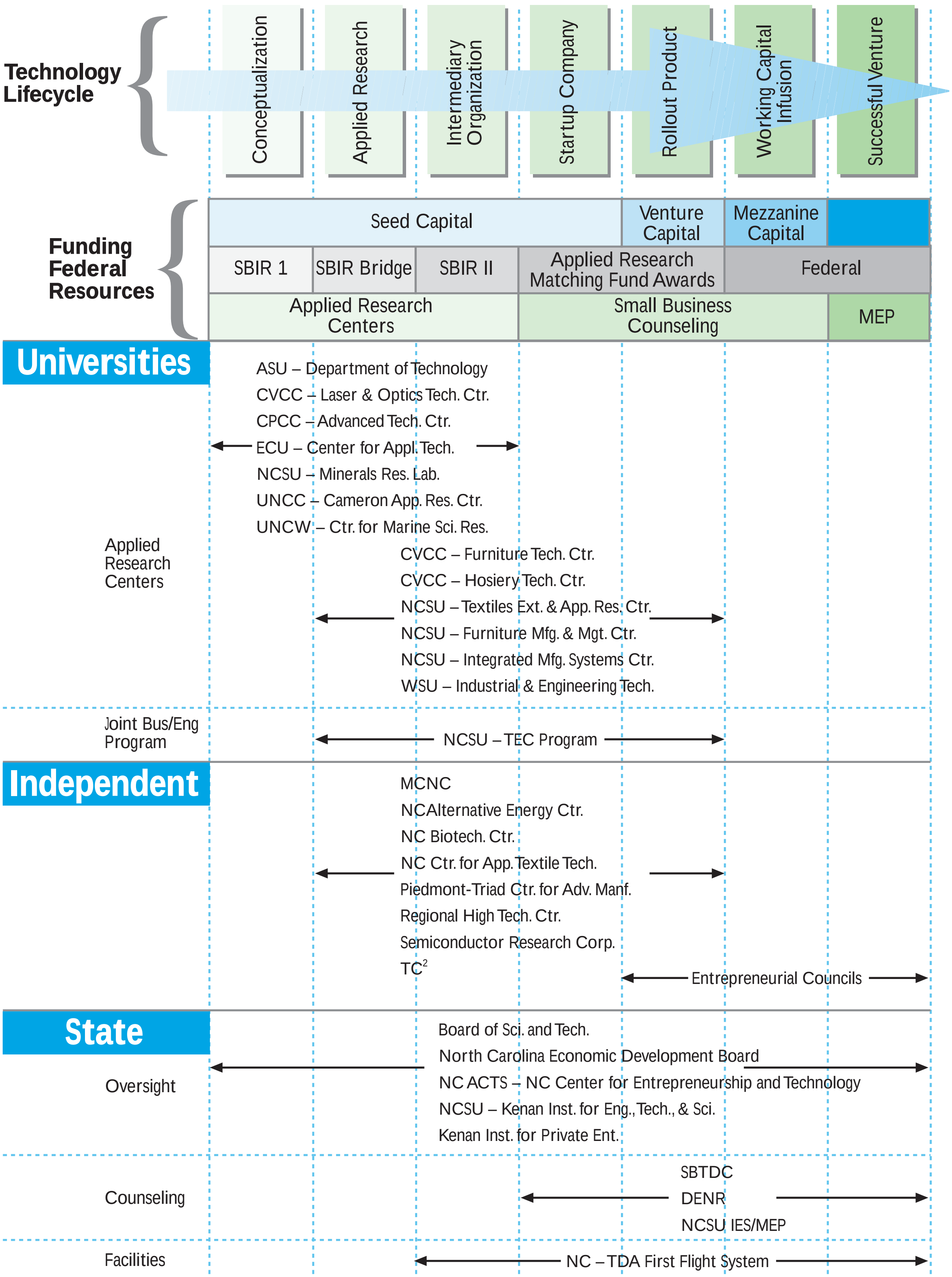



## North Carolina's Technology Transfer Resources

Analysis by the NC Small Business and Technology Development Center (SBTDC) characterized North Carolina's collective technology development, transfer, and commercialization (TDTC) efforts. Figure 27 superimposes the NC TDTC system on KTEC's model of the continuum of technology development. What is obvious from this model is the richness and diversity of the technology assistance services available to at least some of North Carolina's industries.

[30] NovaKnowledge. 1999. *Nova Scotia's Knowledge Economy Report Card 1998.* Halifax, Nova Scotia.

*Figure 27:* **North Carolina's Technology Transfer System**




*Source: NC Small Business and Technology Development Center 1998 (modified)*

Based on its assessment of the technology delivery system in North Carolina, the SBTDC developed a broadly prescriptive set of recommendations for improving technology transfer in North Carolina.[31] Generalized recommendations for university, industry and government elements of North Carolina's innovation system include:

- **Universities** should be encouraged to develop technology transfer capacity and to consider coordination throughout the system.
- **Industry** — Appropriate resources and support should be focused on making North Carolina industry more competitive in Federal SBIR and STTR research funding programs
- **Government** — Policies should be developed that enhance the cultures and practices supportive of technology transfer within and among the innovation triangle elements.

# Research and Development Strengths: Biosciences and Engineering

An in-depth analysis of North Carolina's academic infrastructure in the natural sciences and engineering identified 22 programs at Duke University, NC State University, UNC-Chapel Hill and Wake Forest University as being nationally competitive.[32] Comparisons of academic institutions across the country relative to total research and development (R&D) funding (1994 data) support this assessment. When aggregated into the scientific and engineering disciplines of which they are part, these programs all fall within two broad areas: 1) biosciences and related fields, and 2) engineering. Many of the bioscience programs are represented at more than one institution, while the engineering programs are limited in number and are present at only two campuses. In terms of critical mass, the biosciences appear to be the areas of academic R&D in North Carolina that is currently most competitive for funding at the national level.

As pointed out in *At the Crossroads*, **programs at other academic institutions in the state have achieved excellence within their regions. These programs are capable of providing R&D support and forming important industry-university partnerships within their regions and complementing strengths in R&D activities in the state's primary research universities.** Some of these programs have the potential to become nationally ranked. For example, NC A&T in Greensboro has well-placed engineering programs that are tightly engaged with local industry and that are networked with programs at UNC-Charlotte and NC State University that receive significant R&D funds.

[31] NC Small Business and Technology Development Center. 1998. *Best in Class — University/Industry Technology Development, Transfer and Commercialization in North Carolina.* Chapel Hill, NC.

[32] NC Board of Science and Technology and the NC Alliance for Competitive Technologies. 1998. *At the Crossroads: North Carolina's Place in the Knowledge Economy of the 21st.Century.* (by Edward J Feser, Harvey A. Goldstein, and Michael I Luger of the Kenan Institute's Office of Economic Development). Chapel Hill, NC.

# Human Resources — Brains Powering Progress

Taken together, the number of science and engineering professionals and graduate students in a state is a strong measure of its potential pool of innovators. The history of industrial innovation indicates that new businesses are usually spawned in the same place where entrepreneurs receive their degrees.[33]

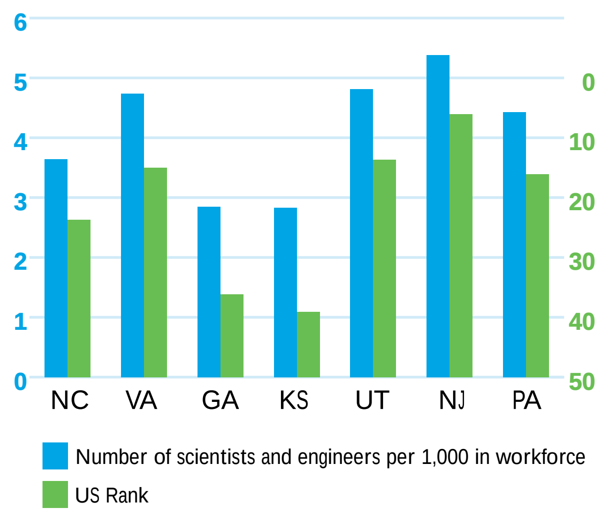
In North Carolina, the relative concentration of scientists in the workforce has increased steadily, growing from 0.1 percent in 1975 to 0.15 percent in 1985 to 0.36 percent in 1997.

Evidence of the potential economic impact of science and engineering graduates is taken from an analysis of the effect of MIT graduates on the Boston area's economy, conducted in by the Bank of Boston. By 1994, MIT graduates had founded 4,000 area firms that employed at least 1.1 million people and generated $232 billion in world sales. While similar studies have yet to be conducted for graduates of North Carolina institutions, it is expected that the results would be of a similar, but smaller nature.

**Strongest Science and Engineering Programs at NC's Research Universities**

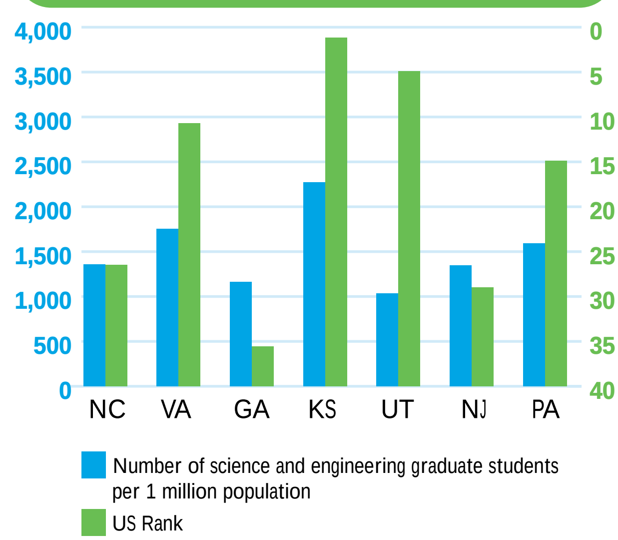
| *Program* | *Institution* |
|---|---|
| Biochemistry | WFU |
| Biochemistry & Molecular Biology | Duke |
| Biochemistry & Molecular Biology | UNC-CH |
| Cell & Developmental Biology | Duke |
| Cell & Developmental Biology | UNC-CH |
| Pharmacology | Duke |
| Pharmacology | UNC-CH |
| Pharmacology | WFU |
| Electrical Engineering | NCSU |
| Ecology, Evolution and Behavior | Duke |
| Chemistry | UNC-CH |
| Materials Science | NCSU |
| Molecular & Genetic Sciences | Duke |
| Molecular & Genetic Sciences | UNC-CH |
| Chemical Engineering | NCSU |
| Neurosciences | Duke |
| Neurosciences | UNC-CH |
| Neurosciences | WFU |
| Biomedical Engineering | Duke |
| Physiology | Duke |
| Physiology | UNC-CH |
| Physiology | WFU |

*Figure 28:* **Scientists and Engineers in the Workforce – 1995 Benchmarks**




*Source: State Science and Technology Institute 1995 data*

*Figure 29:* **Science and Engineering Graduate Students – 1995**




*Source: State Science and Technology Institute 1997 data*

[33] Corporation for Enterprise Development. 1998. *1998 Development Report Card for the States.* (by Daphne Clones et.al.) Washington, DC.

# Funding Resources

## R&D Spending by Universities

- In 1997 the 16 campus UNC system ranked 3rd in the nation among public universities that receive grant funds, trailing only the Texas and California systems.
- Between 1988-1998, research grants to the UNC system overall increased 142 percent.
- 75 percent of the UNC system's research in 1997 was funded by the Federal government.

Year-to-year increases in R&D funding can be distorted by abnormally good (or bad) years in funding. Data in Table 3 show the dramatic increase in funding for research at North Carolina's academic institutions, ranging from 74 percent to almost 1,000 percent. Clearly, increases on a small base are magnified in this sort of measure.

Impressive as these figures are, it is important to note that the totals significantly under-represent the full scale of R&D expenditures at the more research-intensive institutions. For example, NC State University receives significant funding for its various extension programs and other activities that combined for a total of almost $380 M in 1998.

*Table 4:* **Awards to North Carolina Universities for Sponsored Programs**

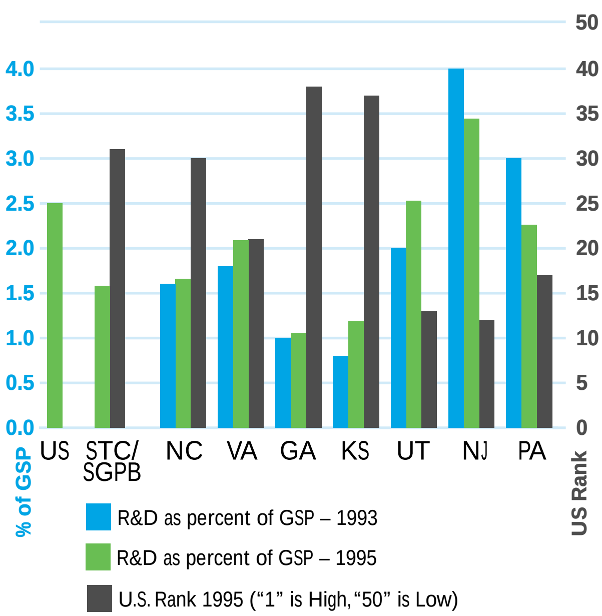
| Institution( Abbreviation) | 1997-98 Research Grants | % increase 1988-1998 |
|---|---|---|
| Appalachian State (ASU) | $ 5,934,478 | 78% |
| Duke University | $ 269,161,228 | 107% |
| East Carolina (ECU) | $ 28,580,992 | 194% |
| Elizabeth City State | $ 3,954,305 | 349% |
| Fayetteville State (FSU) | $ 4,452,956 | 98% |
| NC A&T State (NC A&T) | $ 22,718,560 | 112% |
| NC Central (NCCU) | $ 7,096,747 | 74% |
| NC School of the Arts (NCSA) | $ 430,800 | n/a |
| NC State (NCSU) | $ 128,239,336 | 136% |
| UNC-Asheville (UNC-A) | $ 876,024 | 180% |
| UNC-Chapel Hill (UNC-CH | $ 304,959,392 | 129% |
| UNC-Charlotte (UNC-C) | $ 14,351,301 | 232% |
| UNC-Greensboro (UNC-G) | $ 18,235,193 | 761% |
| UNC-Pembroke (UNC-P) | $ 4,134,107 | 960% |
| UNC-Wilmington (UNC-W) | $ 7,359,448 | 258% |
| Wake Forest University | $ 87,363,158 | 243% |
| Western Carolina (WCU) | $ 7,523,748 | 102% |
| Winston Salem State (WSSU) | $ 4,578,569 | 327% |

Ten Year Record (1988-1998)

## State Government R&D Expenditures

States vary widely in the size of their economy, reflecting differences in population, land area, infrastructure, natural resources and history. Variation in R&D expenditures may reflect differences in the size or natures of their R&D efforts. The measure of choice that controls for these sorts of variables is "R&D Concentration," or the share of the gross state product that the R&D expenditure represents. Nationwide, R&D concentration in 1995 ranged from a high of 8.14 in New Mexico to a low of 0.32 in South Dakota. **North Carolina ranked 29th, tumbling down from 26th in 1993.**

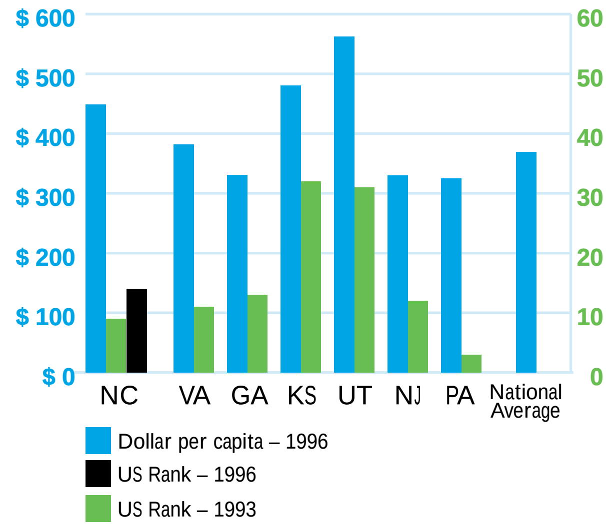
*Figure 30:* **Benchmarked Total State R&D Expenditure as a Percentage of Gross State Products**




*Source: National Science Foundation (1997)*

Another way of normalizing comparisons of state investment in R&D is to look at the amount of higher education expenditures on a per capita basis. **On this metric, North Carolina has historically been above national average, although its rank has declined from 9th in the country in 1993 to 15th in 1996.**

*Figure 31:* **Per Capita Expenditure on Higher Education – 1996 Benchmarks**

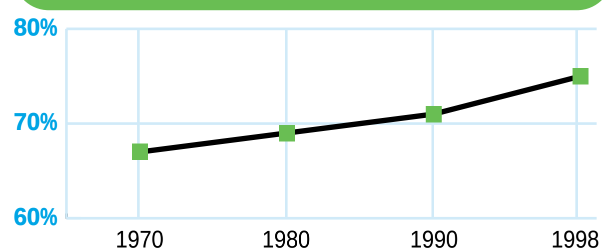



*Source: National Center for Education Statistics (1998)*

## Industrial R&D Expenditures

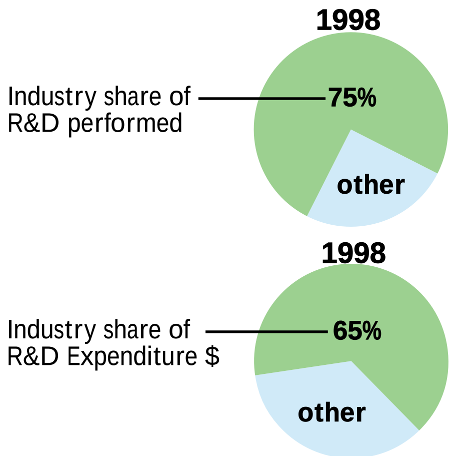
The industrial sector is playing an increasingly dominant role in both the funding and performance of R&D in the United States (Figure 32). In 1998, industry spent over $143.4 B of its funds and performed 75 percent of all research and development conducted in the United States (Figure 33). Industry efforts emphasize the development phase of the innovation equation (Figure 34).

*Figure 32:* **Industry's Share of Total U.S. R&D Expenditures – 1970-1998**



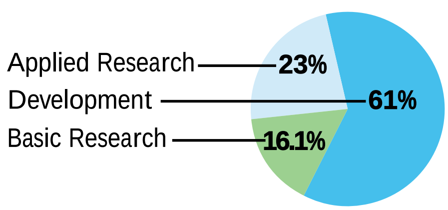

*Source: National Center for Education Statistics (1998)*

### *Figure 33:* Industry's Share of Total R&D Performed – 1998



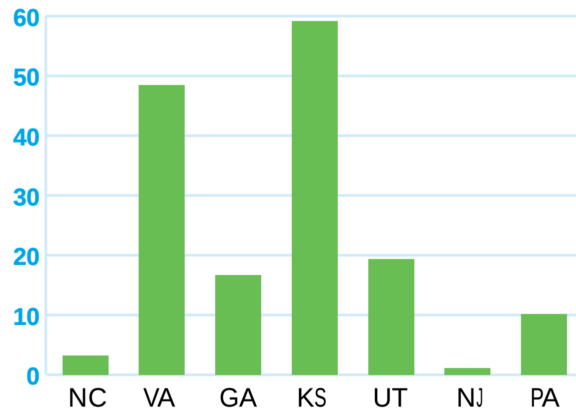

*Source: National Science Foundation 1999*

### *Figure 34:* Industrial Research and Development Activities



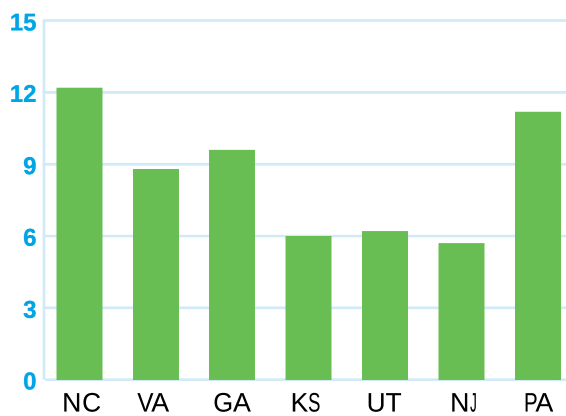

Industry's Share of Total US R&D
*Source: National Science Foundation (1999)*

### *Figure 35:* Federal Support for Industrial R&D – 1997




*Source: NFS's SRS Survey of Industrial Research and Development – 1997*

### *Figure 36:* Industrial Support for University-Performed R&D – 1997




*Source: SRS Detailed Statistical Tables – 1997*

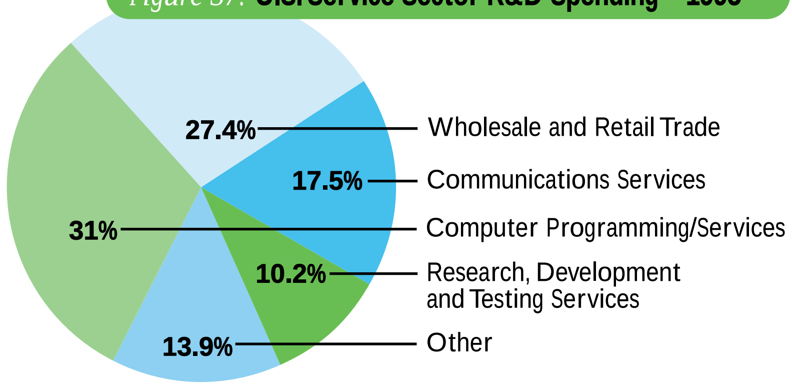
Federal support for industrial research varies widely among the states benchmarked for this report (Figure 35). Such variations reflect the diversity of industries that characterize the economies of these states. It also probably reflects the relative success that the states' industries have in competing for federal R&D support. Given the broad range of technology-intensive industries comprising North Carolina's industry base, it is particularly disappointing to see the state so poorly represented in this category. Less than four percent of the total R&D expenditures by industry in North Carolina was supplied by the federal government.

**In North Carolina, industry spent almost $3.6 Billion on R&D activities in 1997**. Of this amount, industry in North Carolina further distinguished itself from the benchmark states in the relatively larger proportion of its R&D that was subcontracted out to universities (Figure 36). Particularly strong ties exist between NC State University and industry. In 1997, NC State University ranked 3rd among all universities without a medical school in the amount of industrially sponsored R&D and 8th among all universities.

### The Service Sector's Increasing Share of R&D Performance

A striking effect of the shift to an information-based economy is the rise of the service sector as a major performer of industrial R&D. Non-manufacturing industry now accounts for over 25 percent of all industrial R&D, up from eight percent in 1985. Four industry groups are dominant in R&D spending by the service sector: Wholesale and Retail Trade, Communications Services, Computer Programming Services and Research, Development and Testing Services. North Carolina has a strong presence in all of these sectors.

*Figure 37:* **U.S. Service Sector R&D Spending – 1995**




*Percent of Total Service Sector R&D Spending – 1995*

# Intellectual Property and Technology Transfer at NC Institutions

Universities play an active, prominent role in the transfer of knowledge and information that underpins technology-based competitive advantage. Evidence gathered by a blue ribbon task force[34] and in two separate studies benchmarking technology transfer practices in Southeastern U.S. and in North Carolina tell us that:

1) Trends for North Carolina are positive, with significant increases in various measures of technology transfer activity (patent applications, licenses and royalties).[35] There are over 1,000 products on the market that are based on university licensed discoveries.

2) Overall performance of North Carolina's leading public and private research universities is among the best in the nation. Duke, NC State and UNC-CH rank in the top 25 in the country for research expenditures. UNC-CH and NC State rank in the top 15 in the country in 1997 for licenses executed (Table 5).

3) There is particular value to be gained from efforts that encourage the retention of more of the benefits of intellectual property created at the state's institutions by firms operating in the state. This can be accomplished both through increased licensing to in-state firms and through increased numbers of companies spinning off from North Carolina's universities.

*Table 5:* **Technology Transfer in Select NC Universities – 1996-97 Summary Statistics**

| University | 1996-97 Total Research Expenditures | Invention Disclosures | Patent Applications | Licenses Executed | License Income | Patents Issued | Start-up Companies Formed |
|---|---|---|---|---|---|---|---|
| Duke | $360,977.000 | 146 | 69 | 38 | $1,520,000 | 31 | 0 |
| NC State | $334,393,941 | 105 | 48 | 54 | $3,164,795 | 24 | 1 |
| UNC-CH | $263,517,405 | 94 | 66 | 50 | $1,684,093 | 34 | 2 |
| Wake Forest | $55,292,043 | 22 | 15 | 3 | $632,652 | 11 | 0 |
| East Carolina | $5,988,000 | 13 | 8 | 1 | $1,164 | 1 | 1 |
| UNC-Charlotte | NA | 27 | 5 | 3 | $10,000 | NA | * |

*Source: University Technology Transfer Offices and 1997 AUTM survey.*
* Although UNC-Charlotte had no start-ups in 1997 it has spun-out four companies in the past five years.

[33] NC Biotechnology Center. 1994. *Technology Transfer: Working for Collaboration, Commerce, and Competitiveness*. Research Triangle Park, NC.

[34] Association of University Technology Managers, Inc. 1998. *AUTM Licensing Survey FY 1997- Survey Summary*. Daniel E. Massing (ed.). Norwalk, CT. autm@ix.netcom.com

Close links between a university and local industry increases the probability that local firms will license technologies developed at the institution. **UNC-Charlotte** has a small, but growing technology transfer effort that is already paying off in license agreements that are transferring technologies into industry in the Charlotte region. The same phenomenon is starting to occur in **Greenville**, where at least three start-up firms are developing technologies originating at East Carolina University.

Seventy-six jobs in the RTP area exist because of the four recent spin-out companies from UNC-Chapel Hill. To date, NC State spun out 18 companies, Duke 14.[36] In the Triad area both **Wake Forest University** and **NC A&T State University** are likewise moving up the technology transfer learning curve. **Wake Forest** is linking its efforts to a broader initiative involving city, county and private organizations in the area. **NC A&T** has recently hired a technology transfer professional to head its new technology transfer office.

At the larger institutions, both the sheer number and scope of technologies emerging from the institutions' laboratories requires that a less parochial focus be applied to technology transfer efforts. In such cases, even a relatively lower percentage of licenses transferred to North Carolina firms can amount to a significant number of native firms assisted due to a larger pool of technologies being marketed. Ultimately, **technology transfer is a market process**. But regardless of the state economic benefits of transferring technologies to state-based industries, this is important to remember as we consider what, if any, related public policy efforts might stimulate a greater return on public investment in R&D.

Experience has shown that licensing a technology to a North Carolina firm does not guarantee that it will be commercialized here.

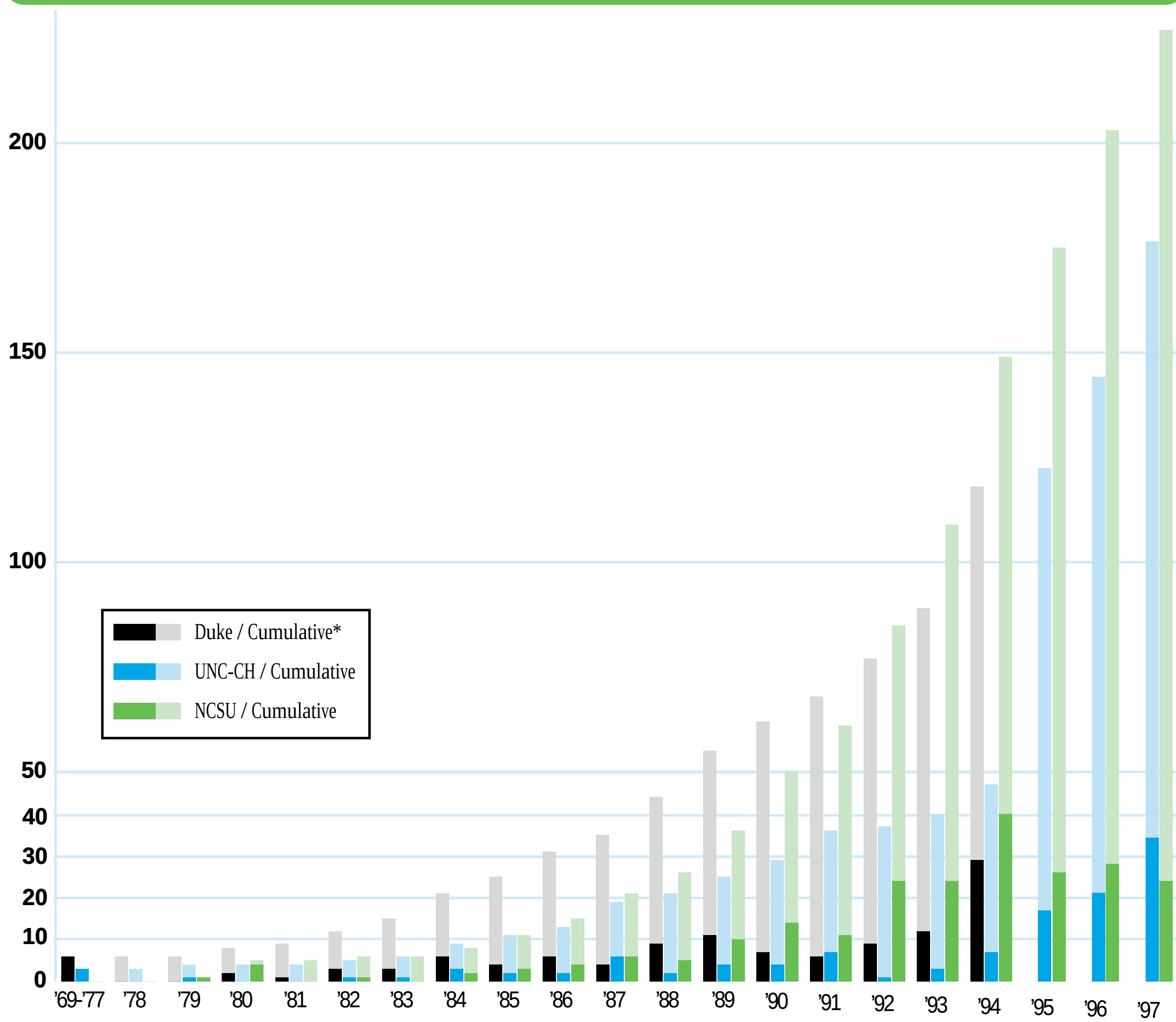
As North Carolina's universities become more actively involved with local industries and move to establish a formal technology transfer effort it might be possible to leverage the experience of the larger campuses in the area of technology transfer. It may also be that there are alternative approaches and models of technology transfer practices that are more appropriate for the scale and types of licenses that are likely to be forthcoming from these smaller campuses in the short-term. One such model is the **Virginia Center for Innovative Technology (CIT)**, an independent, non-profit, state-funded organization established to foster technology-linked economic development in Virginia. CIT obtains inventions from Virginia universities and individuals and it works with all of the research universities in the state to retain the institutions' intellectual property in the state.

When we look at the history of technology transfer in North Carolina, another important fact emerges — application of resources yields results! As each of the Research I universities in Figure 39 added professional technology transfer managers they experienced a direct, non-linear increase in the activity and success of their offices. At least three factors contribute to this increase:

- Stronger research bases ⟶ more and better intellectual property.
- Growing appreciation of university-based R&D as a source of market value.
- Increased number of professionals dedicated to university technology transfer.

[36] Triangle Business Journal. 1999. *Number of University Spin-offs Accelerating.* (by Amal Sabi) July 26.

*Figure 38:* **Patents to Select NC Universities – Cumulative 1969-1997**



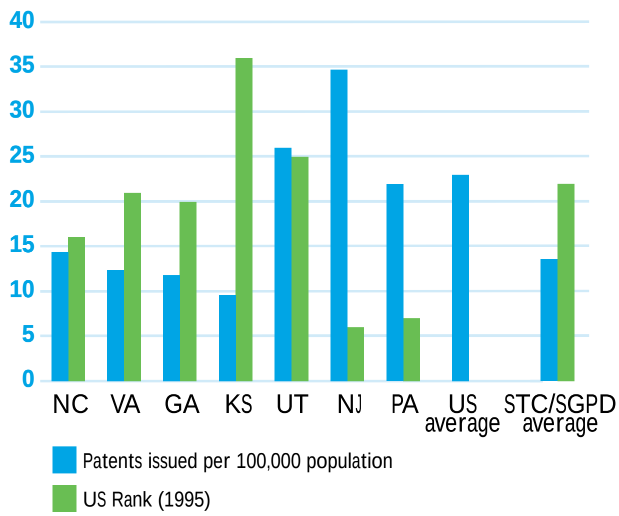

*Source: National Science Foundation and university records* (Note: there are discrepencies and university data)

* Duke data not available for 1995-1997.

# Patents and Intellectual Property in North Carolina

As one of the end products of the R&D process, patents grant exclusive ownership of intellectual property to businesses, academic institutions and individuals engaged in innovative activities. The number of patents awarded to a state serves as an indicator of innovation.

*Figure 39:* **Per Capita Patents and National Rank in Number of Patents – 1995 Benchmark**




Notes: NC ranked #14 in '95, NCSU and Duke University tied for #12 among academic institutions at 32 patents each.

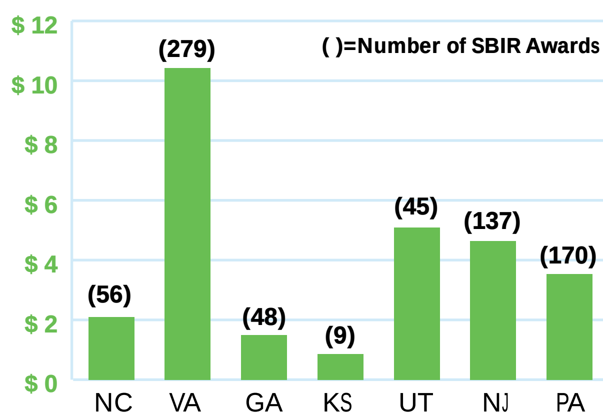
## SBIR and STTR Awards – NC Under-represented and Under-Funded

The Small Business Innovation Research Program (SBIR) provides federal research and development funds to small businesses; awards in 1998 totaled $1.2 billion. SBIR funds the critical start-up and development stages and it encourages the commercialization of new technologies, products and services. The Small Business Technology Transfer Program (STTR) funds partnerships between small businesses and non-profit research institutions, including universities.

Per-capita funding for SBIR and STTR indicates how competitive a state's small businesses are in developing and commercializing innovative technology and products. STTR funding is a measure of how connected are the elements of a state's innovation system. As the program has grown **the number of awards to North Carolina small businesses relative to other states has declined from 12th in 1983 to 22nd in each of the past three years.** Marginal SBIR performance stands in sharp contrast to North Carolina's present ranking as 11th in university research and development funds received.

In recent years, there has been a significant increase in the number of technology-based start-ups and small businesses in North Carolina, increased efforts and funding for technology transfer at the state's universities, and greater awareness of the SBIR and STTR programs as a source of pre-commercialization support. Despite this progress, there has been essentially no change in North Carolina's participation in these programs.

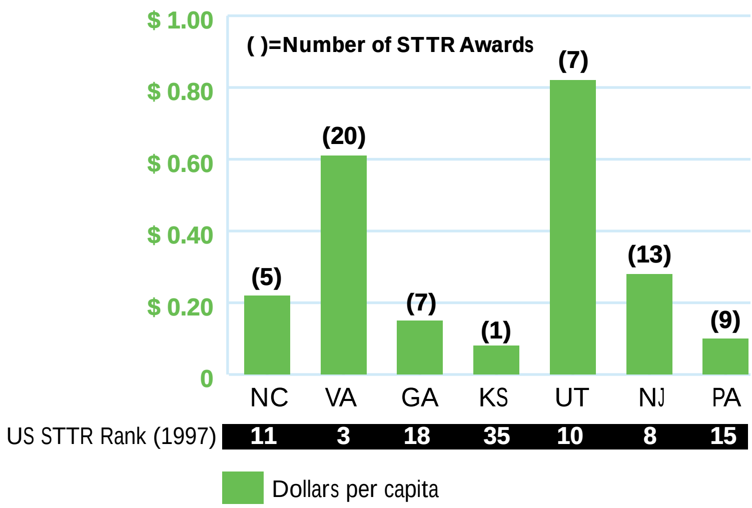
*Figure 40:* **Per Capita SBIR Funds– 1997 Benchmark**




| | NC | VA | GA | KS | UT | NJ | PA |
|---|---|---|---|---|---|---|---|
| US Rank in # SBIR (1990-1994) | 22 | 3 | 25 | 39 | 20 | 9 | 10 |
| US Rank in # SBIR (1997) | 22 | 3 | 23 | 36 | 24 | 10 | 7 |

Dollars per capita

*Figure 41:* **Per Capita STTR Funds– 1997 Benchmarks**




> ***I**n 1986, awards to North Carolina small businesses accounted for less than 2 percent of the total number of SBIRs and less than 1 percent of the total dollars awarded. In 1997, those figures were virtually unchanged; North Carolina awards totaled less than 1.5 percent of the total dollars and less than 1 percent of the total number of awards.*

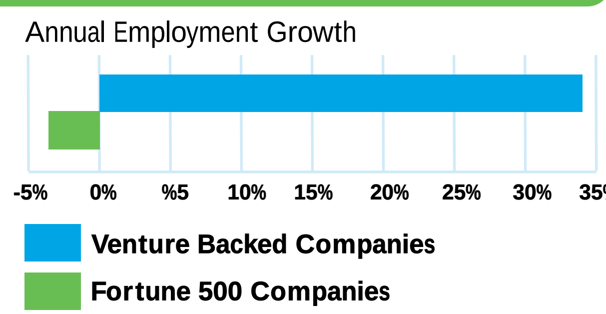
# Commercialization Capacity

## Venture Capital — Location Matters

Venture capital is important because it spurs growth at critical early stages in the commercialization of innovations. Venture capital professionals bring capital, management experience and connections that can be vital to the possibility that new technology firms will be successful. The availability of venture capital, and all that it entails distinguishes the innovative capacity of the United States over Europe and Asia. The geography factor plays out on a more local scale as well. Money goes to where the deals are; as exemplified by the number of venture capital firms with headquarters on Sand Hill Road in Silicon Valley, or in Cambridge, Massachusetts. Venture capitalists want close proximity to their investments to take a hands-on approach to their management.

> ***B**etween 1980 and 1995, only three companies in all of North Carolina's 85 rural counties received venture financing.*

*Figure 42:* **Venture Capital and Economic Growth**




*Source: Progressive Policy Institute 1998*

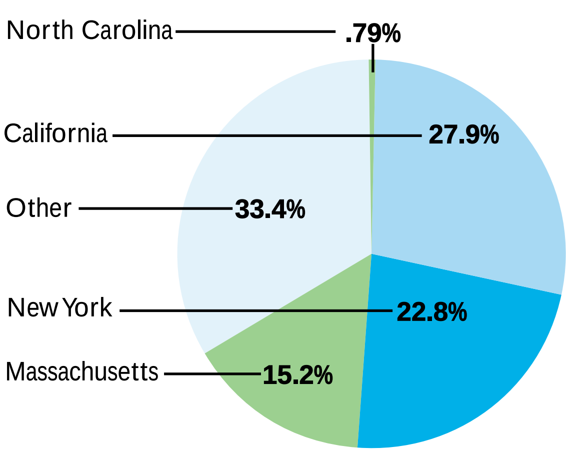
Year-to-year volatility in the numbers and amounts of venture investments made in a given state is high, making it important to consider performance metrics over a span of years. Historically, the Southeastern U.S. has been very poorly represented in venture investment portfolios. Rural firms have a particularly difficult time obtaining growth capital.[37]

[37] Regional Development Services at East Carolina University. 1998. *North Carolina Rural Growth Study Final Report.* (by Brent Lane). Greenville, NC.

There are positive trends:[38]

- The Southeast is now 3rd in the nation with 252 deals in 1997 [after New England (368) and Silicon Valley (708)].
- Venture capital disbursements in North Carolina have increased in each of the past six years.
- Early results for 1999 are at record levels. During the 2nd quarter of 1999 venture capitalists invested $162.8 M in 26 firms campared to less than $60 M invested in 12 firms for all of 1998.[39]
- North Carolina ranked 4th in the country in venture capital investments in biotech firms in 1998.
- Although U.S. venture capital still accounts for almost 73 percent of all the world's venture capital, international funds are becoming larger and more active. International venture funds with interests in specific technology sectors are beginning to invest in North Carolina firms.
- Evidence of the globalization of start-up investments is seen in a recent joint venture involving partners in the United States, Taiwan and Switzerland to fund an RTP start-up.[40]

*Figure 43:* **State Shares of Total U.S. Venture Capital Under Management – 1998**




*Source: 1999 National Venture Capital Association Yearbook*

**Despite this increase in interest and activity, by venture capitalists, North Carolina still possesses less than 1 percent of the $84 billion of professional venture funds available nationally**[41]

Survey results[42] indicate that the time is right for policymakers and leaders in the Southeastern U.S. to consider adopting initiatives that provide incentives to capitalists and entrepreneurs in their states. Efforts should be directed toward the following actions:

1) **Eliminate or streamline regulations** that make it difficult for small business to operate, compete and raise capital. Utah has been cited as a model of a state that is becoming entrepreneur and investor friendly.

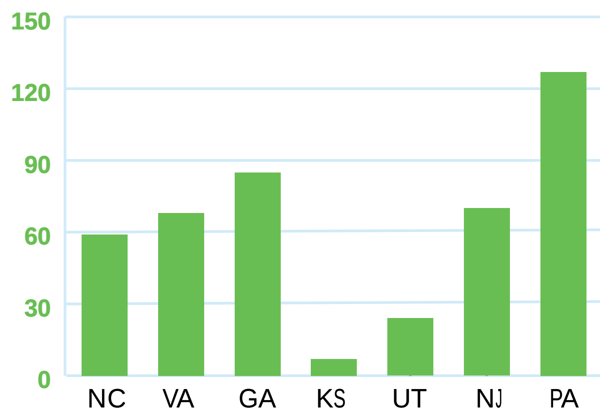
2) **Strengthen Southeastern U.S. universities' capacities in scientific innovation and business management**. The stated ideal situation would have strong management and science programs on the same campus to facilitate development.

3) Encourage a state's large institutional investors, public pension funds, industry funds and university endowments to help **create state-level venture funds** managed by industry professionals.

4) **Build an entrepreneurial culture** that extends from K-12, through community college and universities by rewarding innovation at all levels.

[38] Council for Entrepreneurial Development (CED). 1998 (September). *Connections Spotlight on Venture Capital*. Research Triangle Park, NC.
[39] State Science and Technology Institute. 1999. *SSTI Weekly Digest* – September 10.
[40] Source: Interactive Technologies, Durham, NC. 1999.
[41] National Venture Capital Association. 1999. *1999 Venture Capital Association Yearbook* Venture Economics Information Services, Newark, NJ.
[42] Southern Growth Policies Board. 1998. Research Triangle Park, NC.

*Figure 44:* **Number of Companies Receiving Venture Capital during 1998**




| | NC | VA | GA | KS | UT | NJ | PA |
|---|---|---|---|---|---|---|---|
| U.S. Rank in $ invested | 16 | 9 | 10 | 35 | 24 | 8 | 11 |
| U.S. Rank in # firms | 14 | 11 | 7 | 18 | 31 | 10 | 5 |

Number of firms

## State-supported Seed Capital

Each of the states selected as benchmarks for this study has an innovative approach to venture financing. These states lead the nation in their active efforts to utilize technology for economic development and have created novel state-supported programs to provide seed funds to technology-based startup firms.[43]

- **Georgia's Advanced Technology Development Center** at Georgia Tech operates a state funded technology initiative called the Faculty Research Commercialization Program. Competitive seed capital awards to faculty at Georgia's academic institutions target prototype development.

- **Virginia's Center for Innovative Technology (CIT)**, a state funded, non-profit organization, works with technology managers at all of Virginia's research universities to provide seed capital for pre-commercialization activities.

- **The University of Utah** has an internal **Technology Innovation Grant Program**, funded entirely by set-asides from royalties. Grants are awarded competitively and used for proof-of-concept and prototype development. Utah also has a **Technology Finance Corporation**.

- **Pennsylvania's Ben Franklin Program** operates an Emerging Company Investment Fund that provides seed-level financing for product development.

- **Kansas Technology Enterprise Corporation (KTEC)** is a quasi-public non-profit organization that makes equity investments in its clients, including start-ups and university spin-offs.

- **New Jersey's Commission on Science and Technology** joined private and commercial partners to form the $10 M **Early Stage Enterprises (ESE)** Venture Capital fund. ESE was licensed as a Small Business Investment Corporation (SBIC). Through the SBIC, ESE can augment the local money with a Federal match to generate a pool of $30 M to invest in seed stage New Jersey firms.

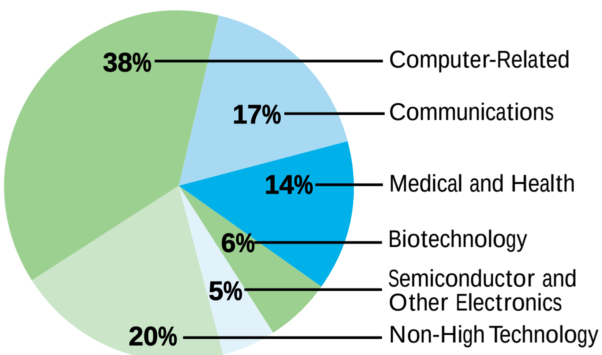
- **North Carolina's** public investment in technology-focused venture funds has been restricted to the **TDA's Innovation Research Fund** and the **NCBC's Business and Technology Development Programs**.

[43] Southern Technology Council. 1995. *Benchmarking Best Practices for University-Industry Technology Transfer: Working with Start-Up Companies.* (by Louis Tornatzky, Paul Waugaman, and Lucinda Casson). Research Triangle Park, NC.

## Science and Technology — The Venture Capital Targets of Choice

Fully 80 percent of the total $16.7 billion of venture capital disbursed nationally in 1998 went to firms in the information technology and the medical/health/ life science sectors, while investments in non-technology firms totaled $3.3 billion. A finer breakdown of investment choices reflects a span of technology areas that include several in which North Carolina has an existing or potential R&D strength.

*Figure 45:* **Venture Capital Disbursements by Industry/Technology Sector – 1998**




Note: 21% of total 1998, venture capital disbursements went to Internet-related companies.

## Technology-Targeted Funds: Private Funds and Public-Private Partnerships

Recent studies have noted that North Carolina's public sector efforts to provide seed capital to entrepreneurial technology firms have not proved sufficient. The consensus of several studies looking into new venture financing in North Carolina is that both the number of deals and the total amount of available venture capital are inadequate to support the transition to a more dynamic, entrepreneurial economy. Positive movements are detected on this front, however, with the establishment of new, technology-based venture funds that represent public-private partnerships. These include:

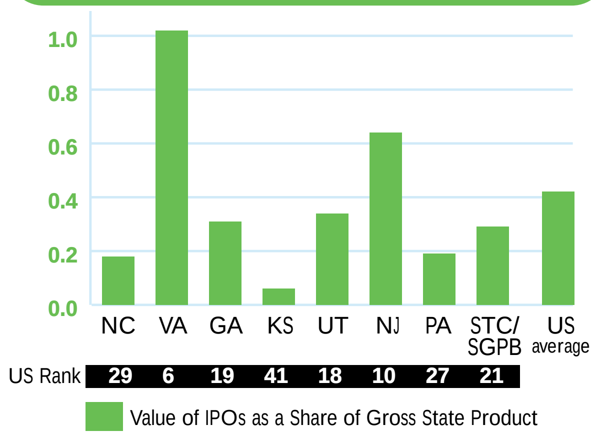
- **Centennial Venture Partners** – an innovative collaboration between the TDA and NC State University to operate a $10 million venture fund that is investing in companies commercializing intellectual properties and scientific discoveries originating at NC State University.
- **NC Bioscience Investment Fund** – a partnership between the NCBC and Eno River Capital (managing partner) to create a $30 million fund to invest at the level of $500,000 to $2 million in up to 12 young bioscience firms.
- **Long-Leaf Fund** – Still in the formation stages, the Long-Leaf Fund will provide seed-level funding for university spin-offs and technology-based firms in the Charlotte and Triad regions. This fund is projected to close on $10 M by October 1999 and to grow to $30 M. Regional leaders in partnership with the TDA are making this happen.

## Initial Public Offerings

Initial public offerings (IPOs) are a mechanism for small and medium-size firms to capitalize their growth through the highly regulated initial offering to sell stock to investors. Successful IPOs reflect confidence on the part of the market in the firm's potential market value and performance. A strong market for investments has underwritten a 50 percent increase in the number of IPOs, with particularly high interest in technology-related offerings. A relatively large number of IPOs reflects that the conditions are present to support entrepreneurial firms with long-term and substantial growth potential.

Although the values of North Carolina's IPOs have trended slowly upwards in recent years, they continue to substantially under-perform both the national and Southeastern region, as well as all benchmark states except Kansas ( Figure 45). This picture may be improving. The value of IPOs in North Carolina should increase as recent venture investments mature and seek growth capital.

*Figure 46:* **Benchmarked Value of Initial Public Offerings – 1997**




## Gazelle Firms — Rural and Urban

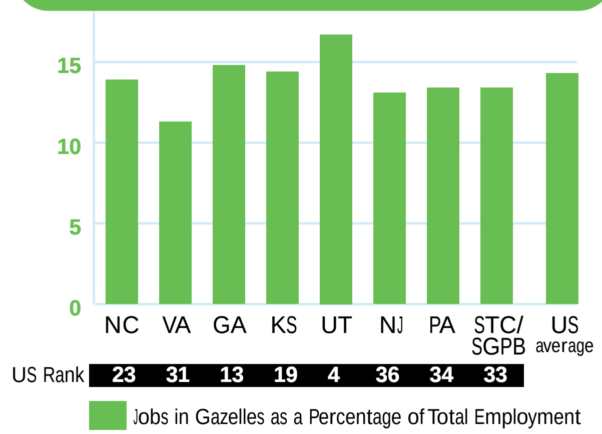
Dynamic and adaptive state economies are characterized as having relatively high proportions of new, rapidly growing firms. Termed "gazelles," these firms have annual sales growth in excess of 20 percent for four years (from a minimum base of $100,000). The number of jobs in gazelle firms relates most closely to overall growth in a state's economy. Collectively, gazelle firms in the United States grew 40 percent in number between 1993 and 1996 and accounted for 70 percent of net new jobs.[44]

## Gazelles Matter in North Carolina

Numerous studies have established on a national basis and in North Carolina that it is a very small proportion of small, high growth firms that account for the overwhelming majority of net job growth.[45 46]

- Locally, a 1988 study by the Kenan Institute for Private Enterprise found that a small, 3.5 percent subset of entrepreneurial growth firms accounted for a regionally consistent 37-41 percent of jobs created across North Carolina (1982-1987).
- This finding was reinforced more recently in the "Entrepreneurial Hot Spots" report that ranked North Carolina 8th in entrepreneurial activity, with Raleigh-Durham 4th, Charlotte 5th and all of North Carolina's rural areas collectively ranked in top 25 percent of 89 U.S. rural areas.

*Figure 47:* **Gazelle Firms' Share of Total Employment**




A recent example of a highly successful gazelle is RedHat Technologies, a firm that took a technology openly available from the Internet, repackaged it and added value through an add-on service component, and took the firm public through one of the highest valued IPOs in history. While these event took place in the Research Triangle area, it is just as possible that it could have transpired anywhere in North Carolina that there is connectivity to the world via the Internet.

**Rural Gazelles – Homegrown Talent Sparking Local Growth**

The 1997 Entrepreneurial Rural Growth Study (NCERGS) examined rural entrepreneurship in detail across North Carolina's 85 rural counties. NCERGS found that:

- 3,058 firms established between 1975-1995 had grown to annual sales of at least $2 million.
- NCERGs firms accounted for only four percent of all rural firms, but they produced 36 percent of jobs in rural North Carolina and 77 percent of the state's net new manufacturing jobs.
- 86.5 percent of NCERGS firms remain and grow in the communities in which they started.
- 68 percent of founding NCERGS entrepreneurs are North Carolina natives and an additional 13 percent are native to the southeast.
- 60 percent of NCERGS founders have a college degree, and 52 percent of this number attended universities and colleges in their rural area.

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[44] David Birch, Anne Haggert and William Parsons. 1997. *Corporate Almanac*. Cambridge MA. Cognetics, Inc.

[45] Kenan Institute of Private Enterprise. 1988. *Where Jobs Come From*. (by John Kasarda). Chapel Hill, NC.

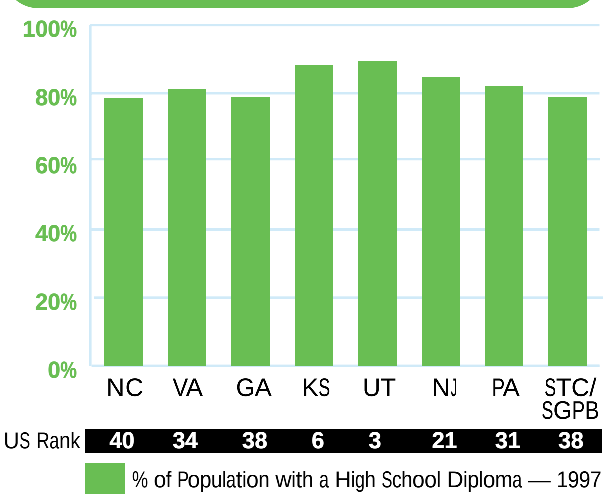
[46] Regional Development Services at East Carolina University. 1998. *North Carolina Rural Growth Study Final Report*. (by Brent Lane). Greenville, NC.

# Knowledge Workers – Education Matters

## High School Graduation Rate

In the knowledge and information economy, education matters. Workers will have to start with a baseline capability that allows for continuous learning and up-skilling. In this environment, a high school diploma becomes the absolute minimum standard for employment consideration. On this measure, there is cause for concern and significant room for improvement in North Carolina in high school graduation rates. North Carolina ranked 40th in 1997, up from 43rd in 1992[47] but down from 10 years ago when the state ranked 37th in the nation.[48] While there is little absolute difference in the actual graduation rates among the states, or among the regions within North Carolina, the perception of poor performance that is conveyed by the overall rank of 40th is considerable.

*Figure 48:* **High School Graduates as a Share of Adult Population – 1997 Benchmarks**

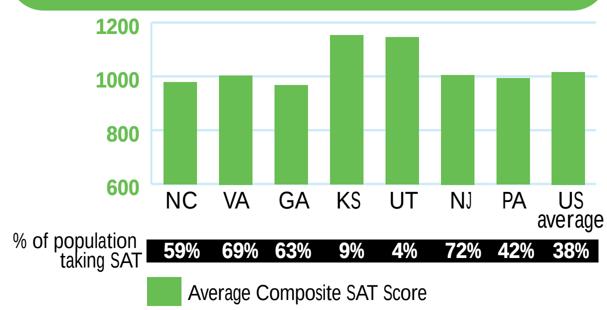



*Source: National Center for Education Statistics – 1999*

## SAT Scores

North Carolina students preparing for college are required to take the Scholastic Aptitude Test (SAT) as an admission requirement to all public and most private colleges and universities in the state. The expectation is that these score measure the aptitude and readiness of the student to undertake college-level coursework, leading to the belief that SAT scores are a reflection of the quality of the state's educational system. North Carolina's SAT scores are in line with most of our benchmark states, but below the U.S. national average.

*Figure 49:* **Average Combined SAT Scores – 1998 Benchmarks**

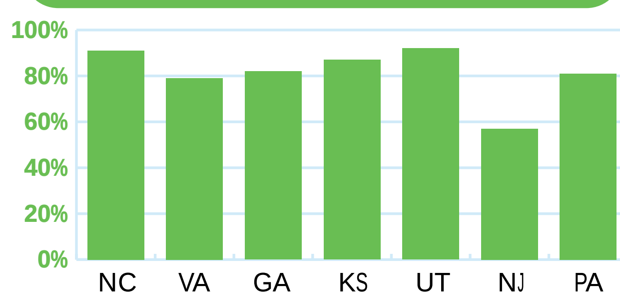



*Source: National Center for Education Statistics – 1999*

## Technology Transfer at its Most Powerful — College Graduates

North Carolina has particularly strong public and private universities and colleges. These institutions represent a real advantage to the state in its efforts to retain the intellectual resource represented by the best and brightest of its high school graduates.

*Figure 50:* **High School Graduates Attending College in Their Home State – 1998 Benchmarks**



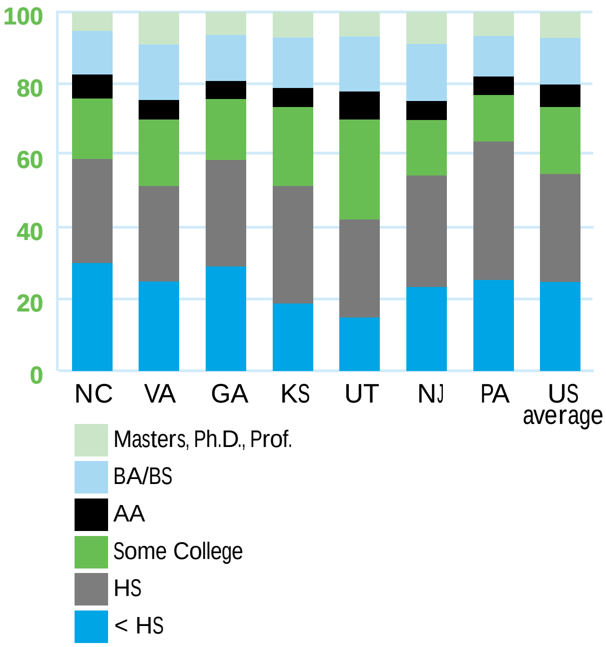

*Source: National Center for Education Statistics – 1999*

[47] National Center for Education Statistics. 1999. *1998 Digest of Education Statistics*. U.S. Government Printing Office, Washington DC.

[48] Southern Growth Policies Board . 1986. *A Profile of the South -1986-1987*. Research Triangle Park, NC.

A comprehensive view of the education profile for the benchmark states is offered in Figure 51.[49]

*Figure 51:* **Educational Attainment of Workforce**

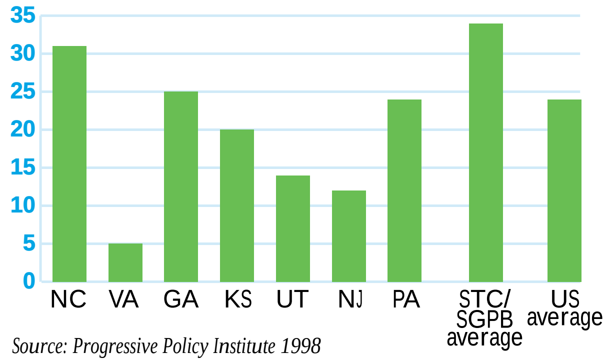



*Sources: National Science Foundation – Science Indicators Series 1998.* The Chronicle of Higher Education 1999-2000 Almanac. *(1990 Census data)*

## Knowledge Jobs

The Progressive Policy Institute has developed an index that rates the states on their ability to compete in the New Economy. One of the five weighted sub-scores that collectively comprise this "New Economy Index" is the category "Knowledge Jobs". This category is comprised of three sub-scores that measure: 1) the percentage of a state's workforce that works in offices, 2) the share of the workforce employed in managerial, professional, and technical positions, and 3) the education level of the workforce. North Carolina ranks an unimpressive 30th in its overall capacity to support sectors with high knowledge content. Although North Carolina's composite score was somewhat better than the average performance across the Southeast region, it was well behind the scores of all the benchmark states and the national average.

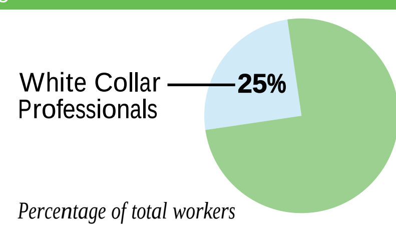
*Figure 52:* **National Rank in Composite Knowledge Jobs Indicator**




*Source: Progressive Policy Institute 1998*

As knowledge and information management have become a greater component of jobs across sectors, the share of total employment engaged in what was traditionally termed "white collar jobs" increased from 22 percent in 1979 to 28.4 percent in 1995. Included in this category of workers are managers, engineers and scientists, health professionals, lawyers, teachers, accountants, bankers, consultants and engineering technicians. In North Carolina, the impact of the RTP and the growing number of technology-based firms across the state are reflected in fact that the state's knowledge worker score in this category exactly matches the 24.9 percent that is the national average.

*Figure 53:* **NC's White Collar Workforce**




*Percentage of total workers*

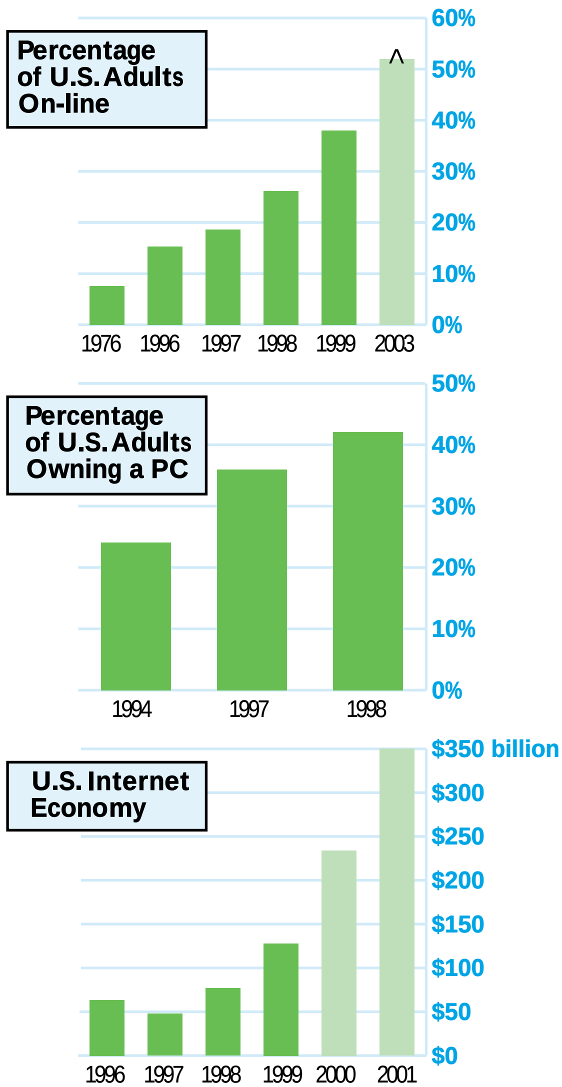
[49] *The Chronicle of Higher Education 1999-2000 Almanac.* Data based on 1990 U.S. Census (most recent data available).

# The U.S. Digital Economy

## An Overwhelming Overview

An emerging digital economy is defined by a growing share of business, government and educational transactions conducted through digital electronic means.

*Figure 54:* **Baseline Measures of Connectivity**




It is absolutely clear that competitiveness in any sector and any arena will demand access to and facility with Internet technologies.

- *The U.S. Internet economy is estimated to have generated some $300 billion in revenue in 1998 and supported over a million jobs.*
- *The compound annual growth rate on Internet usage equaled 74.5 percent over the previous three years.*
- *By 2003, over half of American households will be online.*
- *Over two million firms have registered commercial Internet domain names.*
- *Nationwide, the percentage of classrooms with Internet access has gone from 3 percent in 1994 to 27 percent in 1997 to 44 percent in 1998.*

## North Carolina's Position in the Digital Economy

Recent assessments from a variety of external sources indicate that North Carolina's position as an early adapter of advanced telecommunications technologies is eroding.

Early Strengths:

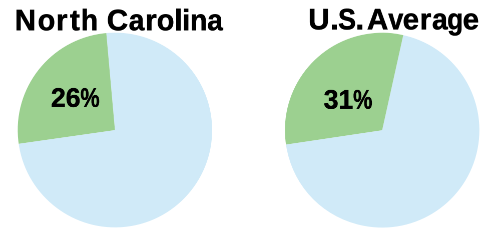
- North Carolina Information Highway Initiative.
- North Carolina GigaNet: established as nation's first gigapop (billions of bit transmitted per second from point of presence) network; linked with high-speed networking hub at Georgia Tech as the platform for the nation's first implementation of Internet 2 architecture.

## Composite Digital Rankings

In an initial, 1997 assessment of state efforts to utilize digital technologies and a follow-up survey to measure progress, the Progress and Freedom Foundation collected data on state use of digital technology in eight areas: Digital Democracy; Higher Education; Elementary and Secondary Education; Business Regulation; Taxation; Social Services; Law Enforcement and the Courts; and Other Initiatives. In a 1998 update, NC fell from 11th in the country to 28th.[50]

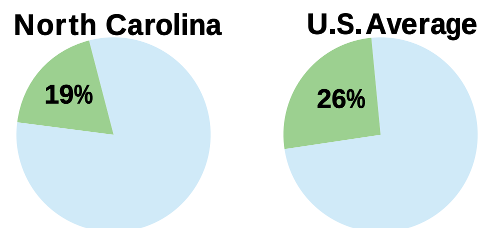
> *On one composite measure of digital competitiveness, NC fell from 11th to 28th in the U.S.*
>
> *In a similar assessment, NC ranked 39th overall in the country.*

*Figure 55:* **Percentage of Adults with Internet Access**



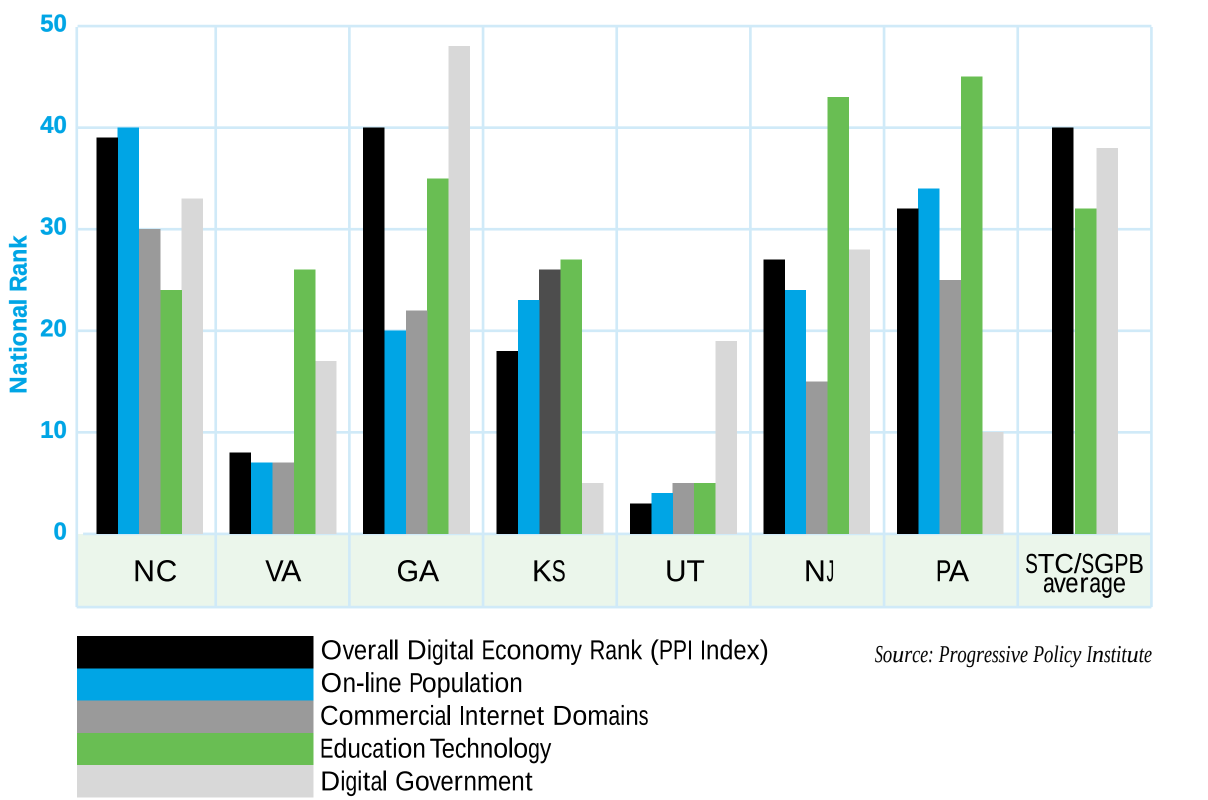

*Source: Progressive Policy Institute, 1998.*

*Figure 56:* **Percentage of Companies with a Registered Commercial Internet Domain Name**




*Source: Progressive Policy Institute, 1998.*

*Figure 57:* **Benchmarking States' Digital Infrastructure – 1998**




*Source: Progressive Policy Institute*

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[50] Progress and Freedom Foundation. 1998. Regional Forum "The Digital State, 1998". Southern Technology Council, Research Triangle Park, NC. Vol. 12, No.2, Fall 1998.

A different composite score based on measures of the percentage of population on-line (NC #40), percentage of commercial establishments with a register Internet domain name (NC #30), percentage of schools with Internet connections (NC #24) and percentage of electronic government transactions (NC #33) has North Carolina ranked at 39th overall in the country.[51]

## Wired Schools

North Carolina was an early leader in terms of digital connections to the public schools through out the state — it continues to rank near the top at sixth in K-12 education and 15th in higher education. However, its position of leadership is not firm. North Carolina's rank has actually declined **from 4th to 6th over the past two years in the K-12 category**.

The Progressive Policy Institute developed a more comprehensive measure of connectivity. This measure computed a weighted average based on the percentage of classrooms wired for the Internet, teachers with technology training and schools with more than 50 percent of the teachers having school-based e-mail accounts. This is the only measure related to Internet access and use on which North Carolina's rank of 24th was better than the national average.

## Telecommuting

Already an active force for digitization in the private sector, telecommuting is about to become a force for change in the public sector workplace as well. In July, 1999 North Carolina Governor Jim Hunt issued an executive order stating that all state departments consider implementing telecommuting programs for employees. The State auditor's office estimates that **North Carolina could save $23 M if just five percent of eligible state employees worked from home. North Carolina raked 38th on the Progressive Policy Institute's comparison of state governments' usage of digital technologies**, indicating that more executive orders of this sort might be needed to make the government sector more functional in the digital economy.

In the private sector, estimates are that the number of telecommuters grew 122 percent, from 8.1 million in 1995 to 18 million in 1998 (Source Cyber Dialog). In North Carolina, 11 percent of Nortel's workforce telecommute through a program that began in 1994, realizing 10 percent greater productivity and an average cost savings of $8,000 per year per employee.[52]

## The Digital Divide — Computer Use in Rural Eastern NC

In July 1995, the National Telecommunication and Information Administration (NTIA) reported that despite gains across America in access to electronic services, distinct disparities in access remain. Low-income households in rural areas are the least connected, experiencing connectivity rates of only 8.2 percent, versus 76.5 percent for high-income (>$75,000) urban households.

The Regional Development Services of East Carolina University in Greenville subsequently conducted an extensive market study of the 22 counties comprising Eastern North Carolina and determined that **27.7 percent of the homes in eastern North Carolina have a computer, 14.5 percent have a modem, and 10 percent have Internet access at home**. This compares favorably with an update from NTIA that indicates a nationwide average computer ownership rate of 24.1 percent and an average Internet access rate of 18.6 percent in 1997.[53]

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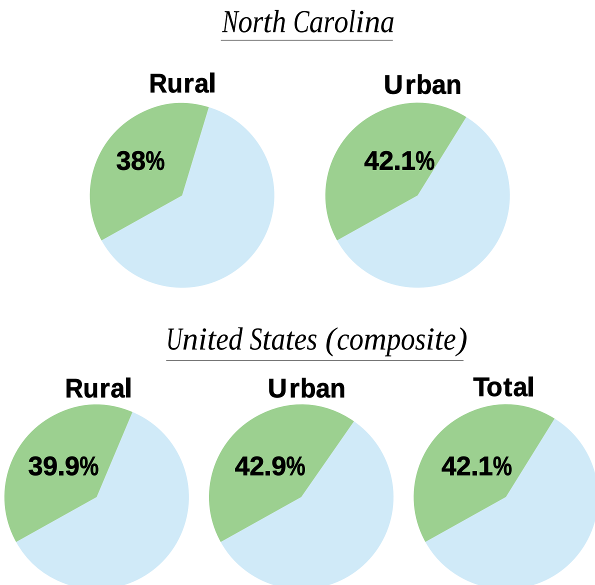
[51] Progressive Policy Institute. 1999. *The State New Economy Index: Benchmarking Economic Transformation in the States.* (by Robert D. Atkinson, Randolph H. Court and Joseph M. Ward). Washington, DC.

[52] News and Observer. 1999 ( July 30, page D-1). *The future of work is at home.* (by Carlene Hempel). Raleigh NC.

[53] Regional Development Services. 1996. *The East Book: A Guide to Markets and Purchasing Patterns in Eastern North Carolina.* East Carolina University. Greenville, NC.

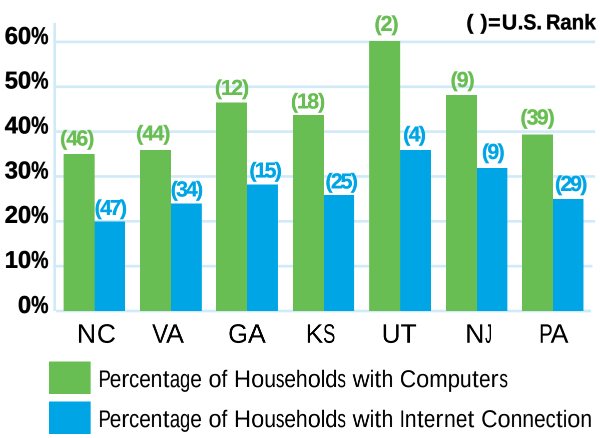
*Figure 58:* **Computer Ownership – the Digital Divide**




Source: NTIA 1998

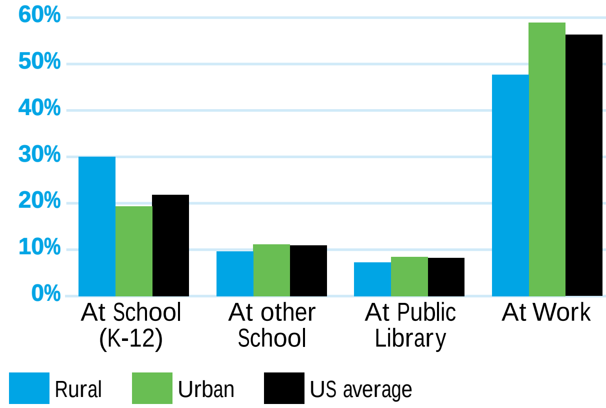
## Usage Statistics

*Figure 59:* **Comparative Internet Usage Rates – 1998 Benchmarks**



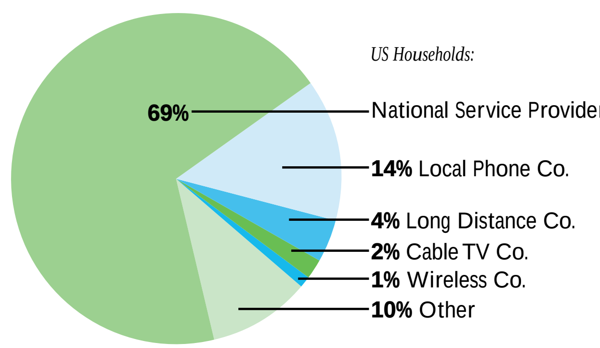

Source: NTIA – 1998

*Figure 60:* **U.S. Internet Access Outside the Home – 1998**




Source: NTIA – 1998

*Figure 61:* **Internet Service Provider – 1998**




Source: NTIA – 1998

# You Do Not Make Progress By Standing Still

As a state, North Carolina has shown great foresight in its previous investments in science and technology and in its application of these investments to support economic development. We have one of the finest higher education systems in the nation. We have internationally recognized centers of excellence in critical areas of research and development. Our economy is growing and diverse, with a strong high technology component in our industrial base. Unemployment is at an all time low in our state and substantially below the national average. Some might ask, why worry.

You do not make progress by standing still. We have maintained strong positions in some areas related to science and technology, but have fallen behind in other key sectors. States that once viewed us as a leader, and even benchmarked themselves against us, have now overtaken us in areas such as biotechnology and information technology. We cannot become complacent and assume that past investments will continue to yield strong returns.

North Carolina needs to evaluate continually its relative position against other states and countries. Our strategies will evolve in light of changes locally and in the global arena in which our industries and citizens must compete. The nature and scale of investments needed to ensure that all regions of the state can participate in a New Economy that will be based on science and technology innovations will vary. A deliberate, thoughtful process that is based on a common understanding of the issues, the realities, and the options, must be put in place.

This is what we hope to accomplish with the *Vision 2030* Project.

The purpose of this report is to provide a baseline assessment of North Carolina's competitive position at the dawn of the 21st Century. The many individuals who will be asked to provide the benefit of their perspectives and experiences to the *Vision 2030* Project will use this report to frame the issues. It is not the purpose of this report to provide in-depth analysis of the information presented. Nor is it appropriate at this time to glean recommendations for new or modified science and technology policy initiatives. Rather, it is within the purpose and process of the *Vision 2030* Project that this document be used as a resource for all aspects of this phased planning project. The ultimate goal of the *Vision 2030* Project is to produce a blueprint that moves North Carolina into a stronger competitive position in the New Economy.