

Request from North Carolina A&T State University to Establish a Doctoral Degree Program in Computational Science and Engineering

Introduction

In May 2006, following recommendations from the Graduate Council and from General Administration, the Committee on Educational Planning, Policies, and Programs approved the request from North Carolina Agricultural and Technical State University to plan a doctoral degree program in Computational Science and Engineering (CIP: 14.9999). North Carolina A &T State University now seeks approval for the program

Program Description

North Carolina A&T State University proposes to establish a PhD degree program in Computational Science and Engineering (CSE). The proposed program will be highly interdisciplinary, drawing expertise and resources from various disciplines across the University, and operating outside a department. It will offer an interdisciplinary curriculum combining applied mathematics, high-performance parallel and scalable computing, scientific modeling and simulation, and data visualization within the domain areas of the physical sciences (physics and chemistry), mathematics, life science, agricultural and environmental science, engineering sciences and applications, technology, and business.

The aim of this program is for students (a) to master components of physical, life, and environment sciences; technology; engineering sciences; and business disciplines coupled with mathematics and computational science so that they can investigate, model, and develop solutions to important computationally challenging problems in these areas; (b) to educate and train researchers and scientists who understand scientific, technology, and business problems and computational theories and methods needed to implement solutions to these problems; (c) to foster computationally oriented research within and among the fields of physical and life sciences, technology, and business, and to prepare students to work effectively in an environment of interdisciplinary studies and methodologies; (d) to train students to be proficient in computational technology, including numerical computation and the practical use of advanced and high-end computing architectures, analysis techniques and algorithms and scientific visualization, as well as in one or more applied disciplines; and (e) to create a next generation of practitioners at the doctoral level in trained physical and life sciences, engineering sciences and applications, technology, and business who are modeling and simulation experts with the required expertise in the associated mathematics and computational science aspects of Computational Science and Engineering.

The proposed PhD degree program in CSE builds upon the University's current curricular strengths and research capabilities in physical and life sciences, computational science and engineering, mathematics, engineering sciences and applications, technology, and business. It is a result of interdisciplinary synergistic collaboration among the College of Arts and Sciences, the College of Engineering, the School of Business and Economics,

and the School of Technology. It will enhance and supplement current graduate research and educational programs in physical and life sciences, mathematics, technology, and business, and further the nurturing of cross-disciplinary interaction and collaboration in CSE among faculty and graduate students. As the first stand-alone CSE doctoral degree program in the State of North Carolina and among HBCU's in the nation, the proposed program will increase the eminence of North Carolina A&T State University in this important technological area.

The academic program is designed to prepare men and women with highly specialized skills for positions in research and consulting in industry, government, and service organizations, and for teaching and research positions in colleges and universities. The interdisciplinary nature of this program will mean that students and faculty from across the colleges and schools within North Carolina A&T State University will be engaged in research with a background in analytical methods that focus on powerful computational tools and methodologies. This diversity of backgrounds and training will contribute to a unique teaching and learning environment for students and faculty alike. While students will pursue a plan of study individualized to their interests and backgrounds, these plans include a required group of selected core courses and common research themes, through the use of common research laboratories and a program office housed with the School of Graduate Studies. After completing the required core courses, students will choose courses from the existing as well as new doctoral-level courses based upon their research interests. The number and type of these courses will depend on the research area and the student's background.

UNC Tomorrow Relevance

This is a core STEM area and the program will produce graduates who will be very attractive to business and industry. Graduates of the Master's degree program in Computational Science and Engineering, established in 2005, are working at Lockheed Martin, Clarkson Aerospace, NAVAIR, ONR, AIRFORCE, Exxon Mobile, Triangle Polymer, and NASA to identify a few. The research and graduates of the program will contribute directly to the kind of high-tech industry North Carolina seeks to expand, and the program will increase diversity at this high level of training.

Disciplinary Panel

Not applicable—previously approved for planning by the Committee on Educational Planning, Policies, and Programs.

Program Review

The review process for requests to establish is designed to determine whether the proposal is developed to the stage appropriate for taking to the Graduate Council and if so what are the issues that may need further attention. Proposals to establish doctoral programs are reviewed internally and externally. The concerns from the reviewers were summarized in a letter to the Chancellor and Provost prior to the presentation to the Graduate Council. That summary follows:

Questions are raised about the strength of the focus on data analysis and machine learning courses. As one of the reviewers put it, "Data intensive computing is now becoming a very important part of CSE, coupling analytic areas such as statistics, data mining, and machine learning with high-performance computing."

That same reviewer thought there should be more attention to organized follow-up courses on computational methods "to provide deeper coverage and better prepare the students for PhD level research."

The other reviewer was concerned that some of the courses beyond the core courses were not appropriately related to CSE. Sometimes using courses offered by other departments doesn't serve the interest of students unless those courses are intentionally adjusted for the role.

A related course issue was also raised that suggested it might be important to make sure that the feeder programs had adjusted their courses to provide appropriate preparation for this program.

While the comments are favorable about Dr. Kelkar and his potential leadership of the program, questions are raised about the faculty for the longer term. The main concern seems to be about the number of senior faculty for the program and what the hiring plan is to address that. The other reviewer expresses this as the program's lack of critical mass regarding faculty and would need to hire several faculty in the core areas.

Related to this are comments about what it takes to gain major research support in this area, which again comes back to senior, visible faculty. Advice is provided that there needs to be a close working relation with faculty in other programs. Not only will the research funding support faculty but also students who are not likely to commit to the program without financial support.

One of the reviewers made the point that it would be very important to establish connections with national labs that could benefit faculty and students who might find internship and employment opportunities.

Graduate Council

The Graduate Council had, as a basis for its consideration, the proposal to establish the program, the summary letters to the Chancellor, two external reviews, and a presentation to the Council by representatives of the program. Among the issues were questions about the curriculum, additional new faculty, how to gain commitment from departmental members to interdisciplinary programs, and how to work with students who bring different strengths and weaknesses to the program.

Response

Representatives of the proposed program described the success of the master's degree program in Computational Science and Engineering, which is set up on an interdisciplinary format. The master's program has successfully integrating faculty from

many department and with that experience the expectation is that the same can occur for the doctoral program. They called attention to the very positive comments by the outside reviewers regarding the program even though they raised some issues. In response to the need for more focus on computational skills, the representative indicated that they will develop a course that will focus on data mining and computational methods. The Provost was present and indicated that NC A&T was prepared to commit four additional faculty positions to the program. They made it clear that students had to be ready to enter a very high-level program and those that were not would have an opportunity to do the work to bring them up to the required standards, especially in computational skills. They also pointed out that they had had interns at national laboratories and in industry and will continue to do so with doctoral students.

Recommendation by the Graduate Council

After consideration of the issues raised by previous reviewers and Council members, the Graduate Council voted, without dissent, to recommend approval for North Carolina A&T State University to establish a doctoral program in Computational Science and Engineering.

Student Demand

While the program will be open to students from any university, their own master's in Computational Science and Engineering will be a good source of students. They had 17 students enroll in the master's program the fall of 2009. The doctoral program will be a small program and should have little or no trouble attracting students since the demand for graduates with powerful computational skills will continue to grow.

Opportunities for Graduates of the Program

The opportunities in computational areas will be very strong in the coming years and the evidence from the placement success of graduates of the master's program bodes well for the doctoral program. Another very positive feature is the opportunity it will provide minorities interested in Computational Science and Engineering areas. In addition to opportunities in industry, this expanding area will need more faculty, and the program makes the point that this would be the only Computational Science and Engineering program at an HBCU in the nation.

Resource Implications

Resource Needs: Faculty and the computational power to do research in a wide range of areas in engineering and other fields. While the program has an accomplished faculty that has amassed approximately \$2.5 million in grants in the past two years, it will need to add faculty to support the doctoral program. The computing power and related support laboratories are already available on the campus.

Funding for the Program: The Provost has pledged four additional faculty members as the program grows and develops.

Estimated Cost to the State Based on the University Funding Formula: Based on the estimated student enrollment the program will generate approximately \$300,000 from state resources.

Recommendation

The staff of General Administration recommends that the Board of Governors approve the request from North Carolina A&T State University for a doctoral degree program in Computational Science and Engineering.

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



Senior Vice President for Academic Affairs

December 15, 2009

General Information Template for Academic Program Review

Degree Area and Level:

Ph.D in Computational Science and Engineering (CIP 14.9999) at NCA&T

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.) and Our Citizens and Their Future: Access to Higher Education (Recommendation 4.2).

Role of Program in Relation to State and Regional Needs:

According to the proposal, "As the triad region and the state of NC is expanding into the high and knowledge based technical areas (aerospace, pharmaceuticals, engineering design, bioinformatics, etc.) the current and projected demand for graduates with PhD in computational science and engineering has been increasing not only in the state but also across the nation. For example, computational toxicology is one of the key areas at Environmental Protection Agency center in NC and requires scientists of interdisciplinary background. The focus research areas identified in (section 1, page 2) in this proposal are current and projected demand areas and the program will generate graduates to meet the interdisciplinary demands of the current market place and global economy. The demands for these graduates in these high tech, high paying areas impacts the triad and NC economy as well as act as a catalyst to attract new high tech industrial sectors to the triad region and the state."

US Labor Department Analysis:

- *Summary* – The Occupational Supply Demand Systems puts this degree program in a broad category of All Other Engineering. The narrative provided explains, "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

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 Computational Science and Engineering is listed as a program)

Enrollment			Academic Year						
			Fall 05	Spr 06	Fall 06	Spr 07	Fall 07	Spr 08	Fall 08
NCA&T	Electrical, Electronics and Communications Engineering	PhD	31	28	32	32	32	32	38
	Mechanical Engineering	PhD	24	22	23	25	23	18	29
	Industrial Engineering	PhD	20	17	16	17	16	20	26

APPENDIX G

Number of Degrees Awarded			Academic Year		
			2005-2006	2006-2007	2007-2008
NCA&T	Electrical, Electronics and Communications Engineering	PhD	6	1	7
	Mechanical Engineering	PhD	4	3	10
	Industrial Engineering	PhD	2	2	5

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 Computational Science and Engineering is listed as a program) - over the last 3 Academic Years, Fall 2005-Fall 2008)

Campus Average			
	Number of Active Programs	Enrollment per Semester	Degrees Awarded per Year
NCA&T	3	25	4
NCSU	13	59	10
UNC-C	2	41	4
UNC-CH	3	27	6
Campus Average		38	6

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

- *Bachelor*
 - BS Atmospheric Sciences and Meteorology (11/09/2007)
- *Master*
 - MS Information Technology (09/07/2007)
- *Doctoral*
 - N/A

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)
- *Master*
 - MS English Education (03/20/2009)
 - MS Mathematics Education (03/20/2009)
 - MS History Education (03/20/2009)
- *Doctoral*
 - N/A