

# MAJOR TRENDS FACING NORTH CAROLINA IMPLICATIONS FOR OUR STATE AND THE UNIVERSITY OF NORTH CAROLINA

University of North Carolina Tomorrow



**Research, Technology Innovation, Universities and  
Global Competitiveness**

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**Research, Technology Innovation, Universities and Global Competitiveness  
A Brief Prepared for the UNC Tomorrow Commission**

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**I. National and Global Trends**

For over 50 years, a strong and competitive industrial base has been the principal driver of the United States' global dominance in commerce and trade, with manufacturing contributing a significant share of American export earnings. The globalization of manufacturing in the last 10 years has resulted in an increased focus in the US on the development of a knowledge-based economy that relies on entrepreneurship, innovation, and technology development as the engines for economic development. This nation's universities are seen as major players in this enterprise, with the task of educating a workforce for the future that has been exposed to the latest in current technologies, and at the same time is trained in sound business knowledge, entrepreneurship, communication skills and teamwork approaches to help meet the economic challenges of the new century. In addition, the universities are being relied upon to produce groundbreaking, high-risk, high-reward research that will drive innovation and the development of new technologies that will help maintain US competitiveness in the global research enterprise.

A 2007 report by the National Academies of Science and Engineering and the Institute of Medicine provides strong evidence that the US is losing ground in its market position for the production of goods and services as well as in the generation of new science and technology findings with significant economic potential [1]. The Center for Studies in Higher Education recently provided an excellent perspective on the history of research universities in the US, the competitive challenges that face them, mostly from Europe and Asia, and the problems that these research universities must address in order to maintain their leadership position in science and technology [2].

The fraction of total national Research and Development (R&D) expenditures by industry in the US dropped from 68 percent in 2000 to 62 percent in 2004. This was accompanied by a corresponding increase in the fraction of funding from the federal government from 22 to 28 percent. In 2004, US colleges and universities accounted for \$42,431 billion in R&D expenditures, corresponding to 13.6 percent of all R&D expenditures in the US. An estimated 61.5 percent of the funding came from the federal government, 19.3 percent from funds provided by the academic institutions, 9 percent from non-profit groups and 5 percent from industry and state government. Approximately 4.3 percent of all 4,387

institutions of higher learning in the US in 2006 were engaged in a significant amount of research. These include the 96 universities classified by the Carnegie Foundation as research universities with very high research activity (RU/VH) and 103 research universities with high research activity (RU/H). The top 100 research universities were responsible for an estimated 79.6 percent of all university research expenditure in the US in 2006 [2]. Clearly, the research enterprise at US universities is focused primarily on a very small percentage of all of its institutions of higher learning, and most of the funding for this work comes from the federal government.

In the last 30 years there has been a significant focusing of federal research dollars in the medical sciences, biological sciences and engineering, while research in the physical sciences, the earth, atmospheric and ocean sciences and the social sciences has seen a much smaller increase. This focus has led to increased fragmentation of curricula into what some faculty see as more “practical” curricula and there is fear of a loss of quality in the basic and social sciences, the humanities and the arts. In this environment, it is imperative that resources be maintained in all campuses to ensure excellence in fields other than the ones currently favored by federal funding agencies [2]. This is particularly the case in the basic sciences and the humanities, areas that play a predominant role in educating our students.

In 2003, there were 130,000 foreign graduate students in US research universities, accounting for 27 percent of total graduate enrollment. In technical fields, foreign graduate students accounted for approximately 41 percent of all graduate students, most of them from China and India. At the same time, there has been a large growth in graduate programs in Korea, China, Taiwan and India so that the competition for this talent with US universities is rapidly growing [2]. Many universities throughout the world aspire to compete with the US universities, and some have had considerable success in the last 10 years [3]. Shanghai’s Jiao Tong University’s Institute of Higher Education did the first worldwide ranking of universities in 2003. The Times Higher-Education Supplement (THES) has produced yearly worldwide rankings since 2004 [4]. A 2006 summary of the World’s Top 200 Universities published by *Newsweek* lists many universities in China, Singapore, Australia, England, New Zealand, Canada, Hong Kong, France, Switzerland, Denmark, Germany, India, Korea, Netherlands, Japan, Belgium, Ireland, Scotland, Austria, and Russia [5]. The steadily increasing globalization of academic research and development will make it increasingly difficult to attract and keep the best minds to populate our faculty and graduate student ranks. As a result, it is imperative that universities maintain their competitiveness in faculty salaries and benefits, research infrastructure, graduate student stipends, digital communications facilities and other infrastructure.

## **II. Regional and Statewide Responses**

The Morrill Act of 1862 established the system of Land Grant Universities in the US. These institutions were mandated to serve the general educational needs of citizens across the nation, initially in the agricultural and mechanical fields. North Carolina State University and North Carolina A & T State University are the two Land Grant

Universities in NC. The Hatch Act of 1887 established a chain of research farms to develop solutions to problems faced by rural counties and the Smith Lever Act of 1914 authorized the formation of the Cooperative Extension Service that created Extension offices in each of the 100 counties in NC. The local Extension agents are university faculty whose job it is to help facilitate knowledge transfer between the university and local communities in a wide range of areas such as agricultural, health, environmental and community development. In many rural counties, the Extension agents are the face of the UNC system to the public. The Cooperative Extension Service at NC State and NC A&T State University has played a long and distinguished role in economic development across the state for more than 100 years.

In addition, the Industrial Extension Service (IES) at NC State University provides support to NC businesses, from offices to factories to hospitals in the form of Six Sigma, energy audits, safety and health, and ISO standards management. IES houses a center of the Manufacturing Extension Partnership, a program of the National Institute of Standards and Technology (NIST) to help small manufacturers optimize the productivity and profitability of plant operations. IES has 13 different regional offices throughout NC and its clients credit IES for over \$270 million in economic impact to date. IES is currently leading an effort to develop benchmarks to quantify the impact of extension and engagement programs involving service-learning, technology transfer, public events, technical assistance, clinical/diagnostic testing and professional development on economic development. In the long term, these benchmarks could serve as a model for tracking the influence of all university programs aimed at economic and community development for the State.

In recent years, most of the campuses in the UNC System have developed their own outreach and extension programs to serve the needs of their local communities and regions and to help in economic development. These programs rely on specific areas of strength and expertise on each campus, very often built specifically to respond local issues in economic and community development. Many regions throughout the State of North Carolina are establishing niche areas of research and development via university, corporate and federal/state partnerships. Programs in marine biology, environmental sustainability, agriculture, tissue regeneration, biofuels, bioinformatics, nanotechnology, aerospace, automotive, complementary and alternative medicine, and robotics are gaining increasing support in regions of the state where workforce development and entrepreneurship have become major priorities.

The State of North Carolina has been a national leader in the use of state investments to enhance economic growth through the establishments of breakthrough initiatives such as the Research Triangle Park (RTP), the North Carolina Biotechnology Center (NCBC), the Microelectronics Center of North Carolina (MCNC), the Centennial Campus at NC State University, and the Research Triangle Institute (RTI).

As a result of these investments, the RTP area of NC is widely recognized as one of the nation's most successful clusters for innovation and entrepreneurship. Several of the state's major universities are located in close proximity to RTP, now home to more than

300 bioscience companies. Today, North Carolina ranks among the top three biotechnology regions in the United States. Over 399 bioscience companies are headquartered in North Carolina, employing more than 47,000 people ([www.ncbiotech.org](http://www.ncbiotech.org)). In addition, the North Carolina Research Campus at Kannapolis, a 350-acre campus being developed by the Dole Food Company in partnership with the UNC System, Duke University, and the Community College System is envisioned to be a major center for nutrition research, business, and education. Another statewide program underway with funding from the Golden Leaf Foundation is the Biomanufacturing and Pharmaceutical Training Consortium (BPTC). Designed to address statewide workforce needs in biomanufacturing, this Consortium, comprising programs at the North Carolina Community College System (BioNetwork), North Carolina Central University (BRITE), and NCSU (BTEC), seeks to train students as well as displaced workers to be competitive for jobs in biomanufacturing. BPTC also draws support from the industry trade group North Carolina Bioscience Organization (NCBIO), the NCBC, and several biomanufacturing companies. Because of the great vision of its leaders and the wonderful investments that NC has made over many years in its infrastructure and its educational institutions, the state is well poised to address future challenges to economic growth through technology and innovation.

### **III. Current Implications for Universities in North Carolina and the US**

North Carolina's economy has been in transition for the past decade. Much of this is the result of loss of jobs in textiles and tobacco manufacturing. Creating employment opportunities in new areas and retooling/training workers to be competitive for those jobs is a major challenge facing the state. Several state agencies have recognized this need for job creation and workforce development and have responded to the challenge.

In May of 2006, the UNC Board of Governors adopted the report of its Special Committee on Community and Economic Development and, for the first time, included "regional and statewide economic development as one of the seven strategic priorities for the UNC system" [6]. This report offered a broad definition of economic development as "those activities occurring at the intersection of the public and private sectors designed to increase the long-term economic well-being and quality of life of its citizens." The activities described are meant to meet long-term economic development objectives for each campus and comprise, not only the creation of intellectual property and technology transfer, but also workforce development, leadership development, and public policy and analysis.

The adoption of this new strategic priority for the UNC system comes at a time of increasing economic and technological competition from other countries, and a general recognition of the important role that universities can play in economic development both regionally and nationally.

In a study commissioned by industry, the Huron Consulting Group reported that NC's public universities have had a broad and significant impact on economic development throughout the state, and that the universities are unique assets that the state should seek

to leverage in its plans for economic growth [7]. For example, in fiscal year 2006, UNC system universities were awarded approximately \$1.0 billion from public and private sources [8]. Scaling from the figures provided in the Huron report [7], this research support is estimated to have a \$1.3 billion impact on the economy of NC, supporting approximately 32,000 jobs. The Huron report listed 32 business startups originating from technologies developed at the two major state research universities alone. However, it also found that the universities in NC faced increased competition from other states that were also recognizing the importance of strategic research investments in their universities and were providing better salaries, benefits, facilities and policies to attract the best and brightest minds to their research institutions [7].

The report from the UNC Board of Governors Special Committee on Community and Economic Development outlined detailed strategies for achieving five major goals [6]:

1. Deliver learning that meets the needs of the 21<sup>st</sup> century
2. Enhance the capacity of public institutions to implement successful and sustainable economic development policies
3. Enhance opportunities for research and innovation
4. Provide support to build competitive businesses
5. Grow high-quality, healthy and attractive communities.

These goals from the UNC Board of Governors are consistent with goals that are being promoted at the national level. The Economic Development Council has outlined what steps must be taken to drive innovation and expand entrepreneurship in order for the US to remain competitive in the global economy [9]. Recognizing that the higher education system in the US is key for the economic and social well being of the country, the 2007 Innovation Agenda calls for closer partnerships among research universities, community colleges in workforce development, as well as enhanced interactions with industry in research, technology transfer, and entrepreneurial activities. As the various UNC campuses analyze the best strategies to implement in order to meet these overarching goals, it is useful to recognize that there are many different ways in which institutions of higher learning can contribute to economic development.

The traditional model for university involvement in economic development is the technology transfer model in which research done at a university is patented, licensed, and a spin-off company is founded to commercialize the new invention or process. For example, in North Carolina, through its Business and Technology Development Program, the North Carolina Biotechnology Center assists North Carolina bioscience companies with financing, networking, marketing strategies, site location, business planning, venture capital, strategic partnerships, and technology assessment. Their Business Program provides low-interest loans to early-stage companies across the state through the Economic Development Investment Fund. This is proving to be an excellent way to stimulate new business development. Finding a way to link these ongoing activities to the expanding banking center that has developed in Charlotte is a challenge that should be addressed by the leadership of the state.

Nationally, university spin-offs account for only 2-3 percent of all new US businesses (400-500 out of 550,000 per year), and university patents constitute only about 2-3 percent of the number of patents produced in the US per year (3,700 out of 150,000 per year) [10]. In addition, revenues from licensing of patents by research universities are only a small fraction (4- 6 percent) of university research revenues. This clearly indicates that the technology transfer model is an important model for the university to enhance economic development, but it is only one of many ways that universities can help the state to be more competitive.

The technology transfer model is much more applicable to the creation of whole new industries, such as the personal computer industry in Silicon Valley and the Systems Biology industry in the Boston area. This activity requires cutting edge science and technology research, aggressive licensing policies, and strong ties between entrepreneurs and academic researchers. However, to transplant new industry to a given region, to help diversify an existing industry, or to upgrade a mature industry, universities can play a major role in education and manpower development, providing updated curricula and technical assistance, providing infrastructure for testing and analysis, convening user-supplier meetings, and providing specialized training for managers and technicians in best practices and optimization [10]. The multi-faceted nature of these interactions makes it possible for all campuses to contribute significantly to economic growth strategically, in alignment with the directions of the regional economy, in a way that is totally consistent with its traditional missions of excellence in teaching and research. This approach to university involvement in economic development is consistent with ideas and concepts recently espoused by other regional and state leaders [11, 12].

As the discussion above illustrates, economic development through technology transfer and generation of spin-off companies is highly dependent on the university's research and outreach component, while other approaches to economic development through education and training are more aligned with a university's teaching and training mission. The final report of the Pappas Consulting Group to the General Assembly mentions that employers want to hire students "who can solve more problems; who can work in teams; who can see the big picture; who can communicate effectively; who can use technology effectively; and who can bring a strong work ethic" [13]. In addition, there is a strong demand, not only to enhance the quality of undergraduate and graduate education, but to enhance efforts to make a college education more affordable, to provide a more seamless transition between K-12, community college and university education, and to ensure the future supply of workers from a highly diverse population [13, 14]. It is clear that a quality K-12 education system is a prerequisite for future economic growth in our global economy [1].

It has long been recognized that one of the factors that could affect the ability of US universities to be competitive in a knowledge economy is the availability of excellent student and faculty talent. Foreign students have populated many slots in graduate and post-doctoral US programs at our best universities for decades. The US economy has benefited as a result since many have elected to stay after completion of their education,

some as members of the faculty at our most distinguished institutions. Countries such as Brazil, India and China have now developed their own educational and research programs and are much better able to maintain their own talented individuals. This effect, combined with tougher immigration and homeland security standards in the US, is likely to affect economic growth through industry-university interactions as well as through normal growth in the private sector [2, 15]. To address the challenges of training North Carolina's own citizens, it is critical to invest in improved K-12 education to foster the economic growth of NC, as has also been documented in a recent report to the legislature [16].

It is of interest to compare the general recommendations of the report from the National Academies Committee on Prospering in the Global Economy of the 21<sup>st</sup> Century [1] to the Goals 1-5 already outlined above from the report of the UNC Board of Governors Committee on Community and Economic Development [6]. The recommendations from the National Academies and the Institute of Medicine are as follows:

- A. Increase talent pool by vastly improving K–12 science and mathematics education
- B. Sustain and strengthen traditional commitment to long-term basic research that has the potential to be transformational to maintain the flow of new ideas that fuel the economy, provide security, and enhance the quality of life
- C. Make the US the most attractive setting in which to study and perform research so that we can develop, recruit, and retain the best and brightest students, scientists, and engineers from within the United States and throughout the world
- D. Ensure that the US is the premier place in the world to innovate; invest in downstream activities such as manufacturing and marketing; and create high-paying jobs based on innovation by such actions as modernizing the patent system, realigning tax policies to encourage innovation, and ensuring affordable broadband access

#### **IV. Potential Responses from the UNC System**

As expected, there is some clear overlap between national recommendations to enhance competitiveness and the UNC system's goals to enhance economic development in the state of NC. This alignment is important since it allows a clearer path to leveraging state and federal efforts to reach the university's goals and objectives. By comparing the detailed action items for each of the four recommendations A-D of the National Academies and Institute of Medicine to the strategic steps described for each of the five goals 1-5 of the UNC Board of Governors Special Committee on Community and Economic Development, it is possible to obtain a combined set of strategies that are aligned with both the national and state or UNC system goals, and these are listed below.

##### *Goal 1: Deliver Learning That Meets the Needs of the 21<sup>st</sup> Century*

###### Strategies

- Emphasize quality and scholarship for all learning and training programs
- Enhance educational, mentoring and training opportunities for K-12 teachers by UNC system faculty, especially in the areas of science, technology, engineering and

mathematics (STEM)

- Increase the availability of a college of education and the number of out-of-state applicants through scholarship and work-study programs
- Significantly increase the state financial support for undergraduate research opportunities
- Provide special graduate fellowships for state residents willing to attend graduate programs on state university campuses
- Provide tax incentives for private firms funding graduate study for employees on state university campuses
- Streamline and facilitate the process of appointing foreign students and researchers with the appropriate visas for research and training
- Offer educational experiences that prepares students for work in an interdisciplinary environment, combining creative thinking, technical and analytical skills, business expertise and communication skills for a variety of audiences
- Integrate campus experiences with what is learned on the job, enhancing cooperative education, service-learning and internship programs
- Enhance emphasis of entrepreneurship training and leadership training in and out of the classroom
- Provide life-long learning opportunities to our graduates when and where it is needed
- Establish strong institutional links with universities in Europe, Asia and South America to provide internalization experiences for undergraduates, graduate students and faculty

*Goal 2: Enhance the Capacity of Public Institutions to Implement Successful and Sustainable Economic Development Policies*

Strategies

- Establish mechanisms for linking teaching and research activities to economic development opportunities
- Establish web based portals on capabilities and expertise at the university in various areas
- Faculty should be available to provide applied research, studies and analyses to state and other leaders as needed
- Provide reward system for faculty participation in economic development efforts
- Provide enhanced training opportunities to staff and managers in the public sector

*Goal 3: Enhance Opportunities for Research and Innovation*

Strategies

- Establish strong collaborative research relationships among institutions
- Enhance ability to conduct innovative research
- Enhance the ability to transfer new ideas into commercial opportunities
- Continue research in core areas and establish links with emerging capabilities in nanotechnology and biotechnology
- Provide state support for multi-institutional research programs involving scientific and engineering advances

- Enhance the level of support for early-career researchers addressing state and regional economic development priorities
- Coordinate regional economic development needs and opportunities with university research and potential funding sources

*Goal 4: Provide Support to Build Competitive Businesses*

Strategies

- Establish web based portal describing university intellectual property available for licensing
- Streamline the licensing process for university intellectual property
- Provide tax incentives for regional industry support of university research
- Address gaps in service and outreach to support technology based economic development
- Develop research capacity in the areas of need of technology based companies in the state or region
- Campuses should serve as hubs of networks to disseminate university technology, best practices, counsel, training and regulatory compliance support for industry
- Management programs should foster entrepreneurship
- Universities should help start venture funds to support investments in technology
- Extension and outreach programs from land grant and regional campuses should be coordinated to maximize strengths and increase accessibility

*Goal 5: Grow High-Quality, Healthy and Attractive Communities*

Strategies

- Support art and culture networks that break down barriers between university and local communities
- Integrate the academic and clinical sides of public health and nursing programs across the state
- Encourage faculty and student participation in community programs
- Make university facilities available to cultural and community groups

These goals and list of strategies or recommendations are offered for consideration and discussion, recognizing that they are all subject to implementation in different ways at the different campuses of the UNC system. The adoption of many of them will be a challenge because they will require a change in the culture of the faculty and the institutions in question. Others that cut across all of the campuses will require coordination and support from the UNC system itself to make them feasible. Finally, many of them can only be made possible through the financial support of the legislature.

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