Implementing a Bachelor's of Science in Information Technology Degree Program in an Engineering School: Lessons Learned

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Abstract

Designed for the student who does not enter with a formal training in computing as well as for the student who might not have a love for theoretical aspects of the mathematical and natural sciences, our new Bachelors of Science in Information Technology (BS-IT) program is perfectly suited for would be IT professionals focusing on the application of computing and information technologies in other disciplines. Formally offered this fall 2002 semester, it is far too early to assess the BS-IT program based on some of the criteria used for our existing IT&E programs such as feedback from students, faculty evaluation of curricula and quality of students attracted to the programs, graduate school acceptances, employment offers and subsequent successes.

Some preliminary results are available in several important areas, however, and this paper has been written in the hope that other universities that are contemplating and/or in the early stages of implementing a BS-IT major (or other non-traditional undergraduate program) in an engineering school might benefit from the lessons that we have learned early on. Most notable are changes in preconceived notions widely held by some IT&E faculty and administrators as to the impact that the BS-IT program would have on the following: student enrollment and their persistence in our existing calculus-intensive IT&E majors; integrity of existing degree programs in related disciplines such as computer science and management information systems; relationships with other GMU schools and colleges offering related IT study options; overall quality, number, and diversity of students who are preparing for careers in the IT profession; availability of resources to support both the BS-IT program and existing programs; and IT&E's growing reputation as a broker of first class IT educational programs and research.

I. Overview of Paper

Our School of IT&E was established in 1985. Until recently, the School of IT&E offered undergraduate majors in the following highly technical core-competency areas: Civil and Infrastructure Engineering (CIE); Computer Science (CS); Computer Engineering (CpE); Electrical Engineering (EE); and Systems Engineering (SYST).

With the explosion of knowledge within the sub-disciplines that comprise computing and information technology, virtually any existing as well as emerging sub-discipline contains far more material than can reasonably fit into a single course - or in some instances, even

two or more courses. As a result, four or even five years at the undergraduate level clearly are inadequate to master all areas that might be considered to lie, for example, within the boundaries of one prescribed 120 semester-hour Computer Science or Information Systems curriculum. Several years ago, the Electrical Engineering discipline experienced a similar phenomenon, resulting in the offering of a separate Computer Engineering Bachelor's of Science degree program.

In response to a request to provide IT-related course material to a broad university audience, four years ago the School of IT&E instituted an IT-minor for non-School of IT&E majors. The response to the IT minor from students with majors in other units has been overwhelming, and it has become the most popular minor ever introduced at George Mason with over 700 enrolled students. The strong response is indicative of a much broader general interest in information technology across a wide variety of disciplines.

During the summer 2001, the School of IT&E formed a committee consisting of students, faculty, industry representatives and community college admissions professionals to discuss methods for meeting these broader interests and demands. The result of the discussions was to establish a new four-year Bachelor's of Science in Information Technology (BS-IT) program that focuses on selected sub-disciplines or areas of concentration during the last two years. The degree was offered for the first time during the fall, 2002 semester. Over 300 students are currently enrolled in the degree, making this the second largest undergraduate major within the School.

The paper provides an overview of the BS-IT program and discusses some lessons learned since its implementation during the fall 2002 semester. The results should be of interest to other universities that are contemplating and/or in the early stages of implementing an IT major at the undergraduate level. We begin by providing a brief overview of the BS-IT program within the context of other undergraduate programs offered by the School of Information Technology and Engineering (IT&E). We then present a summary of the resulting BS-IT curriculum and program structure. Finally, we discuss the lessons learned to date, since implementing the BS-IT program this fall 2002 semester. The primary objective for implementing the BS-IT program was to provide additional opportunities for students with more diverse interests to pursue undergraduate IT studies within our School of IT&E, and the results to date have greatly exceeded what we could have imagined.

II. BS-IT Curriculum and Program Structure

Students in the BS-IT degree program take IT foundation courses as well as a well-defined set of IT core courses. Through this curriculum, students obtain a solid understanding and knowledge of a broad range of IT areas including databases, information security, networks, computers, Web development, and telecommunications. In order to complete the degree, students must choose a concentration in one of two currently available high-demand IT knowledge areas: Graphics and Data Presentation or Information Security and Network Administration. Each concentration includes a six-hour capstone design project. Graduates from this program will fill an important niche in the IT job market that lies between those who graduate with IT business skills (from our Management Information Systems (DMIS program)) and those technical experts who graduate with degrees from existing technical areas such as computer science, computer engineering, and electrical engineering.

The BS-IT curriculum reflects the latest advances in the IT field, including

interdisciplinary and global approaches where appropriate. An acceptable level of competency in IT can be achieved within the constraints of the required 120 semester credit hours of class work and projects. This number of credits meets University requirements as well as the existing Commonwealth of Virginia guidelines for undergraduate degrees.

In addition to University General Education [GE] requirements, including humanities and social sciences as well as mathematics and basic sciences requirements, the BS-IT program requires IT foundation, core, and concentration courses as described below. Each concentration includes a seven-hour capstone design project. As shown in the sample schedule in Table 1, it is expected that the student will complete the capstone design project over a period of two consecutive semesters.

1. IT Foundation Courses. All BS-IT majors must complete the following foundation courses.

IT 101	Introduction to Information Technology (3)
IT 103	Introduction to Computing (3)
IT 108	Programming Fundamentals (3)
IT 212	How Computers Work (3)
IT 250	Introductory Statistics (3)

2. IT Core Courses. All BS-IT majors must complete the following core courses.

IT 213	Multimedia and Computer Graphics (3)
IT 214	Data Base Fundamentals (3)
IT 221	Introduction to Security Technology (3)
IT 300	Introduction to Telecommunications (3)
IT 341	Network and Operating System Essential (3)
IT 443	IT Resource Planning (3)
CS 305	Ethics and Law for the Computing Professional (3)
MSOM 302	Managing Information (3)
MSOM 303	Marketing in a Digital World (3)

Students who plan to pursue advanced degrees are encouraged to take IT 208 (follow-on to IT 108) or comparable course in Data Structures. Additional programming and scripting is incorporated in other courses as well, e.g., INFS 311 (which incorporates Visual Basis) and IT 431 (the advanced web design course that incorporates and evaluates the uses of JavaScript, PERL, and CGI). IT 221 (a security course) is a core course, and security will also be a component of all of the upper division Web related courses. All programs in our School of IT&E have implemented program assessment and continuous improvement processes, so the new BS-IT program is evolving so as to meet the needs of its Northern Virginia IT community.

3. IT Capstone Design Project. All BS-IT majors must complete a two-semester sequence of approved capstone design courses.

IT 492	Senior Design Project I (3)
IT 493	Senior Design Project II (4)

4. IT Concentration Courses. The following two concentration areas are currently available: Computer Graphics and Web Development; and Information Security and Network Administration. The BS-IT program design facilitates the implementation of additional concentration areas in response to demand from our constituents. All BS-IT majors must complete a total of at least 15 semester hours of IT concentration courses from the three categories of courses listed under the student's selected IT concentration area. The student must select at least one of these five courses from each of the three categories of courses listed under the selected concentration in the advising materials available from the IT&E Student Services Office or online at ite.gmu.edu/bsit.

TABLE 1. SAMPLE SCHEDULE FOR BS-IT DEGREE			
First Semester		**Second Semester**	
IT 101 Introduction to Information Technol	3	IT 108 Programming Fundamentals	3
IT 103 Introduction to Computing [GE]	3	IT 250 Intro. Statistics (=STAT 250)	3
ENGL 101 Composition [GE]	3	Natural Science non-lab [GE]	3
HIST 100 Western Civilization [GE]	3	HIST 120 US History [GE]	3
MATH 108 Intro to Calculus Appl. [GE]	3	Literature Requirement [GE]	3
Total Hours	**15**	**Total Hours**	**15**
Third Semester		**Fourth Semester**	
IT 212 How Computers Work	3	IT 213 Multimedia & Computer Graphics	3
IT 214 Data Base Fundamentals	3	IT 221 Introduction to Info Security Tech	3
MATH 125 Discrete Mathematics	3	COMM 100 or COMM 104 [GE]	3
Natural Science with lab [GE]	4	Natural Science with lab	4
Social/Behavioral Science Requirement [GE]	3	Fine Arts Requirement [GE]	3
Total Hours	**16**	**Total Hours**	**16**
Fifth Semester		**Sixth Semester**	
MSOM 302 Managing Information	3	CS 305 Ethics for Computing Profession	3
MATH 111 Linear Mathematical Modeling	3	MSOM 303 Marketing in a Digital World	3
IT 300 Modern Telecommunications	3	IT 341 Networking/OS Essentials	3
ENGL 302 Advanced Composition [GE]	3	IT Concentration Related Requirement	3
Elective	3	Elective	3
Total Hours	**15**	**Total Hours**	**15**
Seventh Semester		**Eighth Semester**	
IT 492 Senior Design Project I [GE]	3	IT 493 Senior Design Project II	4
IT 443 Resources Planning Requirement	3	IT Concentration Related Requirement	3
Global Understanding Requirement [GE]	3	IT Concentration Related Requirement	3
IT Concentration Related Requirement	3	Elective	3
IT Concentration Related Requirement	3		
Total Hours	**15**	**Total Hours**	**13**

III. Existing Concentration Areas

Concentrations are currently available in the following two areas:

A) Computer Graphics and Web Development
B) Information Security and Network Administration.

The BS-IT program is presently managed by the IT&E Dean's Office because of its heavy

reliance on courses offered by departments across the School and University (e.g., Applied and Engineering Statistics [STAT], Computer Science [CS], Electrical and Computer Engineering Department [ECE], Information Systems Engineering Department [INFS], School of Management [MSOM], New Century College [NCLC]; and School of IT&E [ENGR and IT]).

A) Computer Graphics and Web Development Concentration. Courses in the following three categories, described in more detail below, comprise the focus for this concentration: 1) Web development, 2) computer graphics, 3) database management and programming. As part of the five courses required for the concentration area requirement, the student must select at least one course from each of the three categories of courses listed under this concentration.

Category 1: Web Development

NCLC 249	The Internet: Literacy, HTML, Tools, and Virtual Community
IT 331	Web I: Introduction to Web Development
IT 332	Web Site Administration
IT 431	Web II: Intermediate Web Development

Category 2: Computer Graphics / Data Presentation

ENGR 183	Computer Aided Design
STAT 350	Introductory Statistics II
STAT 362	Introduction to Computer Statistical Packages
STAT 463	Introduction to Exploratory Data Analysis

Category 3: Information Systems

INFS 310	Program Structure and Design for Business Applications
INFS 311	Database Management
INFS 312	Computer Architecture and Operating Systems
INFS 315	High-Level Programming Languages
IT 208	Program Design and Data Structures

B) Information Security and Network Administration Concentration. Courses in the following three categories, described in more detail below, comprise the focus for this concentration: 1) information security; 2) network administration; 3) telecommunications. The student must select at least one of the five required courses from each of the three categories of courses listed under this concentration.

Category 1: Information Security

IT 222	Introduction to Information Systems Security Policy and Management
IT 353	Information Warfare and Defense
IT 357	Secure Electronic Commerce (new course)
INFS/IT 462	Information Security Principles
INFS/IT 466	Network Security

Category 2: Network Administration

IT 342 Operating Systems for Administrators
IT 441 Network Servers and Infrastructures

Category 3: Telecommunications

ECE 301 Digital Electronics
IT 471 Applications of Digital Technologies
IT 481 Concepts of Multimedia Processing and Transmission
IT 488 Fundamentals of Satellite Communications

IV. Lessons Learned Since BS-IT Program Implementation

Students completing the BS-IT program will be well-prepared for challenging jobs in the IT industry, as will be confirmed by responses to student surveys as well as to periodically administered employer surveys. Some of the graduates of the program will take either the GMAT or GRE examination, or both. Their success on these examinations will be a direct measure of their acquired knowledge. To the extent that performance on these exams indicates the ability to perform successfully in graduate school or in private practice, they will serve as learning outcome indicators for these more important facets of performance as well. Success of students in obtaining admission to graduate school and graduates' performance as professionals will also serve as a major indicator of learning outcomes. More specifically, the success of the BS-IT program will be assessed continually against benchmarks such as the following:

- Students satisfaction with the program, measured by course evaluations and exit surveys with graduating students.
- The success of graduates in obtaining high-quality employment or advancing to higher positions within their present organization.
- The long-term professional success of the graduates.
- Meeting the enrollment targets and producing enough graduates to meet the demand of Northern Virginia's high technology community.

Of course, it is far too early to assess our BS-IT program using commonly used assessment instruments and criteria such as feedback from students, faculty evaluation of curricula and quality of students attracted to the programs, graduate school acceptances, employment offers and subsequent successes. However, some preliminary evaluation results are available for the BS-IT degree and its relationship to existing programs including the following:

- The impact of the BS-IT program on overall student enrollment
- The impact of the BS-IT on existing degree programs in computer science and management information systems
- The relationship between IT&E and other GMU schools/colleges offering IT-related study options
- Overall quality, number, and diversity of students in the BS-IT degree
- The availability of resources to support both the BS-IT degree and existing programs
- The impact on the School of IT&E's growing reputation as a broker of first class IT educational programs and research.

A major aim of the BS-IT degree program is to attract and prepare a type of student who is different in several ways from the traditional CS major. While the bachelor's degree in CS is very much focused on technical and foundation aspects of computers and computer algorithms, the BS-IT degree is intended for students with an interest in applying information technology to other areas. The jobs that BS-IT majors are expected to fill focus on the application of IT in an increasing number of emerging sub-disciplines. Web development, computer graphics, information systems, telecommunication, network administration, and information security are a few of the sub-discipline areas frequently requested by undergraduates that were not available at George Mason University nor any other university in the region until the implementation of the BS-IT program. The new BS-IT curriculum is sufficiently flexible to serve existing, emerging, and future IT educational needs while preserving the integrity of existing degree programs in more traditional disciplines such as Computer Science (CS) and Management Information Systems (MIS).

Table 2 shows School of IT&E enrollment trends since the IT&E Undeclared (ITEU) option was implemented in fall 1999 and the BS-IT major was implemented during the fall 2002 semester. Since the implementation of the ITEU option, the combined enrollment in our CS and engineering majors has decreased only slightly; however, there has been significant growth in the overall School of IT&E enrollment. Although it is too early to verify using the available data, it appears that some students who might have otherwise waited until the end of their first year to select a major are selecting the BS-IT major early on. It must be noted, however, that the combined number of ITEU students and BS-IT majors enrolling during the fall 2002 semester is significantly greater than the number of students enrolling in the ITEU option during the fall 2001 semester.

TABLE 2. IT&E UNDERGRADUATE ENROLLMENT TRENDS

	99/00	00/01	01/02	02/03
BS-IT	-	-	-	300
IT&E Undeclared	94	312	483	422
Other IT&E	1516	1506	1502	1440

Table 3 shows enrollment trends in our School of IT&E's CS major and the School of Management's Management Information Systems major (DMIS) since the BS-IT program was implemented during the fall 2002 semester. Even though enrollment in the CS major declined during the fall 2002 semester, this decline cannot be attributed directly to the implementation of the BS-IT major. The decline in the number of students pursuing the CS major is representative of a national trend, as reflected in the data on our CS enrollments since the fall 1999. The decline in the number of students pursuing the DMIS major is more difficult to explain in terms of trends alone, even though there was a slight decrease in number of students pursuing the DMIS from the fall 2001 semester to the fall 2002 semester. Over the years, some students entering George Mason University with an interest in pursuing a CS major, but lacking the essential mathematics preparation, have selected the DMIS major. Additionally, during past years, many students entering George Mason University as CS majors have changed to the less technical DMIS major to pursue their interest in IT, even though they were not interested in pursuing the "management"

degree. With over 300 students enrolling in the fall 2002 semester, the BS-IT program has definitely enabled our School of IT&E's ability to attract more students. It appears that the BS-IT program has enhanced our retention capabilities as well.

As described in Section II above, the BS-IT curriculum is designed to allow the student the flexibility to choose a concentration in one of two broadly defined IT knowledge areas, gaining a high level of proficiency that can not be achieved within the structure of existing George Mason University bachelor's of science degrees in Computer Science and Management Information Systems. Selection of the BS-IT program's Advisory Council from a cross-section of George Mason University faculty has helped with the establishment and maintenance of an effective relationship with other George Mason University Schools and Colleges.

TABLE 3. GMU CS AND DMIS ENROLLMENT TRENDS				
	99/00	00/01	01/02	02/03
DMIS	736	842	836	576
CS	902	852	844	770
BS-IT	-	-	-	300

Preliminary data shows that this new BS-IT curriculum serves a more diverse group of student and industry needs than our existing IT&E educational programs. Additionally, the overall quality of students enrolling in the BS-IT major is the same as the quality of students enrolling in other George Mason University majors; however, proficiency is mathematics and computing is less than that of our students majoring in CS and engineering. Also, academic performance for BS-IT majors who changed from majors in Computer Science and School of Management programs shows dramatic improvement.

Even with the rapid growth in the BS-IT program enrollment and the slight decline in enrollments in some of the other IT&E undergraduate programs, no faculty positions have been reassigned from other programs or degree levels. Faculty positions are ramping up as the student enrollment (more specifically, FTE) continues to grow. At George Mason University, funding for education programs is directly related to the number of FTE that the program attains. Ideally faculty selected for the BS-IT program should have an earned Ph.D. or other appropriate credentials in an IT related specialization. It is also desirable that they should have some industry or other practical experience in an area involved with IT, either as full time employees or as consultants. The BS-IT faculty will be available on a regularly scheduled basis to meet in person with students for advising and mentoring. Faculty members are also generally available via regularly read E-mail accounts and appointments outside of normally scheduled office hours.

The BS-IT major can be viewed as the model to be followed by other IT and engineering schools in order to cope with the rapidly changing needs of their high technology community. The BS-IT program's impact on our School of IT&E growing reputation as a broker of first class IT educational programs and research has been tremendous. This is evidence by the number of inquiries that we receive from industry and other educational institutions regarding our newly implemented BS-IT program and other program at the graduate level in Telecommunications (TCOM), Electronic Commerce (E-Commerce),

Enterprise Engineering, and Information Security.

V. Summary

The BS-IT program, designed for the student who does not wish to pursue a highly technical degree in computer science or other IT-related disciplines, is perfectly suited for the individual who wishes to be employed as IT professionals focusing on the application of computing and information technologies. The results to date have greatly exceeded what we could have imagined, even though it is far too early to assess our BS-IT program using commonly used assessment instruments and criteria. With over 300 students enrolling to date, preliminary data shows that this new BS-IT curriculum serves a more diverse group of student and industry needs than our existing IT&E educational programs. Expanding the options available to a much broader spectrum of students is viewed as an excellent strategic move. Key George Mason University administrators are demonstrating greater appreciation for programs and services provided by our School of IT&E through competitive funding and other incentives for our new program initiatives.

Biographical Information

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