The Beginning of a New Discipline:
Undergraduate Telecommunications Programs
in the USA

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Abstract:

A new academic discipline is evolving from within Information Systems Programs. In this paper we present a description and comparison of fledgling undergraduate Telecommunications degree programs in the United States. We conclude that such programs have common characteristics and that this may eventually lead to official accreditation as is currently being studied by ABET.

Keywords: telecommunications curriculum, networking, Internet, Information Systems education

1. INTRODUCTION

Broadly defined, telecommunications refers to the transmission of voice, data, graphics, and video information at a distance (Bone 1985). Telecommunication as a distinct discipline of study separate from within Information Systems (IS) curriculum is just now evolving. This is partly due to recognition of the pivotal role it will play in our future. Telecommunications will change our lives in the next 20 years with at least the same magnitude that computers have changed us the last 20 years. The rapid growth and diversification of the telecommunications industry and its user community has produced a large and growing demand for people with education and credentials as a professional who understand and can use telecommunications to manage the most valuable strategic asset: information. Every type of organization needs experts in the technology, applications, human factors, policy, management, and the many other facets of telecommunications.

The growing importance of telecommunications within IS Programs has led to curriculum developments to add courses and eventually to separate Telecommunications Programs (Barnard et al. 1996). Information Systems (IS) does not own the entire discipline – there is much going on that is not being covered even in proposed IS accreditation curriculum (Denning 2001).

As early as 1992, NSF issued a report expressing urgent need for undergraduate educational programs (courses and laboratories) to reflect the rapid advanced in telecommunications (NSF 1992). While being slow to change curriculum due to inertia is both good and bad, industry will not wait - as can be seen by the explosion of self-study accreditation programs in telecommunications-related topics.

It has been estimated that it takes about two years to train a competent telecommunications technician (Stamps 1985). Twenty years ago, when telecommunications industry was a monopoly, finding skilled people to manage networks was an easier task. As they did for so all of their telecommunications needs, companies relied on the Bell System (AT&T). AT&T was split in 1984 and those days are long gone. Now industry must rely on academic telecommunications programs.

Distinct Telecommunications Programs first appeared in the United States in 1971 when the first graduate program was instituted at the University of Colorado at Boulder. A year later another graduate program was introduced at the George Washington University. In 1974, the first undergraduate telecommunications program was started at Texas A&M University, a third graduate program was started at Southern Methodist University, and night classes for working professionals began at the Golden Gate University (Lewin 1980).

Much of the credit is owed to the International Communications Association (ICA) which provided grants to help start telecommunications programs and facilitate their development since the early 1970s.

Table 1: The Number of Undergraduate Telecommunications Programs in the USA by year

1982	7	(Clemmensen 1982)
1986	37	(Clemmensen 1987)
1997	42	(ICA/CBTA 1997)
2001	206	(Peterson's Guide 2001)

Table 1 shows the dramatic growth of the number of academic telecommunications programs. As an academic discipline, telecommunications is in a similar state to that of computer science in the late 1960s. Many programs have evolved from within computer science departments, electrical engineering departments, schools of business administration, or programs in broadcast communication. At the present time there are few stand-alone "Telecommunications" Departments - the authors are only aware of three: Bowling Green University, Indiana University, and Michigan State University. Currently telecommunications programs are most likely to be located within an established department (different departments at different universities) and most likely at the graduate level. The placement of the telecommunications program within an academic department usually determines the focus of the courses at that particular university – technology-based hardware/software systems versus management/policy/ law versus mass media/broadcasting.

The remainder of this paper is organized as follows: Section 2 presents common characteristics found across different undergraduate telecommunications programs in the United States. Section 3 briefly presents two specific telecommunications programs in depth. Section 4 presents insights for discussion derived from surveying the breadth of different programs. We end with a summary and conclusions in Section 5.

2. COMMON CHARACTERISTICS OF UNDERGRADUATE TELECOMMUNICATIONS PROGRAMS

The technology and marketplace of telecommunications has changed and continues to change so quickly that there is no general agreement on precisely what is comprehended by the discipline of "telecommunications." Established lines between academic departments are consequently being broken down and reconfigured in various ways in order to stake out areas defined as telecommunications. Each program, therefore, has its own emphasis and approach to the subject.

While there are some programs that concentrate exclusively on one core area, the clear trend is to encompass the multiple dimensions of telecommunications in interdisciplinary or integrated programs that expose students to the diverse areas of the field they are likely to encounter during their career. A sample of some of the many programs and their main area of focus are listed in Table 2.

Table 2: Undergraduate Telecommunications Programs (with their corresponding focus area and location within the university)

Illinois State University	B.S. Telecomm Management	Dept. of Applied Computer Science
New York Institute of Technology	B.S. Telecomm Management	School of Engineering and Technology
Ohio University	B.S. Comm. Systems Mgmt.	School of Comm. Systems Mgmt.
Rochester Inst. of Technology	B.S. Telecommunications Engineering Technology	Dept. of Electrical, Computer & Telecommunications Engineering Tech.
St. Mary's University of Minnesota	B.S. Telecommunications Management	Undergraduate Programs
SUNY Inst. of Technology at Utica	B.S. Telecommunications	School of Info. Systems and Engineering Tech.
University of Missouri-Kansas City	B.S. Comp. Science with emphasis in Telecommunications	Computer Science Telecommunications Program
University of Nebraska-Kearney	B.S. Telecommunications Management	Dept. of Industrial Technology

A common thread that runs through all undergraduate telecommunications programs is general conformance to core areas originally recommended by ICA although there is not a standard telecommunications curriculum or accreditation board and no consensus exists on which type of program is better. What is best for the individual student often depends on his or her background/interests and anticipating what future employers will value. There is a consensus, however, that telecommunications is a growth field and that more professionals with solid credentials are needed at all levels.

The telecommunications core areas recommended by the ICA in 1986 include:

- telecommunications basic concepts
- telephone systems
- data communications
- industry survey
- data systems
- economics of telecommunications systems
- telecommunications internship

It is notable that telecommunications policy was not listed as a core area in 1986. Of course, with telecommunications being such a dynamic field, these core areas are being continuously redefined with some

core areas being de-emphasized as new areas emerge. The current proposed criteria for an undergraduate telecommunications engineering program include these six required outcomes: (ABET 2001)

1) the application of technical topics such as electric circuits, computer programming, associated software, analog and digital electronics, voice and data communications, and telecommunications systems

2) the applications of physics in a rigorous algebra/trigonometry environment as a minimum

3) ability to analyze, design, and implement telecommunications systems

4) ability to analyze and implement switching technologies, wide area networking technologies, and policy

5) ability to manage, design, and plan wide area networks

6) the ability to utilize statistics/probability, transform methods, or applied differential equations in support of telecommunication systems and wide area networks

It is probably an understatement to say that consensus is absent among academics, or within industry, on the question of whether telecommunications education ought to include training in the sense of imparting specific proprietary skills (certifications) that are at the same time both temporal and highly marketable.

Complete laboratory facilities are increasingly common among telecommunications programs with a technology focus. In large part due to donations from vendors and private corporations, more universities have laboratories where students can gain hands-on experience on the very technologies they are studying including circuits, network equipment, routers/hubs, switches (PBXs, central office, packet, photonic), and many software development tools and applications (particularly network management software).

There exist two contrasting models for Telecommunications Programs: *interdisciplinary* versus *integrated* (Clemmensen 1987). Interdisciplinary programs tend to span course curriculum offering courses in all of the core subject areas while integrated programs tend to offer fewer core courses overall.

In an interdisciplinary telecommunications program, multiple diverse disciplines (engineering, economic, legal/regulatory, policy) are studied with no single discipline dominating (Clemmensen 1982). Interdisciplinary telecommunications programs can be thought of as developing around the core technologies of telecommunications and drawing resources from various related disciplines as appropriate. The ability to view technological problems from different perspectives (engineering, economic, legal/regulatory, policy) simultaneously has become achievable though the establishment of such interdisciplinary programs.

Integrated telecommunications programs can be defined as programs integrating a discipline with a technology. As examples: public policy integrated with telecommunications technology (Georgia Institute of Technology). Integrated telecommunications programs award a conventional degree for study based in one of the traditional disciplines (computer science, electrical engineering, economics) but broadened by in-depth study of telecommunications technology. Integrated telecommunications programs have broadened traditional studies to consider the technology from the vantage point of only one of the disciplines thereby encouraging specialization and offering insight into the several disciplines concerned with telecommunications.

Telecommunications programs may graduate generalists or specialists depending upon disciplinary emphasis and program structure. This generalist versus specialist distinction is important because it affects both the program's output (what students eventually become after graduation) and a program's input (the type of students the program attracts for admission). In planning a program entrance requirements should be considered – should a diversity of prerequisite education be encouraged as it is in a generalist program or will it be specifically minimized as in a specialist program.

The most common type of course in a telecommunications degree program is the survey course. Characteristically, these survey courses provide a minimum of engineering skills but perhaps enough for a telecommunications generalist.

Each Telecommunications Program has had its own unique development that has led to corresponding strengths and weaknesses. In Section 3 we look more closely at two specific undergraduate Telecommunications Programs to show examples of how different programs have uniquely developed.

3. SPECIFIC UNDERGRADUATE TELECOMMUNICATIONS PROGRAMS

The two programs specified in this section by no means replace analysis of the complete list of undergraduate Telecommunication programs but rather represent different types of programs that have been successful – generally considered the premiere undergraduate telecommunications programs. There is a wide range of programs designed to meet the growing need for telecommunications professionals. Some of the

programs focus on the technical aspects (SUNY-Utica). Other programs focus on management aspects producing analysts and managers who can understand the needs of organizations as well as technology in order to plan, design, implement, and manage networks (Ohio University). Still other programs focus on the social and economic context of telecommunications – the industry, its impact on society and regulatory frameworks (Indiana University). Many programs combine elements of all of these (ICA/CBTA 1997).

Telecommunications / SUNY-Utica
<http://www.cs.sunyit.edu/ISET/telecom/>
Interdisciplinary telecommunications programs at the undergraduate and graduate level are offered are offered at the SUNY-Utica Institute of Technology. Since its inception in 1985, there have been over 500 graduates. The undergraduate program builds upon three areas of study: electrical engineering, computer science, and management. The interdisciplinary nature is designed to teach technically oriented students the business aspects of telecommunications. Topics covered in coursework include products and services, vendor selection, voice/data integration, network design and administration, network management, domestic and international telecommunications policy. The program maintains close ties with industry with an advisory board of 40 industry executives. Students in this program will have the advantage of learning in a "living laboratory" with hands-on experience with state-of-the-art technology cooperatively developed with industry.

Communications Systems Management / Ohio University
<http://www.csm.ohiou.edu/>
Ohio University, in Athens Ohio, has a B.S. undergraduate program in J. Warren McClure School of Communications Systems Management (CSM) that was established in the early 1981. The program has some 700 graduates and about 200 students currently enrolled. In 1988 the School was named in honor of J. Warren McClure, an alumnus and former newspaper editor and Gannet executive. Plans are underway to establish a master's-level program. CSM is a comprehensive four-year undergraduate program in the design and management of voice, data, and image communication systems. CSM focuses on business applications of communication technology. The program's core courses include network design and management, data communications, voice processing, voice and data equipment, the history of the telephone industry, regulatory and public policy issues, system security, project management, international communications, and other issues. Students are required to complete 11 courses related to business administration, as well as courses in public speaking, technical writing, statistics, and computer science. Extensive lab work is required and the University has switching, data, voice, LAN, and WAN labs. Many students participate in internships with supporting organizations.

4. DISCUSSION

The authors feel the following insights derived from surveying the breadth of undergraduate telecommunications programs in the United States may be useful in understanding and guiding the development of telecommunications as a distinct discipline of study.

In many ways the Telecommunications degree is very much related to an IS degree. Telecommunications graduates are expected to be user focused – that is they solve real business problems using telecommunications technology. As is true in IS, the ultimate measure of success is user satisfaction.

Universities attempting to establish a new telecommunications program may partner with private corporations or form a regional consortium to coordinate resources such as internships, equipment loans or grants, adjunct faculty, and new entry-level employees. Universities tend to have fortress-like environments which can shape academic programs by internal processes not sufficiently informed about corporate needs (Erbschloe 1997). There is some evidence that some universities have added telecommunications at the undergraduate level on the theory than it may lead to a later masters degree program which can be lucrative if there is exists such a demand among regional part-time professionals (Lewin 1980).

Although the number of telecommunications programs has increased dramatically, there are still difficulties to be overcome. Faculty and financial resources must be diverted from other departments, the curriculum must be planned and defended, and institutional commitment must be obtained. Attention to these and other issues in program development will ensure a growing number of telecommunications programs in the United States with an increasing geographical diversity to meet the future demand for telecommunications professionals.

The last issue we discuss is telecommunications program accreditation. Just as it took some years for computer science programs to be accredited and degrees to be awarded in computer science, telecommunications programs must move forward so that degrees can be awarded in "telecommunications." University telecommunications programs need to have the vision to be working toward this accreditation goal and need to be willing to accept perceived risk with the accreditation boards in regard to deleting courses that have long been accepted in traditional curriculums but have little applicability in the current environment. The end result needs to be recognition of telecommunications as a discipline in its own right.

5. SUMMARY

Telecommunications, or sharing information at a distance, satisfies a basic human need which has led to a rich history of development. In this paper we have presented a description and comparison of fledgling undergraduate Telecommunications Programs in the United States. As an outgrowth of Information Systems Departments, the growth of the new academic discipline of Telecommunications is undeniable but wise management of its unique curriculum and relationship to other academic disciplines will play a major part in its ultimate development.

So where is education in telecommunications heading? There are many incipient telecommunications programs within IS Programs that consist of a course or two on some aspect of telecommunications (NTEC 1987). There is also a growing push for telecommunications "literacy" for information systems managers. With the two coinciding trends of increased specialization of university education and increased demand for telecommunications professionals, we foresee the emergence of more degree programs, even departments, which specialize in telecommunications and networking. It is even conceivable that "Internet Engineering" will develop into one of the major disciplines within Engineering (Liebeherr 2000).

Today we stand at the frontier of another rapid development. There are problems to be solved and unanswered questions to be discovered but the future belongs to those who press the boundaries of knowledge. Cyberspace as we know it in the form of the Internet will be unrecognizable when compared to the future infrastructure supplied by the convergence of the telephone, cable, computer and broadcast industries. What will remain recognizable is the human need to communicate and the need for knowledgeable professionals from academic Telecommunications Programs to make it happen.

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