

**THE UNIVERSITY OF NORTH CAROLINA**  
**NOTIFICATION OF INTENT TO PLAN A NEW BACCALAUREATE, MASTER'S, OR C.A.S. PROGRAM**

THE PURPOSE OF ACADEMIC PROGRAM PLANNING: Planning a new academic degree program provides an opportunity for an institution to make the case for need and demand and for its ability to offer a quality program. This notification, and the planning activity to follow, do not guarantee that authorization to establish will be granted.

Date: June 23, 2008

**Constituent Institution:** North Carolina Agricultural and Technical State University

CIP Discipline Specialty Title: Computer Software Engineering

CIP Discipline Specialty Number: 14.0903 Level: B  M  C.A.S.

Exact Title of the Proposed Program Bachelor of Science in Web Engineering

Exact Degree Abbreviation (e.g., B.S., B.A., M.A., M.S., C.A.S.): B.S.

Does the proposed program constitute a substantive change as defined by SACS? Yes  No

a) Is it at a more advanced level than those previously authorized? Yes  No

b) Is the proposed program in a new discipline division? Yes  No

Approximate date for submitting the Request to Establish proposal (must be within one year of date of submission of notification of intent to plan): May 2009

Proposed date to establish degree: month August year 2009 (Date can be no sooner than six months after the date of notification of intent to plan and must allow at least three months for review of the request to establish, once submitted.)

***1. Describe the proposed new degree program.***

***a. a brief description of the program and a statement of educational objectives***

The Computer Science Department at North Carolina A&T State University proposes the first BS degree in Web Engineering in the nation. This part of the proposal first reviews the components of Web technology. It then documents the rapid growth of the Web (especially in the almost publicly invisible realm of machine-to-machine communication), giving rise to a rapidly growing demand for Web engineers. (This demand is documented at greater length in the next part of this proposal.) After a definition of Web engineering is given, an outline of the proposed program, including the topics covered each year, is given. The program would satisfy the ABET requirements for accreditation for software and related engineering and would differ from the current Computer Science program in several respects, for example, in analyzing the Web as a social and economic phenomenon and in presenting a gentler introduction to programming. Above all, there is too much material for a computer science program to properly educate Web engineers. The enormous educational opportunities provided by the Web are noted, including online communities, distance learning, and student engagement by virtue of the very nature of the Web. Finally, it is shown that the program would present a unique opportunity to pipeline with the North Carolina Community College System.

In 1989, Tim Berners-Lee wrote the first Web server and the first client program, and, for them to communicate as applications on the Internet, he defined the HTTP protocol, which is still the backbone of the Web. In 1990, he defined the first version of HTML, the markup language supporting hyperlinks that is still the primary publishing format for documents viewed by Web users. HTML was based on the SGML markup language for text documents, simplified so as not to overburden Internet communication. Soon, however, the ability of users to define their own document elements (a feature of SGML abandoned by HTML) was found to be essential, so the first version of XML was introduced as a standard in 1998 and has since become the lingua franca for information exchange. Meanwhile, to ensure that the fundamental Web technologies are "compatible with one another and allow any hardware and software

used to access the Web to work together” [1], the W3C (World Wide Web Consortium) was established in 1994 to create open (non-proprietary) Web standards and guidelines. In 1998, the SGML Open consortium changed its name to OASIS (Organization for the Advancement of Structured Information Standards) to reflect its expanded scope in driving “the development, convergence and adoption of open standards for the global information society” [2].

In Berners-Lee’s original vision, the “Web’s major goal was to be a shared information space through which people and machines could communicate” [3]. The standards for machine-to-machine communication are provided by Web services, which “can be combined in a loosely coupled way in order to achieve complex operations” [4]. The first version of the XML-based messaging framework for Web services, SOAP 1.1, was proposed in 2000. By 2001, there was an obvious need for a common framework for integrating data drawn from many sources (not just a single document) and for recording how data relates to real-world objects. This framework is the Semantic Web [5]. More recent developments include aggregating content, whether the content is owned by the aggregator or provided by other parties, and systems that support the collection, processing, and dissemination of information that is significant because it is produced and consumed by people linked by a social network. Indeed, the Web has evolved into a social phenomenon with global reach that builds communities, enables commerce as well as the activities of governments and organizations, entertains, and educates.

In its April 2008 Web Server Survey, Netcraft reports responses from 166 million Web sites that it queried [6]. This survey reported one million sites in 1997, 10 million in 2000, 50 million in May of 2004, and 100 million in November of 2006 [7]. Many of these servers were devoted to blogging and other user-to-user activities, but, in terms of volume of activity, the future will be dominated by Web services provided by organizations. The U.S. Census Bureau's site devoted to measuring the electronic economy reported that, in 2005 (the most recent year for which figures are available), business-to-business (B-to-B) activity accounted for 92% of e-commerce [8]. E-commerce grew faster than total economic activity in three of the four major economic sectors covered in the report (at annual rates of 27.1% for manufacturers, 5.5% for merchant wholesalers, 22.2% for retailers, and 14.9% for “selected service industries”).

The Computer Science Department at North Carolina A&T State University proposes the first B.S. degree in Web Engineering in the nation, which would prepare students to apply these technologies in principled ways and to understand the use and potential of the Web. According to the International Society for Web Engineering, “Web Engineering covers the realization of solutions within the World Wide Web, its applications and its advancement, in particular its approaches, methods, models, principles and tools, which are based on the information and communication technologies of the Internet” [9]. As such, Web engineering can be seen as a specialization of software engineering, albeit with a unique set of challenges and techniques and exploiting a very special set of technologies. Accordingly, the program would be designed to satisfy the requirements for ABET accreditation for “Software and Similarly Named Engineering Programs” [10]. The program would extend beyond traditional computer science and software engineering topics to include background in techniques to analyze the Web as a social and economic phenomenon. Compared with the current Computer Science program at NC A&T, the proposed program would focus on the many aspects of web engineering while de-emphasizing theory and hardware. Also, much of the programming would be in scripting languages rather than whatever is the currently popular primary language of instruction (currently Java). Scripting languages are extensively used for Web programming, and they generally require less code for a given task and are easier to learn than the languages typically used for instruction in computer-science programs. Because of the availability of open-source software for the Web, the well-defined stack of Web technologies, and the often social or visual nature of many Web applications, all courses would put a premium on engaging the students. Learning in large part would be problem driven, and each course would have at least one substantial project that uses the Web or Web technologies.

In terms of technical content, the proposed program would focus on an area primarily within computer science. A broader program, however, could not do justice to the layers of technologies that build one upon the other. It is anticipated that some senior-year courses would be at the end of a prerequisite chain that would be seven courses long. The courses in question would cover such topics as content aggregation and social computing, which have become standard application areas. In addition, the program would not be just a specialization of computer science since it would also address the Web as a social and economic phenomenon.

The proposed program would require the student to complete 124 credits. ABET accreditation in software engineering requires “one year of a combination of college level mathematics and basic sciences” [10]. For this, the proposed program would follow what has proved successful for the Computer Science program at NC A&T, using the same requirements for twelve science credits and twenty mathematics credits. ABET also requires a general education component, which again would follow the Computer Science precedent, accounting for another 31 credits. Twelve credits would be required for Computer Science courses that are prerequisites for Web Engineering courses or specifically complement the program; these courses cover data structures, database design, operating systems, and networked computer systems. There would be 37 credits of required Web Engineering courses and nine credits of Web Engineering electives. Electives would include approved Computer Science courses as well as additional Web Engineering courses. Finally, there would be three credits of free elective.

The core of the proposed curriculum would be a sequence of courses introducing the successive layers of Web standards and technologies. The following is year-by-year outline of this technology backbone.

- The freshman year would begin with an introductory course where the students would gain hands-on experience with a wide variety of Web-based technologies, investigate the social role of the Web, and be introduced to Web programming. The second course would complete the coverage of Web programming for HTML documents using scripting languages.
- The sophomore year would begin with a course covering XML and closely related standards. This would be followed by a course on the standards for defining the syntax of elements in an XML document (effectively defining a markup language) and for transforming the syntactic structure of an XML document.
- The junior year would include a course on Web services, including standards for exchanging XML-based messages, for describing services, and for listing and discovering services.
- The senior year would have a course on engineering a modern Web site (including such things as information aggregation), followed by a course on systems for social computing and a senior-project course. The first two courses will make heavy use of case studies in areas that are important to society and where the Web will have a strong impact in the near future, including health care, small businesses, and awareness of energy and environmental issues.

Software engineering principles, adapted to the unique characteristics of the Web, would be introduced throughout this backbone. As one progresses down the backbone, both the need for engineering principles and the uniqueness of engineering for the Web increase.

Courses not directly on the technology backbone would include, in the senior year, a course on the Semantic Web and its impact on such areas as health care and business. The junior year would have a course on social and economic aspects of the Web, with a microeconomics course as a prerequisite. This course would in turn be a prerequisite for a junior-year course on trust and security.

Web Engineering students will take four Computer Science courses. In preparation for the first course, students would take a course in the common Object-Oriented programming language. This course would be followed in the sophomore year by the data structures course, which would thus be offset one semester from its position in the recommended Computer Science curriculum. Regarding the remaining required Computer Science courses, database design would be in the junior year, and operating systems and networked computer systems would be in the senior year. These courses would thus be scheduled

roughly as they are in the Computer Science curriculum. Any disadvantage Web Engineering students would have in taking these courses due to not having the full Computer Science curriculum behind them would be compensated for by the greater experience they would have with the topics, all of which introduce practical issues encountered even with modest Web sites.

In outline, then, the proposed program would lead the student in the first three years from technologies that directly engage the user to Web services, which assume no direct human involvement but have become the dominant technology. Freshman-year courses, besides engaging the students with Web technologies, would teach them well-engineered client-server computing that involves visually-rendered HTML documents, thereby teaching them two scripting languages (one for the client side, one for the server side). The sophomore year would take the students through the first semester of the sophomore year of the Computer Science program. It would also cover Web standards and technologies that are more fundamental, but less visually oriented, than Web programming that serves up HTML documents. The junior year would present Web services, which exploit the standards covered in the previous year, and it would cover social aspects of the Web, required for senior-year topics. Finally, the senior year would cover senior-year computer-science topics intimately related to the Web and some advanced standards for realizing the vision of the Web. It would also involve large Web applications, requiring sound engineering, mastery of the various layers of Web technology, and an understanding of the social role of the Web.

All courses would be three credits except for the two first-year courses, which would be four credits each, and the Semantic Web course, which would be two credits. The first-year courses would include formal labs for programming and using Web systems. Other courses will have extensive programming assignments and projects that the students would work on out of class. The Semantic Web course would be only two credits because the topic is advanced for an undergraduate curriculum, has well defined component topics (which can be covered at various levels of detail), and would not be a prerequisite for any other topic in the proposed curriculum.

The opportunities the Web provides for education are enormous, going well beyond the content management systems now typical of distance learning. Academic programs strive for a sense of community, but a program educating Web engineers can develop and maintain a Web community that keeps members in touch minute-by-minute and provides access to any item or member with only a couple of clicks. Becoming a good Web citizenship is nearly as important for the students of the proposed program as becoming a good Web engineer.

As the only bachelor's program in Web engineering in the state and the nation, the proposed program would have responsibilities to a larger community in North Carolina and perhaps beyond. The potential for distance learning is obvious. The first-semester Web Engineering course will be designed so that, among other things, it introduces the students to the technologies that would make distance learning a rich experience.

The North Carolina Community College System (NCCCS) has had an Internet Technologies curriculum program, approved for all 58 constituent colleges, since the fall of 1999 [11]. In the spring of 2006, the Web Technologies curriculum program [12] became available, and most of the Internet Technologies courses were redesigned and moved into this program. Currently, besides Internet Technologies, there are eight curriculum programs with courses relevant to Web engineering [11]<sup>1</sup>. At the same time that Web Technologies became a curriculum program, the NCCCS recognized it as a subject for which certificates, diplomas, and Associate in Applied Science (AAS) degrees may be awarded [13]. Currently, 43 of the constituent institutions of the NCCCS offer this degree program [14]. Other relevant degree programs are Networking Technology (offered at 48 institutions), Computer

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<sup>1</sup> The other curriculum programs are Computer Engineering Technology, Information Systems, Computer Science, Computer Information Technology, Database Management Technology, Electronic Commerce, Networking Technology, and Information Systems Security.

Programming (offered at 35 institutions), Information Systems Security (offered at 22 institutions), and four other programs currently offered by no more than three institutions (in some cases, by none)<sup>2</sup>

The BS degree program proposed here for A&T would have a close relationship with the NCCCS Web Technologies degree program. Community college students would be encouraged to join the A&T Web Engineering online community. Arrangements would be made with the NCCCS for courses with content comparable to the proposed first-semester Web Engineering course so that community college students may master the technologies enabling online engagement. Articulation agreements would be worked out so that a student with an AAS degree could enter the Web Engineering program at a reasonable level. Precedents exist with, for example, the articulation agreement relating the Computer Science programs. In fact, it should be easier to correlate Web courses than to correlate Computer Science courses since the technology base for the former is considerably narrower. Community college students in allied degree programs could become associate members of the Web Engineering community and follow a similar if slightly longer pipeline. Indeed, since a significant part of the proposed Web Engineering program would address the Web as a social phenomenon, students in the social sciences might be enticed into the community. Finally, as Web technology is new and dynamic, the proposed program would involve a support community for community college faculty, keeping them updated and helping with course and lab content.

### ***Educational Objectives***

In the course of their professional development, graduates of the proposed Web Engineering program should

- be able to develop sophisticated Web applications, including machine-to-machine applications, that require extensive engineering
- be able to maintain a sophisticated, secure Web site
- be able to lead a Web development team
- understand the social and economic significance of the Web, its future potential, and problems it faces
- be able to analyze social and economic Web activity in terms of individual players as well as in aggregate terms
- keep up to date with new Web standards and technologies
- participate in the future development of Web standards, technologies, and application areas

The proposed program would have impact beyond A&T and would eminently meet key objectives identified in the Executive Summary of the *UNC Tomorrow Commission Final Report* [15]. In particular, item 4.1 in the Executive Summary (“Our Global Readiness”) is addressed directly by the global impact of the Web. Other impacts the proposed program would have beyond A&T (and the items in the Executive Summary of the *UNC Tomorrow Commission Final Report* to which they relate) are

- pipeline community college students into the program (item 4.2.2: “continue ongoing efforts with the NCCCS to strengthen and streamline articulation ... and to develop a more seamless relationship”),
- support community college faculty in Web-based programs (item 4.2.2 again),
- for rural and underserved areas of the state and for those whose schedules preclude classroom education, provide distance learning based on an online community (item 4.4.2, “focus specific effort in meeting the needs of rural and underserved areas of the state”),

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<sup>2</sup> The four degree programs are (with the number of institutions offering them in parentheses) Computer Information Technology (none listed), Database Management (3), Information Systems Security/Operating Systems (0), and Information Systems Security/Security Hardware (2).

- provide a model for Web engineering education that may be replicated anywhere in the world (item 4.7.1, “apply, translate, and communicate research and scholarship to broader audiences”).

The proposed program by its nature will meet several other objectives identified in the Executive Summary of the *UNC Tomorrow Commission Final Report*. As outlined above, much of the program would be driven by case studies, which would be chosen to reflect the objectives of the Tomorrow Commission. Thus, the objective that “UNC should be more actively engaged in enhancing the economic transformation and community development of North Carolina’s regions and the state as a whole” (see item 4.4 in the Executive Summary) would be addressed by case studies relating to e-commerce and especially to small businesses. The objective that “UNC should lead in utilizing health information to improve health and wellness in North Carolina” (item 4.5.3) would be furthered by case studies where the Web is used, for example, to fulfill needs of the elderly. And relevant case studies would illustrate how to use the Web to “increase community awareness of environmental and sustainability issues” (item 4.6.3). By developing an online community and providing online resources, the program would help UNC “communicate its resources and expertise to wider audiences” (item 4.7.4). Finally, since A&T is a majority minority institution, the program would “increase the educational attainment of all underrepresented populations” (item 4.2.5).

***b. the relationship of the proposed new program to the institutional mission and how the program fits into the institution’s strategic plan***

The proposed BS in Web Engineering program would be consistent with the University's mission and vision and would complement the successful BS in Computer Science program. NC A&T’s mission statement expresses the aspiration “to be the premier interdisciplinary-centered university in America that builds on its comparative advantages in engineering, technology, and business” [16]. The proposed program would involve aspects of engineering, technology, and business, and its interdisciplinary reach would be greater than any of the present BS programs in the College of Engineering at A&T since it would cover topics from economics and the social sciences as well as relate to the STEM disciplines as the current Computer Science BS program does. According to the NC A&T Undergraduate Bulletin, the “University’s evolution toward interdisciplinarity responds to societal and intellectual issues that require new solutions. ... As new problem-solving methods are needed, new disciplines are created at the intersection of old ones” [17] Web engineering is clearly one of these new disciplines.

The FUTURES Planning and Resource Council [16] (charged with the comprehensive visioning process articulating NC A&T’s fundamental goals) has developed a comprehensive strategic plan. The proposed program would address all five of the top-level FUTURES goals. To begin with, the very nature of a Web engineering program speaks to goals III (Responsive Learning Environment) and IV (Responsive Student Services). And Goal V (Enhanced and Diversified Resources) would be advanced by enhancing the University’s core Web competences, which are vital for a multitude of research and entrepreneurial endeavors. Furthermore, the interdisciplinary focus emphasized in Goals I and II would be furthered by the relevance the Web enjoys to virtually all academic subjects and by the inclusion of economic and social topics in the proposed program.

The University’s principal mission, however, is to educate students and to prepare them for careers, and this mission cannot be carried out if students do not enroll in the programs. Given the rapid rise in the use and visibility of the Web documented above, it is paradoxical that there is no four-year undergraduate degree program in Web engineering in the US. Traditional computer science undergraduate programs [18] cannot adequately prepare Web engineers since (as is evident in the outline above) Web technology is stratified so that prerequisite chains among courses can be as long as (in our proposed program) seven semesters. Other topics demand additional required courses so that a set of courses to prepare Web engineers simply cannot fit into a four-year computer science program.

Still, some computer science graduates somehow pick up Web engineering skills when they go on to research or employment. Enrollment in undergraduate computer science programs, however, has steadily dropped in this decade. This drop is even more pronounced in the number of females enrolled in computer science programs. These trends are documented in Figure 1 [19], compiled by HERI (Higher Education Research Institute) at UCLA. It is again apparently paradoxical that computer science enrollment should drop off while the Web, one of the discipline's premier achievements, enjoys rapid development and an enormous increase in use and visibility.

Enrollment in the Computer Science BS program at NC A&T has also declined since a peak early in this decade (although not as precipitously as nationally), as documented in Figure 2 (based on data compiled by the Computer Science Department).

Figure 1. Computer Science Listed as Probable Major Among Incoming Freshmen  
Source: HERI at UCLA

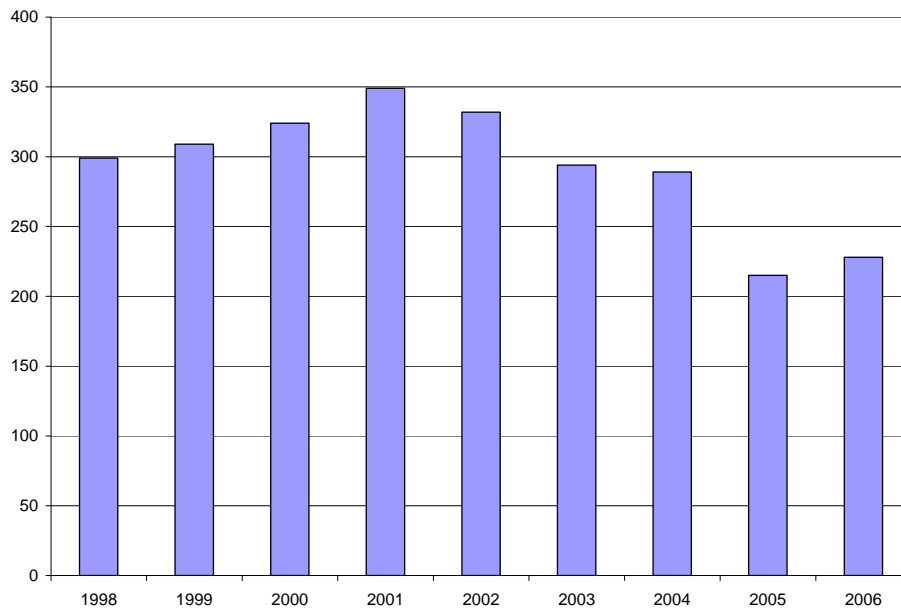
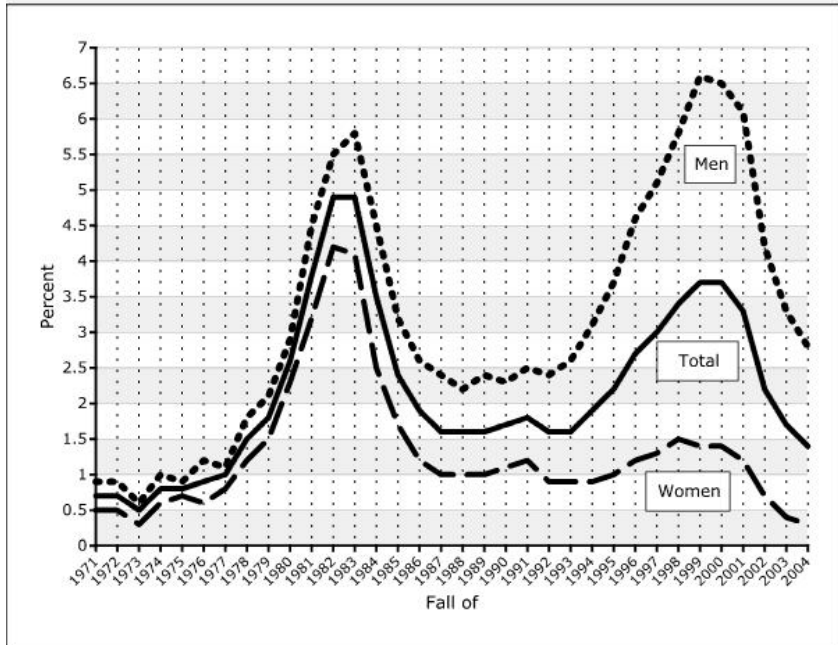


Figure 2. Undergraduate Enrollment in the Computer Science program at NC A&T

Again following the national trend, the percentage of women in the NC A&T Computer Science BS Program has shrunk significantly in the same period (although it is still well above the national average). This trend is documented in Figure 3 (also based on data compiled by the Computer Science Department).

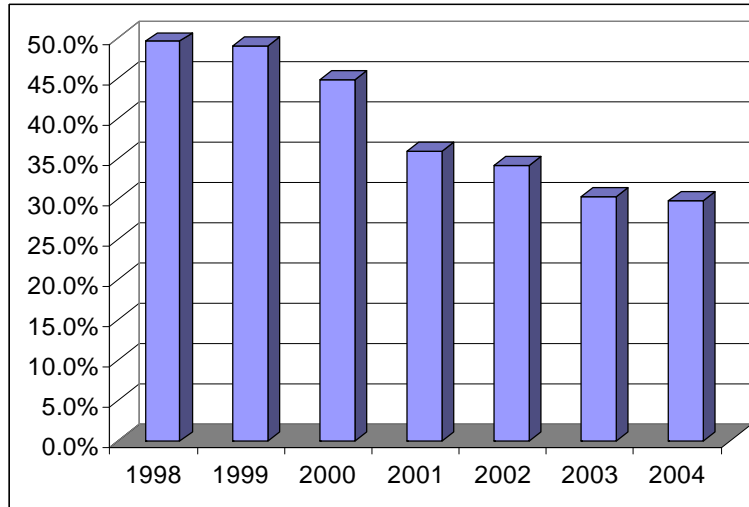


Figure 3. Percentage of Women in the Computer Science BS Program at NC A&T

Declines in enrollment are not due to lack of employment opportunities. Indeed, according to the Bureau of Labor statistics, “[a]s a result of rapid employment growth over the 2006 to 2016 decade, job prospects for computer software engineers should be excellent” [20]. In more detail,

Demand for computer software engineers will also increase as computer networking continues to grow. For example, expanding Internet technologies have spurred demand for computer software engineers who can develop Internet, intranet, and World Wide Web applications. ... New growth areas will also continue to arise from rapidly evolving technologies. The increasing uses of the Internet, the proliferation of Web sites, and mobile technology such as wireless Internet have created a demand for a wide variety of new products. [20]

Some measure of how the Web will figure in this rapid employment growth is provided by the number of jobs advertised on Craigslist for programmers using various programming languages. The Web site Programming Language Popularity [21] reports the results for such a search of Craigslist in May 2008 for 28 programming languages. The results for the top eight are shown in Figure 4

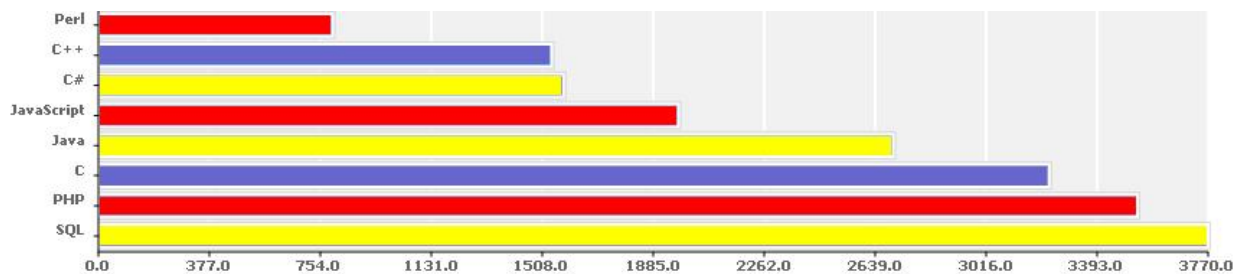


Figure 4. Number of jobs advertised on Craigslist for programmers by programming language, sampled in May 2008 [21]

The figure has been colored to show languages that are exclusively or preponderantly used on the Web in red, languages frequently used on the Web in yellow and languages that are less Web oriented in blue. The most popular language, SQL, is used for databases but is intimately tied to Web development since a server configuration generally includes a database. The second most popular language in job listings is PHP, a scripting language used almost exclusively for server-side scripting in Web development. Perl, the eighth language, is widely used for server-side scripting as well but also in other areas (such as bioinformatics) where its text-processing or resource-management capabilities are useful. The fifth most popular language, JavaScript, is used only for client-side scripting and is for practical purposes the only



option for this. The third most popular language in the job listings, C, was for years the most popular language for instruction in computer science programs, but it is not heavily used for Web development. Most computer science departments switched their primary language from C to C++ (the seventh language on the list), an object-oriented extension of C, in the 1990's. A significant amount of Web development is done in C++, but it is not generally thought of as a Web-programming language. Java (the fourth most popular language in the job list) has superseded C++ in many computer science departments as the language of instruction and is widely used for Web development. C#, the sixth language, was developed by Microsoft as part of the .NET initiative and in many respects can be considered an alternative to Java. Thus, in the ranking according to the number of job listings in Craigslist, the second (PHP), fifth (JavaScript), and eighth (Perl) languages are principally used for Web development, the first (SQL) is nearly ubiquitous in Web development, and the fourth (Java) and sixth (C#) are widely used for Web development. These results strongly suggest that many if not most programming jobs listed in Craigslist related to Web development.

The proposed program would teach JavaScript as the client-side scripting language and would introduce SQL in the first semester and use it heavily thenceforth. Were the proposed program in place today, PHP would be the server-side scripting language. Students would learn Java in the sophomore year and use it as appropriate in subsequent years. Perl was used as the server-side scripting language in the undergraduate Internet Systems class offered by the Computer Science Department at NC A&T for many years but was replaced by PHP because of the latter's popularity and more user-friendly syntax. Java, like C++, is a sophisticated language that offers many advantages but requires significant overhead and meticulous detail for even quite modest programs. The proposed program would start with scripting languages, which are generally higher-level (abstracting more from the underlying system) and support programmer productivity, giving the students a gentler yet very useful introduction to programming.

Students probably would not be exposed to scripting languages in a standard computer science program unless they took a Web development class (which is normally an elective). Also, they would normally be exposed to the most popular language (SQL) in a database class, but, in the proposed program, they would use it extensively from their first semester on. Thus, the Web Engineering program would have the second (PHP) and fifth (JavaScript) most demanded languages on Craigslist as its workhorses while these languages are generally only taught in electives in computer science. The language most in demand (SQL) would be used throughout the proposed program but is restricted to specialist courses in computer science. Finally, Java, ranked fourth, is the progressive primary language for computer science programs but would also be used extensively in the proposed program. Judging from the rankings reported here, then, a student graduating from the proposed program would be better equipped with language skills for the job market than a student graduating from a standard computer science program.

Programming Language Popularity also presents results that give some idea of the interest in various programming languages. It reports a sampling in May 2008 of tags in Del.icio.us that contain the phrase "X programming," where "X" is the name of one of the 28 languages for which Craigslist was search for job listings (as discussed above). Del.icio.us is a social bookmarking web service for sharing web bookmarks; users tag their bookmarks with a number of freely chosen keywords. As Programming Language Popularity states, the tags "ought to reflect what people genuinely find interesting or useful." The results for the eight languages with the largest number of associated tags are shown in Figure 5.

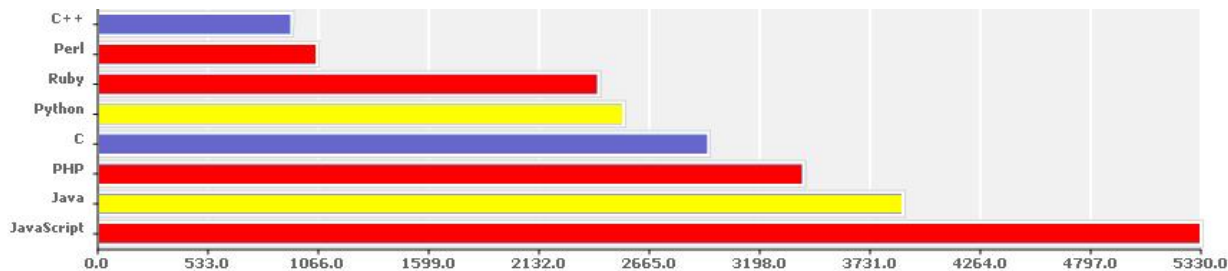


Figure 5. Number of tags in Del.icio.us relating to various programming languages, sampled in May 2008 [21]

Of the top eight languages from Craigslist not appearing in top eight in this ranking, C# (sixth in Craigslist) comes ninth here, and SQL (first in Craigslist) comes eleventh. The languages appearing here that were not in the top eight from Craigslist are Ruby (in sixth place) and Python (in fifth place)<sup>3</sup>. Ruby is a language partially inspired by Perl. Python is similar in many ways to Perl and Ruby and is often used as a scripting language. Both are high-level languages supporting programmer productivity. The major application of Ruby is in Web development, and Python is also used extensively in this area. Thus, in this ranking of popularity, the first (JavaScript), third (PHP), sixth (Ruby), and seventh (Perl) languages are used mainly for Web development, while the second (Java) and fifth (Python) are extensively used for such. These results indicate the interest that the overall community of programmers has in Web development. It is particularly noteworthy that the languages used in the proposed BS program in Web Engineering, as currently envisioned, would be the first three in this ranking.

The demand by employers for Web engineering skills approaches the level of demand for computer science skills in general, yet there is no four-year undergraduate program that develops these skills. While enrollments nationally and at NC A&T in undergraduate computer science programs plummet, some of the top languages from the perspective of programmer interest would be fundamental in a Web engineering program but are nearly ignored in computer science programs. In addition, these languages are higher level than the languages used for instruction in computer science programs, giving the student a gentler introduction to programming, and they enhance programmer productivity. Although there is much more to a Web engineering or computer science program than the programming languages that are taught, programming language use can be a good indicator of a program's focus. Finally, a Web engineering program such as that proposed here should have more appeal for female students than traditional computer science programs since it addresses social phenomena substantially and de-emphasizes "under-the-hood" wizardry. In short, the proposed BS program in Web engineering promises to more than compensate for the decline in computer science enrollment.

### ***c. the relationship of the proposed new program to other existing programs at the institution***

Existing programs at NC A&T that might overlap in content with the proposed program would be found in the School of Business and Economics, the Department of Electronics, Computer, and Information Technology in the School of Technology, or the Department of Graphic Communication Systems and Technological Studies, also in the School of Technology. As will now be documented, these divisions offer nothing or very little that even touches on Web engineering. The proposed program in Web engineering, then, would fill a vacuum that exists across the entire institution.

Relevant courses in the School of Business and Economics would be offered by the Department of Business Administration or the Department of Business Education (whose courses have the subject code "BUED"). In the listings of the courses for these departments in the NC A&T *Undergraduate Bulletin*,

<sup>3</sup> In the ranking of languages from Craigslist, Ruby ranked eleventh, and Python ranked twelfth.

none of the titles or descriptions mentions the Web or the standards on which it is based except for BUED 624, "E-Commerce Design and Implementation." The description for this course states that

Emphasis is given to effective design of Web pages, particularly the data collection forms such as the order and credit forms and how they interface with other business systems [17].

The topic of forms is one of many topics in the HTML and XML standards. Web page design generally relates to layout, and how Web pages interface with other business systems does not address the use of standards as envisioned in the proposed program. In any case, for undergraduates, this course could only be taken in the senior year, and, as there is no Web-related prerequisite, coverage of the basics must be limited.

Courses offered by the Department of Electronics, Computer, and Information Technology have subject code "ECT" (for "Electronics and Computer Technology") or "ITT" (for "Information and Telecommunication Technology"). No course with either subject code mentions the Web or the standards on which it is based in its title or description.

Finally, the Department of Graphic Communication Systems and Technological Studies offers a BS in Graphic Communication Systems with a concentration in Integrated Internet Technologies. The home page for this concentration states that

This concentration prepares the Integrated Internet Technology professional for careers in graphic design and illustration, digital and applied imaging, color photographic reproduction, as they relate to Web design and the Internet and for careers in technical management, customer service, estimating and sales [22].

Thus, this concentration focuses on graphical aspects of a Web page's appearance, a topic that is a side issue for the proposed program in Web engineering. This different focus is evident in the titles and descriptions of courses listed in the Undergraduate Bulletin that mention the Web. Thus the description of CGS 418, "Web Design for Graphic Communication," states [17] that "[s]tudents will be able to create interactive graphics and animations," and CGS 636, "Web Design for Distance Education," is described as integrating "the strategies and techniques of multimedia into distance learning applications." CGS 670, "Web Design for E-Commerce," is said to incorporate "the strategies and techniques of Web design into electronic-commerce applications." Web design here is understood as graphical design. In any case, as regards undergraduates, this course is open only to seniors, and it has no prerequisite.

***d. special features or conditions that make the institution a desirable, unique, or appropriate place to initiate such a degree program.***

The Computer Science Department at NC A&T is particularly qualified to offer a BS program in Web engineering because of its preparation for teaching Web-related topics, the research experience of its faculty, and its geographical location. Because of the absence of acceptable academic texts for much of Web technology, chapters in publishable form have already been written by the proposing team covering the material in the first two years of the Web Engineering program with the exception of the introductory, Web-use-oriented material in the first course. In addition, materials for teaching the topics in these chapters have been developed and used in a number of courses, some over a span of nearly ten years. The chapters and materials have been revised continually in light of feedback from course delivery. If the proposed program is established, the chapters and teaching materials will have to be adapted to students earlier in the curriculum, but this is a well-defined task that can be done by a team of instructors working to a schedule.

The faculty in the Department of Computer Science at NC A&T have extensive research in such Web-related topics as the Semantic Web, grid computing, multiagent systems, Web-based education, and especially network security, and they have advised numerous MS projects and theses in these areas. It is very unlikely that any new development with the Web would escape their notice.

In the Triad region of North Carolina (of which Greensboro is a part), there are over 200 computer-related companies [23], and Greensboro is located on the interstate highway between the Triangle region and Charlotte, the other two regions of North Carolina with a substantial technology sector. One would

expect the local exposure and employment opportunities to generate interest in a local undergraduate Web engineering program.

Finally, NC A&T is a Historically Black College or University (HBCU) and is a leader in graduating African-American engineers and computer scientists. The proposed program, like all programs in the College of Engineering at NC A&T, would serve sizeable numbers of students of all ethnicities, but it would be in an unique position to ensure the involvement of a significant number of well-prepared African-American professionals in a technology historically unique in its impact.

### **Summary of academic needs for Web Engineering at North Carolina A&T State University**

The following points summarize the appropriateness of establishing a Web Engineering program in the Computer Science Department of North Carolina A&T State University based on policies recently announced by the Board of Governors [24]. Topics are listed verbatim from the document circulated by the Board.

- 1) number, location, and mode of delivery of existing programs,

We are proposing the first Web Engineering Bachelors of Science degree in the nation.

- 2) the relation of the program to the distinctiveness of the campus and the mission of the campus,

Section 1.d above describes why NC A&T, an HBCU and one of the three engineering colleges in the UNC system, is particularly qualified to offer a Web Engineering degree.

- 3) the demand for the program in the locality, region, or State as a whole,

Section 1.b above describes the national demand for Web Engineers. As a state with growing number of high tech industries, North Carolina would benefit from such a relevant degree program, as would the local Triad region.

- 4) whether the program would create unnecessary duplication,

As the only undergraduate program in web engineering in the nation, the proposed program would not duplicate any existing programs. Section 1.c above details the relationship between Web Engineering and other programs at NC A&T.

- 5) employment opportunities for program graduates,

As detailed in section 1.b above, a large number of employment opportunities are available for Web Engineers both nationally and within North Carolina.

- 6) faculty quality and number for offering the program,

The faculty of the NC A&T Computer Science Department have been doing research in the Web Engineering topics and have taught classes related to Web Engineering, as described in section 1.d above. With the overlap of Web Engineering and Computer Science, it is expected that the current faculty of the Computer Science Department will be able to support the new program. As the number of students in the new major grows, it may be necessary to add additional faculty based on the existing SCHG to FTE calculations.

- 7) the availability of campus resources (library, space, labs, equipment, external funding, and the like) to support the program,

The new degree program will draw upon the existing resources of the Computer Science Department and the College of Engineering of NC A&T.

- 8) the number and quality of lower-level and cognate programs for supporting the new program,  
The list of lower-level required courses outside the Web Engineering major is similar to those required by the existing Computer Science program.
- 9) impact of program decision on access and affordability,  
Like the existing Computer Science program, the new Web Engineering program should draw students from throughout the state and from the local region. The Piedmont Triad, in which Greensboro is located, is one of three metropolitan regions in the state and is located between the other two on the interstate highways. The Computer Science program has drawn a large number of students who are tied to the locality because of family, job, and other commitments, and the Web Engineering program is expected to do likewise. The use of web based online courses will provide additional access to students who find it difficult to attend traditional lecture courses. No new fees will be required of students in the program, so affordability is not an issue.
- 10) the expected quality of the proposed degree program,  
The proposed program is designed to be accredited by ABET, the accrediting agency for Engineering programs and is in compliance with all SACS requirements.
- 11) feasibility of a joint or collaborative program by two or more campuses, and  
As described in section 1.b above, articulation agreements with the North Carolina Community College system will be sought to provide a smooth transition for students joining the Web Engineering program from any North Carolina Community College.
- 12) any other consideration relevant to the need for the program.  
As detailed above in section 1.b, there has been a national decline in the number of computer science majors. Of major concern is the loss of diversity with the even steeper decline in the number of women in computer science. It is expected that increased emphasis on interaction and social networking will attract a larger and more diverse enrollment into the Web Engineering program.

**2. List all other public and private institutions of higher education in North Carolina currently operating programs similar to the proposed new degree program.**

No other institution of higher education in North Carolina, public or private, operates a Web engineering program at any level.

**3. Estimate the number of students that would be enrolled in the program during the first year of operation: Full-Time 35 Part-Time 5**

The above estimates are conservative. Indeed, as this would be the first four-year Web engineering program in the nation, there is no precedent. Figures have already been given showing employer demand for Web-relevant programming language skills and interest in the relevant languages among programmers themselves. Also, we have argued that NC A&T's geographical location is appropriate. Evidently, then, there is potential for a substantial program.

Perhaps the best enrollment estimates can be reached by looking at enrollments in the undergraduate Internet Systems class (COMP 322), a junior-level course taught by the Computer Science Department at NC A&T since the 2001-2 academic year and whose content is similar to parts of the content in the first

two semesters of the proposed program. According to data compiled by the Department, average annual enrollment in the class has been 32. Since the proposed program would be the first Web engineering program in the nation, however, the program could draw significant enrollment statewide and even nationally not otherwise drawn to NC A&T or even to the UNC system. The potential is particularly promising for attracting out-of-state African-American students as NC A&T is the largest producer in the nation of African-American engineers, many of whom come from out of state.

As mentioned, there is enormous potential for the proposed program to recruit from the North Carolina Community College System (NCCCS). If the proposed program is established, an articulation agreement with the NCCCS would be sought and an online community would be established as a resource not only for students in the proposed program but also for students in related community-college programs and other interested parties. In the long term, such relations could have an enormous impact on enrollment. Impact on enrollment in the first year of the program would be limited to recruiting community-college students receiving certificates or two-year degrees. The proposed program would not compete with the NCCCS for students but rather would cooperate to guarantee community-college students the best opportunities possible.

The potential this program would have for distance learning is obvious. The first-year courses would be appropriate for a large number of K-12 teachers and media resources personnel, and many pupils in the last two years of high school should have the maturity required by these courses. Other targets would include students at liberal arts colleges and at fellow HBCUs. Also, distance learning and the online community would provide recruiting opportunities for the NC A&T program. It has not been determined whether distance learning would be a component of the proposed program in its first year, so it cannot be considered in the estimate of first-year enrollment

**4. If there are plans to offer the program away from campus during the first year of operation:**

- a. briefly describe these plans, including potential sites and possible method(s) of delivering instruction.**

It is expected that Web Engineering courses will be offered online as web-based distance learning in addition to the traditional lecture format. Several Web Engineering courses naturally lend themselves to web-based instruction.

- b. indicate any similar programs being offered off-campus in North Carolina by other institutions (public or private)**

No other North Carolina institution offers an undergraduate Web Engineering program in any format.

- c. estimate the number of students that would be enrolled in the program during the first year of operation: *Full-Time* 0 *Part-Time* 0**

During the first year of the program, we will be concentrating on offering the Web Engineering program in the traditional lecture format. In following years, we expect also to provide classes through web-based distance learning.

**5. List the names, titles, e-mail addresses and telephone numbers of the person(s) responsible for planning the proposed program.**

<b>Name</b>	<b>Title</b>	<b>Email</b>	<b>Phone</b>
Albert Esterline	Associate Professor	esterlin@ncat.edu	336-334-7245
Kenneth Williams	Associate Professor	williams@ncat.edu	336-334-7245
Edward Carr	Assistant Professor (Adjunct)	carr@redux.comp.ncat.edu	336-334-7245

This intent to plan a new program has been reviewed and approved by the appropriate campus committees and authorities.

**Chancellor** \_\_\_\_\_

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