BUILDING A NEW ACADEMIC DISCIPLINE: INFORMATICS

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Abstract
In 1964 the author designed and implemented the first university-level program in information and computer science. This presentation offers a brief account of the key events that led to the birth of the discipline, and of the deliberations used to define and structure degree programs of instruction and research in the discipline. A personal view of the probable future evolution of informatics in academia concludes the presentation.

BACKGROUND EVENTS

In contrast to other presentations offered at this science symposium of the 20th Anniversary World Congress – presentations which describe the state of the art or advances in science -- I would like to go back in time, so as to reminisce how a new academic discipline came into being early in the second half of this century. I shall call this discipline by the generic term *informatics*[1], even though some refer it by other names, notably information science, computer science, computing, information processing and the like. Today there is no university in the world worthy of the name that would not have one or more programs of education and research in this discipline; and in many technical universities such programs are at the forefront of academic enterprise. It is rather remarkable that this growth, perhaps unprecedented in academia, has occurred in less than 40 years since the day when the Georgia Institute of Technology inaugurated its graduate program in information and computer science.

In hindsight, the impetus for informatics *qua* discipline of science came from two principal directions: specific developments in science and technology, and interest of society to exploit them for man's benefit. Interest in purposive organization of man's knowledge is probably as old as the invention of writing, although we have become really aware of it only after the discovery of ancient collections such as the library of Alexandria.

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[1] The term *informatics* was coined initially in the former Soviet Union as *informatika,* denoting modern management of recorded scientific and technical information [Mikhailov, Chernyi and Gilyarevskii, 1968]. It was subsequently adopted in France where *informatique* was given the broader connotation of applied computing. The United States, with its early emphasis on the technology of information processing, has favored the phrases *information science* and, in particular, *computer science* (or engineering). The currently preferred American designation of the fields is *computing*, in recognition of the ubiquity of information processing; European and Far Eastern preference is for the equivalent concept *informatics*.

Ontology (the study of organization of concepts) and classification assumed increasing importance in view of the exponentially growing volume of recorded information that began accumulating after the invention of the printing press. In our century one particular category of recorded information, namely scientific and technical information, acquired an economic dimension as a key element affecting the prosperity of manufacturing firms and even entire industries, and new techniques in librarianship were promulgated under the headings of special librarianship, documentation, and eventually information science.

The phrase "information science" came into broader use after World War II, designating concern with managing the growing proliferation of scientific and technical information, and with husbanding it more effectively as one of the nation's resources. Almost overnight, the concern affected most industrialized countries, with both market and planned economies. In the United States, the 81st U.S. Congress directed the National Science Foundation in 1950 to "foster an interchange of scientific information among scientists of the United States and foreign countries". And less than a decade later, the 89th U.S. Congress authorized NSF in 1958 to establish a Science Information Service through which the Foundation "shall (1) provide, or arrange for the provision of, indexing, abstracting, translating and other services leading to a more effective dissemination of scientific information; and (2) undertake programs to develop new or improved methods, including mechanized systems, for making scientific information available" [Slamecka, 2000].

One of the important aspects of the NSF charge was manpower development: the vision of new techniques and systems for information handling was being readily elaborated [National Academy of Sciences, 1959] but the cadre of highly skilled individuals capable of implementing it was very small or nearly nonexistent. To generate considerate ideas for what knowledge and skills such manpower should possess, the NSF contracted with the Georgia Institute of Technology to organize two international conferences on the subject; these took place in Atlanta in 1961 and 1962, respectively. A year later, the Institute petitioned the Board of Regents of the University System of Georgia to approve the establishment of a new academic unit of the Institute and a new designated graduate degree of Master of Information Science; and it approached the NSF with a request for financial support of the new program. Both proposals were approved, and the new unit admitted the first students in the fall of 1964.[2]

I joined the Institute in summer 1964 as Professor and Director of the School.

A PERSONAL NOTE

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[2] NSF simultaneously awarded a second grant to Lehigh University, of Bethlehem, PA. Lehigh proceeded to establish a "center" for information science which offered several course and conducted research in information retrieval.

In my life I have often been struck by the importance of chance – when being at a particular place at a particular time "causes" a totally unanticipated, major event in one's life to occur. My appointment to establish the academic program of the new discipline was one such event. By various coincidences I had probably acquired a reasonably appropriate background for the challenge. I studied engineering at a technical university in post-war, pre-communist Czechoslovakia; physical sciences and philosophy at the University of Sydney; some social sciences at the University of Munich; and librarianship and computer science at Columbia University in New York. After earning a doctorate from Columbia in 1962 I spent two years heading research at a private firm in Washington, DC, which was one of the world's first companies paving the use of computers in processing non-numeric information. Many of the techniques we take for granted today were invented or perfected there during this time: text retrieval, query language design, Uniterm indexing, computer-aided text condensation and translation, various machine techniques of linguistic analysis that have become staple tools of artificial intelligence later on, as well as computer programming techniques and constructs such as database management.

It was nevertheless a complete surprise when, after delivering a paper at an international meeting at the University of Chicago, a group of administrators attending this conference from the Georgia Institute of Technology invited me to Atlanta.
After three days of interviews and public lectures, the offer that was made was one I could not refuse: how many people are given an opportunity to define and build a new scholarly discipline?

DEFINING THE CONTENT OF A NEW DISCIPLINE

How does one go about designing an academic program for a discipline when there exists no precedent for such a program? The topic might perhaps be addressed adequately in an extensive treatise but hardly in a 20-minute presentation. I shall ignore the more obvious needs: the plant (classroom, laboratory and office space; equipment for each of these; meeting rooms; parking; etc.), and hiring of the faculty (a function of the degrees offered, the size of the student body, and the allocated positions and funds). I would, however, like to comment briefly on two other components of paramount importance: the curriculum, and the research program.

The curriculum reflects the scope of the discipline, and it implies the limits of the exit competencies of the department's graduates. In the case of the new School, three designated degree programs were planned and actually implemented: the master's degree (M.S., 1964); the doctoral degree (Ph.D., 1968), and the undergraduate degree (B.S., 1972). Given a number of specialized "options" (tracks) in each degree program, the size of the curriculum would soon became considerable (about 50 courses in 1970, and 80 in 1975). These mechanistic dimensions, and the expected numbers of students to be served, were relatively easy to estimate. Without doubt the most crucial, and most difficult, task was to define the scope of the discipline: what subject areas comprise it, and how are these likely to evolve in the next 10-15 years? These questions demanded a *vision* of the discipline, of its societal role, and of its future evolution. For professional education, they demanded divining the types of knowledge and skills society required, both then and later.

Fortunately there existed a few very thoughtful visions speculating about the future interaction between human beings and information. The earliest of these was an article by Vannevar Bush, a post-war science adviser to the President who forecast instantaneous access to recorded information by any person, from anywhere [Bush, 1945]. An even more seminal document was written in1961. In it the M.I.T. scientist J.C.R. Licklider actually defined requirements for designing so-called "precognitive systems" [Licklider, 1961] -- systems that come very close to the information utility we know today as the Internet.

In these and other considerations of the impending "age of information", the key to its onset was the digital computer. Since its invention in the 1940s a new body of knowledge, and a new scientific community, began to accumulate rapidly under the name "computer science". As a discipline, computer science of the day focused largely on the machine, its operation and programming, and on its processing of the various signs and signals that represent information digitally; it was not particularly occupied with information processes, or with human and societal uses of information (as was information science). This notwithstanding, there could be no doubt that the indispensable factor that would enable the exciting prospects for advances in human processing and utilization of information was technology – specifically, *digital* technology; after all, it was technology (the development of writing, the invention of paper, and the invention of the movable printing press) which make possible the earlier quantum steps in human information communication. This truism dictated that the programs of the new School must comprise much if not most of the contents of computer science; and it motivated the formal change, in 1965, in the name of the department to School of Information and Computer Science.[3]

While in the 1960s the field was preoccupied with processing printed natural-language text, it was apparent already then that the geometric growth of the digital computer's speed and capacity, as predicted by Moore's Law[4], would in time allow computers to process digitally other analog forms of information such as images, sound and speech, and motion video. By the same token, the concept and postulated development of the "information utility" implied the need to study and understand analog and digital telecommunications.

It was this future-oriented, quasi-engineering perspective that defined, from the beginning, the scope of the discipline embraced by the School of Information and

[3] In 1990 the School's name was changed to "College of Computing".

[4] Moore's Law states that the number of transistors a computer chip can hold will double every 18-24 months, leading to a corresponding increase in performance. Currently (year 2000) chips contain up to 42 million transistors and run at a speed of 1.5 GHz. Chips with 400 million transistors running at 10 GHz are expected to be available in five years.

Computer Science, and that imparted it its quantitative orientation. The latter proved fundamental, as most of the liberally oriented schools of librarianship would soon close their doors. The choice word to describe this perspective is "multidisciplinary" – but that characteristic caused a number of unexpected consequences. The most taxing of these was the need to design and teach a large number of courses, basic and advanced, that should have but did not exist elsewhere at the Institute: courses in finite mathematics, logics, linguistics of natural language, human information processing, systems theory, information economics, communications – all in addition to the required new courses in information processes and systems, and in computer hardware and software. (The ensuing impact of the introduction of these courses was more predictable: unhappiness in other university departments over "turf encroachment".)

FORMULATING A RESEARCH PROGRAM

In mid-1960, research in information and computer science was beginning to thrive, with support of agencies such as NSF, ARPA, NASA and NIH. The issue facing the new School was a balance between basic and applied research, given that it had chosen to support both a professional (baccalaureate and master's) and a theoretical (doctoral) program of education.

The basic research program was defined largely in terms of interest of individual faculty members. Because some of them had "migrated" to the new discipline from other fields, the School sought, and was awarded by the NSF, three-year unrestricted financial support for them and their graduate students. The initial basic research directions selected included problems in semiotics, linguistics, systems theory, information processing, programming languages, theory of computing, and other.

The research predisposition of other faculty members, including mine, favored addressing relevant societal applications of information technology. Two examples from the era of 1965-1975 include 1) medical informatics (an innovative degree program in medical information and computer science was implemented jointly with the Emory University School of Medicine; and a prototype of an advanced patient record system then designed currently supports one of the largest patient databases in the U.S., at the Grady Memorial Hospital in Atlanta); and 2) distance learning (a computer-aided system for remote self-instruction was actually installed and used by the Georgia Governor's office in mid-1970s).

As the size of the School and of its faculty grew, so did its scholarly productivity. The combined scholarly output of the School during the first 15 years comprised nearly 300 publications [Slamecka and Gehl, 1978].

SUBSEQUENT EVOLUTION OF INFORMATICS

The program in information and computer science at the Georgia Institute of Technology established a broad, multidisciplinary model of the discipline. In its first decade, a number of universities in and outside the United States adopted this definition and built similar programs. Others, including most U.S. departments of computer science, opted for narrower, computer-delimited definitions of the field; these dominated the U.S. university scene during the decade of the1980s. Since 1990, however, after the U.S. Congress again expressed a strong preference for society-oriented science and technology, leading American universities have begun to revert to broader, multidisciplinary models of the field, often under the designations of “computing” or “informatics”.

Overall, many of the early visions of the coming of the “information age” have proved almost uncannily accurate, and over the past 40 years have led to today’s designs and applications of information processing techniques, devices, systems and utilities [Slamecka, 1994]. The field is now attempting to identify probable future trends and dimensions of the academic discipline of informatics. In my personal opinion, information technology has by now largely mastered the processing and multilateral conversion of the visual and aural (and soon olfactory and tactual) signs and symbols that man’s senses perceive as inputs to and outputs of the human mind. (This is not to suggest that the designs and applications based on present-day technology have run their course: as Moore’s Law continues to predict performance characteristics of digital technology for at least the next decade, we can look toward developing digital devices ten time as powerful as those of today, and toward new applications that are beyond the ability of today’s technology.) However, despite some early and largely unmet expectation of artificial intelligence, the information processing algorithms of the human mind are not understood. Their elucidation, and eventual programming on automata, appears to be the next grand challenge of informatics.

To deal with this challenge, informatics is repositioning itself on the academic field. At present it is forging “strategic alliances” with disciplines previously ignored: the cognitive sciences, neural biology, and biochemistry. Meanwhile, theoretical computer science is closely following work in molecular biology and quantum physics, the two areas from which there may emanate the next generation of computing devices that promise to be orders of magnitude more powerful than machines built from silicon chips. A still different impetus is coming from a new interdisciplinary field derived from materials science and called nanotechnology; it envisions to be able to design and produce inexpensively machines and other products, including self-reproducing automata, from molecules and atoms. Optical sciences intend to contribute new optical and laser cable strands of unprecedented capacity. Going in the opposite direction, the medical sciences and schools have just signaled, through a broad initiative of the National Institute of Health, their intent to embrace biomedical informatics as an integral component of *their* intellectual domain and institutions.

These are some of the symptoms of the metamorphosis that the discipline of informatics may expect in the future. They are part and example of the increasing rate of recombination among the fields and specialties of science itself. It remains to be seen how well this new dynamism of science can be supported by the institutional structure of science, particularly the universities.

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