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Who Are We?

This new column calls for information technology to be defined as a profession rather than a discipline and invites computer scientists to cross the chasm.

To most of the hundred millions of computer users around the world, the inner workings of a computer are an utter mystery. Opening the box holds as much attraction as lifting the hood of a car. Users expect information technology professionals to help them with their needs for designing, locating, retrieving, using, configuring, programming, maintaining, and understanding computers, networks, applications, and digital objects. They expect academic computer science to educate and train computing professionals, to be familiar with the changing technologies, and to maintain research programs that contribute to these ends. Students aspiring to be professionals look to faculty for a comprehensive, up-to-date view of a world with many fragments, for making sense of rapidly changing technologies, for assistance in framing and answering important questions, and for training in effective professional practices.

In short, everyone has become dependent on IT professionals as much as on the information technologies themselves.

Who are the IT professionals? They are a much larger and more diverse group than computer scientists and engineers. They have organized themselves into professional groups in three categories covering at least 40 specialties (see the accompanying table). The first category comprises the major technical areas of IT and spans the intellectual core of the field. The second category comprises other well-established fields that are intensive users of IT; although their practitioners focus on issues in their own fields, they draw heavily on IT and often make novel IT contributions. The third category comprises areas of skill and practice necessary to support the IT infrastructures that everyone uses.

But wait! Are we entitled to use the term "profession" in connection with IT? What are the hallmarks of a profession? Do we meet them?

What Makes a Profession?

Today, most people understand computer science as a discipline that studies the phenomena surrounding computers. These phenomena include design of computers and computational processes, representations of information objects and their transformations, hardware, software,

On the Drawing Board

Some of the topics to be explored in this column include:
•Crossing the chasm •The identity of an IT profession •Careers in a wired world •Entrepreneurship and innovation software quality •IT education

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IT Profession		
IT-Specific Disciplines	**IT-Intensive Disciplines**	**IT-Supportive Occupations**
Artificial intelligence	Aerospace engineering	Computer technician
Computer science	Bioinformatics	Help desk technician
Computer engineering	Cognitive science	Network technician
Computational science	Digital library science	Professional IT trainer
Database engineering	E-commerce	Security specialist
Computer graphics	Financial services	System administrator
Human-computer interaction	Genetic engineering	Web services designer
Network engineering	Information science	Web identity designer
Operating systems	Information systems	Database administrator
Performance engineering	Public policy and privacy	
Robotics	Instructional design	
Scientific computing	Knowledge engineering	
Software architecture	Management information systems	
Software engineering	Multimedia design	
System security	Telecommunications	
	Transportation	

efficiency, and machine intelligence. In Europe, the discipline is called "informatics" and in the U.S. "the discipline of computing." The computing profession is understood as the set of people who make their livelihood by working with computing technologies.

But "making a livelihood" is a narrow view of profession. If you examine other professions, you see four hallmarks:

•A durable domain of human concerns.
•A codified body of principles (conceptual knowledge).
•A codified body of practices (embodied knowledge including competence).
•Standards for competence, ethics, and practice.

A profession includes institutions for preserving the knowledge and the practices, enforcing the standards, and educating professionals. Health care, law, and libraries are three prominent examples that illustrate these principles.

Health care. Health is a permanent concern of all human beings. Breakdowns in health are inevitable because of disease, accident, or aging. Health-care professionals take care of people's concerns in health. Hospitals, HMOs, insurance companies, government health programs, the national medical association, the medical colleges, and medical schools are the principal institutions of this profession. Their curricula and certification programs codify their conceptual and professional knowledge. Doctors must be licensed to practice medicine and can obtain certificates testifying to higher levels of competence in various specialties. Doctors who violate professional standards are subject to reprimand or censure by the national medical associations, malpractice lawsuits, and loss of license.

Law. The rule of law is a permanent concern of most human beings. Most people live in societies with governments, constitutions, legislatures, and laws. Implementing agreements and carrying out actions without violating laws or incurring penalties is an ongoing concern for them. Breakdowns are inevitable because people do break laws and because many business practices are governed by contracts. Two allied professions help people deal with their concerns and recurrent breakdowns about laws: the legal profession (lawyers, judges) and the law enforcement profession (police, other law enforcement agents). Law schools, police academies, legislatures, courts, and the national legal and police associations are the principal institutions of these professions. Lawyers must pass a bar examination and be licensed to practice law. Lawyers who violate professional standards are subject to reprimand or censure by the legal association, malpractice suits, and loss of license. Similarly, police are trained rigorously and are subject to sanctions.

Libraries. The preservation and sharing of recorded human knowledge is a durable concern of many human beings. Progress in technology, law, commerce, politics, literature, and many other aspects of civilization depends on access to knowledge created by our ancestors. Civilizations can be interrupted or lost when they lose access to their own historical documents and records. The profession of library science helps people

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deal with these concerns by preserving documents, making them available publicly, cataloging and organizing them, and preserving them. Curricula in library science preserve and transmit bodies of conceptual and professional knowledge about libraries. Libraries, schools of library science, and library associations are the principal institutions of this profession. Librarians must earn certain credentials to practice the profession and are subject to reprimand or censure by their professional associations.

How IT Stacks Up

How well does IT meet the four criteria for profession? The durability criterion is clearly met: computation and effective communication are ongoing concerns and sources of breakdowns for all human beings. Ours is a world of information and numbers, many processed by machines and transmitted by networks. The telephone and fax are ubiquitous, the Internet soon will be, and databases are springing up like weeds everywhere in the Internet—all technologies that extend the distance and time over which people can successfully coordinate actions. Nearly everyone in every developed country is affected by digital telecommunications; leaders in underdeveloped countries are aggressively installing informational infrastructures to accelerate their countries' entries into world markets. In the same way, computation is an integral part of the daily practices of finance, engineering, design, science, and technology. Word processing, accounting, databases, design automation, and report-writing software impact every other profession. The digital world offers many new kinds of breakdowns, ranging from failures of computers and communications, to software bugs, to the challenge to install software that improves an organization's productivity. In other words, the concerns are not phenomena that surround computers. It is the other way around. The computers surround the concerns.

The body of principles criterion is clearly met. Our conceptual knowledge is codified in the curricula of our degree and training programs and is often proposed or endorsed by professional societies.

The body of practices criterion is not met—yet. Few university programs define criteria for different levels of professional competence and test people. Professional societies do not do this. The Institute for Certification of Computer Professionals (ICCP) does it in a narrow area, but is not widely known or used. The growing interest in state licensing of software engineers, however, is prompting the professional societies to examine the certification of skills of IT professionals. And the growing interest in forming IT colleges is prompting academic leaders to include professional knowledge in the curriculum.

The professional responsibility criterion (ethics, standard practice) is partially met. The professional societies (mainly ACM and IEEE) have codes of ethics but do not enforce them. We have yet to develop criteria of competence and to ask our colleges and universities to certify their graduates. There are all too many discontent users, a signal that we are not listening carefully to them and serving them.

So IT meets several of the criteria and is moving toward meeting the remaining criteria in the next decade.

In thinking about the IT profession, we need to distinguish crafts, trades, disciplines, and profession [2]. A craft is a set of practices shared by a community of practitioners but does not enjoy a recognized social status. A trade is an organized group of practitioners (some may be craftsmen) with restrictions imposed by society in return for freedom to practice the

trade for the benefit of society. A discipline is a well-defined field of study and practice. A profession may include many disciplines, several trades, and many crafts. It embodies a core value of listening to its clients and for being socially responsible.

The U.S. Department of Education, acting under a Congressional mandate, has defined a profession as a set of people who have at least two years of post baccalaureate education and whose field is on an approved list. This definition is much narrower than the one offered earlier.

The Identity of an IT Profession

What do people think you care about? What actions do you take? Are your words and actions aligned? What standards do you adhere to? What do you offer them? How do you interact with them? What breakdowns do you resolve? Create? The answers to these questions manifest an organization's identity in the world.

The current identity of our field is a mixed bag. We are seen as passionate innovators and prolific inventors. We are seen as nerdy—single-mindedly focused on IT and inept with social relationships. We are seen as technology-centered, not human- or user-centered. We are seen as oblivious to the social, political, and business consequences of our tools and services. We are seen as avoiding responsibility for malfunctions of our tools and breakdowns in our services. We are seen as difficult to communicate with.

The challenge facing professional societies is to promote a new identity characteristic of a profession. We must articulate standards for professional members and organizations. We can promote the adoption of those standards by enlisting industry leaders to do so in their organizations and by giving visibility to organizations, companies, schools, and government that exemplify those standards.

Through cooperative action, professional societies can address large issues facing the IT field that not one of the specialties addresses adequately on its own. Principal among these are:

•Developing, codifying, and teaching methods for designing and implementing safe and reliable software systems, especially the large systems in critical applications. This is seen by many as the central mission of our field.
•Reforming IT education to bring more coherence, endowing it with a common core, and incorporating professional practices alongside conceptual principles.
•Providing programs for the ongoing (lifelong) education of IT professionals.
• Providing standards for professional competence at multiple levels in each specialty and certifying individuals who meet those standards.
•Learning to connect with and be responsive to customers, clients, and users.

The Role of Computing

It is an irony that the discipline that gave birth to the IT profession is not the driving force in the profession. Computer scientists are the inventors and visionaries, but the field is being driven by the large numbers of pragmatists who are the users of the field and include many powerful business, civic, government, and industry leaders. Computer scientists need to come to grips with the fact they are no longer in control of the field. They do not call the shots. Their research is not the driving force behind most IT innovations. They are one of many professional groups in the field. What role can they play?

I believe the natural role for computer scientists, consistent with their history as the progenitors, is the custodian of the intellectual and scientific core of the field. This is an important role that must be filled by someone if the IT profession is to achieve coherence. But it will not come automatically. It will come if computer scientists learn to embrace commercial applications, interactions with other fields, and the concerns of their customers. This may be a chasm too wide for many computer scientists to cross [1].

In recent years there have been many tensions between computer scientists and software engineers. Software engineers claim to be an engineering discipline and want out of computer science departments; for their part, computer science departments do not want to lose an important segment of their field. Many of these tensions arise, in my view, from a failure to distinguish the body of principles from the body of practices. Software engineering and computer science share the same conceptual principles, but they have significantly different professional approaches and practices. They can share curricula in the principles, but they need to go separate ways with professional practices. With the interpretation of the IT profession offered here, both are part of the profession but there is no requirement that one be part of the other.

I have been troubled in recent years by the skirmishing between software engineers and computer scientists, by the insularity of many computer scientists, and by the question of coping (in education) with the large demand from pragmatists for help. Somehow we have to adapt, take leadership, but give up our traditional feeling of control over the shape of the discipline. My conclusion is that we need to think in terms of *profession* rather than discipline, for there appear to be many disciplines that want to be part of the profession. Once we come together as a profession, we will be better able to accomplish the goals that no one of us can do alone.

A Profession of Information Technology

Here is a summary of the forces forming an IT profession:

•Most of those who use computers and communications do so through hardware, software, and networks whose inner workings are mysteries to them.
•People in business and their clients, people at home, people in science and technology, and people depending on large software systems have concerns about the design and operation of reliable hardware, software, and network systems to help them do their work.
•These people seek professional help in taking care of their concerns. They expect computing professionals to be responsive, competent, ethical, and able to anticipate future breakdowns.
•The Profession of IT is coming into existence to provide that help. It currently has a negative identity, but professional societies can define and promote a strong professional identity.
•The education of IT professionals must account for practices as well as descriptive knowledge. It must include training as well as general education. It may not reside in any single university department, being distributed among computer science, software engineering, computational science, computer engineering, and related departments such as astronomy, physics, chemistry, biology, management science, linguistics, or psychology—each of which contributes important specialties to the profession.
•Individual IT professionals should embrace boundaries between their specialties and others in the profession. As a whole, the IT profession must embrace its boundaries with other fields to assure a constant stream of life-giving innovations.

Through its research, the Profession of IT must anticipate future breakdowns that others will encounter. A close interaction between computer researchers and others is essential so that the questions under investigation remain connected to real concerns, both short and long term. Otherwise computing research can drift into irrelevance and cease to earn public support. C

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