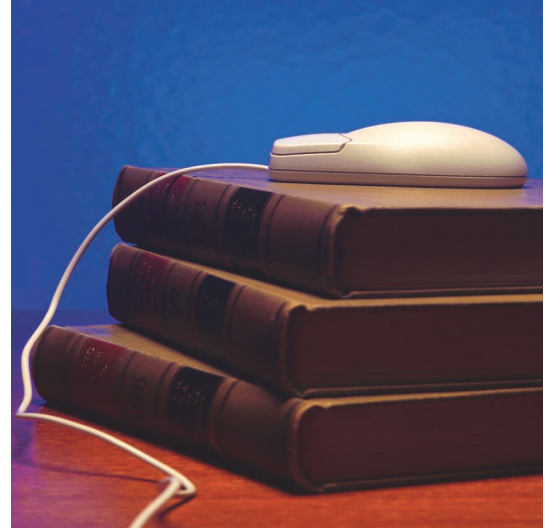


Employers complain that their new IT workers graduate from college without real-world know-how. But what is IT, and how do you teach it?

**William D. Armitage
and Arthur I. Karshmer**



Florida's Universities Tackle the IT Curriculum

If there is one truism about the relationship between employers and higher education, it is this, expressed by the employer: “Brand-new degree holders don’t have the right mix of skills. They might be well prepared in their major field, but they lack business savvy and a real-world approach.” Many professors would respond, “It’s not our job to prepare students for a job—we’re not a vocational school.” And, of course, there’s a third perspective in this dispute, the student’s: “I’d like to be more marketable, but by the time I fulfill my general education requirements and the courses for my major, I don’t have time left for business courses. Besides, the catalog doesn’t list any courses in ‘Real World.’”

Information technology, as much as any other field, suffers from this poor match between preparation and expectation. In Florida, workforce groups told legislators and university groups they were unhappy with their entry-level IT employees’ preparation. As a result, in May 2000, the Board of Regents (the body then governing Florida’s public university system) called for the establishment of IT degree programs. However, the board didn’t mandate a blueprint, leaving each of Florida’s 10 public universities to determine the shape of its program.

The gamut of resulting programs reads like a study in diverse curricular approaches. We’ll give an overview of these IT and IT-related programs, examining in more detail the bachelor’s

degree in IT at our institution, the University of South Florida (USF). Despite the great diversity of Florida’s programs, one aim is consistent across all 10 institutions: to provide graduates that meet the IT needs of employers in their region of the state. This frank nod to vocational concerns, by itself, makes these programs distinct from most university offerings because it places the target outside the walls of the institution.

Any target, however, is difficult to hit when it’s ill defined. And when the Florida universities implemented their IT programs, there wasn’t—and isn’t even today—agreement on a clear and complete definition of information technology.

WHAT IS INFORMATION TECHNOLOGY?

Last year, the Information Technology Association of America (ITAA), an industry association, reported that no accrediting group, academic society, or professional organization represents IT. Therefore, a comprehensive description of the field’s content and structure remains elusive. But we can use various statements from IT literature to close in on a definition.

A 1999 report first defines IT as a term that “... refers only to computer-based systems” (P. Freeman and W. Aspray, “The Supply of Information Technology Workers in the United States,” Computing Research Association [CRA], http://www.cra.org/reports/wits/it_worker_shortage_book.pdf). Computer-based systems include many elements and activities, from hardware issues such as chip design and production, to the design and implementation of complex systems, all the way

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to end use of such systems. As Peter Denning had already observed (in an unpublished talk in 1998), such a broad-ranging definition would include academic disciplines from computer science to computer engineering to information systems and management information systems. Freeman and Aspray go on to say "... these disciplines capture some aspects of what we regard to be information technology, but none of them covers all aspects." They finally conclude that "... one of the attributes of information technology that makes it worthy of study is its pervasiveness in society."

In an interesting 1997 report by the US Department of Commerce titled "America's New Deficit: The Shortage of Information Technology Workers," the authors concluded, "In a broad sense the term information worker can be applied to data entry personnel, auto mechanics who use computer diagnostic equipment, ..., loan officers, ..., computer scientists and engineers." (<http://www.technology.gov/reports/itsw/itsw.pdf>). The ITAA, on the other hand, broadens the definition by including "any skilled worker who performs any function related to information technology." The definitions begin to grow so broad that they are no longer coherent.

Much of the difficulty of establishing a definition with clear boundaries is separating the *IT professional* from the *IT-enabled worker*. (The problem of identifying IT professionals is not a new one. As early as 1993, the National Research Council called for some sort of classification scheme for computer professionals.) The CRA report presented a simple graph in which the line separating the IT-enabled worker from the IT professional was a function of levels of IT knowledge versus levels of domain knowledge (domain knowledge being knowledge specific to the application area). The report concludes that the level of formal education has a high correlation with the worker's category (IT-enabled versus IT professional). The level of formal versus job-related knowledge seems critical in our identification of the IT professional. The CRA group concluded that "... there is some question whether it (job-related training) can adequately replace the foundational knowledge acquired in the formal degree programs. ..."

While definitions aren't set in stone, it seems clear that IT is a superset of many of the traditional computing-based academic disciplines and that the development of a meaningful IT curriculum is a serious challenge. We believe that the IT professional of the future will require an academic background well grounded in the core concepts of computer science, computer engineering, and information systems, as well as the opportunity to become familiar with domain-specific knowledge in a particular area of interest. A 2001 article by Denning supports this view (P. Denning,

"The IT Schools Movement," *Comm. ACM*, vol. 43, no. 8, 2000, pp. 19-22). As Denning put it, "We are at last beginning to address the challenge of designing an education for an IT professional that is not constrained by the idiosyncrasies of any particular specialty, most notably computer science."

Although the IT program at the University of South Florida is based on a more traditional computer science discipline, it falls somewhere in the middle of the other IT degree programs in Florida in terms of conceptual foundations. The "For Further Reading and Browsing" sidebar explores the roots of information technology, computer science and other subjects that this article mentions.

A DIVERSITY OF PROGRAMS

Florida is a large state. In contrast to its stereotype as a homogeneous land of retirees and tourists, the truth is that industry, culture, and even weather all vary widely in different areas of the state. Each public university responds to and derives some of its character from its location, so it isn't surprising that paths to IT and IT-related degrees in Florida are as varied as the institutions offering them. Aside from the common aim of addressing nearby employers' needs, responses to the Florida Board of Regents' call for IT programs have been highly diverse. Some institutions seized the opportunity to create something new, while

others decided that their existing degree programs already addressed the Regents' concerns. In fact, some universities had established their programs in response to the same pressures that prompted the Regents into action.

Existing and modified

The Warrington College of Business of the University of Florida in Gainesville offers degrees in computer information systems and in decision sciences. The CIS degree is largely programming, database, and the like, while the DIS program places more emphasis on corporate decision-making tools. Both programs existed before the Regents' call for IT degrees. Students "never have issues searching for jobs nationwide," reports Brian Ray, director of the Undergraduate Programs Office at Warrington. "Our undergraduate programs are consistently rated one of the top 25 in the country by *U.S. News & World Report*."

Across campus, UF's College of Fine Arts and College of Engineering cooperate on a strongly interdisciplinary pair of programs: the BA and BS in Digital Arts and Sciences (DAS). These programs also predated the Regents' emphasis on IT but arose from the same origins: companies requesting graduates more suited to fill their open positions. "We think we have a unique program," says

We must forge relationships between the university, other educational institutions in the region, local businesses, and governmental agencies.

Denise Atteberry of the Department of Computer and Information Science and Engineering, “in that our students are required to take traditional art classes, such as hand drawing, so that they must be both engineers and artists at the same time.” The programs have a large common core; beyond that, the BA places greater emphasis on art, while the BS gives more weight to computer science and engineering. The programs do not aim low. “We’re hoping to produce the person who will create the next graphics standard for the industry,” Atteberry says.

In Jacksonville, the University of North Florida’s Department of Computer and Information Sciences offers two programs leading to a BS degree: the Information Systems program includes a minor in business; Information Sciences allows any other, student-selected minor. When the Regents called for IT programs, UNF decided that its current offerings, including these two programs, already fulfilled the aim of providing the skills employers needed. “One thing we’re proud of is that it’s a very hands-on program,” explains Judith Solano, chairperson of the department. “Students have developed applications—not just talked about managing the process. This puts them in a very strong position to enter the field.”

Paul Hart, chair of the Department of Information Technology and Operations Management at Florida Atlantic University in Boca Raton, explains his program’s motivation: “There are few very large corporations in south Florida, but there are many small and medium-size firms looking for IT employees with many skills.” The BS program in Management Information Systems existed long before the Regents’ charge, but it has undergone continual change in response to focus groups composed of executives of firms who have hired FAU’s MIS graduates. Over the last 12 years, FAU has developed and refined two tracks in the program: one centered on Internet development and the other on object-oriented programming. In response to recent industry demand, both tracks have become more oriented toward Web services.

The University of Central Florida in Orlando offers a BS in information technology. Like some others, this program, which graduated its first student in May 2002, was instituted prior to the Regents’ call but arose from the



For Further Reading and Browsing

- ▶ Peter J. Denning, “The IT Schools Movement,” *Comm. ACM*, Aug. 2001, pp 19-22.
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- ▶ Mary-Louise G. Piner, “Defining Computing Curricula for the Modern Age,” *Computer*, June 2001, pp. 75-77.
- ▶ Information Technology Assoc. of America, <http://www.itaa.org>.
- ▶ Lego Mindstorms home page, <http://mindstorms.lego.com>.

same source: industry concerns that new graduates weren’t a good match with employers. “There is expected to be a huge demand in many industries for IT professionals,” points out Gerald Marin, director of the IT program at UCF, “and we hope to produce future employees with sound theoretical knowledge and practical technology skills.” Students take a core of required math and programming courses, “followed by courses in databases, computer networks, system software, distributed applications, and others depending on their particular interests.”

New and tailor-made

In Fort Myers, the bachelor’s degree in Computer Information Systems at Florida Gulf Coast University began with the institution’s founding just five years ago. The university will soon launch two additional degree pro-

grams: the BS in Applied Science in Computer Technology in fall 2003, and the BS in Software Engineering in the spring or fall semester of 2004. FGCU designed the Applied Science in Computer Technology program for students enrolling from the community college level; it also receives grant funding in conjunction with Edison Community College. To ensure proper preparation for IT coursework, the university designed two programming courses to enhance the skills of AA and AS degree holders. Walter Rodriguez, chair of the Departments of Computer Information Sciences/Decision Sciences and Computer Science/Engineering, defines the programs as “the perfect marriage between business and computer science, because the curricula combine business savvy with computer programming, systems analysis, and information science knowledge—using user-friendly approaches.”

The IT degree program at the University of South Florida in Tampa is actually headquartered at the regional campus in Lakeland. This BS in Information Technology program, created in direct response to the Regents’ call, differs from traditional computer science curricula in three ways. First, students become highly involved in tailoring a specific industry emphasis into their degree; few, if any, graduates will have exactly the same set of courses in their programs. Second, to maintain a strong research flavor, the department bases newly developed courses on current local research and research from other institutions. Third, required attendance by program majors at a colloquium program emphasizing community-university interaction adds academic and social components and provides an opportunity for students to begin building career networks.

Florida International University in Miami used an interesting approach to create what is, in effect, a multidisciplinary program. FIU presently offers a BA in Information Technology only as either a second major (concurrent with a primary major), or as a sequential, second degree for returning students. “We appear to be unique in Florida programs,” observes Masoud Milani, director of the School of Computer Science’s IT program, “in that our degree is offered as a second degree, which fulfills our aim of producing IT-enhanced graduates.” Of the 30 semester hours required for the program, 24 are Information Technology courses; the six remaining credits are usually in the specialization area of the primary major. The option of returning for a second degree is popular with professionals looking to change careers into IT.

The University of West Florida in Pensacola responded to the Regents’ call for IT programs by developing a highly distributed, multidisciplinary degree program—Interdisciplinary Information Technology—with tracks in

Bioinformation, Computer Technology, Digital Media, e-Learning Support, and Digital Enterprise. In contrast to institutions that centralize administration of their IT degree programs within one or two departments, UWF handles administration of each track through the department responsible for that track’s “non-IT” discipline, with coordination by the Provost’s office. “This is the first time this kind of program has been tried,” says Kathryn Fouché, associate dean of the College of Arts and Sciences, “and it all seems to be working. We are very pleased so far, but not ready to relax.” The new program granted its first degree in December 2002.

Florida State University, in Tallahassee, has also opted for a highly interdisciplinary program with even more options for specialization disciplines. The university established an interdisciplinary School of Computational Science and Information Technology (CSIT) to administer and coordinate the program. Twelve FSU departments are affiliated with CSIT; each offers courses that emphasize or have a bearing on the discipline’s computational techniques.

Florida Agricultural and Mechanical University, also in Tallahassee, has not yet implemented an IT program, but its planning is nearing completion. Dhyana Ziegler, assistant vice president at FAMU, believes that “as we embark on this new economy in Florida, we’re going to need a variety of skills in the technology area to support the new media-oriented industries that will be part of it.” Plans are for a program that emphasizes digital media and digital arts; the university is examining existing programs as models, including the IT program at the University of Central Florida and the Digital Arts and Sciences programs at the University of Florida.

While it might have been convenient if all of the programs reviewed in this article were named “Information Technology,” they are not so named, and this is not surprising. In such a mix of pre-existing and new programs having such variation of purpose, there is wide diversity among the names used to describe them. Table 1 attempts to present these different program names in a format that compares them in a more concise structure.

We do not mean for the table to be exhaustive; it lists only those programs that departments at each school identify as being in response to, or fulfilling the purpose of the Board of Regents’ call for degree programs in Information Technology.

COMMON AND UNCOMMON THREADS

It might seem that in a field as dynamic and difficult to define as IT there would be more differences than similarities between these institutions’ programs. It turns out, however, that the common threads outnumber the uncommon.

Paths to IT and IT-related degrees in Florida are as varied as the institutions offering them.

Table 1. What they call it and what they teach.

Degree field name	As offered by	Emphasis
Applied Science in Computer Technology	Florida Gulf Coast University	Designed in collaboration with Edison Community College for students enrolling from the community college level; enhances preparation with courses in networking and additional programming skills.
Computer Information Systems (CIS)	Florida Gulf Coast University	Preparing students for careers in the computer and information technology industry; includes programming, systems analysis and design, networking, databases, and business concepts.
Decision Sciences (DIS) and Computer Information Systems (CIS)	University of Florida	The Warrington College of Business administers the CIS and DIS programs, and they have a strong business orientation. CIS emphasizes programming and databases, while the DIS curriculum is heavily oriented toward decision-making tools that corporations use.
Digital Arts and Sciences (DAS)	University of Florida	Depending on degree, emphasizes art (BA) or computer science and engineering (BS). Both have heavy overlap in the complementary area.
Information Systems and Information Sciences	University of North Florida	Both programs have heavy interdisciplinary emphasis: the Information Systems program in business administration (which is also the student's minor) or the Information Sciences program in conjunction with any other minor.
Information Technology (IT)	Florida International University	Offered only as a second major, or second sequential degree. Aims to produce "IT-enhanced" graduates.
	University of Central Florida	Aim is to produce students for IT professional careers. The core program includes programming and math with other work in databases, networking, distributed systems, and student-selected areas.
	University of South Florida	Central computer science core. Students tailor specific industry emphasis into degree work, as well as local and other research programs. Emphasizes interaction and networking with community professionals.
Interdisciplinary Information Technology	University of West Florida	Emphasis is on "specialization discipline" (bioinformation, digital media, e-learning support, digital enterprise), versus IT. Exception: the computer technology track, administered by the Computer Science Department.
Management Information Systems	Florida Atlantic University	Emphasis on graduates for professional IT career. Two tracks: Internet development and object-oriented programming.
Software Engineering	Florida Gulf Coast University	Not yet completely defined: starts in 2004.

All programs include in common a list of agreed-upon prerequisites, a virtual necessity in such states as Florida, where successfully completing an appropriate associate degree at a public community college qualifies a student to enter a public university as a junior. Additionally, each program contains a significant core of IT-related courses, although with some differences between programs.

Masoud Milani of Florida International University correctly observes that "while Computer Science looks at the theoretical aspects of computers, IT looks at the same areas from a different standpoint—more practical." The IT programs' emphasis on employable skills makes them more similar in a sense to each other than they are to most of the other degree offerings at their institutions.

In longevity, some of Florida's programs have decades-long histories, others have yet to graduate their first students, and others are still in the planning stage. However, given IT's dynamic nature, the universities all recognize that no program can be static and still continue to meet the outside world's needs; they are taking extraordinary measures to ensure that the programs remain relevant. For example, Paul Hart of Florida Atlantic University (FAU) reports that "at the urging of a member of [FAU's] Board of Trustees, an IT workforce development coordinator has been hired. This individual is intended to serve as an interface between the university and businesses, civic organizations, and government agencies in south Florida."

Programs do differ in their target—the product each aims to produce. Few programs emphasize preparing a student for graduate school, although graduate programs do exist, and schools are proposing others. Instead, most programs envision their typical graduate becoming an IT professional, likely employed by a business firm's or government agency's IT department. Some programs, instead or additionally, attempt to produce "IT-enhanced" graduates—degree holders who could go into marketing, art, accounting, or some other field, taking with them a technical background that makes them more effective in today's IT-intensive business environment.

With such an emphasis on practical, employable skills, the universities also recognize that internships with local business and other agencies are—at least—desirable. But an internship's value varies from program to program. Some programs award no course credit for an internship; others allot as much as six semester hours, sometimes making the internship all or part of a major senior year project or "capstone experience." One factor in the decision is that degree programs are limited to a set number of credit hours; allocating some to an internship makes fewer available for coursework. And some program directors believe that, as a practical matter, offering college credit for an internship is unnecessary when students who participate in them already garner so many other personal advantages. In the Digital Arts and Sciences program at the University of Florida, for example, internships are recommended but not required; nonetheless, internship opportunities there are highly competitive.

Many of the departments present colloquium programs or the equivalent. However, only the program at the University of South Florida (which assigns a mandatory one semester hour of credit for its colloquium), makes attendance a requirement.

Some programs try to produce "IT-enhanced" graduates who could go into marketing or another field.

means that students coming into the IT program from community colleges with AA degrees have exactly the same standing as students who have completed their general education requirements at one of the four-year universities.

To enter the IT Department at USF in the junior year of study, a student must have completed the courses listed below in his or her first two years of study, maintaining a 2.5 grade point average in them. These courses easily fit into the state's 60 credit-hour guidelines for either an AA degree or completion of the first two years at a four-year university. The Florida system's

total articulation means that all students attending community college in the state have access to these courses.

- *General computing.* This covers: Introduction to Databases, Programming Concepts, and Object-Oriented Programming;
- *Math and science.* Physics Concepts, Discrete Math, and Precalculus Algebra are included; and
- *Other.* This includes, General Psychology, Macro Economics, and Introduction to Statistics.

The final two years of the IT degree program require 60 credit-hours of study and include the following required computer science and IT-related classes: Computer Organization, Database Systems, Human/Computer Interfaces, Software Engineering, Computer Networks, Data Structures and Algorithms, Program Design, Operating Systems, IT Ethics and Social Issues, Senior Project, IT Colloquium, and IT Concepts.

IT students must also take three associated classes: International Issues, Advanced Technical Writing, and Communications for Scientists and Engineers.

Finally, each IT student must choose five elective classes (15 credit-hours) to bring a more domain-specific focus to his or her degree program. A faculty advisor must approve the set of five electives, which can come from many related areas.

The IT program at USF parts from traditional computer science curricula in three major areas—the student's involvement in defining a course of study, the incorporation of newly developing courses that are based on current local research and findings from other institutions, and interaction with the community.

Students tailor their degree emphasis

USF is a large, diverse educational institution. On campus, the university has a major cancer research center (the H. Lee Moffitt Cancer Center & Research Institute), a Shriners Hospital, and an Embassy Suites hotel. These facilities—along with more than 200 degree programs, including medicine—are rich resources for aspiring IT pro-

THE USF IT DEGREE PROGRAM

Florida is a 2+2 fully articulated educational system. This

professionals. If IT is indeed pervasive in our society, the USF community offers the student a rich microcosm of that society.

Each IT student's set of five elective courses bolsters the program's basic computer science curriculum with domain-specific education. Rarely does the IT program graduate two students with identical sets of courses. Here are a few of the many possible electives: Computer Graphics, Database Systems, Artificial Intelligence, Medical Informatics, Computer Networks, Educational Computing, International Business, Bioinformatics, and Hospitality Management.

Newly developing courses

We believe that the complete IT student should be introduced to a wide variety of science and engineering concepts, including such issues as basic logic, DC circuits, automata theory, computer structure, robotics, and real-time control. IT Concepts, taught at the program's entry level, offers an overview of many of these concepts, which later courses isolate for study. The course provides the conceptual glue for the degree, revealing the overall tapestry of computing's conceptual model by emphasizing interconnections among the base components.

The primary tools for IT Concepts were developed in other engineering and computer science programs—logic simulators, DC circuit analysis programs, automata simulators, and the Robolab robotics and programming environment developed at Tufts University for use with the popular Lego Mindstorms robot. These highly interactive tools ensure that the IT Concepts course holds the interest of entering students while they learn basic concepts and component interrelationships.

Moreover, this particular course will ultimately have a broader impact than just the USF IT program. We plan to develop scaled versions of IT Concepts and make them available to all middle and high schools in our service area. Indeed, we intend to distribute to other schools—on loan for one semester at a time—a complete course including a laptop computer, a Mindstorms kit, Robolab software, the various simulators, and video-based instructional media for teachers.

The Human/Computer Interfaces course is based on local research, an active project at the USF Lakeland campus to adapt a graphical user interface (GUI), and the computer in general, for use by the blind. Using these difficult interface issues as a focal point, our HCI course will combine general principles with actual domain-specific issues. The research program, active for more than 10 years, is currently funded by grants from the National Science Foundation and the National Institute on Disability and

Rehabilitation Research (NIDRR) in the US Department of Education.

During their last year of study, all IT students undertake a senior project. Although this approach is common in various educational settings, we have expanded the boundaries of the concept, conducting this capstone course in conjunction with local business. Each student carries out the senior project with supervision from a faculty member and an IT professional from a regional business organization or governmental agency. This lets the student apply domain-specific knowledge from his or her elective courses to solve a real problem.

Community-university interaction

We believe that to build a successful IT program, we must forge relationships between the university, other educational institutions in the region, local businesses, and governmental agencies. To this end, we have instituted a colloquium series required of all IT students. To graduate, every student must give proof of attendance at six colloquia over a two-year period. Collect six tickets—you've met the requirement.

The colloquium series, convened monthly, features speakers from the IT Department, other faculty from the larger university community, local IT professionals, visiting scientists, and students themselves. We use electronic notifications, postal reminders, and local newspapers to invite potential participants to the colloquia.

There are no signs that the information technology field will ever stop changing. Consequently, every IT program in Florida's public universities is truly a work in progress. What is new in these degree programs is the realization that their transformation is inevitable, and that it must be closely and continually coordinated with the local community's needs. Will these programs' practical, real-world orientation prompt more traditional programs, such as Computer Science, to become more employer-oriented? Or, instead, will those traditional programs become more theoretical, freed by the IT programs from vocational concerns? If Florida's diverse experience so far is any indication, we will most likely see both outcomes, and perhaps some others as well. ■

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