

External Review

**Computer Science Program
Department of Mathematics and Computer Science
College of Arts and Sciences
Western Carolina University**

March 3, 2009

Reviewers

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I. Introduction

a. Visit by the Review Team

The external members of the review team arrived by Sunday afternoon, February 8, and departed Tuesday afternoon, February 10.

b. Meetings Conducted by the Review Team

Sunday evening:

- Dinner with all members of the Computer Science faculty (Mark Holliday, William Krehling, Andrew Dalton)

Monday:

- Breakfast with all members of the Computer Science faculty
- Tour of the Department computing facilities by Andrew Dalton
- Meeting with Department Chair, Mark Holliday
- Meeting with members of the Computer Science faculty other than the Chair and associated members of the Mathematics faculty
- Lunch meeting with Computer Science students and alumnus
- Meeting with members of the Computer Science faculty other than the Chair
- Meeting with the Computer Science Committee other than the Chair
- Meeting with Melissa Wargo, Assistant Vice Chancellor for Planning and Effectiveness
- Work meeting for members of the review committee
- Dinner meeting with members of the Mathematics faculty who are involved with the Computer Science Program

Tuesday:

- Breakfast meeting with Provost Carter
- Meeting with Dean Ford and Associate Deans
- Work meeting for members of the review committee
- Meeting with all members of the Computer Science faculty

II. Analysis of Program

The mission statement of the Computer Science Program well matches the missions of the Department, the College and the University. The Computer Science curriculum is a balanced blend of traditional courses and courses in areas such as security and networking that are likely to give students an advantage both in today's marketplace and in graduate school. Problem-solving skills are taught across the entire Program curriculum including a concentrated emphasis on those skills in the first two courses. The reviewers applaud this effort, especially as reflected in the structure of the CS 150 and 151 labs. The Program's curriculum stresses the study of software engineering. The reviewers view this as a specific strength of the Program and encourage even further development of students' software engineering skills through group work in the Capstone courses. Group projects are an excellent means for building both technical and communication skills in students; at the same time they generate fewer projects for faculty to supervise.

The prerequisite structure of the computer science curriculum is flat. After the first two required courses, CS 150 and CS 151, students can take the remaining computer science

courses in any order (except that the two Capstone courses must be taken in the senior year). Because of the small number of faculty and low student enrollments (a common occurrence across the country) the Program is not able to offer its courses as often as would be ideal; hence, the given prerequisite structure makes it easier for students to complete their coursework in four years. However, the reviewers suggest the faculty review and change the structure in order to better balance student readiness with scheduling flexibility. Further, if, as was stated to the reviewers, the computer science faculty wishes to seek ABET accreditation for the Program in the future, it is to the advantage of the University to ensure that the department has the resources necessary to build and maintain an ABET accreditable program. The reviewers' experience with ABET leads them to believe that ABET is unlikely to find the current prerequisite structure acceptable. As student numbers grow and the state's economy stabilizes, the University is encouraged to add computer science faculty to the Program to ensure that courses are continuously updated and offered on a more frequent schedule.

The number of students electing a major in computer science has been lower than desired during the last several years. However, this past fall the Program saw an increase in the number of students electing to take the first course (CS 150) in the major. This is in keeping with national trends and hopefully will continue. Members of the WCU computer science faculty have made an effort to improve their enrollment by establishing the only high school programming contest in the state and are to be commended for this effort. The reviewers suggest that faculty members also recruit inside the University by using service courses to identify talented students capable of the major and encouraging them to take an exploratory course in computer science. Women students in particular need to be told that they are capable of achieving success in an untried area before they are likely to attempt it.

The Program's curriculum is a total of 70 hours of computer science, mathematics, and laboratory sciences. This is the minimum number of hours required for accreditation. Given the current economy, the reviewers fear that there may be attempts to reduce this number. The reviewers strongly believe doing so would harm the Program. Computer science is one of the more demanding majors for students, but graduates are extremely well-positioned for careers or further study. According to the National Association of Colleges and Employers, computer science is the 4th most recommended major in 2008 and computer science majors earned the highest average starting salary among the top 10 majors. WCU should protect the quality of its Computer Science Program; this in turn will help the Program achieve accreditation.

The Program requires that students earn a grade of C or better in all required computer science courses. The reviewers believe it would better serve the students if this requirement were relaxed to a C average over all courses in the major. Here the reviewers are excluding CS 150 where a grade of C or better is required to move on to CS 151. Students who consistently do poorly in courses will still be checked by the requirement, but students who do poorly in one or two courses due to extenuating circumstances will not. The reviewers do not believe this will weaken the overall quality of the Program.

The Program has an assessment plan in place but needs some time to establish and document the feedback/improvement loop. Portfolios are being effectively used as a direct measurement technique. The reviewers encourage the continued use of that strategy beginning as early as possible in the curriculum. The reviewers also encourage the use of other direct measures such as alumni and employer surveys, the administration of the ETS Computer Science Field Test to seniors as a required part of the Capstone course, and the feedback of an industrial advisory board. An advisory board can help the Program in many ways including assessment of the curriculum, placement of students into jobs both during and after their time in the Program, education of students through outside speakers, and fund-raising. Use of the Field Test over time will reveal any insufficiencies in the curriculum that are causing students to score below the Program's desired levels in the areas of discrete structures, programming, algorithms and complexity, systems, software engineering, and information management. ABET, like all accrediting organizations today, places heavy emphasis on program assessment and the use of assessment results to effect continual improvement of the program through a documented assessment plan.

The faculty/student ratio in courses in computer science needs to be kept reasonably low so that students have sufficient one-on-one contact with the faculty. Small class size is a huge advantage of programs like WCU's over programs in large research institutions and should be a bragging point in recruitment. The reviewers spent time with several computer science majors and were pleased that the students felt strongly that they made a good decision to come to WCU. Some had transferred from schools where their courses had been given in large sections taught by graduate students. The WCU students were extremely pleased with the faculty and said repeatedly that the faculty cared about them and worked very hard to develop relevant assignments and structure the courses to increase student learning. It should be pointed out that several of these students made a conscious choice to attend a school where their class sizes were small and their courses were taught by full-time well-qualified faculty.

The reviewers believe the Program is not making its many accomplishments as visible to the University community as it could. The reviewers suggest that newspapers and other University publications as well as the Department web site be used to change this situation. Situations that would provide merited visibility include bringing in a student newspaper reporter (if possible) when exciting projects are presented by students, recording student presentations and placing them on the Department's web page (with student permission), publicizing student professional meeting presentations and journal publications in University publications as well as on the Department web site and in the involved student's home-town newspaper, publicizing the high school programming contest in as many home-town newspapers as possible, doing the same for awards to majors, assuring that Program majors and faculty are nominated for University- and College-level awards when appropriate, and making faculty and Program students available to the surrounding school systems for special presentations. Faculty members are already doing some of these things; the reviewers encourage enhancement and recognition of the time such efforts take.

The Program uses open-source software throughout its curriculum and is to be commended for the savings in money that this produces both to the University and the students. The open-source model encourages collaborative innovation and allows students to study and modify the source code of the programs they use. In addition to reducing cost, faculty members have taken advantage of this model to enhance educational opportunities for their students.

All members of the Computer Science faculty take part in the planning and assessment process as well as the advising of students. These are strengths of the Program and should be continued.

III. Analysis of Faculty

a. Qualifications

Members of the Computer Science faculty have remarkable qualifications and compare well with faculty at much larger institutions.

b. Resources and Support

At this time, members of the computer science faculty are fairly compensated. Library holdings are excellent, in part due to the inclusion of the electronic databases from the ACM and IEEE. Lab space is currently adequate and located near faculty offices. The reviewers, however, do have several resource and support concerns.

The Department of Mathematics and Computer Science has written a new set of guidelines for the annual evaluation of faculty, their tenure, promotion, and reappointment, but the document has not yet been approved. The reviewers have made a number of suggestions for Program improvements that would take time and effort on the part of faculty to put in place, and it is not clear that the proposed evaluation guidelines would give due regard to these efforts. For example, the reviewers recommend that the Program put together an industrial advisory board. Making repeated contact with prospective members of such a board, planning meetings, attending meetings and incorporating the board's suggestions into an assessment plan would all take time. The reviewers cannot in good conscience recommend that faculty invest this time without assurance that their efforts will be rewarded in their evaluations.

The reviewers suggest that the Department together with the Administration develop a plan for laboratory and faculty office machine replacement and maintenance. Currently replacement hinges on one-time allotments of money in "good years". ABET would expect the University to provide assurance that the Program's equipment be sufficient throughout their accreditation period. Of even more concern to the reviewers is that faculty members do not teach their classes in the same building that houses their offices. Traveling between buildings makes it very difficult to maintain the appropriate setup of computers and software in classrooms. Reviewers feel that faculty members should teach in Stillwell in order to facilitate classroom demonstrations that include equipment that cannot be permanently stored in the room because of the cost of the equipment and/or the need for others to share the equipment. There is a startup and shutdown cost associated with many computer science classes that could be reduced if classes were

always taught in a room that could be controlled by faculty. One other concern is that as the Program grows, the system administration that is currently done by members of the faculty may become excessive.

c. Teaching, Research/Creative Activity, and Service

It is clear to the reviewers that the quality of the faculty in the Computer Science Program is exceptional, both in terms of scholarly activity and teaching. All of the faculty members were given high marks in teaching excellence by the students with whom the reviewers spoke. Faculty members are allowed to pursue their strengths with respect to their professional activities and to date have been adequately rewarded for their accomplishments. They participate in scholarly activities such as grant writing and research, regularly publish in peer-reviewed venues, and care deeply about their teaching. In the past five years, faculty members have published over 20 scholarly articles in refereed journals and refereed conference proceedings, been involved with grants totaling over \$600,000, and won multiple awards for their work.

IV. Analysis of Operational Facilities and Budget

The recently renovated facility that houses the Computer Science Program is excellent. However, as discussed above, the reviewers are concerned that there is no regularly scheduled replacement of computer equipment in faculty offices and labs, and that faculty members cannot teach all their classes in the same building that houses their offices.

V. Summary of program strengths and areas for improvement

The greatest strength of the Computer Science Program is its faculty. They are all well-qualified and extremely productive, working hard to ensure that students are given the education they need to compete both in the job market and in graduate school. The faculty participate regularly in scholarly activities and in service to the Department, College, University, and profession. Faculty members have established a first-rate curriculum that includes both fundamentals and current trends presented through a variety of ways that facilitate hands-on-learning and independent thinking. This is supported by the fact that students are well pleased with the education they are receiving. Faculty members have also established the foundations for a solid assessment plan by requiring student portfolios. The recently renovated building housing the Program is ample and currently the equipment in faculty offices and labs is adequate.

Areas for improvement include budgetary support for equipment replacement, specific recognition in Department evaluation documents of faculty efforts in Program assessment and recruiting, and the addition of a faculty member to allow for growth and for the establishment of needed prerequisites without reducing scheduling flexibility. WCU could better compete with other computer science programs if they were an ABET-accredited program. This would require a strong assessment plan with the requisite feedback and improvement cycle in place.

VI. Summary of Recommendations

Recommendations to the Program

The following recommendations are made under the assumption that credit for the time and effort needed to enact them will be reflected in the evaluation documents for Computer Science Program faculty.

- Strengthen your prerequisite structure to avoid repetition of needed preliminary material in upper level courses and increase time spent on new material.
- Deepen connections to the business community by forming an industrial advisory board and use it to discover more co-op and employment opportunities for students and gain additional assessment information. Include alumni of the Program as board members. In addition to forming the advisory board, hold 1- or 2-day workshops that feature areas of need identified by regional industry and businesses. Such workshops can bring money into the Department and will build stronger relationships with the companies involved.
- Increase visibility of the Program. Polish your web pages and be sure they include up-to-date information on courses, course schedules, and news items of interest to parents, prospective students, current students, and alumni. Consider an online secure alumni database to which alumni can add their current employment information. Nominate members of the faculty for internal and external awards. Publicize exciting work being done by students and faculty. Create professional-looking brochures for distribution at recruiting events. Give every student who participates in your high school programming contest a copy of the brochure. Get addresses so you can follow up with a letter that further highlights your Program.
- Strongly encourage if not demand that group projects be done in the Capstone courses. This reinforces software engineering skills learned in CS-263 and CS-363 and lessens the number of projects overseen by the instructor.
- Enhance and maintain a strong program of assessment. Continue the use of portfolios both as a showcase for student work and as a source of assessment data. Write a formal assessment document that includes mission, goals, and student outcomes and how they relate to each other and courses. Establish a schedule for data collection and analysis. Members of the faculty might collect certain data every year but analyze it every other year. Identify courses in which communication is taught, practiced, and assessed, and in which students are required to work in teams.

Recommendations to the Administration

- Hire an additional computer science faculty member in order to grow the program while maintaining its quality.
- Establish a 4-year replacement cycle for all laboratory machines and faculty office machines. Computer Science needs current equipment to support an up-to-date curriculum since the hardware is woven into the subject matter of the discipline.
- Allow faculty to teach classes in the same building that houses their offices in order to facilitate classroom demonstrations that include equipment that cannot be permanently stored in the room due to cost or the need for others to share the equipment.