An Overview of the JHU EPP Computer Science and Information Systems and Technology Graduate Programs

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As a cornerstone of JHU's Graduate Programs for Professionals, the Computer Science (CS) and Information Systems and Technology (IS&T) programs have evolved in response to rapidly emerging technologies and the global economic environment. Both programs offer a mix of foundation and applied courses that enable students to develop a deep understanding of information technology. As the more traditional program, CS emphasizes underlying theoretical principles, while the newer IS&T Program encourages students from a wide range of backgrounds to pursue a more eclectic and applied course of study.

INTRODUCTION

For more than four decades, technical professionals seeking to continue their education have turned to JHU and the Whiting School's Engineering and Applied Science Programs for Professionals (EPP). Although computer science (CS) was just emerging as a discipline when JHU first developed it in The Evening College, which supported part-time education, the CS Program has since become a leader in EPP graduate programs. With outstanding faculty, an extensive curriculum, excellent facilities, and a strong student body, the CS Program has continually reinvented itself to keep pace with a rapidly evolving technology base and changing demands. EPP has also responded to the changing global environment in computing and networking through the creation of the Information Systems and Technology (IS&T) Program to meet the burgeoning need for experts in applied areas of information technology (IT).

Although CS has been the largest of the EPP graduate programs for nearly two decades and IS&T has developed into a robust program in the last decade, much has changed in the past several years. Areas associated with IT have evolved significantly, and most universities now offer both graduate and undergraduate CS degrees as well as a variety of degrees associated with information systems. Courses that once served as a part of the graduate core curriculum have become undergraduate prerequisites, courses previously characterized as advanced now serve as foundation courses, and new fields of study have emerged both within CS, such as bioinformatics, and from CS, such as IS&T.

In this article, we present an overview of EPP's CS and IS&T programs. After providing a short history in the next section, we focus on key activities of the past decade. Current offerings and requirements are described, and an overview of the program committee, faculty, and advisors is provided. A brief analysis is given of enrollments, indicating some past and recent trends, and new approaches are described for enhancing student

opportunities based on partnerships and online courses. Finally, we highlight a few recent achievements before making concluding remarks.

THE COMPUTER SCIENCE PROGRAM

A Brief History

Courses in CS were initially offered in JHU's part-time program in Numerical Science (now Applied and Computational Mathematics) in the 1966–1967 academic year. In recognition of the emergence of CS as a discipline and the increasing popularity of the CS courses offered at JHU, a separate part-time CS program was established in 1971, with Bob Rich serving as the first Chair. The program rapidly grew into the largest program within EPP, and by the early 1980s, more than 80 sections of 34 classes were offered in areas ranging from traditional topics in operating systems and compiler design to cutting-edge topics in graphics and networking. Students were required to take two classes in the areas of languages, algorithms, and computational theory, and the remaining classes were divided roughly into the areas of architecture and software. Of the faculty at the time, approximately 10 continue to serve, providing both continuity and a sense of tradition.

In 1985, Vince Sigillito was appointed Chair, guiding the CS Program during the evolution of the Whiting School's Part-Time Programs in Engineering and Applied Science.[1] By the late 1980s, CS as a field of study had evolved, and some of the lower-level and introductory courses then offered in the program were converted to undergraduate prerequisites, increasing the rigor of the program and making it more appealing for the increasing number of incoming students that held bachelor's degrees in CS. In addition, CS was one of the initial programs to offer courses in Montgomery County, which has led to its strong presence today at the Montgomery County Campus (MCC).

By 1990, more than 70 courses were offered at APL and MCC, with strong interest in the areas of artificial intelligence, data communications, and software engineering. All of these areas had numerous course offerings with large enrollments each semester. CS students could also choose an option in Telecommunications, which was offered jointly with what was at the time the Electrical Engineering (EE) Program. This option enabled students to take a variety of telecommunications courses from both CS and EE.

In 1994, Sigillito retired, and long-time faculty member and Vice Chair Robert Grossman became Program Chair. Then in 1996, Ralph Semmel assumed program leadership, and Grossman continued on as Vice Chair.

The Program Today

Interest in the focal areas of the early 1990s began to wane, but with the growing popularity of the Internet, the advent of the World Wide Web, and the dot-com boom there emerged an immense interest in communications systems, networking, and distributed computing. The Telecommunications option ultimately evolved into the Telecommunications and Networking option that continues to be jointly offered with what is today the Electrical and Computer Engineering Program. Richard Nieporent of MITRE has long served as the CS Coordinator for this option and has played an instrumental role in developing a robust set of offerings and attracting key faculty.

In 1996, Marty Hall, who had been one of the CS Program's principal artificial intelligence instructors, developed and offered a new course, Distributed Development on the World Wide Web. The course was hugely successful, and Hall went on to write a best-selling book based on the materials he developed for the course.[2] The book has been translated into multiple languages and adopted by universities throughout the world.

Hall joined the Program Committee in 2001 and played a key role in winning a multi-year award through the Maryland Applied Information Technology Initiative that supported the development of new CS courses. He then teamed with Hash Malik, a fellow Program Committee and faculty member, to guide the creation of a concentration area in Distributed Computing that today includes nine courses. Significantly, Hall later prepared a second edition of his best-selling book with another EPP CS faculty member, Larry Brown.[3] Hall and Brown have also written a two-volume follow-on book set, which is in its second edition, that is used in some of the advanced distributed computing classes.[4,5]

The CS Program has also developed comprehensive offerings in other areas of emerging importance in recent years. For instance, a Bioinformatics concentration area was established to enable students to develop expertise in computational biology. Ed Addison, a successful entrepreneur with a strong interest and significant expertise in bioinformatics, assumed leadership of the initiative and established the Bioinformatics concentration area which now has eight courses. In addition, a separate Advanced Certificate for Post Master's Study in Bioinformatics was established that enables students to focus intensely in the field and take related courses outside the Whiting School of Engineering. Moreover, in 2002, EPP and the Krieger School of Arts and Sciences teamed to create a joint Master's Degree Program in Bioinformatics consisting of CS and biology courses from both schools. Finally, in 2005, JHU's Academic Council approved an online version of the degree program.

A recent initiative in CS stems from recognition of the increasing vulnerability of computing systems and the significant economic and productivity impacts due to information systems succumbing to malicious attacks. As a result, a new concentration area in Information

Security was established in 2002. This area was coordinated with Gerry Masson, who at the time served as Chair of Homewood's CS Department and now serves as Director of JHU's Information Security Institute (JHUISI). There are now nine courses offered in Information Security, and JHUISI students can take many of them.

EMERGENCE OF THE INFORMATION SYSTEMS AND TECHNOLOGY PROGRAM

At the height of the dot-com boom in the latter part of the 1990s, the demand for IT courses of all types was high. Students with diverse backgrounds were seeking to enter the IT field, even if they did not have technical degrees. In response to the growing national demand for IT education, many universities established IT departments, and sometimes even schools. Students flocked to these programs, but many were seeking deeper technical insights and less emphasis on the business-oriented courses that were often core to those programs.

While students from all technical disciplines have always been welcome to join the CS Program, the prerequisites in math and CS can be daunting for those with degrees in disciplines such as education or business. EPP recognized the need for a program that would be technically rich while appealing to a broader student body than that comprising CS. Consequently, in 1997, EPP established a new Master's Degree Program in IS&T.

Semmel and Roger Westgate, who had been Associate Dean responsible for part-time engineering education and then acting Dean of JHU's Whiting School of Engineering, gave a detailed description of the inception of the IS&T Program in an earlier *Technical Digest* article.[6] Given the program's initial leveraging of applied CS courses, Semmel served as the first Chair. He turned over Chair responsibilities to Bruce Coury in 1998 but continued his association as CS Coordinator for IS&T. Coury, at the time an APL researcher and former professor in industrial engineering, could serve as Chair for only 1 year and transitioned leadership to Allan Bjerkaas in 1999.

Upon being appointed Associate Dean for EPP, Bjerkaas asked Semmel to again assume leadership of the program in 2002. In his second tour as Chair, Semmel appointed John Piorkowski as the IS&T Coordinator. In this role, Piorkowski, an APL staff member who had been teaching and advising in the IS&T Program, assumed responsibility for many of the IS&T planning and operational activities.

By design, IS&T is the most eclectic degree program offered in EPP. Students can take nonelective courses from IS&T, CS, Systems Engineering, and Technical Management as well as two elective courses from up to two additional EPP programs. This eclectic orientation has made IS&T a natural focal point for collaborative efforts with other JHU schools. For example, IS&T has led an effort for EPP in a joint initiative with the School of Professional Studies in Business and Education to offer the five-course Graduate Certificate in Technical Innovation and New Ventures.

PROGRAM HIGHLIGHTS OF THE PAST 10 YEARS

Offerings and Requirements

There are currently nine concentration areas in the CS Program, and more than 80 graduate courses and 5 undergraduate prerequisite courses are offered (see the box, CS Concentration Areas). Students must take a set of three foundation courses in algorithm analysis, computer architecture, and software engineering, and then three courses in a concentration area of their choice. The remaining courses are electives, two of which may be taken from relevant programs outside CS. Highly qualified students nearing completion of the degree may pursue independent study with CS faculty to add depth in a particular area or to pursue specific research interests.

At the undergraduate level, students who are seeking a master's degree in CS and who are entering from fields outside CS are expected to hold a technical degree and have taken courses in Java or C++, data structures, machine organization, and discrete mathematics or other math courses beyond Calculus II. Students who have not satisfied these prerequisites may take the undergraduate courses offered by JHU. Similarly, students entering Bioinformatics but who do not have biology backgrounds must take undergraduate courses in biology and biochemistry. To facilitate the entrance of CS and other engineering students into the Bioinformatics Program, a special CS undergraduate course has been developed that covers the necessary molecular biology needed for graduate Bioinformatics classes.

The IS&T curriculum is structured similarly to the CS curriculum. Students start with three required foundation courses in software engineering, networking and telecommunications, and decision support systems. The course in software engineering is the same foundation course required of students pursuing a graduate degree in CS, while the other two are tailored for the IS&T graduate degree and are not available to CS students. The remaining courses must include at least two advanced IS&T courses. Up to two electives outside IS&T are permitted, with students typically choosing courses in CS, Technical Management, and Systems Engineering.

While IS&T does not have concentration areas, the offerings are being evaluated to create areas that could serve as a basis for a depth requirement similar to that in CS. Currently, 14 IS&T-specific courses are offered (see

CS CONCENTRATION AREAS AND COURSES

Undergraduate Prerequisite Courses

605.201	Introduction to Programming Using Java
605.202	Data Structures
605.203	Discrete Mathematics
605.204	Computer Organization
605.205	Molecular Biology for Computer Scientists

Graduate Concentration Areas and Courses

I. Software Engineering

605.401	Foundations of Software Engineering
605.402	Software Analysis and Design
605.403	Software Project Management
605.404	Object-Oriented Programming with C++
605.405	Conceptual Design for High Performance Systems
605.701	Tools and Techniques of Software Project Management
605.703	Software Reuse
605.704	Object-Oriented Analysis and Design
605.705	Software Safety
605.706	The Software Development Process
605.707	Software Patterns
605.709	Seminar in Software Engineering

II. Systems

605.411	Foundations of Computer Architecture
605.414	Software Development in the UNIX Environment
605.711	Contemporary Computer Architecture
605.713	Robotics
605.714	System Development in the UNIX Environment
605.715	Software Development for Real-Time Systems

III. Theory

605.421	Foundations of Algorithms
605.423	Applied Combinatorics and Discrete Mathematics
605.424	Logical Foundations of Computer Science
605.425	Compiler Theory and Design
605.721	Design and Analysis of Algorithms
605.722	Computational Complexity
605.723	Signal Processing
605.725	Queuing Theory with Applications to Computer Science
605.727	Computational Geometry
605.728	Quantum Computation

IV. Information Security

605.431	Principles of Enterprise Security and Privacy
605.432	Public Key Infrastructure and Managing E-Security
605.433	Embedded Computer Systems—Vulnerabilities, Intrusions, and Protection Mechanisms
605.434	WWW Security
605.731	Network Security
605.732	Cryptology
605.733	Java and Web Services Security
605.734	Information Assurance
605.735	Biometrics

V. Database Systems and Knowledge Management

605.441	Principles of Database Systems
605.445	Artificial Intelligence
605.447	Neural Networks
605.741	Distributed Database Systems on the World Wide Web
605.742	XML: Technology and Applications
605.744	Information Retrieval
605.745	Reasoning Under Uncertainty
605.746	Machine Learning and Data Mining
605.747	Evolutionary Computation

VI. Bioinformatics

605.451	Principles of Computational Biology
605.452	Biological Databases and Database Tools
605.751	Computational Aspects of Molecular Structure
605.752	Simulation of Biological and Complex Systems
605.753	Computational Genomics
605.754	Analysis of Gene Expression
605.755	Systems Biology
605.759	Independent Project in Bioinformatics

VII. Visualization and Human–Computer Interaction

605.461	Principles of Computer Graphics
605.462	Data Visualization
605.463	Image Processing
605.465	Natural Language Processing
605.761	Applied Computer Graphics
605.766	Human–Computer Interaction

VIII. Data Communications and Networking

605.471	Principles of Data Communications Networks
605.472	Computer Network Architectures and Protocols
605.475	Protocol Design
605.477	Internetworking with TCP/IP I
605.478	Cellular Communications Systems
605.771	Local Area Networks
605.772	Network Management
605.773	High-Speed Networking Technologies
605.774	Network Programming
605.777	Internetworking with TCP/IP II
605.778	Voice Over IP

IX. Distributed Computing

605.481	Distributed Development on the World Wide Web
605.482	User Interface Development with the Java Foundation Classes
605.485	Electronic Commerce
605.781	Distributed Objects
605.782	Web Application Development with Servlets and JavaServer Pages (JSP)
605.783	Reusable Software Components with JavaBeans
605.784	Enterprise Computing with Java
605.785	Web Services: Framework, Process, and Applications
605.786	Enterprise System Design and Implementation

Graduate Special Topics Courses

605.791	New Technical Ventures
605.792	Computer Ethics

the box, IS&T-specific Graduate Courses), 3 of which are cross-listed directly as CS courses. In addition, 25 courses from CS and 4 courses in Technical Management and Systems Engineering are co-listed in IS&T for a total of 42 courses.

Starting with the Spring 2006 semester, IS&T students will be able to enroll in a capstone course. The capstone is designed for those desiring to engage in a major independent project involving a substantial enterprise information system design that incorporates several elements of the IS&T curriculum. The capstone has a broader focus than independent study and specific required components.

At the undergraduate level, IS&T students, like their counterparts in CS, are expected to have completed courses in Java or C++ and data structures. They are also expected to have taken a year of college mathematics, but courses such as finite mathematics may be substituted for the calculus sequence required of CS students. The goal is to minimize the entry prerequisites for students coming from nontechnical disciplines while ensuring that students will have sufficient underpinnings to complete the IS&T-specific courses and the selected set of applied CS courses. The prerequisites also serve IS&T students well when they take systems engineering and technical management graduate courses as part of their core curriculum.

For students wishing to continue in formal education programs once their degrees are complete, an Advanced Certificate for Post Master's Study in CS or IS&T is offered and may be completed by students who hold a master's degree in CS, IS&T, or a closely related discipline. Students take six courses, five of which come from either CS or IS&T and one of which can be taken from other programs.

In both the CS and IS&T programs, faculty members and students are expected to focus on underlying fundamentals in courses rather than specific applications or commercial systems. While several courses also enable students to develop expertise in particular application-oriented topics (e.g., programming languages), the intent is to impart foundation knowledge that will enable students to work with a wide range of existing and emerging information technologies.

Program Committee and Advisors

The CS and IS&T programs are led by a Program Committee with 12 members. Half of the members are from or have close affiliations with APL, and the other half are drawn from industry, government, and academia. The committee meets annually to discuss the state of the programs, evaluate initiatives, and propose and endorse objectives for the next year. At the annual

faculty meeting held each spring, the Program Chair presents a summary of Program Committee discussions and decisions.

To help students in developing plans of study, the CS and IS&T programs have 11 advisors. Advisors evaluate and approve student program plans, assist with registrations and open houses, and answer student questions on

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IS&T-SPECIFIC GRADUATE COURSES

635.411	Foundations of Networking and Telecommunications
635.412	Local and Wide Area Network Technologies
635.413	IP Networking and Applications
635.421	Foundations of Decision Support Systems
635.431	Information Systems Architectures and Methodologies
635.476	Information Systems Security
635.482	Web Site Development
635.483	Electronic Commerce
635.711	Internetworking: Methods, Technologies, and Devices
635.721	Human–Computer Interaction
635.731	Distributed Architectures
635.781	XML: Technology and Applications
635.792	Management of Innovation
635.795	Information Systems and Technology Capstone Project

CS AND IS&T PROGRAM COMMITTEE

Ralph D. Semmel, CS and IS&T Program Chair
Principal Professional Staff, APL

Robert S. Grossman, CS Program Vice Chair
Principal Professional Staff, APL

John A. Piorkowski, IS&T Coordinator
Principal Professional Staff, APL

Marty Hall
President, coreservlets.com Inc.

Horace Malcom
Principal Professional Staff, APL

Hashmat Malik
President, Software Productivity Strategists Inc.

Robert L. Martino
Division of Computer Research and Technology, National Institutes of Health

Richard J. Nieporent
Senior Principal Engineer, MITRE Corporation

John Sadowsky
Scientist, Leading Edge Design and Systems

Vincent G. Sigillito
Principal Professional Staff (ret.), APL

Scott Smith
Professor and Chair, Computer Science, Whiting School of Engineering

J. Miller Whisnant
Principal Professional Staff, APL

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an ad hoc basis. Three advisors play special roles. Eleanor Chlan, who was also recently appointed as EPP's first full-time Senior Lecturer, advises students who do not have degrees in CS or IS&T and who do not satisfy the minimum course requirements for direct admission into the graduate programs. Robin Grasso advises Bioinformatics students. Grasso also has developed a handbook that is used for all CS and IS&T advisors, and she distributes updates to the handbook annually. Richard Nieporent advises CS students enrolled in the Telecommunications and Networking option.

One issue that CS and IS&T advisors face more frequently stems from the nation's increasingly mobile society. Students are more often applying to the programs after transferring to the area. Many of them have taken graduate courses with other colleges and universities and do not want to lose credit for the work they have done. Similarly, there are students close to completion of their programs at JHU who move from the area and do not want to lose their credit. Advisors work with students in both cases to develop options that will allow them to leverage their work and complete their programs. For incoming students, up to two classes may be waived if a sufficient number of graduate courses have been successfully completed at other institutions. Similarly, students who have left the area can work with advisors to develop a plan for completing their programs through JHU online courses, JHU independent study courses, and approved transfer courses from other institutions.

Faculty Achievements

Between CS and IS&T, there are nearly 100 faculty members, all with graduate degrees and almost 40% with Ph.D. degrees. About 20 faculty members have served with the programs for 20 years or longer. Richard Nieporent enjoys the distinction of the longest affiliation, having taught in the CS Program since 1979.

While it is not feasible to list all faculty achievements from the past decade, several recent accomplishments are representative. John Sheppard and Bunny Tjaden, for example, prepared three papers with EPP students that were presented at conferences in 2004 and 2005. Similarly, Eleanor Chlan presented a conference paper in 2005 based on her dissertation research, which is also serving as a basis for a new CS graduate course she is offering in visualization.

Although such recognition in conferences and journals is welcome and desired, the focus of the CS and IS&T programs has always been on the classroom experience. Thus, faculty members are continually encouraged to enhance their courses. One approach that students particularly appreciate is the incorporation of hands-on labs and demonstrations in classes to augment lectures. Over the years, CS and IS&T faculty have developed a number of special laboratory facilities, with recent ones focused on communications and networking, distributed development, and information security. Jeff Gustin has guided the newest addition in support of his real-time software development class. Gustin is having his students use LEGO Mindstorms kits and a real-time Java development environment to explore concepts based on small robots (Fig. 1).

Enrollments

From its start in the early 1970s, the CS Program grew rapidly. Enrollments peaked in the 1991–1993 academic years at more than 3000 per year and then dipped in response to a drooping national economy. Enrollments picked up again as a result of the dot-com boom and peaked once more in the 1999–2002 academic years. The maximum number of annual enrollments during that period topped 3600 (Fig. 2 provides semester details).

With the passing of the dot-com era, CS enrollments have declined. While the decrease is not surprising, several contributing factors are worth highlighting. First, CS enrollments at the undergraduate level have dropped precipitously nationwide. In fact, recent surveys indicate that the number of newly declared majors in CS declined 32% between 2000 and 2004, and the number of incoming freshmen expressing an interest in majoring in CS dropped by 59% during that same period.[7] Although some anecdotal evidence indicates that undergraduate CS enrollments are stabilizing, and perhaps even starting to increase at some institutions,
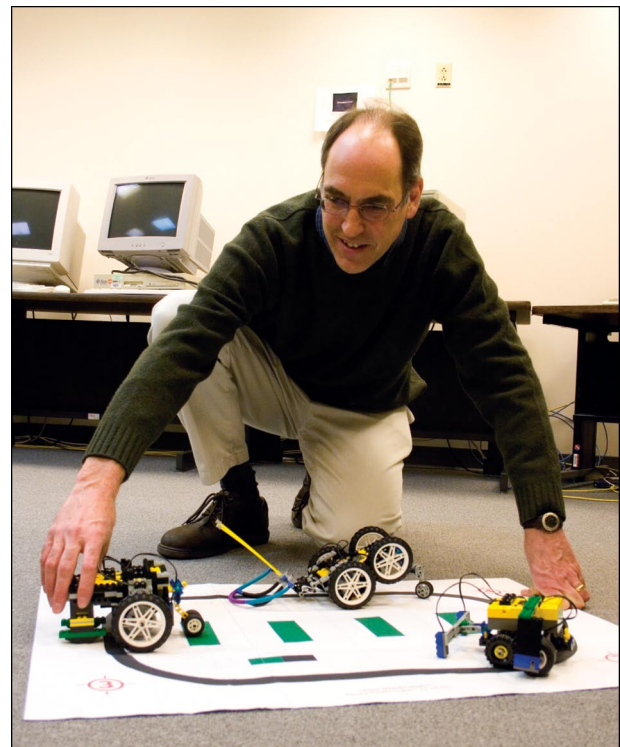
Figure 1. Use of LEGO Mindstorms for real-time software development.
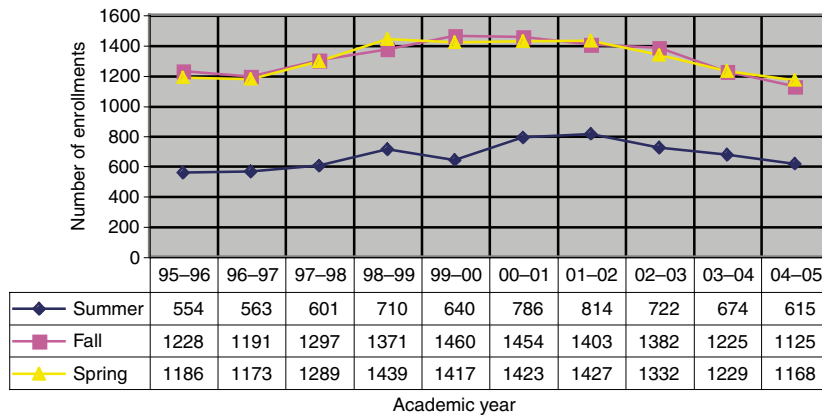
Figure 2. CS enrollments by semester for the past 10 academic years.

Academic year	95–96	96–97	97–98	98–99	99–00	00–01	01–02	02–03	03–04	04–05
Summer	554	563	601	710	640	786	814	722	674	615
Fall	1228	1191	1297	1371	1460	1454	1403	1382	1225	1125
Spring	1186	1173	1289	1439	1417	1423	1427	1332	1229	1168

In CS, the partnerships have been focused on industry. With Lockheed Martin, for example, CS is supporting the Engineering Leadership Development Program. Three CS courses are offered at Lockheed Martin and have been tailored to satisfy specific company requirements while retaining full academic rigor. The remaining courses are taken at EPP educational centers, in particular at APL and MCC, or online.

IS&T's most significant partnership initiative has been with a coordinating government activity supporting multiple organizations. All required courses are offered at a government site and are drawn from the set of IS&T-specific and applied CS offerings. Significantly, there are on the order of 100 enrollments per year in the IS&T partnership program. In addition, a multi-year schedule has been developed that enables the partnership students to plan complete schedules early in their programs.

there will be a smaller pipeline of students for graduate CS programs, especially large ones like EPP's, for several years to come. A second, related factor is that software development offshoring and outsourcing have discouraged students who would otherwise have pursued CS. This has occurred despite an anticipated demand for IT professionals in the United States that significantly exceeds the expected supply.[8] Finally, many companies have become more frugal with tuition benefits, which has restricted the number of courses that students can take in a given year.

In IS&T, the enrollment picture is still evolving. Starting with 9 enrollments in the spring of 1997, the program has grown steadily and now has more than 300 enrollments each academic year (Fig. 3). Moreover, because of the eclectic nature of the program, in any given semester many IS&T students take courses in other programs. The enrollments in courses outside IS&T are attributed to the supporting program and are not included in the IS&T enrollment numbers. A positive impact is that IS&T has helped bolster enrollments in a number of EPP programs, including CS.

Online Courses

During the past several years, online courses have been gaining in popularity, and EPP intends to increase the availability of both online classes and programs. Surveys conducted by JHU have shown that although the direct interactions of a classroom setting are reduced, the convenience of online classes outweighs issues that might be associated with the online format. In particular, many part-time students travel for business and travel schedules cannot always be known at the beginning of a semester. Online courses allow students to continue taking classes regardless of travel requirements. Similarly, students who do not live in the area or who
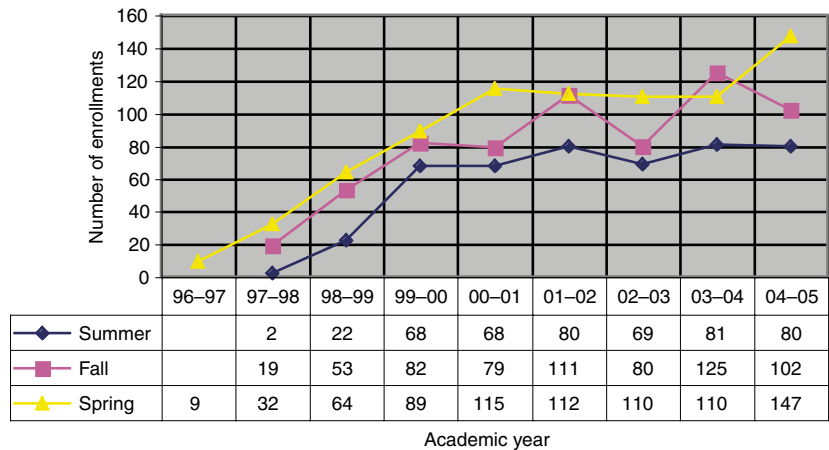
Partnerships

An exciting development in the last several years has been the establishment of educational partnerships with industry and government. This has been an EPP thrust, and both CS and IS&T have participated at a significant level. Under the partnership programs, EPP offers a selection of courses at the location of a partner organization. Students benefit from the convenience of the offerings and from the explicit support given by managers and colleagues. Employers benefit from the targeted education that is provided.

Academic year	96–97	97–98	98–99	99–00	00–01	01–02	02–03	03–04	04–05
Summer		2	22	68	68	80	69	81	80
Fall		19	53	82	79	111	80	125	102
Spring	9	32	64	89	115	112	110	110	147

Figure 3. IS&T enrollments by semester since the program's inception.

may have to move from the area can still take advantage of JHU educational opportunities.

In CS and IS&T, faculty members are given the opportunity to propose new online offerings each year, and both programs are considering whether to offer fully online degrees. Currently, 10 CS and 3 IS&T courses are offered online. While the number of courses offered appears to indicate that students could complete a degree online, not all required courses are yet offered in that format. In particular, CS foundation courses are not online, although the course in foundations of algorithms is under development to support the Graduate Bioinformatics Program that will be offered online in conjunction with the Krieger School of Arts and Sciences. In IS&T, two of the foundation courses are offered online.

CONCLUSION

CS is not the program it was more than 30 years ago, nor, for that matter, a decade ago. It has been continually reinvented in response to emerging technologies, student interests, employer needs, and economic demands. Evolving from a set of software development courses in mathematics, it has become a vibrant and comprehensive program that has long served as an EPP pillar. Graduates of the program have both the theoretical foundations and hands-on experience needed to serve as technical and conceptual leaders in the development of complex information systems.

IS&T, a more recent addition to EPP, has evolved into a robust program in its own right. Leveraging its base in CS, IS&T has attracted a new community of students to EPP. In some ways, these students signal the future of IT. Graduates of the program have the appropriate mix of theory, technology, and management to enable them to lead diverse teams in developing solutions to complex information-based problems across a wide range of areas.

Both programs have arrived at a juncture, with the outlook for the future depending largely on perspective.

Some say that demand and enrollments will continue to diminish as globalization and outsourcing ultimately displace ever greater numbers of U.S. IT workers. Others contend that with demand for IT professionals strong and growing, there is a need for U.S. colleges and universities to increase the number of CS and IS&T graduates. Moreover, given the currently undersubscribed undergraduate programs across the nation, there will be an even greater need for focused graduate programs to produce highly educated IT professionals. As for us, we see IT playing ever more critical roles in all facets of life and are looking forward to a bright future as we enter the next stage of evolution for both the CS and IS&T programs.

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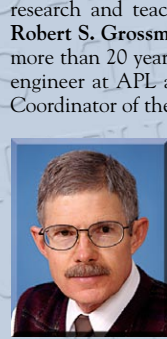
Ralph D. Semmel serves as Chair of the CS and IS&T programs in JHU's Applied Science Programs for Professionals. Dr. Semmel is a member of APL's Principal Professional Staff and heads the Laboratory's Applied Information Sciences Department and Infocentric Operations Business Area. His Ph.D. is in computer science, and his research and teaching experience is in the areas of artificial intelligence and database systems. **Robert S. Grossman** is Vice Chair of the CS Program, where he has taught software engineering for more than 20 years. Dr. Grossman, who has a Ph.D. in bioengineering, is an electrical and software engineer at APL and a member of the Principal Professional Staff. **John A. Piorkowski** serves as Coordinator of the IS&T Program. Mr. Piorkowski is a member of the Laboratory's Principal Professional Staff and Head of the Program Management Office in APL's Applied Information Sciences Department. He has an M.S. in electrical engineering and a Post Master's Certificate in telecommunications. Mr. Piorkowski has both engineering and teaching experience in the areas of networking and communications. **Eleanor B. Chlan**, whose Ph.D. is in CS, is a full-time Senior Lecturer with JHU, supporting both the CS and IS&T programs. Dr. Chlan's research and teaching interests are in the areas of information visualization and discrete structures. Further information on the CS and IS&T programs can be obtained from Dr. Semmel. His e-mail address is ralph.semmel@jhuapl.edu.

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