Request to Plan a Doctoral Program in Nanoengineering at North Carolina A&T State University

Introduction

This is a request from North Carolina A&T State University for approval to plan a doctoral program in Nanoengineering (CIP 14.9999).

Program Description

The discipline of ***Nanoengineering*** encompasses the knowledge and capability to control the arrangement of atoms and molecules enabling novel chemical applications with customized properties. Nanotechnology refers to structures less than 100 nanometers in size (approximately 1000 times smaller than the width of a human hair).

The proposed interdisciplinary doctoral program in Nanoengineering is being established in conjunction with the Joint School of Nanoscience and Nanoengineering (JSNN) that has been established by North Carolina Agricultural and Technical State University (NC A&T) and the University of North Carolina at Greensboro (UNCG) with designated funding from the General Assembly. This program will involve extensive collaboration among the faculty members of the NC A&T College of Engineering, the faculty members of the JSNN, and the faculty members in the basic and applied sciences of both universities. The program will be named a Ph.D. in Nanoengineering.

The proposed program is unique within the UNC system for several reasons. The JSNN involves collaboration between two major universities with complementary strengths and history. UNCG has a strong tradition in the liberal arts and has built considerable strength in the basic sciences. NC A&T State is a Historically Black University with strong programs in the engineering and basic sciences. Both institutions are classified by the Carnegie Foundation of New York as “research universities with high research activity.” The Ph.D. in Nanoengineering degree program will create a platform for interdisciplinary interactions between faculty members at JSNN with faculty members in more traditional programs at NC A&T State and UNCG. Very few Nanoengineering educational programs exist, and therefore, personnel with advanced training in Nanoengineering are in high demand.

A primary feature of the program is interdisciplinary teaching and research in the fundamentals of nanoengineering, as applied to chemical, biochemical, physical, and nanomaterials principles, and their application to emerging areas of nanoengineered materials. Through the program’s coursework, students will receive a strong background in nanoengineering theory, as well as in the experimental and computational techniques utilized in the discipline. In their first year, students will be required to take a set of four courses in the Fundamentals of Nanoengineering that will introduce them to the theoretical underpinnings of the field. A laboratory rotation through four laboratories will also be required in the first year to provide exposure to ongoing research activities, provide experience with laboratory techniques, and aid students in the selection of a dissertation topic. In addition, a professional development seminar is required during the first year that will focus on important issues related to a career in research (e.g., grant writing, ethics, and legal issues).

In the second and third years of the program, students will take advanced elective courses in a related nanoengineering discipline to ensure they have substantial depth of understanding in their area of research and interest, and to enable them to effectively carry out advanced nanoengineering research. After admission to candidacy for the doctoral degree, the student will begin Ph.D. dissertation research during the second year. Although the student will learn through a number of traditional classroom experiences, the student's research activities and technical literature study will be the primary educational vehicles of the program. The student will learn how to apply engineering theory to real-world nanoengineering problems using research methodologies and leading-edge equipment to create innovative solutions and enable new technologies.

The Ph.D. in Nanoengineering will be a 60 credit-hour degree program. It is planned that the Ph.D. in Nanoengineering will have a similar structure to the Ph.D. in Nanoscience at UNCG and will utilize some of the same courses where appropriate (e.g. Nanotechniques, Professional Development Seminar).

The North Carolina General Assembly appropriated funding in 2007 to establish the Joint School of Nanoscience and Nanoengineering, including funding to construct a new building for the School and funding to purchase laboratory equipment. The facility is scheduled for completion Fall 2011 and will be managed by the Gateway University Research Park on the South Joint Millennium Campus of NC A&T State and UNCG. The Triad business community has been very supportive of JSNN because of its potential for economic development, and JSNN has already developed relationships with companies both within and outside the Triad.

UNC Tomorrow Relevance

This proposed program would address several Recommendations within the UNC Tomorrow Report including the components to enhance Our Global Readiness (Recommendation 4.1), Our Citizens and Their Future: Access to Higher Education (Recommendation 4.2), Our Communities and Their Economic Transformation (Recommendation 4.4), Our Health (Recommendation 4.5), Our Environment (Recommendation 4.6), and Our University's Outreach and Engagement (Recommendation 4.7).

Disciplinary Panel

The panel included faculty members from ECU and NCSU in addition to the NC A&T State faculty presenters. Panel members discussed the curriculum of the proposed program, and asked about the subject matter of the rotation through four laboratories that students complete in the first year. NC State University mentioned the new online Master of Nanoengineering degree program that it is currently developing, and panel members agreed that students in both Nanoengineering programs could benefit from taking courses in the other program. Panel members asked about the relationship of the proposed program to the Ph.D. in Nanoscience degree program at UNCG, and also about employment opportunities for graduates of this proposed program.

Response
The campus provided satisfactory responses to the questions raised in the disciplinary panel. NC A&T State University explained how the Ph.D. in Nanoscience and the proposed Ph.D. in Nanoengineering are complementary programs with completely different focuses and content objectives. The Nanoscience program focuses on understanding the physics and scientific principles of the nanotechnology, whereas the Nanoengineering program focuses on the design, fabrication, and manufacturing of nanodevices. Also, giving several examples, NC A&T State described how employment opportunities are good in North Carolina for graduates of both doctoral programs. Overall discussion of the proposed Ph.D. program was positive, with consensus on the desirability of offering this degree program.

Student Demand
No other public or private institution in North Carolina offers a Ph.D. degree in Nanoengineering, although there are other doctoral programs that have nanoscience components. In addition to UNCG's doctoral program in Nanoscience, a Ph.D. in Nanoscale Science was initiated in 2007 at the University of North Carolina at Charlotte, and Duke University offers a Certificate in Nanotechnology. At the Masters level, NC A&T State's Master of Science in Nanoengineering degree program (that was approved by the Board of Governors in February 2011) has already enrolled eleven students for Fall 2011. Recognizing student demand in this area, and as discussed at the disciplinary panel, NC State University is currently developing an online Master of Nanoengineering degree program. Given the employment opportunities available in North Carolina for Nanoengineering graduates (see below), and the small number of Nanoengineering programs now offered in the state, the student demand for the proposed program appears good.

Opportunities for Graduates of the Program
In Spring 2005, the then Governor of North Carolina instituted the Governor's Task Force on Nanotechnology and North Carolina's Economy, which was tasked with developing "a roadmap for an aggressive and coordinated initiative to advance successful nanotechnology-based economic development and high-wage employment across North Carolina." This task force released "A Roadmap for Nanotechnology in North Carolina's 21st Century Economy." The Roadmap listed the following imperatives to enhance North Carolina's competitiveness in this area:

1. Increase our ability to innovate,
2. Increase the levels of collaboration between our companies and R&D centers,
3. Develop a well-educated and trained workforce,
4. Provide a supportive public and political policy environment, and
5. Diversify our technology cluster portfolio to include nanotechnology.

The JSNN addresses all five of these imperatives, while the proposed doctoral program addresses the imperatives of developing a well-educated and trained workforce, and of increasing the levels of collaboration between academia and industry. Nanotechnology is rapidly becoming a large part of the world's economy, generating an array of materials, technologies, and new products. Lux Research has estimated that by 2015, "nano" containing products will account for $3.1 trillion of the world's economy. M. C. Roco of the National Science Foundation estimated in his 2004 paper in the American Institute of Chemical

Engineering Journal that there would be a world-wide need for approximately 2 million nano-trained workers. Recently, the Project on Emerging Nanotechnologies (a partnership between the Woodrow Wilson International Center for Scholars and the Pew Charitable Trusts) ranked North Carolina 8th in its list of top 10 states in terms of its concentration of nanotechnology companies, universities, research laboratories, and organizations. In addition, Raleigh, NC has moved into the top 5 "Nano Metros." In response to the study, Governor Perdue said "Nanotechnology is fundamental to North Carolina's economic development strategy of growing jobs and building a new economy."

Resource Implications

The North Carolina General Assembly appropriated funds for the creation of the Joint School of Nanoscience and Nanoengineering, including $46.3 million to build the JSNN facilities (scheduled to be completed Fall 2011) and $8 million for capital equipment for JSNN in addition to recurring funding. The recurring JSNN budget includes seven faculty positions for the Nanoscience program, and seven faculty positions for the Nanoengineering program. The recurring budget can help provide support for the Ph.D. in Nanoengineering program.

The resource needs of a proposed doctoral program are typically specified more fully in the proposal for establishment. As an estimate to begin the program (based on the University funding formula), in the program's proposed first year of operation with five full-time and two part-time students, the estimated cost to be provided by State funding would be approximately $168,000 if fully funded by the General Assembly. When the program is fully operational, the program plans to enroll 30 full-time and 10 part-time students.

Recommendation

The staff of the General Administration recommends that the Board of Governors approve the request from North Carolina A&T State University to plan a doctoral program in Nanoengineering.

Approved to be Recommended for Planning to the Committee on Educational Planning, Policies, and Programs

Vice President for Research and Interim Vice President for Academic Planning **May 26, 2011**

General Information Template for Academic Program Review

Degree Area and Level:

Ph.D. in Nanoengineering (CIP 14.9999) at North Carolina A&T State University

Addressing UNC Tomorrow:

This proposed program would address several Recommendations within the UNC Tomorrow Report including the components to enhance Our Global Readiness (Recommendation 4.1), Our Citizens and Their Future: Access to Higher Education (Recommendation 4.2), Our Communities and Their Economic Transformation (Recommendation 4.4), Our Health (Recommendation 4.5), Our Environment (Recommendation 4.6), and Our University's Outreach and Engagement (Recommendation 4.7).

Role of Program in Relation to State and Regional Needs:

According to the proposal, "The Ph.D. in Nanoengineering will provide the student with both breadth and depth in the "nano" field and enable students to take research and development positions in industrial, governmental or academic research settings as well as technical leadership roles in entrepreneurial and burden sharing organizations (e.g. SEMATECH, NC Biotech, etc.). There is a wide variety of industries that use nanoengineering skills. Students may find employment in nanoelectronics, materials, aerospace, chemicals, automotive, consumers goods such as sporting goods and textiles, defense, communications, medical devices and medical diagnostic technology, pharmaceuticals including drug development and delivery, information technology, environmental engineering and energy, just to name a few."

US Labor Department Analysis:

- *Summary* – Overall engineering employment is expected to grow by 11 percent over the 2006-16 decade, about as fast as the average for all occupations. Engineers have traditionally been concentrated in slower growing or declining manufacturing industries, in which they will continue to be needed to design, build, test, and improve manufactured products. However, increasing employment of engineers in faster growing service industries should generate most of the employment growth. Job outlook varies by engineering specialty.
  Source: http://www.occsupplydemand.org/OSD_UnitOfAnalysis.aspx?CLUSCODE=024A-05&ST=NC&PathNo=1

- *Summary Data* – Not applicable for the level of this degree.

Availability of Program Statewide (Enrollment and Degrees Awarded in Last 3 Years):

- *Public universities* – Not available
- *Private universities* – Not available

Available or not from Academic Common Market: Not available

NCA&T Campus enrollment and degrees awarded in similar programs at the Doctoral level:
(*Based on two CIP digits – 14 CIP is the summary group for Engineering under which Nanoengineering is a program.)*

Enrollment			**Academic Year**						
			Fall 07	Spr 08	Fall 08	Spr 09	Fall 09	Spr 10	Fall 10
NCA&T	Electrical and Electronics Engineering	PhD	32	32	38	37	39	37	37
	Mechanical Engineering	PhD	23	18	29	30	33	33	35
	Industrial Engineering	PhD	16	20	26	26	39	38	39
	Computational Science and Engineering	PhD	N/A	N/A	N/A	N/A	N/A	N/A	6

Number of Degrees Awarded			Academic Year		
			2007-2008	2008-2009	2009-2010
NCA&T	Electrical and Electronics Engineering	PhD	7	3	8
	Mechanical Engineering	PhD	10	6	1
	Industrial Engineering	PhD	5	6	3
	Computational Science and Engineering	PhD	N/A	N/A	N/A

Campus Average of enrollment and degrees awarded in this degree area at the Doctoral level:
(*Based on two CIP digits – 14 CIP is the summary group for Engineering under which Nanoengineering is a program - over the last 3 Academic Years, Fall 2007-Fall 2010)*

Campus Average			
	Number of Active Programs	Enrollment per Semester	Degrees Awarded per Year
NCA&T	4	25	5
NCSU	13	64	10
UNC-CH	1	44	7
UNCC	2	52	5
	Campus Average:	46	7

NCA&T Degree Programs added in the past three years:

- *Bachelor*
  - BS Motorsports Technology (11/05/2010)
  - BS Bioengineering (06/11/2010)
- *Master*
  - MS Bioengineering (06/11/2010)
  - MS Nanoengineering (02/11/2011)
- *Doctoral*
  - Ph.D Computational Science and Engineering (01/08/2010)

NCA&T Degree Programs discontinued in past three years:

- *Bachelor*
  - BS Visual Arts, Art Education (03/20/2009)
  - BS Music Education (03/20/2009)
  - BS Romance Languages and Literatures, French Secondary Education (03/20/2009)
  - BS Romance Languages and Literatures, Spanish Secondary Education (03/20/2009)
  - BS Earth and Environmental Sciences (02/11/2011)
  - BS Agricultural Economics (02/11/2011)
  - BS Family and Consumer Science Education (02/11/2011)
  - BS Technology Education (02/11/2011)
  - BS Health and Physical Education (Teaching) (02/11/2011)
  - BA Romance Languages and Literatures, French (02/11/2011)
  - BS Health and Physical Education (02/11/2011)
- *Master*
  - MS English Education (03/20/2009)
  - MS Mathematics Education (03/20/2009)
  - MS History Education (03/20/2009)
  - MS Agricultural Economics (02/11/2011)
  - MS Animal Health Science (02/11/2011)
  - MS Plant, Soil, and Environmental Sciences (02/11/2011)
  - MS Technology Education (02/11/2011)
- *Doctoral*
  - N/A