CURRENT TRENDS IN THE ACADEMIC ORGANIZATION OF U.S. INFORMATION SCIENCE AND TECHNOLOGY PROGRAMS

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Abstract *¾Since their inception in the late 1960s, academic programs in information science and technology (IS&T) in the United States have almost exclusively been assigned to colleges of arts and sciences, engineering, or business. Moves between academic units have largely been due to considerations arising from local academic politics. The recent explosion of academic and industrial interest in computing and its applications has led to a general realization that education and research in IS&T cannot be limited to narrowly defined academic units. A natural response would be to form broader academic units comprising all of the core information science and technology disciplines. The fact that this has not happened is largely due to significant institutional and cultural barriers between the academic units currently housing IS&T programs. Very recently, several efforts have been made to bridge or evade these barriers. This paper will discuss and contrast these efforts and their implications for the future of IS&T education.*

Index Terms ¾ academic organization, computing disciplines, information science and technology, undergraduate education

U.S. INFORMATION SCIENCE AND TECHNOLOGY DEPARTMENTS: ORIGINS AND DEVELOPMENT

Computers first appeared on the campuses of United States universities in the 1950s. By the 1960s, they were widely used for research and administration and courses dealing with aspects of computer programming were starting to appear. The academic units offering these courses were primarily determined by the affiliation of the faculty members teaching them. Typical locations (and some of the early courses) were mathematics and physics departments (Fortran programming, numerical analysis), colleges of business (Cobol programming, management information systems), engineering (Fortran programming, logic design), and even library science (information retrieval). New courses were steadily introduced, keeping rough pace with the rapid development of computing. By the end of the 1960s, these courses evolved into complete degree programs in the information science and technology disciplines.

The new degree programs did not initially result in the creation of new academic units. Computer science degrees were usually offered within mathematics departments. Computer engineering was generally a concentration within an electrical engineering degree program, just as "management information systems" was a concentration within an undergraduate business administration program. Gradually, however, departments were split off or restructured to offer the new programs. Most commonly, these departments remained in the academic unit of origin. For example, computer science departments that split off from mathematics departments most often remained in a College of Arts and Sciences. Similarly, a newly restructured Department of Electrical and Computer Engineering remained in a College of Engineering, and a Department of (Management or Computer) Information Systems remained in a College of Business.

There were some initial attempts to break with this pattern. For example, the University of Michigan's first computer science degrees were awarded (under the rubric of "communication sciences") as early as 1959. Shortly thereafter, John Holland and Arthur Burks helped to form a Department of Computer and Communication Sciences in Michigan's College of Literature, Science, and Arts. The organization and affiliation of this very successful academic unit lasted for three decades.

Similarly, Georgia Institute of Technology founded its School of Information Science in 1964, offering. a Master's degree in information science [3]. A doctoral program was added in 1968. The school changed its name to "Information and Computer Science" in 1970 and added an undergraduate program in 1972.

Academic programs in the IS&T disciplines tend to be relatively expensive to run. These programs needed (and to some degree still need) specialized hardware and software and sophisticated system administrators. The U.S. tradition of paying discipline-based market-rate salaries to faculty strained department and college budgets, while also leading to increasing divergence between salaries of computer science faculty and arts and sciences faculty. The situation was exacerbated by a shortage of IS&T faculty at the end of the 1970s, due at least in part to the ability of industry to pay higher salaries and provide better computing environments [2]. It became difficult for research-oriented departments to hire qualified faculty, and the situation was considerably worse for teaching-oriented departments.

The strains of this period did not fall equally on the various academic units. At most U.S. universities, colleges of engineering and business have more resources than colleges of arts and sciences. Furthermore, salary divergences

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between IS&T faculty and other faculty in engineering and business tend to be less pronounced than those in arts and sciences. It is therefore not surprising that the last two decades saw many computer science programs moving to colleges of engineering. Some of these programs were housed in departments of computer science that simply changed their college affiliation. Other programs found homes in restructured departments with names like "computer science and engineering" (Arizona State University), "electrical engineering and computer science" (University of Kansas), "computer science and computer engineering" (University of Missouri), and even "electrical and computer engineering and computer science" (University of Cincinnati). These moves and restructurings most often resulted from considerations of local academic politics, rather than careful consideration of the most suitable location for a computer science program.

Some program names tried to pay homage to a broader view of the computing disciplines. Examples include "information and computer science" (Georgia Institute of Technology, University of California at Irvine) and "computer and information science" (University of Florida). A few computer science programs remained in departments closely linked to their roots in mathematics (e.g. "Mathematics and Computer Science" at Kent State and Drexel Universities).

AUTONOMY: SCHOOLS AND COLLEGES OF COMPUTER SCIENCE

At the same time, a few programs were able to convince their institutions that computing was a discipline that needed an autonomous academic status alongside engineering, business, and arts and sciences. The leaders in this effort were Carnegie Mellon University and Georgia Institute of Technology. Carnegie Mellon's School of Computer Science (http://www.scs.cmu.edu) was founded in 1988, 25 years after CMU initially formed a department of computer science. Georgia Tech's College of Computing (http://www.cc.gatech.edu) was formed in 1990, 27 years after the foundation of its school of information science. The research and educational activities of these autonomous units place them at or near the top of all rankings of U.S. computer science programs. The Carnegie Mellon and Georgia Tech units both contain laboratories and institutes devoted to specialized topics within the computing disciplines. For example, the School of Computer Science contains a robotics institute and a language technologies institute, and the College of Computing contains a cognitive science program and a graphics, visualization, and usability center. Both of these units are headed by deans. However, neither unit includes faculty or degree programs in computer engineering or information systems. Despite their size and success, both of these units are best regarded as college-level computer science departments.

OPENNESS TO OTHER DISCIPLINES: COLLEGES WITHOUT WALLS

Granting autonomous academic status to a computer science department tends to give the new unit access to more resources, while also allowing it to respond more flexibly to new opportunities and challenges. However, these units are effectively still computer science units, and as such are tied to only one of the IS&T disciplines. This limitation is serious and restrictive; ideally, an autonomous IS&T unit should carry out research and education across the IS&T disciplines. It is also important that an effective autonomous IS&T unit be able to reach out to scholars and programs across campus who have interests in developing or applying the rapidly evolving computing disciplines.

Recently, several attempts have been made to develop a new approach to the academic organization of the computing disciplines that can address these limitations. In 1999, a Cornell University task force was charged with investigating how Cornell should address the central role played by computing and information science. The task force's primary recommendation was to create a new campus unit called a Faculty, initially named the Faculty of Computing and Information (FCI). According to the task force report, "This Faculty is intended to complement the traditional academic structures of the university in order to provide more flexibility to respond to new educational and research needs in the fast-paced Information Age". [1] The idea is that the FCI, headed by a dean, should contain Cornell's Computer Science Department, but should also cut across the usual college structure by including faculty whose primary affiliation is with other departments. The FCI will also have a broadly based governing board.

The task force report lists the responsibilities of the FCI as follows:

- offering computer science degree programs at all levels
- developing and overseeing a university-wide undergraduate computing program
- creating interdisciplinary programs of computing research and scholarship in computational science, social impacts of computing, and digital arts
- creating new educational programs bringing the ideas of computing and information science to all disciplines

While Cornell's model is both innovative and ambitious (it has recently been emulated by Duke University), it is important to look at what it omits. It makes no significant change in Cornell's existing structure of departments and degree programs. Computer Science moves from the College of Engineering to the FCI. Computer Engineering remains in its department and college, with the hope that some of its faculty will also affiliate with the FCI. No change is envisioned for the computing-related programs in Cornell's Business School. The task force report takes pains to emphasize that the FCI is not a college, and also to assert

that college boundaries are likely to inhibit interdisciplinary activities. It might be best to describe the FCI as a "college without walls".

OTHER RECENT MODELS

The two models discussed so far either promote a computer science department to a college, as implemented by Carnegie Mellon, Georgia Tech (and also at about the same time by Northeastern University), or create a "college without walls" centered on a department of computer science, as proposed by Cornell and Duke.

Very recently, several universities have introduced or proposed new academic units for the computing disciplines with organizational models that depart from the two described above.

(a) Indiana University has established a School of Informatics (SI), headed by a dean, whose vision is given as "studying the art, science, and human dimensions of information technology" (http://informatics.indiana.edu). The SI spans Indiana's Bloomington and Indianapolis campuses; it offers a bachelor's program in information technology, Master's programs in bioinformatics, chemical informatics, health informatics, human-computer interaction, and several programs dealing with new media. Indiana's SI is orthogonal to its existing IS&T departments (Computer Science, Accounting and Information Systems). It has its own faculty, some of whom also have faculty appointments in Computer Science or Accounting and Information Systems.

(b) Pennsylvania State University has established a School of Information Sciences and Technology (SIST) (http://ist.psu.edu). The SIST is also orthogonal to Penn State's existing IS&T departments (Computer Science and Engineering, Management Science and Information Systems). As at Indiana, Penn State's SIST is distributed over multiple campuses. It offers degree programs at all levels in Information Sciences and Technology. It has its own faculty, some of whom also have faculty appointments in other IS&T departments.

(c) Colorado State University has just established a Virtual College (VC) (of information science and technology) charged with coordinating all campus activities in IS&T disciplines. The VC has no dean, contains no departments, and awards no degrees, but rather provides a forum for representatives of all departments with IS&T interests to interact across college boundaries. The VC core departments are Computer Science, Electrical and Computer Engineering, Computer Information Systems, and Journalism and Technical Communication. The VC is responsible for an undergraduate minor in information technology and for several online professional Master's degrees. It is also expected to propose and create new IS&T programs that reach into all disciplines.

(d) New Jersey Institute of Technology has just created a College of Computing Sciences (CCS) that contains two newly formed departments: Computer Science and Information Systems. These departments were formed by splitting a single department (Computer and Information Science), formerly located in NJIT's college of science and liberal arts. The CCS is headed by a dean. It is charged with spearheading educational and research activities in a broad range of computing disciplines. For example, NJIT currently offers degrees at all levels in a number of IS&T disciplines (computer science, information systems, information technology, human-computer interaction, computational biology, biomedical computing). Some of these programs are jointly offered with other units on campus and at other institutions. The CCS is expected to nurture these programs and collaborations while also developing new ones It also has campus-wide responsibility for an interdisciplinary undergraduate information technology program.

The responses of U.S. universities to the organizational challenges presented by information science and technology can be characterized in terms of five models: promote a computer science department to an single-department college (Carnegie Mellon, Georgia Tech, Northeastern); create a "college without walls" based on a computer science department (Cornell, Duke); create a college-level unit orthogonal to existing departments, possibly including some faculty shared with other units (Indiana, Penn State); transform an existing department into a college that contains multiple departments (NJIT); create a "virtual" unit that crosses college boundaries (Colorado State).

CONCLUSIONS

The universal impact of information science and technology on all academic disciplines and professions makes it extremely difficult to identify a reasonable or effective home for IS&T within the traditional organization of U.S. universities: colleges of arts and sciences, engineering, business, medicine, etc. The five models described above are all attempts to deal with this issue.

The primary components of the problem are structural and cultural. The structural issue arises from the way in which U.S. universities generally assign resources

(budget, space, faculty lines, …). Resource allocations to college-level units are based at least partly on student interest and enrollment. Existing units are therefore not usually willing to yield their computer-related departments and programs to a newly created unit, even if a compelling argument can be made for its intellectual cohesion and academic potential. The cultural issue arises from the fact over the past decades, distinct academic cultures have arisen in colleges of arts and sciences, engineering, and business. Cultural differences can occur with respect to a wide range of academic issues. Examples include the relative emphasis placed on undergraduate and graduate teaching, publication practices (e.g. conferences vs. journals), and the weight given to consulting in tenure and promotion consideration. These cultural differences make it difficult to form a new college-level unit composed of departments formerly housed in different colleges. In particular, none of the new IS&T units have so far succeeded in including programs previously housed elsewhere. In particular, they include no departments formerly housed in engineering or business colleges.

In this context, the most straightforward solution is simply to promote an existing computer science department to a college-level unit, as at Carnegie Mellon, Georgia Tech, and Northeastern. The new unit gains significantly greater autonomy, flexibility, and access to resources. Unfortunately, its share of the IS&T spectrum is limited to computer science.

Cornell and Duke have addressed the limitations of a college-level unit based on a computer science department by making the boundaries between units more permeable. While the core of the new unit is still computer science, Cornell and Duke explicitly invite participation by faculty from other units and departments. This approach should make it much easier to create new degree programs and concentrations that cross departmental and college boundaries. Furthermore, the Cornell-Duke model gives the new unit campus-wide responsibility for new IS&T programs. Colorado State has adopted a similar strategy, but has chosen to avoid the obstacles and pitfalls of campus politics by creating a virtual unit. The success of permeable-boundary models depends on the commitment of the collaborating colleges to close collaboration over the longer term. If this collaboration cannot be sustained, the Colorado State model reverts to independent departments in separate colleges. The Cornell-Duke model should be more stable even in the absence of collaboration, since the computer science department is included in the new college-level unit.

Indiana and Penn State have taken quite a different approach, creating orthogonal college-level units that offer only explicitly interdisciplinary degree programs. It remains to see how these programs will fare in competition with the traditional IS&T programs (computer science, computer engineering, information systems).

New Jersey Institute of Technology is the only research-oriented U.S. university that has chosen to create a college-level unit containing more than one department. The two departments in the new unit give it the potential to represent a wide range of IS&T disciplines and applications. As with the Cornell-Duke model, the new NJIT unit has campus-wide responsibility for new IS&T programs. NJIT currently offers a wide range of IS&T degree programs and hosts several IS&T research centers. Many of these programs and centers activities are explicitly interdisciplinary. The disciplinary range of the new unit should allow it to strengthen and extend these programs.

U.S. universities have adopted a number of innovative approaches to deal with the limitations imposed by their organizational structure in the light of the universal impact of information science and technology. Similar problems and opportunities arise in the biological sciences, and they are also the focus of intense organizational innovation. The impact of genomics, proteomics, and computational biology is analogous to that of IS&T, and the biological sciences are also distributed across a variety of academic units (arts and sciences, human and veterinary medicine, agriculture).

Each university's approach to IS&T is conditioned by its internal and external context. Relevant factors include quality and size of IS&T programs and departments, competition between these units, competition with other universities, and interaction with industry. The first two factors are essentially local, but the others may be local, regional, or national. Similarly, the effectiveness of each approach, with respect to the university's education, research, and service missions, will vary with the institution's context.

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