

Telecommunications - A Discipline of Our Own
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ABSTRACT – Academic degree programs in Telecommunications are characterized. Then, after reviewing Computer Science’s march to discipline-ness in the late 1960s, a similar future is recommended for Telecom.

INTRODUCTION

Degree programs in Telecommunications differ widely over the universities that offer them. A Telecom graduate from the U of W works as a TV journalist because W’s Telecom Program is in its Communications Department. The U of X prepares Telecom students to be enterprise Telecom Managers because its Telecom Program is in its Business School or its Information Science Department. The U of Y’s Telecom Program, in its Computer Science Department, teaches students how to design protocol soft-ware. And, the U of Z teaches its Telecom students to design telecom hardware because Z’s Telecom Program is in its Electrical Engineering department.

My program’s web page, www.tele.pitt.edu, points to the North American Telecom Programs I know. Observe that different schools and departments have their own view of what Telecom is, some offer separate degrees (but only their own version), and they all claim the name. But, no university’s Telecom Program does all of Telecom.

The next two sections characterize these Telecom Programs. The next section deals with several general characteristics and the subsequent section deals specifically with curricula. My program at the University of Pittsburgh is used to illustrate.

GENERAL CHARACTERISTICS

Characteristics discussed in this section are the level of degree offered, enrollment, governance, personnel, and industry involvement.

Degrees Offered. Since the first US Telecom Program, at the University of Colorado in 1972, most North American programs offer a Masters. While a Bachelors in Telecom is more common in Europe and Asia, North American programs that offer a BST, typically do it as a specialization of EE Technology (as at Texas A&M and RIT). Pitt started its Telecom Program in 1986 by offering an MST. While Pitt doesn’t offer a BST yet, we added a PhD program in 1993 to stimulate research and research funding. I know only three other US universities that offer a Telecom-focused PhD.

Enrollment and Demographics. Telecom Programs have many sizes. From 1987-95, my program’s enrollment grew 20% a year to about 90 students, constrained mainly by the potential student’s unawareness that: (1) Telecom Programs existed and (2) the University of Pittsburgh had one. After declining enrollment from 1996-99, probably caused by increased competition from more universities, we started growing again after creating a wireless specialization. By Fall 2001, Pitt’s Telecom Program had 90 MST students and 25 PhD students. Now, the economy has us shrinking again. While Pitt’s program is among the largest in the US, it’s less than half the size of Colorado’s huge program.

We have no demographic statistics about Telecom Programs because we have no organization to collect it. So, I'll describe my program's demographics, and suggest where we may or may not be typical.

- Our enrollment is 60/40 full-time/part-time. Our part-time percentage is higher than typical because: (1) Pitt is in the hub of a metropolitan region and (2) we encourage commuters by offering evening classes and all courses as a 3-hour class per week. In the last several years, our part-time percentage has declined because, we hypothesize, potential part-time students must work 60 hours a week.
- Our enrollment has consistently been about 20% women, a higher percentage than in comparably technical graduate programs like EE or CS. This correlates to our friendliness to part-time students, since most of our female students are part-time.
- 12% of our American alumni are African-Americans. This percentage is much higher than typical because of Pitt's strong (and continuing) commitment to Affirmative Action and because Pittsburgh and the University of Pittsburgh are pleasant multi-cultural environments.
- About 45% of our students are international – high for a graduate Telecom Program, but low for most technical graduate program. The percentage has risen from 30% in ten years because: (1) Telecom is increasingly popular with internationals, (2) we create a friendly international environment, and (3) our US enrollment has flattened. Significant numbers of students come from Thailand, India, PRC, Taiwan, Norway, and Korea – with smaller numbers from 30 other nations. Remarkably, we've had ten Fulbright scholars in the last six years.
- We've attained and maintained these enrollment figures with relatively little financial aid. Most of our students pay tuition and many pay Pitt's higher out-of-state rate. Our international enrollment is high despite a policy that precludes up-front aid to international Masters students. Our percentage of students on aid is 15-30%, depending on our level of research funding. While many PhD students are aided by research grants, more than a third are supported by a company or their home country's government, and they pay tuition. This is very unusual and makes my PhD program a net asset to Pitt's bottom line. All this is very atypical.

Governance. Telecom degrees may be offered by one university's Business School or another's department of Electrical Engineering, Communications, Computer Science, or Information Science. Some universities resolve Telecom's fragmentation by "inter-disciplinary" programs, where participating units share a degree pro-gram (but do their own thing within it). Some progressive universities have re-organized for the information age – notably, Georgia Tech's College of Computing is a natural home for a Telecom Program. When Pitt's Telecom Program started in 1986, it was placed in what is now the School of Information Sciences. While our governance isn't typical, this school is unique.

Another issue differentiating Telecom Program governance is how a university's administrative layers allocate resources like operating revenue, financial aid, and faculty positions. *Type A* administrators allocate resources using patronage or base it on past practice. They need new programs, like Telecom, because they need *cash cows* to subsidize the embedded base of established disciplines. Recently, the Directors of two US Telecom Programs became so frustrated with Type-As in their respective bureaucracies that they requested direct funding from their alumni or state government, respectively. Each has subsequently "resigned" or "retired." *Type B* administrators allocate resources based on planning, investing in the future, and data (like

class size and number of majors). While their units have less welfare to support their declining disciplines, they have greater success with new ones.

Personnel. Three staffing models are seen across the programs at various universities.

- The traditional *department* model – with a Chair, a dedicated faculty, and staff – is unfortunately rare (more on this later).
- The *top-heavy* model has a full-time Director, often paid out of the Program’s tuition revenue (“soft” money). This Director, often not a tenure-track professor, typically has little teaching or research responsibility. Since this program may have no regular fulltime faculty, the Program Director has to find adjunct faculty or “borrow” instructors and courses from other departments.
- The *bottom-heavy* model has a fulltime faculty, all with tenure-track positions and paid out of hard money, but no fulltime administrator. In this structure, as at Pitt, the participating professors share administrative and laboratory responsibilities.

At some universities, professors teach 3-4 courses per term, and don’t do much research. Telecom programs at such institutions need smaller faculty than programs at research-oriented universities, where typical teaching load is 3-4 courses per academic year. We believe research and teaching reinforce each other – especially in a field like Telecom, where the art changes so rapidly that professors who contribute to these changes have an advantage in the classroom over professors who only read about them (if that). As a related issue, some programs and courses haven’t changed for twenty years, while others innovate regularly. Pitt’s Telecom Program has made a strong commitment to the latter.

Some Telecom Programs are financed well enough to hire a *Lab Manager*. Such programs have better labs than programs that rely on the faculty to acquire equipment and develop exercises – especially a faculty doing research. In 1986, Pitt seeded its Telecom Program with five new faculty lines. Subsequent positions were, and have continued to be, used to hire professors. We now have seven professors, but still no fulltime administrator or Lab Manager, all on hard money.

A Telecom programs’ commitment to *distance education* is based on whether its university has made a strong commitment or is still “waiting to see.” Some US Telecom Programs are almost entirely remote. Potential students have requested remote study from my program, but we believe individuals are too distributed to reach economically with acceptable quality. While Telecom enterprises could concentrate student/employees into a few locations that could be economically accessed, industry is lukewarm about employee education. So, like “shoemaker’s kids,” most of Pitt’s Tele-com courses are taught in the traditional classroom.

Industry Involvement. Successful programs need relationships with companies in the Telecom industry. In the US, giving from our industry is below the tradition-al level from other industries – automotive, chemical, computer, and pharmaceutical – especially now. We Telecom Programs are not ungrateful, we appreciate that our industry differs from others, and we know we don’t have our collective act together. But, we need more support from our industry than established science /engineering programs need from theirs. Confounding this, some companies only support universities that purchase *their* products or services. Further confounding this, some universities are dishonest about how gifts are allocated. For example, suppose ABC Telecom donates \$1.5M to endow the “ABC Telecom Chair” at the U of Z. If Z were adding a position to

its growing Telecom program anyway, the university avoids using its internal funds. ABC helped the U of Z, but not its Telecom Program. ABC has simply paid for “naming rights.”

In the mid-1980s, AT&T discussed building a prototype “Campus of the Future” at Pitt’s campus in the Oakland section of Pittsburgh. This project included creating an academic program in Telecommunications at Pitt. AT&T’s financial backing, and equipment donations from Western Electric, had started Colorado’s Telecom Program 15 years earlier. Our founding Director, Fritz Froehlich, came to Pitt from Bell Labs, as I did. In the years that followed, we received large contributions of equipment, services, and cash from Bell Atlantic, Hewlett-Packard, Fore Systems (now Marconi), Cisco, and others. From 1998-2000, AT&T gave financial and academic seeding for my program’s new wireless curriculum. Pitt’s Telecom Program is grateful to all our corporate sponsors, but we wouldn’t exist without AT&T. Exacerbating the difficulty Tele-com Programs have attracting corporate sponsors, our angels keep transforming themselves, making continuity difficult. The recent economy isn’t helping this.

At a 1991 meeting, Pitt’s Telecom faculty debated: “*who is our customer?*” We agreed our most important customers are not our students (they are our product), nor the tuition payers, nor the university’s administration. We concluded our most important customers are the enterprises that hire our graduates – because if we please them, we please all the others. So, we created an advisory board and invited industry representatives. While we listen to what our advisors say, we don’t always do what they want. This board has recommended courses that we have created – one is even required. But, some representatives from the industry, viewing education in the short-term, want certification courses (what academics call “training”). Various Telecom Programs have responded to this pressure in varying ways. My program’s position is to give industry what is in its long-term best interest – good employees who will be useful on their first day of work and even more valuable five years later.

CURRICULUM

Prerequisites, courses, and requirements are discussed.

Prerequisites. Minimizing admission requirements lets a graduate Telecom Program matriculate students with many kinds of backgrounds. But, such programs typically don’t offer technical courses. At the other extreme, graduate Telecom Programs in EE Departments usually limit matriculation (hence, enrollment) to BSEEs. With an intermediate stance, the entry requirements for Pitt’s MST are calculus, probability, and programming. Most of our incoming Masters students have a Bachelors in EE, CS, or IS, but we get many from other engineering areas, Physics, Business, and even a few from Psycho-logy and the arts. Remarkably, in our 16 years, four Music majors have earned our MST.

Before many students take technical courses, they need more background than is ensured by our prerequisites alone. Since we admit students who may not: (1) have had a basic Networking course, (2) be EEs, or (3) know C/Unix, we offer “remedial” courses (not for MST credit) for students who lack such background. We matriculate students from many backgrounds and equalize them internally. Being hired as a hardware designer or a protocol programmer depends on the student’s undergraduate major, but all our graduates are well-qualified for jobs in network design and consul-ting, network and Telecom management, technical and sales support, and systems engineering.

Combining curricular breadth, technical depth, and moderately open admission is popular with students and the companies that hire them. Being able to do it seems correlated to being housed where we are. Telecom Programs in Business Schools don't require the technical propensity we do and Telecom Programs in EE Departments don't require our propensity for breadth.

Courses. The courses a Telecom Program offers are also determined by the academic organization in which the program is housed. A one-dimensional Telecom Program inside a:

- *Business School* offers typical business courses, but with a Telecom orientation. Some may also have slightly technical courses in network management and telecom administration.
- *Department of Communications/Journalism* offers traditional courses from these disciplines, but with a television orientation.
- *Electrical Engineering Department* offers highly technical courses that are heavy in electronics and math, such as electromagnetic theory, antennas, signal processing, and random processes.
- *Computer Science Department* offers courses in computer networks, protocols, and distributed processing and databases.
- *Information Science Department* offers courses in network design, management, security, and policy.

Initially, Pitt's MST curriculum resembled the "inter-disciplinary" MST program already at Colorado. But, Pitt's Telecom faculty evolved our curriculum through four subsequent re-organizations. With a multi-dimensional charter, Pitt's Telecom Program offers a richer set of courses than any Telecom Program we know of, especially any one-dimensional program. While we try to offer the union of the various orientations, we don't cover every aspect of Telecom equally well. Table 1 lists our graduate courses, organized into nine categories and four tiers. See www.tele.pitt.edu for details.

<u>Specialty</u>	<u>Remedial</u>	<u>Introductory</u>	<u>Core</u>	<u>Advanced</u>
Networking	Intro to Tele	NtwkDesign	<u>Performance</u> Ntwk Managmt	Queuing Theory
Systems/Technology	EE Survey	<u>Electro Comms</u>	Digital Transm Photonic Comms Switching Sysys Intelligent Ntwk	Signals/Noise IP Telephony
Computer Networks	C/Unix	<u>Computer Ntwks</u>	LANs Broadband WAN	Dist Processing Dist Database
Administration		Acctg/Finance Techn Impact	Project Mngmt Telecom Mngmt	<u>Case Studies</u>
Policy & Economics		US Telecom Pol International Pol	Informtn Policy	Ntwk Economics
Human Communications		Human Comms Service Design	Orgnzl Behavior Systems Enginrg	
Wireless	Intro	Foundations	Cellular Teleph Mob Data Ntwks	CDMA Modul/Coding Prop/Antennas
Security	Intro	Ntwk Security	Survivability Cryptography	Adv Cryptog.
Directed Study			Special Topics Independ Study	Practicum Thesis

With a multi-dimensional charter, we offer courses in all the Telecom areas except television journalism. Computer Networking courses are offered jointly with Pitt's CS Department. Even without classic Signal Detection Theory, which is taught in EE at Pitt, we offer more Electronic Communications and Wireless courses than most EE Departments offer at other universities. Having mitigated "turf battles," our inter-actions with the other disciplines are fairly seamless to students of all kinds across the University of Pittsburgh. For example:

- *Introduction to Telecom* is taken by some Telecom students, but not for credit. This course is very popular campus-wide, and is required by Manufacturing Engineering, Hospital Administration, and other graduate programs at Pitt.
- *EE Survey* also can't be used for MST credit, but other majors take it for credit. Since this course covers basic undergraduate EE, and *Electronic Communications* is similar to an EE senior elective, both courses are verboten to Pitt's EEs.
- 13 Telecom courses are pre-approved electives for EE graduate students. Many of Pitt's EE and Computer Engineering undergraduates take at least one Telecom course.
- Our Computer Networking courses, which we joint-list with CS, split about 50/50 between CS and Telecom students.
- Five of our general networking courses are very popular with MSIS students.
- Telecom students select electives freely from CS, EE, IEOR, and IS and several have cross-registered at Carnegie-Mellon University.

Requirements. Even more varied than entry requirements, the various Telecom Programs have a wide range over how many courses, and which ones, are required. The required courses in Pitt's MST are underlined in the Course Table above.

- *Performance* covers basic queuing theory and simulation techniques.
- *Electronic Communications* covers modulation, transmission lines, Fourier analysis, etc.
- *Computer Networks* is an in-depth course in communications protocols.
- *Case Studies* is a capstone course that presents real-world examples.

We have two more requirements, because we want our students to be exposed: (1) to the business side of Tele-com and (2) to considering the human user as a "system component." Every Pitt MST (and PhD) student must take at least one course from a list of courses in Tele-com management or policy. They also take at least one course from a list of "human communications" courses. Some students complain about these requirements, but Pitt's Telecom faculty feel strongly about them and the people who hire our graduates agree with us. While some MST programs require a Masters thesis, we don't – but we encourage it for students who wish to go on to PhD study.

DISCIPLINE-NESS

This section presents the precedence and rationale for Telecom to be its own discipline, discusses how today's university environment makes it even more necessary, and describes the assistance the new discipline needs.

Precedence. Computer Science became a discipline of its own in the late 1960s and early 1970s. Most universities had some Math professors working in numerical methods and computational complexity, a group of EE professors specializing in digital design and computer architectures, and several departments that taught programming in Fortran or Cobol. Separating them and

merging the pieces into a single discipline was difficult. Neither Math nor EE wanted to give up an area it considered, not just part of itself, but an important part with a promising future. University “elitists,” seeing computers as a temporary fad, thought “Philistine” programs like Computer Science didn’t deserve discipline status. Despite this opposition, universities created Computer Science departments, and professors from different departments became colleagues. While the Math/EE “culture clash” still divides many CS Departments, if Computer Science had remained in EE or in Math, it would not be the complete discipline it is today.

While the analogy to the future of Telecommunications is compelling, there are important differences.

- During the late 1960s and early 70s, most US universities enjoyed baby-boomer enrollment growth and post-Sputnik investment in engineering and science. It was a golden age, with a lot of revenue. Now, most universities live in a difficult economy. When a new program is at the bottom of a university’s “food chain,” like Telecom programs are, one Type-A administrator at any level can “tax” a program from fully succeeding.
- Not two, but five existing disciplines – Business, Communications, Computer Science, Information Science, and Electrical Engineering – think Tele-com is, not just part of itself, but an important part with a promising future. In today’s economy, they cling to Telecom, and for the wrong reasons.

Table 2. Dissertation Titles

A reliability assessment of the public switched telephone network infrastructure
 Examining strategic interactions in one LEC market – and its effect on expected prices
 A network-independent call-processing architecture for future narrowband and broadband telecom services
 Auctions and preemptions in reservation-based computer networks
 Mobility in adaptive dynamic clustered hybrid routing in wireless ad-hoc networks
 Buffer management and QoS predictability for best-effort traffic
 A market model for bandwidth management of Intserv and Diffserv QOS interconnections
 Spare capacity reduction using vertical sharing in multi-layer mesh networks
 Multi-dimensional analysis of emerging signaling protocols
 The impact of pricing & user budget constraints on the behavior of packet networks
 A spare capacity allocation model, analysis, and algorithm
 A photonic ATM switch with output buffers for broadband services
 ATM multi-point survivability
 Multi-layer fault recovery for survivable ATM networks
 Approaching the long-tailed distribution in packet data streams
 Soft-Switch overload control

- Then, the nation’s elite universities led the way in creating the Computer Science discipline, and for altruistic reasons. Now, the elite universities don’t typically have the better Telecom programs. If a top-20 university has a Telecom program, it’s typically the top-heavy “cash cow” type, with few dedicated faculty and little investment. While poorer, the universities ranked 25-125 are more innovative, and take more risks (the “Avis syndrome”).
- Then, the ACM took the lead as the protector of Computer Science’s integrity and as the new discipline’s advocate on campus. The emerging Tele-com discipline has no such angel.

Rationale. While existing disciplines rightfully claim pieces of Telecommunications, one can view Telecom as its own discipline with these nine sub-disciplines:

- Network design & management
- Electronic and photonic systems
- Wireless systems
- Computer networks
- Network security
- Telecommunications administration
- Telecom policy and economics
- Human communications
- Television journalism

The key question is this:

There are these nine moons. Should they rotate around five different planets or should all nine moons rotate around the same planet?

Examining required courses gives one rationale for discipline-ness. Not only do required courses depend on the technical orientation of the degree program, but some are imposed by the school or department in which the program is housed. Some EE and CS Departments are reluctant to grant a Masters degree to someone who hasn't had a graduate course in, for example, Electronic Devices or Compiler Design, respectively. While such courses might be required because they are thought to lie at the heart of their respective disciplines, neither one lies at the heart of Telecommunications.

Another compelling case for Telecom's discipline-ness comes by examining some PhD dissertation titles. Table 2 lists the dissertation titles of my Telecom Pro-gram's PhD graduates and some current students who are close to completion. While each dissertation whose title is listed above came from the same PhD program, would these dissertations have been better if they had come from different disciplines? Were these students well equipped for a PhD-level job in the Telecom industry, or as a Telecom Professor, after having studied with the other students who wrote dissertations on this list? Or, would they have been better equipped if they had studied with fellow students who focused on electronic devices or compiler design? The answers to these rhetorical questions imply the answer to Telecom's discipline-ness question.

Branding. We need a naming convention, and an organization to defend it.

"Telecommunications" must be protected and, like "Computer," it should be used as an adjective in program names.

- The Business or Information Science dimension should be called "Telecom Management."
- The Communications dimension should be called "Telecommunications Journalism."
- The CS dimension of Telecom should be called "Computer Networking."
- And, analogous to "Computer Engineering," the EE dimension should be called "Telecommunications Engineering."
- Only the *multi-dimensional* programs should be allowed to use the general name "Telecommunications Science" or just "Telecommunications."

Let me give an example of how potential students and employers are misled and need an organization to enforce truth in advertising about Telecom Programs.

I recently visited one of the top ECE Departments in the US. They have a brochure that claims they have a Telecom Program. But, the brochure doesn't mention a Telecom curriculum – because they don't have one. While the brochure listed more “Telecom Professors” than we have at Pitt, all but two are device specialists. I bet only one professor listed in the brochure can recite the layers of the OSI model, and only two or three know even how many layers there are. While Pitt's EE Department is ranked below this department, its MSEE students get a much stronger “Telecommunications Engineering” specialty than students at this “better” department do, because Pitt's EEs can take courses from my Telecom Program – courses that don't appear in our EE Department's brochure.

While no organization can dictate that a university, or any of its components, must be honest or must conform to some naming convention, such an organization could publish its list of Telecom Programs, listed by the categories that the organization defines. This organization could publish its lists in the order of their judged quality and could omit from its lists those programs whose quality is judged to be below their standard, or that exist in name only. This sounds like ranking and accrediting and, while some of the nation's Telecom Program Directors have met and voted that we don't want these things, we do need them. The main reason we voted against accreditation is we didn't think the outcome was worth the effort. It seems like we could be accredited and ranked without having to give up so much time to the procedure. And, while “process” is important, Telecom needs an accrediting and ranking process that emphasizes content.

Advocacy. Besides accrediting and ranking, we need an organization to advocate Telecom's evolution to discipline-ness by collecting data about various pro-grams, suggestions from enterprises that hire graduates, and student demographics. This organization could influence universities to house their Telecom programs where they will be allowed curricular and matricular freedom and can have a multi-dimensional curriculum. The form of governance also matters, and department status should be encouraged for two reasons.

- Department status symbolizes “having arrived.” It's the difference between being perceived as temporary or permanent, between being a colony or a nation. It lets the Director, now a Department Chair, sit at the Dean's table with the leaders of the other “real” disciplines. Department status means credibility on campus.
- The higher a program resides in its university's food chain, the less vulnerable it is to Type-A administrators.

But, the main reason the Telecom discipline needs advocacy is to help each program acquire resources on its respective campus. An external organization influences how a university's budget units fund its Telecom Pro-gram the same way most ranking/accrediting bodies, like Newsweek Magazine or ABET, do for their respective disciplines. Chairs, Deans, Provosts, Chancellors, and Trustees all have two common vulnerabilities: (1) they care about public ranking and (2) they are susceptible to threats of de-accreditation. If an accrediting/ ranking organization considers governance, budget, space, student-teacher ratio, lab quality, etc., when it accredits and ranks programs, then the universities will provide them. This is *blackmail* when a program hasn't earned an increased share of its university's resources. It is *justice* when the program is only trying to keep its fair share of the revenue it brings in.

Confounding this, some university's top administrators, and the boards that advise them, have a false *university-centric* attitude. Some believe that students come to the U of X because of its overall ranking, or the beauty of its campus, or its football team's prowess. They think that, if the university didn't offer a Telecom Program, the students who major in Telecom would just major in something else. They think offering multiple degree programs is inefficient. They don't appreciate that most Telecom majors, especially tuition-paying international graduate students, come to the U of X, not because of how wonderful the university is, but to study Telecom. If the university didn't offer Telecom, these students would have gone to another university. While Program Directors try to explain this to their bosses, it's like telling the emperor about his clothes – an external advocate is much more credible.

While some university administrators control Tele-com Programs for their cash-cow potential, others have a more altruistic, but equally destructive reason – they perceive Telecom as part of a “vision” of the unit they manage. Middle managers, not just at universities, tend to think the unit they run is more relevant than being a budget unit. Selected pieces of Telecom get captured in the visions of what these administrators think their units ought to be. Unfortunately, few visions cover all the components of the Telecom discipline. EE educators are familiar with this phenomenon at a higher level when trying to optimize a curriculum that's good for the electronics industry and that lets graduates pass the Professional Engineers Exam. But, they don't see it when they look down.

As an analogy, consider the Czechs, an industrious and peaceful people in central Europe. Throughout their troubled history, some ruler in one neighboring nation after another has coveted the people and the land where they live. In the previous century alone, the Austrians, the Germans, and the Russians have included the Czechs and their territory in a vision of what their own country should be. And, during those rare times when the Czechs were free from foreign domination, they were artificially joined with the Slovaks because, after World War I, some diplomats from other countries had yet a different vision for the Czechs. But, nobody ever asked the Czechs what they wanted. It's only recently that the Czechs have had their own republic. And, now, with control over their own destiny, the world watches them thrive and wonders why it took them so long. Duh.

Balance. While the emerging Telecom discipline needs protection from campus forces that don't serve its best interests, it also needs internal leadership to define the discipline and encourage the various programs toward greater uniformity. Residing in the overlaps of several existing disciplines, Telecom also finds itself in the overlap of differing educational philosophies. Two dichotomies exist.

- *Liberal v. professional education.* The goal of a liberal education is well-rounded scholarship and the goal of professional education is job-oriented skill. While Telecom students need a professional orientation like engineers, Telecom professionals need better communications, finance, marketing, and people skills than the typical professional engineer needs. This suggests Telecom education, particularly at the Bachelors level, should be more “liberal” than engineering education (but not too much more).
- *Theoretical v. practical presentation.* A technical Telecom course can be presented theoretically and mathematically or it can be presented practically and by example – essentially the EE/EET split. While the EEs and EETs couldn't find a common ground (another reason to get Telecom away from both), hopefully the new Telecom discipline can.

The emerging Telecom discipline must be led to select the best balance of these philosophies, where “best” is defined by what’s in the Telecom industry’s best interest.

CONCLUSION

Some university administrators might ask: “*Why would I give up a cash cow and let Telecom become its own discipline?*” The answer is: “*Because it’s in the best interest of your students.*”

Some stalwarts of existing disciplines might ask: “*Why would we further fragment our discipline by letting Telecom to secede from us?*” The answer is: “*Because it’s in the best interest of the Telecom industry.*”