The Profession of IT

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Crossing the Chasm

The keys to a coherent profession are bridges between computing technologists and the multitude.

In the previous installment of this column I demonstrated that information technology is rapidly becoming a profession in the same way that health care, law, and library science and management have all become professions. Already at least three dozen organized professional groups represent specialties in the IT field. While the discipline of computing may be the mother of all these specialties, it is not the matriarch. Many IT professionals do not want to be identified as computing technologists; computing does not speak for them.

Before exploring this further, I want to explain my use of the term "computing technologists." I need a short name for the large group of people who deal with the scientific core of IT. This group includes computer scientists, network engineers, database engineers, security engineers, software engineers, graphics engineers, and computer engineers. I chose the moniker "computing technologists" for this group because they are all members of the computing field and because they all work with technology. I also use the term "computing discipline" for their field. When I use the pronoun "we," I am speaking as a member of this group. I argued previously that computing technologists are a subset of all IT professionals.

It is an irony that the computing discipline, which gave birth to the IT profession, is not the driving force in the profession. We computing technologists 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. We need to come to grips with the fact that we are no longer in "control" of the field. We do not call the shots. Our research is no longer the driving force behind most IT innovations. We are one of many professional groups in the field. What role can we play?

I believe our natural role, consistent with our 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 this role will not come to us automatically. It will come only if we learn to embrace commercial applications, interactions with other fields, and the concerns of our customers. This may be a chasm too wide for many of us to cross.

Thus we face a dilemma. Should we hold a conservative view, insisting our disciplinary offspring not separate and the newcomers merge? If so, we run the risk of being sidelined in the new profession. Should we seek a leadership position in the new profession? If so, we must cross a chasm separating our current concerns from those of the multitudes who

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seek our expertise. To cross the chasm, we must embrace the birth of a new profession. I am committed to this end.

Crossing the Chasm

As computing technologists, we have earned a reputation for independence, invention, and vision. We are admired for our accomplishments. At the same time, we are criticized for being insular and disdainful of applications. We are no longer the primary inventors of software and some hardware. We find ourselves challenged by a multitude of users with mundane, practical concerns about using and relying on computers. We have lost any sense of control over developments and directions in our field.

I believe that computing technologists are experiencing a phenomenon described eloquently by Geoffrey Moore a decade ago. No relation to Gordon Moore (the Intel founder famous for the 18-month doubling law of processor power), Geoffrey Moore was a principal of the Regis McKenna advertising agency headquartered in Silicon Valley. Well before the dot-com boom, Moore had witnessed hundreds of new technology companies start life with marvelous inventions and rapid early market growth—only to collapse suddenly within three years or their first $20 million of expenditures. Their sales unexpectedly leveled or plummeted and they went out of business. They did not know what happened to them.

But Moore did. He explained the phenomenon and offered advice for those planning new companies. He recalled an earlier model of mindsets toward technologies, which divided people into five groups: the inventors, the visionaries, the pragmatists, the laggards, and the ultra-conservatives. Each successive group takes longer to grasp the implications of the new technology and to be sold on its use.

Moore suggested the distribution of people among categories follows a bell curve, meaning that the pragmatists are by far the largest group. The founders of companies are often inventors working in concert with visionaries. The founders meet initial success by selling their technology to other inventors and visionaries who are quick to grasp the implications. But their downfall comes when they saturate the market of visionaries and attempt to persuade pragmatists to purchase their technology. The pragmatists worry about stability, dependability, and reliability; they want to use the technology but don't want to be victimized by breakdowns or held hostage by single suppliers.

Moore invokes the metaphor of a chasm: the company leadership discovers too late its marketing story and approach communicates with other early adopters like themselves, but not with pragmatists. They do not have the resources or expertise to build the bridge. And so they go out of business.

Computing technologists are the inventors and visionaries in Moore's model. The multitudes of eager new users are pragmatists, whose concerns and demands differ sharply from those of early adopters. Computing technologists thus face a chasm separating the world they know from the world in which computers are going to thrive in the future. To cross the chasm, they must embrace the emerging IT profession.

The chasm between scientists and citizens who live and work with technology extends much further than computing. Science journalist Takashi Tachibana says that the chasm between technologists and non-technologists widened during the 20th century into a gulf. Unless technologists can find ways to communicate effectively with the multitudes, the basic research enterprise feeding technological development will dry up and the average person will be unable to make well-grounded assessments about technology.

Struggles in the Growth of Computing

Moore's model suggests a successful company must chart a growth process that gradually expands to larger markets of people with different mindsets. The discipline of computing illustrates this well. Computer science has been subject to demands from pragmatists for a long time and has struggled across several small chasms along the way. The earlier crossings were the marriage of the separate roots of mathematics, electrical engineering, and science into the single discipline of computer science (1960s), embracing systems into the core of computing (1970s), embracing computational science (1980s), and embracing various branches of engineering such as software, computer, database, network, graphics, and workflow (1990s).

Computer scientists crossed these smaller chasms (which seemed quite large at the time) and are now facing the most challenging of all—the chasm that separates computing, the discipline, from IT, the profession.

To Cross the Chasm

Computing technologists need to adopt new practices in a number of related areas. The common aspect of these areas is the practice of listening to customers and working with them to take care of their concerns. This is not easy. Our tradition as inventors and visionaries is fresh; it inclines us to create products and then extol the virtues of our creations. Michael Dertouzos (director of MIT's Laboratory for Computer Science) calls this the supply-side mind-set—a practice of "creating goodies and throwing them over the wall" where the ordinary users pick them up and (hopefully) put them to good use. He contrasts this with a demand-side mind-set, a practice of listening to customers and developing technologies of value to them. There are six places to look as we do this.

• *Applications*. We use the term "applications" to refer to systems that apply our technological principles in specific domains of science, engineering, business, and commerce. For example, databases of medical records with user interfaces tailored to medical terminology, 3D imaging systems for MRI scans, and real-time monitoring systems for intensive-care patients, are medical applications. Applications bring us cheek-to-jowl with pragmatists. In fact, the words "applications" and "users" annoy these pragmatists: it sounds as if we think their world is subservient to ours. The way they see it, their world drives ours.

We need to come to grips with the fact that we are no longer in control of the field.

• *Innovation processes*. About 50 years ago, our forebearers articulated a "pipeline model" for innovation. This model became the basis of public policy for federal sponsorship of research in universities. According to this model, innovations result ultimately from ideas created by researchers or inventors; these ideas flow through a pipeline containing stages of peer review, prototype development, manufacturing, and marketing, with only the best ones reaching consumers as products. This model places a great deal of value on free and open exchange of ideas. However, during the 1990s another model emerged (actually, if you take a longer historical view, it reemerged) the marketplace model. According to this model, entrepreneurial groups experiment with technology, seeking to develop prototypes for market as quickly as possible. They place a great deal of value on transforming people's practices through new products and services. Many intend to sell their technology to a larger company rather than develop their own customer base. The flow times in the idea-pipeline model are a few decades and, in the marketplace model, a few years. The U.S. federal government funded most of the idea-pipeline research through federal grants in universities totaling approximately $10 billion in 2000, while venture capitalists funded entrepreneurs at the much higher level of approximately $50 billion. Both models are a reality of innovation and must be understood by professionals and taught in universities.

• *Interdisciplinary research and boundaries*. The newspapers and technical magazines are filled with stories about new technologies arising in collaborations between people from different fields. Look at the steady stream of IT inventions in medicine, libraries, business, e-commerce, biotech, entertainment, transportation, astronomy, telecommunications, science, and banking, to name a few. Look at the success of interdisciplinary research groups like the Santa Fe Institute, government research labs, and supercomputing centers. Look at all the interdisciplinary programs promoted by the federal research agencies. IT professionals need to become proficient and comfortable with interdisciplinary teams exploring boundaries of their fields.

• *Professional knowledge*. A person's professional competence is measured mostly by embodied skills demonstrated in action. Levels of competence, such as beginner, rookie, entry-level professional, proficient professional, expert, virtuoso, and master all refer to degrees of skill, responsibility, and strategic outlook. Professional knowledge is different from the conceptual knowledge we learn in most classrooms. It comes from experience, apprenticeship to more competent professionals, and lots of practice. IT professionals need to understand and appreciate both kinds of knowledge and to maintain a balance between the two.

• *Promoting fluency*. The Snyder Panel report, issued by the National Research Council's Computer Science and Technology Board in 1999, argued that it is our professional responsibility to promote understanding of IT among citizens. They maintained that "literacy" is too shallow. They proposed fluency instead, defined by a three-part framework: intellectual capabilities (such as algorithmic problem solving), concepts (algorithms, data representations, and limitations are some examples), and skills (such as using common desktop applications and the Internet, keeping up to date). The framework needs to be widely taught and adopted so that all citizens, regardless of profession, can work effectively with information technologies.

• *Lifelong continuing professional education*. Information technology changes so rapidly that much of it becomes obsolete within a few years. This affects concepts as well as facts. Many of the conceptual frameworks one learns as a student become obsolete over time as new concepts and principles are invented. Most universities pay little attention to continuing professional education, leaving graduating IT professionals with the impression that their bachelor's and master's degrees will last them a lifetime. Working professionals discover soon enough they need continuing education. Few find their alma mater to be of much help. They must look to community colleges, private vendors, corporate universities, and professional societies for help with continuing education. Universities ought to take this more seriously.

Obstacles

Various barriers exist in our education system and its interactions with business and industry. The main ones are:

• In other professional fields, the BS degree is not regarded as the entry degree for new professionals. One must undertake a period of apprenticeship such as medical residency or paralegal assistant before one can be declared a full-fledged member of the profession. In computing (and most of engineering) we try to make the BS the entry degree. It is misleading to let advanced beginners believe they are entry-level competent. Some serious curriculum reform is needed.

• In the university, IT faculty are not expected to practice professionally, as in health care, law, art, music, or theater. Faculty evaluations employ standards adopted from science and mathematics, which emphasize research publication. The curriculum emphasizes conceptual knowledge over embodied professional knowledge. The evaluation criteria favor pure computing areas over applications. In this environment, it's difficult to expect students to gain an appreciation for professional practice. It's difficult to bring in an experienced industry person as a tenured faculty member. And it's difficult to get interdisciplinary collaborations going and to teach students that such collaborations across field boundaries are a fertile source of inventions. (It doesn't help that members of the other disciplines often look to computing technologists as programmers and system technicians rather than as full partners.)

• Many engineers, scientists, and technologists outside of IT are well-versed in physical models and continuous math (such as calculus) but not in computational models and discrete math. The "engineering fundamentals" most engineers learn are based in "engineering science" and are light on IT or discrete math. This needs to be reexamined.

• The major universities pay little attention to continuing professional education. Their faculty members hold this activity in low esteem and leave it to service units, lower-ranked institutions, and private vendors.

• Many industry people do not see a need for a profession. IT workers are in short enough supply and any limitation on who might be hired would be unwelcome. Many industry leaders are supporting the uniform computer information transaction act (UCITA), which relieves them of responsibility for defective software and discourages professional responsibility for reliable, dependable software systems.

• Industry and academia do not cooperate well. There is a vast network of over 1,600 corporate universities whose annual spending equals that in the public universities—and yet there is almost no interaction between them and the public universities in regard to curriculum, professional degrees, and continuing education. Universities and businesses have difficulties agreeing on joint research projects because of intellectual property issues. Many business leaders are loath to support academic programs, believing the goveernment is already paying for them with their taxes. Industry hires almost all IT graduates but complains they lack working knowledge of technologies.

Signs of Progress

Although it is clear from the summary of obstacles we have a long way to go before successfully crossing the chasm, there are some hopeful signs that we will make it:

• There has been a strong positive reaction to the NRC report on fluency. Many teachers' groups are examining it for use in teacher training and in their K-12 curricula. Several universities are designing "IT across the curriculum" initiatives based on it.

• The ACM and IEEE Computer Society have cooperated successfully on the development of a major new curriculum proposal called Computing Curriculum 2001. It is based on the notion that the core curriculum in computing should be useful to the many fields that draw on computing and has been developed with considerable input from representatives of those fields. The proposed core is not the union of everyone's favorite concepts, but rather the intersection between the interests of the many participating groups. This curriculum will be a significant step toward a core curriculum for IT.

• There is a growing movement in universities to establish Schools of Information Technology based on a common, interdisciplinary IT core and offering a professional master's degree. In most cases this means combining departments of computer science, computer engineering, software engineering, information systems, operations research, engineering management, and possibly other IT-based groups into the one school. Under the auspices of ACM and the Computing Research Association (CRA), Peter Freeman (dean of Computing at Georgia Tech) has organized a community of IT deans.

• There has been strong growth in interdisciplinary research conferences, for instance, computational science and e-commerce.

• A growing number of universities are creating programs in e-commerce, network engineering, information security and assurance, and computational science—all professional and all interdisciplinary.

The previous struggles of computing to cross smaller chasms broadened the discipline and prepared it for the new profession. We are starting to move. Who said crossing a chasm is easy? C

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Further Reading

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