Teaching Computer Science at a Small University

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Abstract
Small universities do not have all of the resources that larger ones do. There are fewer computers, fewer teachers, fewer technicians and of course less money. Charleston Southern University (CSU) seeks to be one of the smallest universities to meet national accreditation standards in computer science (ABET-CAC). This presentation will provide a history of how the department has grown and demonstrate how we use labs that are much smaller and less well equipped than any accredited program in computer science. We will demonstrate the use of virtual machine software (VMware and Virtual PC) to reduce the amount of hardware required to run an effective lab, the use of instructor controlled labs (using NetSupport), show the importance of using software alliances (Microsoft) to achieve excellence without all of the expense.

History

Charleston Southern University is a small, Christian liberal arts college founded in 1964 in Charleston, South Carolina. With about 2900 students, the University is one of the largest private colleges in the state, offering about 35 undergraduate and graduate degrees. However, it is still small, and resources are scarce. However, the school and its Computer and Information Science department have been making a big impact on the University and its graduates since 1969 when the first course to use computers was introduced.

The process of creating a department of computer science has been a long process. In 1969, Fred Worthy (M.A.T. University of Colorado), a professor in the physics department responded to students' requests to learn FORTRAN. Using the University's IBM System 34, Worthy used his NASA experience in FORTRAN to teach. At that time students would turn in data entry forms to be punched by staff members who would run the programs. Eventually, another punch card

machine was purchased as well as a removable Winchester disk for class. In 1978, Worthy went on sabbatical to Clemson to study COBOL, assembly and ALGOLW. Upon his return in 1979, the first standalone course in programming was taught.

As Worthy continued to work with data processing, arrangements were made to allow students access to a terminal in the data processing department where they could key in their programs directly into the computer and do away with punch cards. Work was limited to Tuesday and Thursday nights. It usually took at least two weeks turnaround time for students to get results, but they were "in the computer age."

With the demand for computer scientists and information systems specialists at an all time high, the University needed to offer a degree. However, according to the accreditation rules of the Southern Association of Colleges and Schools (SACS), a degree could not offer a bachelor's degree without two Ph.D.'s in the field. With great foresite, Loren Radford, Stan Ricketts and Worthy designed an Institute to house computer courses without offering a degree. The Information Systems degree was actually a business degree with an emphasis in information systems with 18 hours within the Institute. The Mathematics department created a new degree with 28 hours of mathematics and 34 hours of computer science. The degree programs first appeared in the 1982 catalog. Although the two programs have evolved with changing technology, they retain the basic framework put into place by these early visionaries.

The new computer science program needed a home. An old Biology laboratory was selected as the first computer laboratory. The room was not perfect; the tables were old Biology laboratory tables, complete with sinks. (see Figure 1) Besides being available, one wall of the laboratory was also a common wall above the Data Processing department. Initially, six IBM personal computers were placed on the lab tables with cables from the lab down through the floor into the Data Processing department's System 36. By Fall 1983, the curriculum was expanded to include other courses including Database Management and COBOL on the System 36.

Figure 1 First Computer Laboratory with Biology Sinks

In 1984, the University hired Jim Roberts (M.S., Texas A&M), a retired Air Force Lt. Colonel, with masters degree in computer science as the Director of the Institute. The Institute's title was the Computing and Information Sciences Institute (COINS).

SACS grew concerned about the college computer being used by students. A small IBM System 36 was purchased to create a "stand alone" laboratory, no longer connected to the university System 36. In January 1991 Charleston Southern University and IBM entered into a Jointly Defined Effort to establish a Center for Computer Integrated Manufacturing (CIM) education, training and demonstrations. The university was to become a training site for IBM customers. As part of this agreement, IBM would provide the University with an IBM AS/400 Model B45 with an estimated value of $450,000. The University spent an additional $50,000 on dividing the laboratory into three rooms: a classroom, a seminar, and a room to house the system. The first course offered on the new AS/400 was COBOL. Other courses were developed including database management and short courses teaching the operating system. As a part of the IBM educational training program, the University was encouraged to offer short courses for the benefit of the business community. Beaufort, SC Commission of Public Works, Georgetown, SC tax office, Westbury Trucking Company, and Coberg Dairy participated.

In June 1994, IBM discontinued their involvement in the training program. The AS/400 was transferred to CSU. As part of this arrangement, the university would remain a part of the IBM CIM in Higher Education Program and the CIM in Higher Education Alliance. Part of this alliance is the Higher Education Software Consortium. As part of this Consortium, the University can take advantage of a special software package program from IBM.

From 1994 to 1997, the AS/400 system was used in the expanding COBOL courses, and data base management. In addition, all COBOL students were taught the principles of operating a mid-range computer system. A few students (five to six) were made lab assistants whose responsibility was the AS/400. These students were taught the fundamental information needed to keep the system running or restore the system after a failure.

During the spring of 1997, Version 3 Release 2 Modification supporting TCP/IP was installed allowing PC's running Client Access 400 access over the Internet. Eight direct dial phone lines were also installed into a router to allow students who did not have Internet access the ability to get to the AS/400 from off campus.

The Last Five Years

In 2000, the university had 5 PC laboratories, each with 24 computers. In 2001, Mary Gene Ryan and Pat Bower applied for and received a $1.75 million grant from the Department of Education to spread technology through out the University curriculum (Naylor and Hambrick, 2003). Some of the funds were used to create a state of the art laboratory capable of live Internet online classes. Some funds were used to train faculty from all areas how to update classes to use computer technology. Every faculty member was given a laptop and all rooms were fitted with projectors. Two mobile carts of laptops were added to allow any room to act as a computer laboratory. All classrooms provide wired and wireless access to the Internet.

To move the computer program forward, funding was approved to hire a Ph.D. in computer science in 1999. After two number of years vacancy, Jack Briner (Ph.D., Duke University) was hired. Briner came with 4 years of teaching and 6 years of industrial experience. After a year of observation, Briner began the process of developing a new curriculum which would meet the

Accreditation Board of Engineering Technology (ABET) and follow the Association of Computer Machinery (ACM) and the Institute of Electrical and Electronic Engineer (IEEE) Joint Task Force recommendations (Joint Task Force on Computing Curricula, 2001). Most recently he wrote and was awarded a National Science Foundation grant to attract and support computer science students under the Computer Science, Mathematics, Engineering and Science (grant) program. This will support up to 29 students per year for the next four years. Together with two new Ph.D. positions, the program is set to take a leap forward. However, the leap forward is not designed to break with the department philosophy but to build on it.

The Department Philosophy

The mission of the department is to provide students a Christian learning environment which will prepare students for a broad range of graduate schools and job markets. In particular, we believe that the following skills are critical: reasoning and problem solving; in-depth knowledge of at least one programming language and an appreciation of other forms of computation; an understanding of the foundation of computing (theoretical); the ability to apply theory in programming, networking and system administration; the ability to effectively communicate both in oral and written forms; and, an understanding of the ethical and social issues involved in computing. To achieve our mission, we apply the following techniques. All of our courses require reasoning skills. The skills are built using a prerequisite structure that ensures that skills deepen as students come closer to graduation. Students are required to work on projects beginning in COIN217, Visual Basic, through to their final senior project. All courses integrate the theoretical into practice so that the student will be prepared for the marketplace. Specifically, the courses Applied Networking and Applied Operating Systems give students a hands-on computer environment in which to apply principles to cutting-edge technologies. After the first course, all courses require have an ethics component: a paper or debate. In most classes, Students are required to present results of projects or research to the class. How can we achieve these goals with such a small faculty?

Dedicated Faculty.

COINS has a dedicated faculty who share the philosophy that involved students learn best. Students are made to realize early that computer skills, like art, cannot be taught; they must be learned through initiative, hard work and constant practice. Consequently, COINS' faculty do not "teach", but rather "coach" by creating the environment where the students "learn by teaching themselves" through hands-on involvement with realistic problems. Lecture is used sparingly. Unlike most universities, almost all COINS courses are taught in a computer laboratory where students immediately apply, test, and/or practice topics while they are being discussed. This "learn-by-doing" or "learn-by-teaching-oneself" philosophy has paid off handsomely for our students. This ability to self-teach is a critical quality in the workplace given that computer professionals must reinvent themselves every two years due to technology turnover.

Small Class Size.

Additionally, small class size with a maximum of 24 students per class and a senior project requirement that brings each student into a direct working relationship with one of the faculty al-

low the faculty to know each student personally. Consequently, COINS students have a sense of belonging, and because of the senior project, also have ownership in the program.

Emphasis on Teamwork.

COINS emphasizes teamwork in all of its courses. Employer input indicates that teamwork is an essential quality in computer workplaces since almost everything is done in teams. According to them, graduates of most institutions are not ready for teamwork since most academic experiences emphasize competition between students for grades instead of teamwork.

Focus on the Fundamentals.

COINS' main focus is on fundamentals with the goal of producing well-rounded graduates who are able to function at all levels of the workplace. This includes not only technical fundamentals, but also people-skills. Each student is required to communicate his or her work orally and in writing throughout the curriculum, and especially during his or her senior project defense before a panel of faculty, professionals and peers. Employers increasingly prefer well-rounded graduates with fundamental skills to those who focused on acquiring a greater number of technical skills (which usually are dated almost before the student graduates). They cite greater value to the company. Employers also know that they will have to train whomever they hire to function in their own particular technical environment. They have discovered that they are better equipped to teach the specific technology than the fundamentals. Comments from several employers and alumni have validated this philosophy

Diverse System Environment.

Students need a well rounded view of computing. Many students today graduate without ever having worked on a computer larger than a PC. We believe that students need to have been exposed to a number of different systems and operating systems. CSU maintains state-of-the-art mid-size computers which gives CSU much of the technology necessary to capitalize on the emerging trends. CSU's ability to attract and prepare students for the decades to come depends on our ability to keep pace with the needs of industry.

Continuing the tradition of hands-on-experience with the IBM series, Fred Worthy remains one of the few instructors of hands on AS/400 and iSeries computers in South Carolina (Roberts, 2005). However, paradoxically there are a number of sites using these computers. For example, almost every grocery store in the area uses a machine running the AS/400 operating system.

Using VMware and Virtual PC, the department can simulate multiple, concurrent operating systems on one piece of hardware. This makes efficient use of computer resources and provides a level of security. Students may be administrators on the virtual machines without corrupting University machines. Linux, other variants of UNIX, Microsoft operating systems and others can be learned without exposing the University to unnecessary maintenance of University operating systems and hardware.

The Learning Environment

Keeping Students On Track

All computer courses are taught in the laboratory setting. One difficulty with this setting is that students have a hard time focusing when the faculty are trying to lecture or give out important information. There are a number of products on the market which allow an instructor to take control of students' computers. CSU uses NetSupport School ("Networked Classrooms With NetSupport School", 2005). Figure 2 shows views from 39 student seats on the instructor's console. Any picture may be clicked to show a window size view of a particular student's machine. The instructor may take control of the keyboard and mouse or may share the keyboard and mouse with the student.

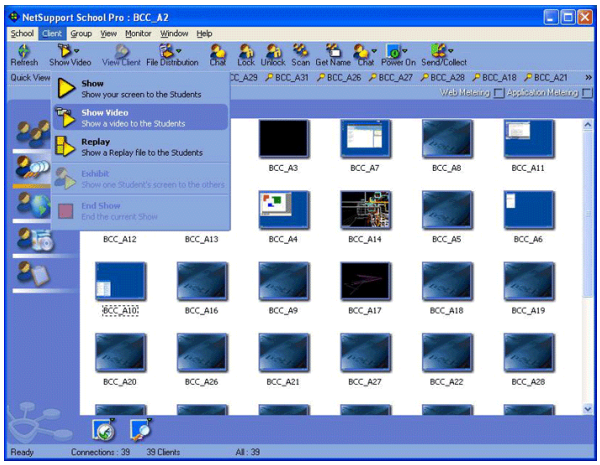

Figure 2 NetSupport School Thumbnail View

The thumbnail view allows the instructor to look over multiple shoulders at once. However, it is impossible to look over everyone at once. The system also provides the ability to limit the applications that may be started by the student (see Figure 3). Likewise, students may need to be limited to certain Internet domains to keep them on track. Figure 3 shows the use of limiting which domains can and cannot be accessed. Also, the tool provides the ability to lock student terminals completely so that they will focus their attention to the front of the classroom when appropriate. NetSupport provides other tools such as file distribution, homework collection, testing and surveys as well.

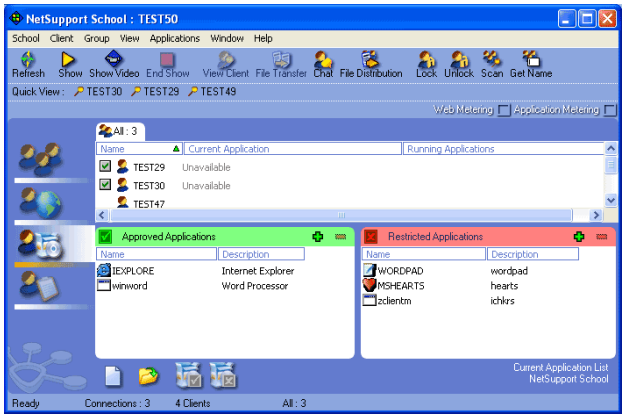

Figure 3 NetSupport Application Control

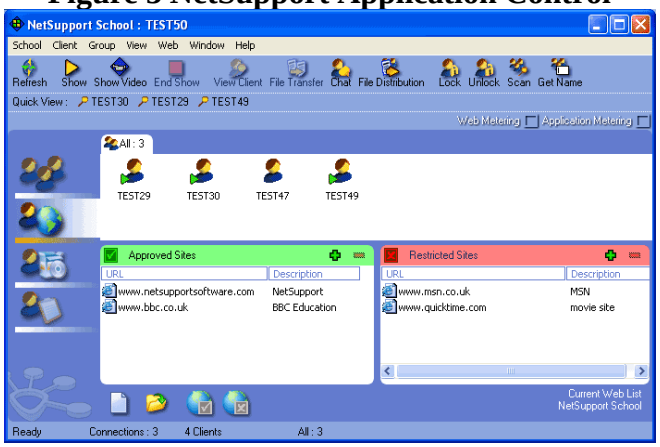

Figure 4 NetSupport Network Control

Broadening Student's Horizons Without Breaking the Bank

Students need exposure to a broad range of systems. CSU supports three operating systems: OS/400, Windows (XP/2003 Server), Linux ("Red Hat Enterprise Linux - Academic Editions," 2005 and "Fedora Project," 2005). OS/400 is run on the i520 E-server. Windows XP are the standard for all student workstations. Linux Enterprise Academic Version is run on a Dell, multiprocessor server.

These Windows XP workstations, in turn run VMware ("VMware Workstation 5," 2005). VMware Workstation software emulates the hardware necessary to run multiple virtual machines under a host operating system, such as Windows XP. The virtual machines do not know that their I/O requests are being redirected through the host operating system or being multitasked with other operating systems or programs running on the host operating system. Each virtual machine may use physical or virtual disks on the host machine. Physical disks are faster. However, virtual disks are transportable. To prepare for a class, a virtual hard disk image can be created and each student can get a copy of the image to run on his/her machine without hurting any other users.

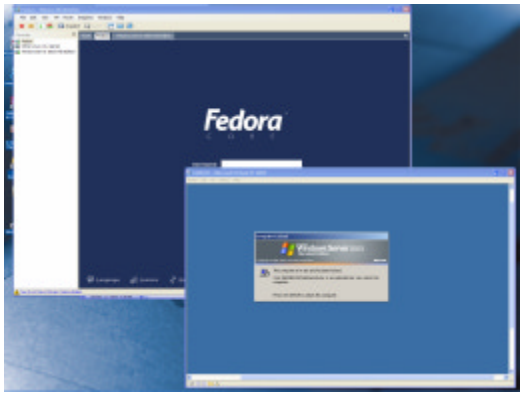

Figure 5 VMware running Fedora and Windows Server 2003

More recently, Microsoft has developed a similar product, Virtual PC. The software works well with Microsoft operating systems. However, it requires patches to run Linux. Figure 6 shows

Virtual PC being used to test a student's ASP server project. On the left hand side, the server (marked as COIN331) is the student's virtual machine. On the right side, the host is accessing the server over the network. The server is collecting packets that are being sent on the network with Ethereal (Combs, 2005).

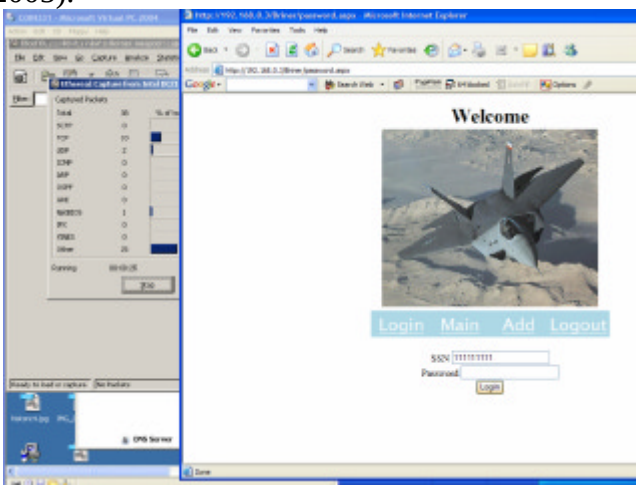

Figure 6 Virtual PC Running as a Server to Host Machine

The primary advantage of Microsoft's Virtual PC is that it is available under the Microsoft Developer's Network Academic Alliance (“MSDN Academic Alliance Developer Center,” 2005). MSDNAA allows the department to purchase the right to distribute software development software to departmental students, faculty and staff. Student's may check out software or may purchase a copy for minimal production and mailing costs. Software includes Microsoft operating systems, compilers and development tools (such as Project, Visio, and Access). Software distribution is controlled by software provided by Microsoft (see Figure 7). Students are given an account to login which allows them to obtain keys and ask for software to be delivered or to reserve a copy to borrow. Software costs are minimal, $799 for the first year and $399 for subsequent years.

Figure 7 MSDN Academic Alliance Software Center

The Next Five Years

The next five years look bright. The department is in the process of hiring its third Ph.D. in computer science. A new science building on campus has left the department room in an older building to outfit two new laboratories with state-of-the-art networking equipment and computers. More importantly, the department will have the infrastructure completed to allow it to proceed towards ABET-CAC accreditation. The curriculum has been designed to meet the curriculum suggested by ACM/IEEE and the requirements of ABET. After the first two years of graduates complete the new computer science degree, the department will seek accreditation. Based on reports from an outside reviewer, we have a good chance to achieve accreditation.

Acknowledgements

This material is based in part upon work supported by the National Science Foundation under Grant No. DUE-0422409. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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