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Curriculum design for information technology associates degree programs

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CURRICULUM DESIGN FOR INFORMATION TECHNOLOGY ASSOCIATES DEGREE PROGRAMS

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ABSTRACT

The purpose of this document is to present a series of curriculum designs for a variety of Associate's Degree Information Technology (IT) programs. The proposed targets of these designs are technical schools, community colleges, and universities offering Associate's degrees in IT. The particular emphasis of these designs is to provide a maximum benefit to IT students by making it possible for these students to master core subject matter to qualify for specific entry-level positions. Furthermore, these designs should be flexible enough to accommodate modifications based on input from community members and business leaders wishing to hire well-trained, qualified, entry-level, employees.

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INTRODUCTORY REMARKS ON THE NEED FOR IMPROVED IT ASSOCIATES TRAINING PROGRAMS

The information technology (IT) job market has gone from a seller's to a buyer's market. From the mid 1990s until early spring 2001, graduating or otherwise qualified IT students received numerous job offers with high salaries and bonuses (VanLengen, 2003). Today, the combination of the "dot-com" implosion, economic recession, and offshore outsourcing has led to fewer job offers being made to new graduates. About 500,000 tech jobs were lost during this time (Bowman, 2003). Job openings in the current market require more hours of job experience as well as a working knowledge of increasingly sophisticated work techniques – both of which were previously only gained by extensive time in the actual work force (Rosencrance, 2003).

[1]However, cursory examination of the current IT job market indicates that many jobs are available for qualified college-graduate individuals. For instance, a nationwide search of "information technology" jobs showed over 1000 open positions posted in one day.[1] A similar search the key words "entry level" yielded over 1000 postings made over a 30-day period.[2] Thus, there still seems to be high demand for experienced and knowledgeable graduates in various UNIX disciplines. However, a common comment in

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[1] The search was done on Monster on January 11, 2007. The search used "all" as the locations modifier. with "computer services", "computer hardware", "computer software", "information technology", and "Internet/e-commerce" as job categories. http://jobsearch.monster.com/jobsearch.asp?q=&re=0&fn=9005&fn=543&fn=6&fn=660&fn=554&sort=dt&vw=b&cy=US&brd=1%2C128%2C1862%2C1863&JSYESREG=1&JSNONREG=1&rad=&zip=&Image1.x=37&Image1.y=31

[2] The search was done on Monster on January 11, 2007. The search used "all" as the locations modifier. with "computer services", "computer hardware", "computer software", "information technology", and "Internet/e-commerce" as job categories, and with "entry-level" as the experience modifier. http://jobsearch.monster.com/jobsearch.asp?re=5&pg=20&q=entry+level&fn=9005&fn=543&fn=6&fn=660&fn=554&sort=dt&vw=b&cy=US&brd=1%2C128%2C1862%2C1863&JSYESREG=1&JSNONREG=1&JSNONREGN=1 .

several alumni surveys done at Northern Arizona University (VanLengen**,** 2003) was that there is a significant need to provide more UNIX training in the curriculum to satisfy positions in system/network administration, testing, networking, and support to compliment similar skills developed in the Microsoft-based curriculum.

Demand for qualified graduates would also seem to be high in the IT security field. According to a Southwestern Illinois College online report (Bushong, 2003), the IT industry "is strewn with statistics of financial losses, proprietary information theft, and even jail sentencing for apprehended hackers." The report also recognizes community and technical colleges as prime settings for network security education. Therefore, colleges and universities need to examine their IT curriculum to ensure that students are being properly prepared to take advantage of the positions in the IT security field, and to meet current and future job trends. New programs must be designed to provide skills, knowledge, and experience in common IT topics. Students must be able to complete classes and programs that provide a solid theoretical background upon which post-graduation experience and training can be based. Furthermore, the curriculum must also provide a level of practical knowledge that can be applied to a job from day one and can serve as a substitute for a level of actual work experience.

These programs must also be designed to be compatible with the needs of the local hiring community. Why a limited focus on the local community? Community colleges are geared toward local students and local needs (McPhail, 2005, pp. 4-5). For instance, there is no benefit to teaching, say, Solaris UNIX if the local user community is exclusively HP-UX UNIX. Conversely, there is no point for a school to teach UNIX skills at all if the hiring community uses Microsoft Windows almost exclusively. This is

especially true if colleges want to take advantage of the local community in terms of either hiring local experienced instructors or placing graduates with local companies; the curriculum developer must design the curriculum so that it takes advantage of both local hiring and placement opportunities.

Finally, IT curricula must provide some sort of concrete evidence that the graduate has key practical knowledge that can substitute for or supplement work experience. Many positions are advertised with required experience levels measured in months or years, as well as requirements for certifications and knowledge of software or hardware suites. These requirements are used by hiring managers or (more often) human resource offices to filter out large numbers of applicants (Pau, 2007). The curriculum must be such that a manager or HR office will be willing to take a "chance" on the recent college graduate, or somehow get that graduate past the filters.

In short, there is a significant opportunity for a properly designed and implemented IT curriculum program to meet community needs by training students in the practical skills and knowledge needed by an IT professional. However, as can be seen in the next section, there are obstacles present that can hinder a designer from creating a workable IT program.

FALLACIES IN CURRENT IT ASSOCIATES TRAINING PROGRAMS

There are many ways that a curriculum can be either improperly designed or poorly executed. For instance, many creators of curriculum designs never consider the issue of instructor capabilities and qualifications. Robert Norton noted in a paper presented to the American Vocational Association (1993) several ways in which a curriculum can fail. The failings that Norton notes include (1) the inability to recruit or retain instructors that are competent, knowledgeable, and expert in the subjects they are asked to teach; (2) not having instructors design courses or teach classes that they know best;(3) not taking advantage of an instructor's "field" experience during class instruction or course design; (4) not having instructors teaching subjects they enjoy; and (5) not using adequate textbooks, supplies, and other materials for the courses and programs in the curriculum.

These issues force the curriculum designer (and the college that implements the curriculum) to perform several key actions. Obviously, the college must acquire, retain, and adequately and competitively compensate and train instructors with desirable skills, knowledge, and experience. The college must further concentrate on recruiting instructors with experience and specialization in the "whole" of particular courses or subject matter (i.e. a telecommunications instructor being familiar with call centers, the public phone network, and switched networking; a networking instructor being proficient in wiring, intranets, Internets, application of both Microsoft and Linux server systems in various environments, and using Cisco technology; etc.).

IT curriculum must also include instructor involvement in course and program design. Taking advantage of an instructor's field experience and practical knowledge is absolutely vital to proper curriculum design and implementation. Course structure, content, and student performance metrics need to be defined and designed using considerable instructor feedback.

Significant efforts should be made to identify and acquire relevant, useful, and complete textbooks, supplies, and other materials for the subjects being taught. In IT, information (particularly that found in books and textbooks) is quickly out of date; therefore it is incumbent on the institution to be prepared to expend sizable sums keep instruction material up-to-date. As in curriculum designed for engineering, biology, and physical sciences, facilities, laboratory supplies, and equipment planning should be a part of the curriculum design. Facilities should include labs and classrooms equipped with individual workstations, high speed network and Internet access; space to provide experience in the design, installation, and running of networks of various sizes; space to accommodate team projects; and infrastructure to accommodate computer projection, appropriate computing and software infrastructure/applications, and printing, so that the entire curriculum can be adequately delivered without major reconfiguration (Gorgone et al, p. 2).

Keeping equipment current is another matter. According to Gordon Moore's now-famous "Moore's Law" (Moore, 1965), the number of transistor switches that can be placed on an integrated circuit doubles every 24 months. Similar extrapolations exist for hard disk storage per unit cost, performance, and programming complexity ("Moore's Law," 2006). It stands to reason that within two to three years a student computer

console that was perfectly capable for an advanced server administration class may only be capable of serving an introductory operating system or hardware repair class. In fact, Gorgone et al (p.2) place a "paramount" replacement cycle time for a school at as little as 12 months. Another consideration is that even basic hardware is subject to change – especially in terms of input/output interfaces, bus design, and peripherals. Finally, since much of the equipment will be used and handled by inexperienced students, breakage is unavoidable (and often provides a good learning experience). As a matter of operations, the institution must be prepared to upgrade, maintain and repair (outside of the classroom), demote, and replace equipment at regular, short intervals.

Norton (1993) also noted that employees and employers also pay a high cost for improperly developed curriculum. He says (p.4):

> The employee is spending time and money learning things which are unnecessary, and is likely to think that training is of poor quality. Of course, the employer loses by: (1) paying for irrelevant training, (2) paying the salary of the employee in training, and (3) by failing to gain more of a valuable employee.

Therefore, it is key that both industry and job description analyses be conducted during curriculum development and curriculum revision. However, while IT industry standards are easy to locate, obtaining employer needs and standards is a bit of a difficult issue. Many companies, especially the larger ones, will not reveal their employee education needs and standards in fear of giving away a competitive advantage.

Companies will admit, however, that an employee with certification can bring many benefits to an organization (Netwind.com, 2006). These benefits can include a feeling of "quality assurance" in the product (the knowledge and experience that the

employee or candidate has), simplified recruiting and hiring (again, where requiring an appropriate certification assures a minimum knowledge level in applicants, thus gaining higher quality candidates while minimizing the initial applicant screening process), and the benefit in a competitive business market of having employees with well-known credentials.

There are therefore benefits to the student to choose an institution that does certification preparation as part of its curriculum. Thus, it does make sense for an institution in a competitive education environment to place some emphasis on certifications, as they do confer many benefits to the holder. These benefits may include enhanced credibility in performance/knowledge claims on resumes, a competitive advantage in tight job markets, and enhanced job and promotion opportunities (*ibid.*).

Certifications do play a major role in helping build curriculum. They do so by allowing the manufacturers and key users of a product/service to identify and define key procedural and/or theoretical elements that must be mastered. This saves the curriculum developer time and effort in identifying these elements, thus making curriculum development easier. Therefore, it is incumbent on the curriculum design and instructor preparation to make absolutely certain that the program and course metrics, as well as the teaching methodology, place all certification preparation in terms of student practice and real-world simulation – not memorization.

However, IT programs have long been held guilty of teaching curriculum with the "sole" purpose of the student obtaining some kind of industry certificate. In a competitive education-industry environment, however, such an attitude towards certification can place a graduate at a disadvantage. As Jonathan Bischke (2001) put it in

his article "Avoiding the Paper MSCE Disease": "An example of a Paper MCSE is somebody who could tell you word for word what the 23rd question on the second Networking Essentials Transcender Exam is, but couldn't tell you how to map a drive from a command prompt." A holder of a "paper" certification is somebody who knows theory or has memorized facts and procedures, but can't apply the knowledge because of lack of experiential reference. While preparing a student for industry certification does have its place in IT curriculum development, it should only be done in conjunction with other activities that (1) give students practical knowledge, (2) give students practical experience, and (3) give students the best chance possible of getting hired.

Fortunately, there is a move among the certificate authorities like Microsoft to add performance-based simulations of key techniques used in their major products and most common procedures (Ward, 2005). Because of this development, the curriculum needs to be designed so that the student gets hands-on practice with major products, procedures, and techniques – so that the student actually performs the steps that will be tested. The curriculum must also make sure that the student gets additional, test-like simulation practice when using the actual products is impractical or too costly for the college. Finally, the curriculum must ensure that the student obtains field experience on the products being tested, in industry environments via internships, externships, part-time jobs, mentoring, or “ride along” programs.

The curricula must have an effective balance of raw knowledge, applicable skill, certification preparation, and reasonable initial-job expectations for the graduate. As a Microsoft CTEC trainer put it:

> An MCSE is really a learner's permit. It indicates you have a basic understanding of NT and could go into most situations and not destroy workstations or servers. It does not mean you are qualified to go into a large enterprise environment and write a script to add 100 groups and 2,000 user accounts on your first day. It also does not mean you should be a senior systems engineer by your second month at work (Lewis, 2006).

Unfortunately, many certification centers and cram schools give students unrealistic job opportunity and salary expectations (*ibid.*). Therefore, it is important to curriculum development that realistic graduate goals are set, and that courses are developed with these goals in mind.

Another issue that technical colleges run into, especially in developing entry-level curriculum, is offering certifications or certification training well beyond what is realistic for the entry-level candidate with little experience. For instance, it would be inappropriate for an Associate's degree program to offer training for high-level certifications such as Cisco's Certified Internet Engineer or ISC^2 Certified Information Systems Security Professional programs – programs that require years of high level experience and advanced preparatory education. It would be far more appropriate to offer entry-level certifications such as the ones discussed by Will Willis at CertTutor.Net (2002). These certifications include the offerings by CompTIA (including the A+ hardware servicing certification and the Net+ network servicing certification), Microsoft MCP certifications (each of which is an element for higher-level MCSE certifications), Novell's CNA, and Cisco's two-test CCNA.

A factor that can hinder the student from best benefiting from an IT program is that the program may be too broad and not have a definitive focus. There are several specialties in the IT industry on which a graduate can focus, including desktop support, network support, the Microsoft specialties, the UNIX specialties, telecommunications and phone support, programming, database operations, IT security, documentation and technical writing, and IT management. It is acknowledged that all of these require a common set of core knowledge classes. These core classes should be in both the IT and general knowledge categories. However, there is no sense in forcing a student to take, for instance, an advanced Visual Basic programming class when the student plans to be a network administrator who only needs basic C shell scripting skills.

Finally, there is the issue of making sure classes and skill sets are taught in a logical order. Many smaller career colleges have a difficult time with this because of staggered student start dates, scheduling issues, lack of instructor availability, and the need to make sure students are in classes all the time (instead of waiting for a particular class in a sequence). Other schools, because of inflexibility in existing accredited course numbers and programs, put certain classes wherever there is an open class in the curriculum instead of rewriting it. It is important to maintain course and skill-set order (particularly by course call numbers or course levels) when assigning students to particular classes. It does no good to teach a student a class on server administration when he has not had hardware support or basic network theory.

Should the designer be successful in overcoming or bypassing the issues that plague many existing IT programs, the next step is to codify into the curriculum specific

requirements and expectations that will make the degree (and the student) desirable to hiring managers and HR offices.

SPECIFIC NEEDS, REQUIREMENTS, AND EXPECTATIONS FOR THE PROSPECTIVE ASSOCIATE'S DEGREE GRADUATE

From the perspective of a hiring organization, the student that graduates with an IT associate's degree must have certain qualities, credentials, attributes, and skill sets to be hirable and usable. An IT program must be prepared to identify what those needs are at both a community and national level, and be ready to meet those needs in its curriculum.

A key element that must be incorporated into an IT curriculum is the idea of professionalism. Public and employer perceptions of the typical IT worker include words like "nerd", "techie", and "geek" (Carnes, 1999). Furthermore, the view of those outside the profession (supported by various stereotypes and segments in popular media) are that IT personnel are almost always male, single, overweight and stand-offish to the point of being rude and condescending to computer users. A further popular notion is that IT workers view corporate networks as their personal play-things (Nemeth, et al, 1995), and that actual users, work, and business are inconveniences that get in the way of hacking and playing games (Silverman, 2000). From a corporate perspective, IT workers (and computer infrastructure in general) are seen as profit-neutral at best – and at worst, cost-centers instead of profit centers (Robert Frances Group, 2001). No longer can an IT graduate be seen merely as someone who works with computers and networks; the emerging IT graduate profile is that of individuals able to provide detailed logical designs, plan and manage system development efforts, and evaluate the impact of information systems in a variety of traditional and non-traditional corporate, scientific, and liberal arts contexts (Dahlbohm and Mathiassen, 1997).

Therefore, from the first day of a college IT training program until graduation, the student must be inundated with notions of professionalism. The student must act in a matter that destroys current public perceptions of IT, and must be as anti-stereotypical as possible. To that end, the student while in school must be exposed to (and put into practice) concepts such as politeness, ethics, and professional interpersonal interaction. Furthermore, the student must also be given an introduction into basic business practices, with the idea that the future IT employee will eventually be directly responsible for the increased growth, profit, development, and vitality of the company.

Furthermore, there are three dimensions of employee performance with which IT professionals (and thus the institutions that train these employees) must be concerned. Hafner and Trauth (2000) define them as the "technical" dimension, the "functional" dimension, and the "human" dimension. The technical dimension of a system includes its correctness (relative to its design specifications), its reliability, and its efficiency in using computing resources (memory, processing power, etc.). The graduate must excel in skill sets that involve troubleshooting micro scale issues (field-replaceable units, for instance), identifying and working with major parts of an installed system, systems optimization, and handling of day-to-day operational issues. Since many of the issues that fall under this category involve directly communicating with a customer, there should also be an emphasis on interpersonal communication skills among the "professional" skills referred to above. Traditionally, however, training in the technical dimension has taken a far higher fraction of teaching resources (see Figure 1). IT graduates with traditional training operate in a vacuum of troubleshooting, without

considering overall business needs, client and customer desires, and/or the political, regulatory, and ethical outcomes of their actions.

The functional dimension is defined as that part of an information system that focuses on the customer's business objectives. Neither a new system install nor the handling of a troubleshooting issue can be regarded as a success (regardless of its technical excellence or conformance to established standards) if it solves the wrong problem, provides the wrong information, requires information that is not available, or includes subsystems that are not compatible. The graduate, therefore, must be proficient in understanding the customer's overall needs, providing formal presentations and related feedback response, and troubleshooting solution-oriented issues.

The human dimension of an information system includes its usability and its compliance with the legal, ethical and policy requirements of the client or customer (and of society at large). This dimension is so important that some advanced systems administration texts are including discussion of the topic. For instance, the popular IT book Unix System Administration Handbook (Nemeth et al, 1995) devotes an entire chapter to policy and political issues involved in being an IT specialist. The authors present several important facets of IT work that often get neglected, including: policy and procedure development, approval, and legality; user agreements; emergencies; legal situations; scopes of services; trouble-reporting systems; financial models; procurement; piracy; management; human resources; ethics; patents; documentation; and security.

Furthermore, in this human dimension other supposedly non-technological issues come into play. There are concepts of data privacy, data accuracy, ownership of data, and accessibility of data that need to be dealt with by any organization using IT resources

(Mason, 1986). A lack of awareness of issues like these can cause consumers and companies many problems (which can be expensive and painful to remedy). Unfortunately, technology can serve to make these issues worse. Mason illustrates this in two examples – one where a technology-reinforced research project violated the privacy of individuals who, unknowingly, participated in it in an embarrassing manner; the other where inaccurate data collection and entry caused financial hardship and death.

Incidentally, all three of these dimensions involve the mastering of "soft skills" in the realms of communication and teamwork. Table 1 lists the specific skills and sub skills needed.

According to Gorgone et al (p.4), true IT professionals have a set of required characteristics that have changed little over the years. These traits include having a broad business and real world perspective, having strong analytical and critical thinking skills, having strong interpersonal communications and team building skills, having strong ethical principles, and having the ability to design and implement solutions that enhance an organization's performance. A curriculum design, therefore, must provide specialized courses in application design, development, deployment, and project management (*ibid*, p. v).

From the technical end, an IT graduate will also need to have certain basic knowledge to be hirable and trainable by an organization. According to the US Bureau of Labor Statistics (US Dept. of Labor, 2006), an entry level candidate will be expected to be able to perform routine maintenance, systems monitoring, basic troubleshooting, installation, cleaning, and assisting users. They will need to be able to document their discoveries and repairs via paper, email, or in person. Later, as the graduate gains more

experience, he will then be expected to become an expert in his systems, providing guidance to management, and applying more of the theory he learned in school. However, before a candidate can be hired, his education must prepare him for the realities of the corporate IT world.

PROGRAM DESIGNS

In the process of creating the following program design curriculum, I looked at and borrowed elements from ten existing IT programs and four curriculum development papers. To my knowledge, however, there is no specific program or white paper that incorporates all the elements that I propose below.

Accreditation Requirements

A desirable IT program design is one that can contribute to help ensure the accreditation of the college that teaches that program:

> "*The goal of accreditation is to ensure that education provided by institutions of higher education meets acceptable levels of quality. Here you will find lists of regional and national accrediting agencies recognized by the U.S. Secretary of Education as reliable authorities concerning the quality of education or training offered by the institutions of higher education or higher education programs they accredit* [italics in the original]" ("College Accreditation in the United States", 2006).

For a college to become accredited in a particular subject, the college must meet the requirements of a regional or national college accreditation council. Accreditation is a process by which a facility's services and operations are examined by a third-party accrediting agency to determine if applicable standards are met. Should the facility meet the accrediting agency's standards, the facility receives accredited status from the accrediting agency. Accreditation bodies for institutions that focus on developing career-oriented skills like IT include the Accrediting Commission of Career Schools and Colleges of Technology (ACCSCT), Accrediting Council for Continuing Education and

Training, Accrediting Commission of Career Schools and Colleges of Technology, and the Council on Occupational Education.

Some institutions choose, for various reasons, not to participate in an accreditation process. According to the United States Department of Education, it is possible for postsecondary educational institutions and programs to elect not to seek accreditation but nevertheless provide a quality postsecondary education. Yet, other unaccredited schools simply award degrees and diploma without merit for a price. In the United States, unaccredited degrees may not be acceptable for civil service or other employment. The use of such degrees is restricted in Oregon, New Jersey, Indiana, Illinois, North Dakota, Nevada and Washington (K12 Academics, 2007).

However, a program should seek accreditation because it provides a structured mechanism to assess, evaluate, and improve the quality of an IT program ("Why Should My Program Should Seek Accreditation?", 2007) . It also assists students and their parents choose quality college programs. Finally, it enables employers to recruit graduates that are better prepared.

Many IT schools use ACCSCT as an accreditor. ACCSCT reviews schools, curricula, instructor qualification, and other operational functions within a school, on a regular basis (every 5 years under normal conditions, and at more frequent intervals for newer schools/programs or for programs that have trouble meeting standards). ACCSCT's basic Standards of Accreditation document (2007) outlines general requirements for a school and its curriculum. These requirements include an appropriate program length during which students acquire both the knowledge and training needed for entry into the IT industry, and are roughly the same length as other comparable

training programs (or can justify any significant deviations in comparable length) (*ibid*, p.64) with equivalent credit requirements and definitions for the associates degree (*ibid*, p.70). A standardized course numbering system that is similar to other programs must be implemented as well (*ibid*, p.69). The program must also provide ACCSCT a detailed instructional outline and syllabi with the goals of the program and each class in it (*ibid*, p.64). Other key requirements for accreditation include providing instructional material and equipment materially similar to that used in the occupation itself (*ibid*, p.64). Finally, there must be a clear division between courses offering general education, applied general education, and technical education (*ibid*, p.79).

Local industry contributions to the curriculum

A significant issue that technical colleges have today is that they often fail to consult experienced IT instructors and local professionals during curriculum development. ACCSCT notes very clearly that it prefers that an accredited program have at its disposal an independent program advisory committee to review established curricula, materials, equipment, and facilities ("Standards of Accreditation", p.64). The purpose for this outside review is to insure that the curriculum and school meet local industry requirements of students and graduates.

Instructor Qualifications, Recruiting, Compensation, and Retention

Aside from the basic accreditation requirements, the good IT instructor will have several year of experience working "in the field": i.e., in a corporate or private production-level IT system. This way, the instructor can bring "real-world" experience and examples into the classroom to supplement book learning and established curriculum.

The ability (or lack thereof) of an instructor to bring actual examples (and therefore realistic simulations) of issues dealing with customer service, project management, administrative chores, etc. can make the difference between whether or not the student is successful after graduation.

Ideally, an instructor will work only part time as an instructor, or (if dedicated to a career as an IT instructor) will return to the work force at regular intervals to become reacquainted with industry and current practices (Gorgone et al, 2003, p.1). At minimum, a critical mass of faculty is needed to provide proper coverage of the entire curriculum at any given time with enough interest to remain abreast of current developments in IT (*ibid*, p. 1).

ACCSCT standards also work to ensure faculty quality by defining a set of instructor qualifications.. Instructors for ACCSCT-accredited institutions must have certifications and licenses according to the law of the state in which they teach ("Standards of Accreditation", p.75). ACCSCT also requires that instructors be able to "demonstrate a command of theory and practice, contemporary knowledge, and continuing study in their field" ("Standards of Accreditation", p.75).

This proposal makes the assumption than a qualified IT instructor with several years of progressive work experience outside of the education field, should be compensated (1) at a level commensurate with what he could make working in the "real world", and (2) at a living wage for the community in which he works. In fact, the argument can be made that IT instructors should be paid *more* than their non-education counterparts in order for the educational profession to be more attractive than other available positions (Frey, 2007). Unfortunately, this is often not the case for IT

instructors at the associates' level (*ibid*). There is no real motivation for a potential instructor to teach in a long-term capacity when industry or private enterprise can offer superior compensation. The opposite is actually true; qualified instructors will leave the education profession in order to reap monetary rewards and/or take care of their families and obligations. Of particular concern is the ability to live in the community in which an instructor teaches. IT colleges are typically located in communities with IT industries; IT industries, in turn, increase the cost of living within those communities. In an article in the Seattle Post-Intelligence (*ibid),* for example, it was noted that a significant number of full-time and part time faculty don't earn enough to keep up with their locale's rising costs. Often they work second jobs or leave the education profession entirely (*ibid*)**.**

In my opinion, many colleges also make the fundamental mistake of having differing pay scales for different levels of classes. This assumes that lower-tier (100- and 200-level) classes are somehow easier to teach or require less knowledge or preparation than upper-level classes. Furthermore, colleges often pay part-time instructors less than full-time instructors for the same amount and quality of work (*ibid).*

Key Areas of Study

This proposal breaks down the associate's level IT curriculum into a series of six certificate diploma tracks, plus a block of general studies classes to round out the student experience. These tracks are UNIX, hardware/software, Microsoft, Network, Security, and Telecommunications. Each will be discussed separately, below.

UNIX

The following model curriculum provides colleges and universities with a basic framework to prepare students with a set of broad perspectives that should enable a student completing this curriculum to obtain and accomplish entry-level employment in the UNIX specialties. This knowledge includes file system handling, knowledge of UNIX system architecture (i.e. kernels, processes, input/output, and file trees), user environments, shells, security, networking, logging, rights, policies, firewalls, backup and recovery, scripting, customer communications, and problem determination and handling. Several texts in the "**Dummies"** series prominently mention file system navigation, process control, text editing, and windows environments as need-to-know information (Bellomo, 1999; Levine and Young, 1998). Beyond that, students should become familiar with the current and historical uses of the different UNIX environments, basic and advanced user skills, basic and advanced administration skills, basic and advanced setup and deployment skills, business and operational usage of the platforms, as well as coverage and demonstrated competency on the major UNIX variants used in the business world.

The US Department of Labor (DoL) has defined the skill-sets and the major tasks of major job functions on their O*Net web site. The DoL summary report for this type of certificate diploma/job track can be found in O*Net's "Summary Report for Network and Computer Systems Administrators" (2007). Further justification for the major skill sets presented below as needed for a UNIX or Linux system administrator can be found in Table 2 as the interrelationship between O*Net-defined tasks and Brainbench certificate offerings.

This conceptual framework, however, does not provide curriculum development personnel with a clear statement of the requirements of the curriculum, nor does it establish a specific implementation. Specific courses are often listed and offered based on faculty skill, resources, local industry needs, and organization needs for consistent content coverage between various tracks/programs. What is suggested here, therefore, is a series of concentration programs that fulfill the ACCSCT curriculum development, skills description, and community needs requirements. These programs can be the basis of a certificate diploma or dedicated worker/skills upgrade plan. Ideally, this proposal can also be integrated (in part or wholly) into a larger associate's or bachelor's degree program. Having been designed for 4 credit-hours/40 contact-hours per class system, this 24-credit program is ideally suited to be used as a core requirement set within a larger network/systems administration degree program.

A 40 contact-hour class setup seems to be ideal for traditional semester-based colleges/universities, as well as technical specialty colleges (such as CollegeAmerica, and ITT Technical Institute) where classes are taught in much shorter periods. In the traditional setting, 40 contact-hours yield four 1-hour classes each week for a 10-week semester. At specialty colleges, 40 contact-hours can be accomplished in one month with four 2.5-hour classes per week. A 4 credit-hour program was chosen on the basis of attempting to be compatible with established college and corporate training programs.

The small survey in Table 3 involving local community and technical college programs shows a variety of UNIX offerings. Outside of the collegiate setting, there are several industry training programs that specialize in UNIX, also shown in Table 3.

Further, this UNIX concentration proposal should provide the student a a reasonable opportunity to test for and pass at least two industry certifications exams; key elements from several certification programs (as well as all elements from two certifications) are part of this curriculum. Having a certification prior to hire indicates that to the employer that the student can be put to work much more quickly with more basic information, and with less on-site familiarization and on-the-job training, than other candidates.

This proposal places a high priority on two entry-level certifications: the CompTIA Linux+ certification and the Solaris SCSA certification. Because of its vendor-independence, development preference, and low-cost qualities, Linux use in industry is rapidly becoming more prevalent. According to CompTIA (2004), qualifying for a Linux+ certification gives an individual a recognized industry credential that offers proof of knowledge and expertise in Linux technologies. CompTIA Linux+ certification is an international industry credential that validates the knowledge of individuals with at least six months of practical Linux experience. The skills and knowledge measured by this examination were developed with global input to assure accuracy, validity and reliability. Earning the CompTIA Linux+ designation means that the candidate can explain fundamental open source resources/licenses, demonstrate knowledge of user administration, understand file permissions/software configurations and manage local storage devices and network protocols in different UNIX environments.

As Solaris and SunOS variants, developed for the Sun SPARC processor, are the most widely used proprietary flavors of UNIX (“Popular Operating Systems List”, 2006), it stands to reason that high-qualified UNIX candidates will also have a skill-set in this

operating system (OS). Concentration on this certification will give students exposure (perhaps their first) to hardware platforms that are not originally Intel x86-based. Also, since this certification track has many higher-end administrative/engineering tasks built into it, students taking this portion of the track should be getting good exposure to many advanced concepts and upper-end uses for UNIX in the corporate environment.

According to Sun Microsystems (2005), the SCSA certification is for system administrators who perform essential system administration procedures on the Solaris Operating System, and for technical application support staff responsible for administering a networked server running on the Solaris OS. By the nature of this certification and its objectives, qualified students can be expected to have acquired more advanced UNIX skills.

In addition to Linux and Solaris being used extensively in industry, companies and publishers associated with CompTIA and Sun Microsystems (particularly, Course Technology, Sybex, Novell, and Thomson Course Technology) have prepared curricula and texts that are either ready-made for college-level education, or that can be rapidly adapted for such use. The placement of these certification programs within the proposed curriculum makes for a natural stepping-stone between the introductory UNIX, entry-level UNIX, advanced UNIX, and senior UNIX levels.

With additional directed training, students will also be familiarized with other common and specialty UNIX variants. Combined with the mainline skills developed from the above certification Preparation courses, there is the possibility of qualifying for additional certifications (including, but not limited to) Hewlett-Packard's HP-UX Customer Service Associate certification, Novell/SuSE's Certified Linux Professional

certification, ten various certifications from Brainbench, Red Hat's Certified Technician certification, and IBM's AIX User certification.

Core Class #1 – Introduction to UNIX Operating Systems.

This class is a basic introduction into the world of UNIX and non-Microsoft operations. The major topic areas in this class include a history of UNIX/UNIX development, basic descriptions of major UNIX variants, experience in basic UNIX operations, demonstrations of common command and utilities, input/output handling, file editing with VI, a description of the UNIX file system and file attribute handling, an introduction to process/job control, and an introduction to the three major shells found in UNIX (sh, csh, and ksh).

Several existing programs were reviewed for the writing of this project; many of them included an introductory UNIX course that served as a natural complement to introductory MS-DOS and MS-Windows classes taught at roughly the same time. This, typically, is described as a "100-level" or "core" class. No prerequisites, other than basic college entrance, should be required for this class. This class can be taught to students with no previous computer experience.

This class would also be appropriate for "user"-type students – those that may need to use UNIX platforms as part of their jobs, but have no intention of going on to be administrators. As such, this class could also be offered as part of a "job-upgrade" or "weekend-college" program, or modified for use as "introductory training" for local companies.

Classroom requirements, beyond the compulsory standard teaching equipment, would include having student computers with either Microsoft Windows with Internet capabilities, or a UNIX variant with Internet capabilities. The student computers should be able to access a UNIX server configured with Internet servers and student login/storage/printing accounts.

The following are two examples of textbooks that could be used for this class:

- Your UNIX: The Ultimate Guide; Das; 2001
- System V UNIX: A Practical Guide; Sobell; 1995

Core Class #2 – UNIX Shell Scripting.

According to Das (2001), the UNIX system administrator must be an accomplished shell programmer. The ability to use command-line utilities in a scripted, repeatable manner saves much time, reduces redundancy, and eliminates mistakes. To that end, a scripting class should be a mandatory requirement of any UNIX curriculum.

The purpose of this class is to further explore common UNIX administrative operations, and delve into the world of making shell scripts for advanced system administration. This class will provide insight and understanding of the types and major uses of shells and shell scripts, and will thoroughly demonstrate the uses of bash/sh, csh, ksh, perl, and expect scripts. For each of the major shells, the student will be taught file handling, text handling, I/O and case handling, looping, decision making, and logical program design.

This class is provided here as a 200-level course. Introduction to UNIX Operating Systems is a requirement for this class, since the utilities and kernel commands used in

scripting are introduced in that class. Formal classes in flowcharting and Boolean/sequential logic are also a recommended prerequisite; however, the short overview/review in these subjects during this course could suffice in many cases if a general education class containing logic is taken beforehand.

Classroom requirements, beyond the compulsory standard teaching equipment, would include having student computers with either Microsoft Windows with Internet capabilities, or a UNIX variant with Internet capabilities. The student computers should be able to access a UNIX server configured with Internet servers and student login/storage/printing accounts.

The following are two examples of textbooks that could be used for this class:

- Mastering UNIX Shell Scripting; Michael; 2003
- UNIX Shell Programming; Kochan et al; 2003

Core Class #3 – CompTIA Linux+ Certification Preparation.

This class provides further exploration of the Linux variant of UNIX, plus provides training for an entry-level certification. Specifically, this class will focus on the CompTIA Linux+ certification requirements, but will also cover major RedHat and BrainBench certification requirements as an addendum.

This class will expose the student to a brief primer on the history of Linux and GPL development, provide the student with the opportunity to install, configure, and manage a Linux system, provide an introduction to UNIX/Linux security, teach the student about UNIX documentation, and provide information on how hardware is handled under Linux.

During the review of the draft for this curriculum, several instructors suggested that short segments on the Linux development timeline as well as the history of GPL development would be appropriate. Therefore, this has been added to the proposed material.

This class provides the first of many industry certification opportunities in this curriculum. The CompTIA certification track was chosen here because of the wealth of materials available that are quickly adaptable for classroom use. In addition, given the low-cost nature of Linux, as well as several industry moves toward making this variant "mainstream", an effort should be made to emphasize Linux as much as possible in any UNIX curriculum. During the review of the draft for this curriculum, several instructors suggested that short segments on the Linux development timeline as well as the history of GPL development would be appropriate. Therefore, this has been added to the proposed material.

As many of the concepts presented in this class are merely reinforcement and adaptations of concepts in classes one and two, this class is presented here as a 200-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, would include having student computers with computer equipment capable of having a student easily load and run a Linux variant, with console and X-Windows, as well as Internet capabilities. The student computers should also be able to access a Linux server configured with Internet servers and student login/storage/printing accounts.

The following are two examples of textbooks that could be used for this class:

- Linux+ Study Guide; Smith; 2005

- Linux+ 2005 ; Eckart et al ; 2005

Core Class #4 – Solaris SCSA Certification Preparation, part 1.

This class provides exploration of the Solaris variant of UNIX and non-Linux/proprietary versions of UNIX. This class will include an introduction to Solaris systems concepts, installation and maintenance of proprietary systems, booting and shutting down systems, advanced system/file security concepts, advanced user environment concepts, advanced process control concepts, and an introduction into disk and file system administration.

There was significant debate among draft reviewers regarding whether a Solaris class-set was appropriate for this curriculum. The decision for inclusion came down to these factors:

- Sun has classroom-appropriate curriculum already developed.
- Sun dominates the industry in the production of non-Intel processors using some sort of UNIX variant.
- Solaris will run on either SPARC or Intel platforms, thus saving classroom equipment costs.
- During the evaluation of other curricula, it was noted that there are competing tech schools offering Solaris coursework.

Again, since many of the concepts presented in this class are merely reinforcement and adaptations of concepts in classes 1, 2, and 3, this class is presented here as a 200-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, would include having student computers with computer equipment capable of having a student easily load and run a Solaris variant, with console and X-Windows, as well as Internet capabilities. The student computers should also be able to access a Solaris server configured with Internet servers and student login/storage/printing accounts.

The following are two examples of textbooks that could be used for this class:

- Exam-Cram: Solaris 8 System Administrator; Ambro; 2001
- Solaris 8 Training Guide; Calkins; 2001

Core Class #5 – Advanced UNIX/Solaris SCSA Certification Preparation, part 2.

This class provides further exploration of the Solaris variant, plus provides training for entry-level Solaris certification. This class also begins the discussion of advanced UNIX administration concepts. This class will cover UNIX networking, system logging and auditing, advanced disk management and file system concepts, swap space, role-based access control and advanced system security, network file systems, Internet name services, and advanced Solaris management and installation concepts.

In addition to the reasons noted for class four, Solaris SCSA part two is offered because the topics being presented include many advanced topics needed for rapid corporate job advancement. The student should have by this time mastered basic administration and user skills. As such, this class should be rated in the 300-level range. The equipment and textbook recommendations for this class are the same as for core class four, as this class is a continuation.

When the first draft of this proposal was reviewed, several instructors noted that (1) many students might not appreciate a "one-size-fits-all" curriculum, and (2) many students/instructors might appreciate two different approaches to the senior administration and business integration topics. Therefore, two different elective approaches were developed for students whose career goals/interests might be different that others. The student must choose one out of the following two classes: Senior Unix Administration, and Linux Workplace Integration. Each will be discussed below.

Elective Class #1 – Senior UNIX Administration and Internetworking Operations.

This class provides high-end training for UNIX/Linux/Solaris administrators in business networking operations. This class will include discussion and experience in web, FTP, SSH, mail, DNS, and telnet administration, UNIX routing and firewalling, access control lists, Kerberos account management, quotas and auditing, performance testing, and business suite integration (databases, CRM, etc.). In addition, there will be some additional opportunity to train for additional UNIX and certification variants (HP-UX, SCO, Brainbench, lip, SAIR, RedHat, Novell/SuSE, AIX, etc.).

This class focuses on senior administration skills in a variety of generic UNIX environments related to common business environments. This class should be taught as a 400-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, would include having student computers with computer equipment capable of having a student easily load and run a UNIX variant, with console and X-Windows, as well as Internet capabilities. The student computers should also be able to access a UNIX server configured with Internet servers and student login/storage/printing accounts.

The following are two examples of textbooks that could be used for this class:

- UNIX System Administration Handbook; Nemeth et al; 2002
- Essential System Administration; Frisch; 2002

Elective Class #2 – Linux Integration into the Workplace.

This class provides high-end training for integrating Linux into business operations. This class will include discussion and exploration in the areas of system cost containment, Internet administration, file system administration, routing and firewalling, compiling and maintaining programs and kernels, benchmarking and performance, desktop and server replacement strategies, Windows and Novell replacement/hybrid strategies, and business suite integration.

As with Elective Class 1, this class focuses on gaining senior administration skills in a business environment. However, the focus of this class is on Linux integration, which many companies are looking at as a method of reducing costs and total cost of ownership. The job opportunities in this portion of the industry should be enormous in the next 10 years as industry continues its conversion from proprietary-source software to public-source software. This class should be taught as a 400-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, would include having student computers with computer equipment capable of having a student easily load and run a Linux variant, with console and X-Windows, as well as Internet capabilities. The student computers should also be able to access a Linux server configured with Internet servers and student login/storage/printing accounts.

The following are two examples of textbooks that could be used for this class:

- Linux Administration Handbook; Nemeth et al; 2002
- Moving to the Linux Business Desktop; Gagne; 2004

Hardware/Software Support

According to the DoL's Bureau of Labor Statistics (2006), there are many paths of entry to a job as a computer support specialist. While there is no universally accepted way to prepare for a job as a computer support specialist, many employers prefer to hire individuals with some formal college education – such as a computer-related associate's degree.

A number of companies are becoming more flexible about requiring a college degree for support positions (*ibid)*. The completion of a certification training program, offered by a variety of vendors and product makers, may help some people to qualify for entry-level positions. The benchmark for being a well-qualified hardware/software support specialist is, generally, earning a computer support certification (*ibid*).

The DoL has defined the skill-sets and the major tasks of major job functions on their O*Net web site. The DoL summary report for this type of certificate diploma/job track can be found in O*Net's "Summary Report for Computer Support Specialists" (2007). Further justification for the major skill sets presented below as needed for a hardware/software support specialist can be found in Table 2 as the interrelationship between O*Net-defined tasks and Brainbench certificate offerings. Relevant computer experience will of course supplement, and may substitute for, formal education and or certifications during the hiring process.

Beginning computer support specialists usually work for organizations that deal directly with customers or in-house users. Then they may advance into more responsible positions in which they use what they have learned from customers to improve the design and efficiency of future products. Job promotions usually depend more on performance

than on formal education. Computer support specialists at hardware and software companies often enjoy great upward mobility; advancement sometimes comes within months of one's initial employment (*ibid).* Therefore, it should be considered a basic requirement of an IT associate's degree curriculum that students be given extensive exposure to hardware and software support.

Core Class #1 -- Hardware Servicing, part 1/ CompTIA A+ "Essentials" Certification Preparation.

This class is a basic introduction into hardware support. The major topic areas in this class include a history of computing, a discussion of lab safety, an introduction to basic customer service, an introduction into tools used in the trade, a discussion of environmental and electronic concepts, an introduction into CPU and I/O evolution, and hands-on experience with motherboard resources, I/O, memory, hard drive methods, and power supplies. The skills provided in this class, as well as most of the classes in this track, meet the basic requirements set forth by O*Net for basic problem resolution, diagnostics, daily performance maintenance, and customer support of desktop PC hardware and software. This class should be taught as a 100-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and

workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following are two examples of textbooks that could be used for this class:

- The Complete PC Upgrade & Maintenance Guide; Minasi, et al; 2005.
- A+ Certification All-in-One Exam Guide; Meyers; 2006.

Core Class #2 – Hardware Servicing, part 2/CompTIA A+ "602/ Troubleshooting" Certification Preparation.

This class is a follow-up to part one. The major topic area in this class includes discussions and hands-on experience on typical computer repairs. Simulations will include observation and recording of symptoms, basic baselining of systems, and diagnostics. Additional theory will be presented in the areas of memory, data storage, printing, and SCSI devices.

Classes one and two focus on the requirements for earning the CompTIA A+ test through passing the "Essentials" test and the "220-602 IT Technician" test. This class should be taught as a 100-level class. Classroom equipment requirements and recommended textbooks are the same as class one.

Core Class #3 -- Software Servicing 1/Microsoft Desktop Support Specialist OS Support Certification Preparation

This course explores the fundamental principles involved in installing, maintaining, configuring, and supporting a variety of Microsoft-based operating systems. The design of this class is based on Microsoft course 2261 – Running Applications on Microsoft Windows. This class is a 40 class-hour course that prepares students for the

Microsoft 70-271 (Installing, Configuring, and Administering Microsoft Windows) MCP exam. The class will provide individuals who are new to Microsoft operating systems with the knowledge and skills necessary to troubleshoot basic problems end users will face. This is an introductory course designed to provide an overview of operating system concepts and how to troubleshoot Windows. The course also covers how to install Windows, how to perform post-installation configuration, how to answer end-user questions, how to troubleshoot startup and local user files, how to monitor and analyze system performance, and how to configure and troubleshoot peripherals and driver settings. This class should be taught as a 100-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following are two examples of textbooks that could be used for this class:

- MCDST: Microsoft Certified Desktop Support Technician Study Guide; Ferguson and Causey; 2006.
- MCDST 70-271: Supporting Users and Troubleshooting a Microsoft Windows XP Operating System; Stewart; 2004.

Core Class #4 -- Software Servicing 2/ Microsoft Desktop Support Specialist Applications Certification Preparation

This course explores the fundamental principles involved in installing, maintaining, configuring, and supporting a variety of Microsoft-based applications and suites. The design of this class is based on Microsoft course 2262 – Running Applications on Microsoft Windows XP. This class is a 16 class-hour course that prepares students for the Microsoft 70-272 (Supporting Users and Troubleshooting Desktop Applications) MCP exam. The class will cover basic troubleshooting guidelines and tools, compatibility and security issues related to applications, issues involving web browsers and email clients, and issues involving maintaining Microsoft Office. This class should be taught as a 100-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following are two examples of textbooks that could be used for this class:

- MCDST: Microsoft Certified Desktop Support Technician Study Guide; Ferguson and Causey; 2006.

- MCDST 70-272: Supporting Users and Troubleshooting Desktop Applications on a Windows XP Operating System; Carswell and Heinig; 2004.

To offer some variety to students participating in this track, only one of the following four courses is required: CompTIA Server+ Certification Preparation, HP Printer Support Certification Preparation, Advanced Desktop Servicing Operations, and Inttroduction to Macintosh Operations. Each elective will be discussed below.

Elective Course #1 -- CompTIA Server+ Certification Preparation.

This class is to serve as a follow-up to the A+ with a variety classes, as it focuses on advanced hardware skills required to maintain server-class equipment. This class also serves as a preparation for the Comptia Server+ certification. The course objectives include knowing specifics about system bus architectures, fault tolerance, using servers in a variety of network and daemon roles, application server model theory, storage and memory solutions, RAID and backup solutions, multi-processor environment, troubleshooting, upgrading, monitoring, installation planning, and server best practices. In addition to meeting the O*Net "Summary Report for Network and Computer Systems Administrators" (2007) requirements, it also to meets some of the advanced technical and management requirements of the "Summary Report for Computer Systems Engineers/Architects" (2007). This class should be taught as a 200-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a

server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following are two examples of textbooks that could be used for this class:

- Server+ Guide to Network Server Support; Conrad; 2001.
- Server+ Certification Bible; Kay; 2001.

Elective Course #2 – HP Printer Support Certification Preparation

This class serves as a follow-up to the printer maintenance portions of the A+ preparation classes. Printer repair is a niche within IT hardware maintenance that can stand on its own as a lucrative position or career.

The purpose of this class is to provide a wide range of skills, knowledge, and experience for disassembly and assembly, calibration, usage and troubleshooting tips and tricks for HP Laserjet printers. Students who successfully complete this course will be able to test for HP service qualification on the HP LaserJet 42XX/43XX, LJ 5000/5100, 8XXX, and LJ 9XXX series printers. Certified professionals also qualify for warranty labor reimbursements and service partner program entitlements.

HP printers and their certification tracks were chosen on the basis of (1) a pre-existing certification curriculum that can be converted to college classroom use, and (2) an abundance of HP printers in the corporate world. This class should be taught as a 300-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of printer components and peripherals that can be repeatedly disassembled and reassembled.

Recommended training materials for this course include HP's web-based online training resources (an example of which can be found at http://h20181.www2.hp.com/plmcontent/NACSC/Printers/LaserJet/34198_122106/LJ_p2015_with_FAQ/default.htm). An example of a textbook is the following:

- Fix Your Laser Printer and Save a Bundle; Lapsansky; 2005.

Elective Course #3 -- Advanced Desktop Servicing Operations.

These purposes of this class are to expand on the concepts introduced in core classes one through four and make them more applicable to complicated, real life corporate situations. This class in particular demands an instructor with an extensive amount of IT experience outside of academia.

Students will experiment with alternative means of loading operating systems and software (network loads, software images, serial and parallel connectivity), enterprise system design, alternative system designs, virtual machines, resource utilization, load and stress testing, and laptop/portable computing administration. Since an extensive amount of problem solving practice is involved in this class, analyst job role requirements set forth by O*Net's "Summary Report for Computer System Analysts" (2007) and

"Summary Report for Computer Engineers/Architects" (2007) are met by this class. This class should be taught as a 400-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

No textbooks are anticipated for this class; as a lab class, the materials will be based heavily on the instructor's "real world" experience.

Elective Course #4 -- Intro to Mac Operations, Service, and Support.

Besides Windows and Linux, students may be called upon to work on Apple Macintosh-based equipment on occasion. The purpose of this class is to give students a broad exposure to Apple technologies, since it likely be the only formal education they receive on the subject.

This class is based on the 40-class-hour AppleCare Technical Training course (the preparatory to the Apple Desktop Service Exam 9L0-002). In this class, students will learn how to access and use standard Apple diagnostic resources and tools, learn the Apple Troubleshooting Flowchart, cathode-ray tube safety and operational theory, LCD operational theory, proper disassembly procedures for Apple products, and how to

network Apple products. Students will also learn the basics of operating Mac OS-9 and OS-X. This class should be taught as a 400-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Macintosh operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of Macintosh components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following is an example of textbook that could be used for this class:

- Desktop and Portable Systems: A Guide to Supporting, Servicing, and Troubleshooting Apple Computers; Asturias and Gagen; 2007.

Microsoft

Microsoft has the "preeminent position in PC software, emerging on-line services, and other strategic resources" (Software Industry Report, 1995). Recent estimates have had Microsoft having somewhere between a 75% (EUbusiness, 2007) to 93% market share (Thurrott, 2003), depending on product class. Therefore, it is incumbent on any accredited IT program that Microsoft products be covered in the curriculum.

Fortunately, Microsoft also has a large education and certification organization; the majority of their tier-1 products have pre-developed curriculum that can be adapted easily for the collegiate organization. Of primary concern to this curriculum are two certification tracks – the Microsoft Certified Professional (MCP) certification, and the Microsoft Office Specialist (MOS) certification. The MCP track validates students' skills and knowledge in network and operating system products; certain combinations of multiple MCPs can lead to higher-tier certifications like the Microsoft Certified Systems Administrator (MCSA) and Microsoft Certified Systems Engineer (MCSE) certifications. The MOS track, on the other hand, validates the students' skills and knowledge in various office productivity products, such as Word, Excel, Outlook, and PowerPoint. Each product has a basic MOS certification, and a master certification.

During the review of other college curricula, it was noted that almost all of the courses on MS operating system, server, and network products were in some form based on MCP, MCSA, and MCSE certification curriculum. While there may be concerns about "teaching to the certification," it seems that the prevalent view is to use the MS certification curriculum as the basis for college-level curriculum.

The DoL summary report for positions related to the Microsoft certificate diploma/job track discussed here is the "Summary Report for Network and Computer System Administrators" (2007). Further justification for the major skill sets presented below as needed for a Windows system administrator can be found in Table 2 as the interrelationship between O*Net-defined tasks and Brainbench certificate offerings. The goal of this portion of the presented curricula is to develop the skills and knowledge needed for Microsoft network and computer system administration candidates.

Core Class #1 -- Introduction to Disk Operating Systems.

This class covers basic Microsoft (MS) Disk Operating System (DOS) and Windows concepts. Like the UNIX track counterpart, this class serves as an introduction to basic MS operations. Students are taught basic operating system theory including the boot process, interrupt handling, CPU instruction cycle theory, and device driver theory. A short history of operating systems and computer history is included in this course. DOS command usage and theory are covered in detail. Batch file programming is also covered, along with the skills needed to modify key files in MS operating systems for customized usages. This class should be taught as a 100-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Windows and DOS operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of components, peripherals,

and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following are two examples of textbooks that could be used for this class:

- Inside MS-DOS 6.22; Minasi and Minasi; 1994.
- Windows XP Under the Hood: Hardcore Windows Scripting and Command Line Power; Knittel; 2002.

Core Class #2 -- Introduction to Microsoft Office.

This course introduces the elements of the several popular programs inside the MS Office suite. This includes development of basic skills in word processing, spreadsheet management, presentation design, and web design. Emphasis will be placed on the basic fundamentals of document creation, saving, and printing, along with the more advanced concepts of presentation design and documentation management. Also covered in this class is the basic MS graphical user interface stylebook that is the basis for almost all MS-certified software – which will allow students to rapidly learn the "look-and-feel" of other MS software used in this curriculum. This class should be taught as a 100-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Windows and Office suites. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts.

The following is an example of textbook that could be used for this class:

- Microsoft Office 2003: Introductory Concepts and Techniques; Shelly, Cashman, and Vermatt; Course Technology; 2003.

Core Class #3 -- MCP Windows Professional Certification Preparation

This course expands on concepts introduced by the Microsoft Desktop Support Technician classes, and introduces the student to the job aspects of administrating a work environment using many desktop machines loaded with Windows Professional OSs. This course also assists the student in preparing for the Windows Professional MCP exam.

The major topics covered by the class include performing various installs of Windows, implementing and conducting administration of system resources, configuring and troubleshooting devices and drivers, optimizing and monitoring system performance, configuring and managing multiple desktop environments, and implementing desktop security. This class can be taught at the 200-level.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following is an example of textbook that could be used for this class:

- MCSE Guide to Microsoft Windows 2000 Server Certification Edition; Palmer; 2003.

The next four classes that focus on MOS preparation are electives. These classes are the MS Word certification preparation class, the MS Excel preparation class, the MS Outlook preparation class, and the MS PowerPoint preparation class. The student will chose two classes from among them.

Elective A Series Class #1 -- Microsoft MOS-Word and MOS/E-Word Certification Preparation.

This class is designed to develop proficiency in the MS Word word processing program. Experience will be provided in all the features of this program and the graphics interface provided by MS Windows. Projects include practice in the advanced functions of Word, including using Visual Basic for application macros, working with master documents, indices, tables of contents, and creating online forms. Additional practice will involve using split screens, sorting, and merging. An additional focus will be on completing simulations of the tasks found on the MS-Word MOS exam. This class should be taught as a 200-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Windows and Office suites. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts.

The following is an example of textbook that could be used for this class:

- Microsoft Word 2000; Zimmerman et al; 2001.

Elective A Series Class #2 -- Microsoft MOS-Excel and MOS/E-Excel Certification Preparation.

This course is designed to develop proficiency in solving business problems with the aid of MS Excel, a spreadsheet program. Emphasis is placed on creating, saving, customizing, and printing spreadsheets useful for business practices. Additional concepts presented will include using immediate and advanced formulas, complex charts, macros, and functions to solve business calculations. An additional focus will be on completing simulations of the tasks found on the MS-Excel MOS exam. This class should be taught as a 200-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Windows and Office suites. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts.

The following is an example of textbook that could be used for this class:

- Microsoft Excel 2000 – Illustrated Complete; Redding et al; 2000.

Elective A Series Class #3 -- Microsoft MOS-PowerPoint and MOS/E-PowerPoint Certification Preparation

This course is designed to develop proficiency in MS Powerpoint (PPT). PPT is a tool that enables users to quickly create dynamic slide presentations for home, small office, and corporate use. Students will be instructed on how to create, modify, and delete presentations, how to work with both text and graphics, how to deliver presentations, and how to manage the presentation files. An additional focus will be on

completing simulations of the tasks found on the MS-PPPT MOS exam. This class should be taught as a 200-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Windows and Office suites. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts.

The following is an example of textbook that could be used for this class:

- Microsoft Office 2003; Pasewark and Pasewark; 2005.

Elective A Series Class #4 -- Microsoft MOS-Outlook and MOS/E-Outlook Certification Preparation

This course is designed to develop proficiency in MS-Outlook, a popular email, calendar, contact management and task-scheduling suite in use by many companies worldwide. In this class, students will be instructed on how to use Outlook as an email tool, how to manage message archives, how to save and use contact lists, how to use the events scheduler, and how to use the note taking function. An additional focus will be on completing simulations of the tasks found on the MS-Outlook MOS exam. This class should be taught as a 200-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Windows and Office suites. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts.

The following are two examples of textbooks that could be used for this class:

- Take Back Your Life!: Using Microsoft Outlook to Get Organized and Stay Organized; McGee; 2004.
- Microsoft Office Outlook 2003 Step by Step; Blanton and Wrothwell (eds.); 2003.

Core Class #5 -- MCP Windows Server Certification Preparation part 1.

Core Classes 5 and 6 focus on exposing the student to back office operations and administration using MS Windows Server products. While examining various curricula, I noticed a wide variance on how many contact hours were involved in teaching the Server product. For instance, Microsoft has three classroom courses totaling 110 contact hours. CollegeAmerica uses two courses total 80 contact hours. Other colleges use one class total 40 contact hours. What is discussed here is a two course strategy.

This portion of the curricula focuses on the 1st half of Windows Server MCP preparation. Topics discussed include a variety of installation techniques, troubleshooting and configuring accessed to shared/served resources, and configuring/troubleshooting user and group accounts. This class should be taught as a 300-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals,

and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following is an example of textbook that could be used for this class:

- MCSE Guide to Microsoft Windows 2000 Server Certification Edition; Palmer; 2003.

Core Class #6 -- MCP Windows Server Certification Preparation part 2.

This portion of the Windows Server curricula focuses on the parts of Windows Server MCP preparation not covered in course 5. Topics discussed configuring and troubleshooting shared hardware, managing and optimizing shared resources, optimizing storage use, setting up network domains and Active Directory trees, configuring network connectivity, and configuring security. This class should be taught as a 300-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following is an example of textbook that could be used for this class:

- MCSE Guide to Microsoft Windows 2000 Server Certification Edition; Palmer; 2003.

Core Class #4 -- MCP Windows Network Infrastructure Certification Preparation.

This class introduces students to the concepts of designing and building a Microsoft-based network. The idea behind this class is to give students some exposure to working with MS products in medium-to-large computing environments that have (1) 200-20000 users, (2) 5-150 physical locations, (3) multiple server-based applications and services, and (4) network connectivity to those services through a variety of network, intranet, extranet, and Internet means.

Topics covered in this class include configuration and management of DNS, configuration and management of DHCP, setting up remote access, troubleshooting a variety of network protocols, setting up and maintaining routing protocols, and setting up and running a variety of certificate and security services. This class should be taught as a 400-level class

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them.

The following is an example of textbook that could be used for this class:

- MCSA/MCSE: Windows Server 2003 Network Infrastructure Implementation, Management, and Maintenance Study Guide: Exam 70-291; Suehring, et al; 2006.

Network

The following model curriculum provides colleges and universities with a basic framework to prepare students with a set of broad perspectives that should enable a student completing this curriculum to obtain and accomplish entry-level employment in the various networking and network management specialties. The basic core courses of study will prepare individuals to troubleshoot, repair, and maintain computer systems and basic local area network problems. A well-designed network core track should prepare students to design, implement, and manage linked systems of computers, peripherals, and associated software to maximize efficiency and productivity. The program should also include instruction in systems design and analysis, networking theory and solutions, types of networks, network management and control, network and flow optimization, security, configuring, and troubleshooting.

The US Department of Labor (DoL) has defined skill-sets and the major tasks of major job functions on their O*Net web site. The DoL summary report for this type of certificate diploma/job track can be found in O*Net's "Summary Report for Network and Computer Systems Administrators" (2007), and "Summary Report for Network Designers" (2007). Further justification for the major skill sets presented below as needed for a network administrator or network support specialist can be found in Table 2 as the interrelationship between O*Net-defined tasks and Brainbench certificate offerings. The goal of this portion of the presented curricula is to develop the skills and knowledge needed for network systems administration and operation candidates.

This proposal places a high priority on two entry-level certifications: the CompTIA Network+ certification and the Cisco CCNA certification. Because of its vendor-independence, development preference, and low-cost qualities, Linux use in industry is rapidly becoming more prevalent. Qualifying for a Network+ certification gives an individual a recognized industry credential that offers proof of basic knowledge and expertise in general networking technologies. The Cisco CCNA, on the other hand, provides proof that the graduate has hands-on lab experience with industry-leading Cisco equipment, and has basic knowledge in routing protocols such as RIP, routed protocols such as TCP/IP, and IOS command-line management of Cisco routing and switching equipment.

During the review of other associate's level curricula, it was noted that roughly half of the basic networking courses offered relied on some form of the Cisco CCNA certification curriculum. While there may be concerns about "teaching to the certification," it seems that the prevalent view is to use at least some of the Cisco certification curriculum as the basis for college-level curriculum. Likewise, many of the "Introduction to Networking" course titles looked at either are based on the Linux+ curriculum or use a Linux+ textbook.

Core Class #1 – Introduction to Networking 1/CompTIA Network+ Certification Preparation part 1.

This class is a basic introduction into the world of networking operations. This class will include discussion on networking media and equipment, connection types,

physical and logical topologies, the standard OSI model, basic networking protocols and APIs, and networking specifications and standards.

Core Class #2 – Introduction to Networking 2/CompTIA Network+ Certification Preparation part 2.

This class is a continuation of the basic introduction into networking. This class will include discussion on network implementation, the various NOS systems, repair tools and techniques, fault tolerance, network defense and disaster recovery, network support, and diagnostic and troubleshooting tools.

Most of the existing programs that were reviewed while developing this curriculum had networking studies requirement as prerequisites. These prerequisite classes are to ensure that the student had a solid background in network theory and basic setup – knowledge that will be required and build upon in later classes.

Typically, these classes were described as “100-level” or “core” classes. No prerequisites, other than basic college entrance, should be required for these classes. These classes can be taught to students with no previous computer experience.

It should be noted than some programs had this core requirement as a 40 contact-hour class. However, the CompTIA Network+ study program (on which this curriculum was based) calls for 80+ hours of study. Further, several programs such as the one at CollegeAmerica also call for Introduction to Networking as a two-part class. I have chosen to emulate the CollegeAmerica approach, as this most closely matches the CompTIA program and ensures that students have the best opportunity to learn and retain knowledge and skills.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable.

The following are two examples of textbooks that could be used for this class:

- Network+ Guide to Networks, Tamara Dean, 2005
- Guide to Networking Essentials, Toshomo, Tittle, and Johnson, 2004

Core Class #3 – Intro to Cisco Networking Technologies/CCNA Certification Preparation part 1.

Classes 3 and 4 prepare the student for working with Cisco networking equipment, and for eventually taking the Cisco CCNA certification tests. It was decided to break the CCNA preparation courses into two classes in order to follow the Cisco 2-test track, instead of the 1-test track. I decided to do this in order to give students a less stressful learning experience while ensuring that all the necessary skills were presented.

This class is based on the curriculum for Cisco class "INTRO", Introduction to Cisco Networking Technologies. Cisco teaches this as a 36 class-hour course. After completing the course, the student should be able to create a simple point-to-point network, a simple Ethernet network, determine the most appropriate network topology

for typical user requirements, list the issues related to shared LANs and the solutions that LAN technology provides, add a hub and a switch to expand an Ethernet LAN, and list ways in which LANs can be optimized, define how networks can be connected by routing protocols, construct a topology and network addressing scheme with subnet mask computations, add a default gateway, and predict the behavior of traffic to on-network and off-network IP addresses, compare UDP to TCP and explain the relationship of reliable data delivery to the TCP process and observe the functions of UDP and TCP in communicating with sites not on an Ethernet LAN, define major WAN multiplexing and access technologies, list the components of an enterprise network, define its installation and testing processes and how these differ from the installation and testing processes of smaller networks, complete and verify initial IOS software device configuration, use Cisco IOS commands to accurately determine network operational status and performance, manage operating system image files to maintain an accessible operating system file, manage device configuration files to reduce device downtime, and execute adds, moves and changes. This class should be taught as a 300-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable.

This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

The following are two examples of textbooks that could be used for this class:

- CCNA: Cisco Certified Network Associate Study Guide: (Exam 640-801); Lammle; 2007.
- CCNA Self-Study: Introduction to Cisco Networking Technologies (INTRO); McQuerrey (ed.); 2004.

Core Class #4 – Interconnecting Cisco Networking Devices/CCNA Certification Preparation part 2.

This class is based on the curriculum for Cisco class "ICND", Interconnecting Cisco Devices. Cisco teaches this as a 40 class-hour course. After completing the course, the student should be able to build a functional configuration to support the specified network operational requirements, given a network design, use the appropriate show commands to display network operational parameters so that anomalies are detected, use the appropriate debug commands to monitor network operational parameters so that anomalies are detected, explain how bridging and switching operates, explain the purpose and operations of the Spanning- Tree Protocol, build a functional router configuration to support the specified network operational requirements, given a network design, and describe the features and operation of static routing. This class should be taught as a 400-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances. The following are two examples of textbooks that could be used for this class:

- CCNA: Cisco Certified Network Associate Study Guide: (Exam 640-801); Lammle; 2007.
- CCNA Self-Study: Interconnecting Cisco Network Devices (ICND); McQuerrey (ed.); 2003.

Core Class #5 – Storage Area Networking.

The dramatic increase in exchange of highly valued data across an enterprise network has resulted in the need to better understand and manage storage area networs (SANs), network attached storage (NAS) and direct attached storage (DAS) networks. Sharing storage over existing networks usually simplifies storage administration and adds flexibility since cables and storage devices do not have to be physically moved to move storage from one server to another. SANs also provide for central network booting of

servers, easier duplication of data for backup purposes and a common method of disaster recovery mitigation.

This course will cover the dominant mass storage technologies, specifically rotating magnetic and optical media. This course begin with the basics of track and sector layout on rotating media and culminates with the examination of distributed network storage methods that are iSCSI, DAS, NAS, and SAN technologies. Other topics include storage and compute virtualization, configuration management, storage farms, backup and recovery. This class should be taught as a 400-level class.

Since this is a fairly new technology, not many curricula offer a SAN course or certificate. Regis University offers a 120 contact hour, 4 class Master's certificate course. Several University of California campuses also offer an 8 contact hour extension/upgrade course.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of storage chassis, routers, switches, hubs, and PIX firewall appliances.

The following is an example of textbook that could be used for this class:

- Storage Area Network Essentials: A Complete Guide to Understanding and Implementing Sans (Veritas Series); Barker and Massiglia; 2001.

Security

The following model curriculum provides colleges and universities with a basic framework to prepare students with a set of broad perspectives that should enable a student completing this curriculum to obtain and accomplish entry-level employment in the security specialties. This knowledge includes knowing the basic uses for IT security, learning security management skills, and having basic competency on the major IT security techniques used in the business world.

Again, this conceptual framework does not provide curriculum development personnel with a clear statement of the requirements of the curriculum, nor does it establish a specific physical implementation. This program can be the basis of a certificate diploma or dedicated worker/skills upgrade plan. Ideally, this proposal can also be integrated (in part or wholly) into the larger associate's degree program.

Having been designed for four credit-hours/40 contact-hours per class, this 20-credit program is ideally suited to be used as a core requirement set within a larger network/systems administration degree program. I performed an analysis involving local community and technical college IT security programs indicates the following patterns that confirm the suitability of the design. The programs looked at include security certificate programs hosted at Aims Community College, Front Range Community College, Inver Hills Community College, Arapahoe Community College, Middlesex Community College, Edmonds Community College, and Gateway Community College. Program lengths vary between 15 and 56 credit hours, with an average of 26.25 credit hours, and a median of 20 credit hours (150, 560, 262.5, and 200 contact hours, respectively). The most common components/course titles of these

programs include Introduction to Networking, Information Security Fundamentals/Principles, Network Security Fundamentals/Principles, Introduction to Computer Forensics, Disaster Recovery, and NOS/OS/IOS-Specific Security Design and Security Administration

Outside of the collegiate setting, there are several industry training programs that specialize in entry-level IT Security as well. Cisco offers a variety of product-specific security courses that involve 40 contact-hours per specialty. TechNow also offers a series of boot camp-type classes, each of which cover a specific element of the CISSP CBK or high-end security certification. Each class is between 8 and 48 contact hours.

This proposal places a high priority on two entry-level certifications. The CompTIA Security+ certification tests for entry-level security knowledge mastery of an individual with two years on-the-job networking experience, with emphasis on security. The exam covers industry-wide topics, including communication security, infrastructure security, cryptography, access control, authentication, external attack and operational and organization security. CompTIA Security+ is often taught at colleges, universities and commercial training centers. The ISC^2 Systems Security Certified Practitioner (SSCP) credential offers information security tacticians, with implementation orientations, the opportunity to demonstrate their level of competence in the seven domains of the compendium of best practices for information security, the ISC^2 SSCP CBK. The SSCP credential is ideal for those working toward or who have already attained positions as Senior Network Security Engineers, Senior Security Systems Analysts or Senior Security Administrators.

CompTIA and ISC^2 have prepared curriculum that is either ready-made for college-level education, or curriculum that can be rapidly adapted for such use. Furthermore, the placement of these certification programs within the proposed curriculum makes for a natural stepping-stone between the introductory and senior security class levels.

The US Department of Labor has defined the skill-sets and the major tasks of major job functions on their O*Net web site. The DoL summary report for this type of certificate diploma/job track can be found in the "Summary Report for Computer Engineers/Architects" (2007) and "Summary Report for Computer System Analysts" (2007).. Further justification for the major skill sets presented below as needed for an information security administrator can be found in Table 2 as the interrelationship between O*Net-defined tasks and Brainbench certificate offerings. The goal of this portion of the presented curricula is to develop the skills and knowledge needed for IT security candidates.

It should be noted here that, unlike some programs reviewed, this curriculum will make no attempt to prepare a student for ISC^2's premier security certification, the CISSP. The CISSP is well beyond the scope of this program in terms of offered classroom instruction and classroom/field experience.

Core Class #1 – Introduction to IT Security/CompTIA Security+ Certification Preparation.

This class is an introduction into basic IT Security Knowledge. It will cover general network security topics, infrastructure security, basic cryptography, and operational and organizational security.

This class is, again, based on the 80-hour CompTIA Security+ curriculum. However, since it is not expected that the student be able to certify at this point in the program, certification exam-worthy coverage of all the topics covered is not needed at this time. Thus, this class is only 4 credits instead of 8.

This class is provided here as a 200-level course. The Introduction to Networking classes are a requirement for this class, as many of the commands, tools, and theory used here are introduced in those classes.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

The following are two examples of textbooks that could be used for this class:

- Security+ Guide to Network Security Fundamentals; Bosworth, Calvert, and Campbell; 2002
- All-in-One Security+ Certification Exam Guide; White et al; 2002

Core Class #2 – Principles of Network Security.

This class provides further exploration into topics regarding safeguarding and securing various types of networks. This course also begins the series of advanced coursework that will involve specific details and hands-on experience on how to complete various chores that a future IT Security specialist may be called upon to perform. The student will be exposed to network defense fundamentals, security policy design and implementation, network intrusion detection and response strategies, firewall topologies and configuration, VPN and Extranet concepts, documentation and testing, ethics and standards, and ongoing security management concerns.

This class provides the first of many opportunities to look into the specifics of the IT Security industry. The instructor would be encouraged to provide as many examples and practicum experiences as possible to the students, as well as give students the opportunity to test/evaluate/design various security conditions.

Some of the concepts presented in this class are merely reinforcement and adaptations of concepts in classes 1-3, while others (particularly the practical examples) are new. This class is presented here as a 300-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a

server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

The following are three examples of textbooks that could be used for this class:

- Security Awareness: Applying Practical Security in Your World; Ciampa; 2006
- Guide to Network Defenses and Countermeasures; Weaver; 2006
- Hands-On Ethical Hacking and Network Defense; Simpson; 2005

Core Class #3 – Disaster Recovery Operations and Management.

This class provides exploration into the distinct field operations of disaster recovery, particularly focusing on the operation and management specialties. This class will include discussion of and practical challenges in using various backup tools and data storage techniques, various data recovery techniques, controlling viruses, Trojans, spyware, malware, infrastructure control and management, personnel and logistical handling, disaster planning and management, and business continuity planning.

This class provides significant follow-up to the data and operations recovery aspects covered in the Security+ class. As this particular specialty can be a career of its own, this class is presented at the 400 level.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

The following are two examples of textbooks that could be used for this class:

- Disaster Recovery Handbook; Wallace and Webber; 2004
- A Primer for Disaster Recovery Planning in an IT Environment; Hiatt; 2000

Core Class #4 – Computer Forensics.

This class provides exploration into the distinct field of computer crime investigation. This class will include discussion, examples, and practice in investigations and forensics as a profession, professional ethics and goals, computer crime investigations, field and lab tools, intrusion detection techniques, evidence handling, data acquisition, recovery, and analysis, and how to be an expert witness.

This class provides significant follow-up to investigation aspects covered in the Security+ class. As this particular specialty can be a career of its own, this class is presented at the 400 level.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

A variety of data backup and recovery software/hardware should also be provided.

The following are two examples of textbooks that could be used for this class:

- Guide to Computer Forensics and Investigations; Phillips et al; 2005
- Computer Forensics: Incident Response Essentials; Kruse; 2001

When the first draft of this proposal was peer reviewed, several instructors noted that (1) many students might not appreciate a "one-size-fits-all" curriculum, and (2) many students/instructors might appreciate two different approaches to the senior security topics. Therefore, three different elective approaches were developed (with one being required for completing the program) for students whose career goals/interests might be

different that others. These approaches are UNIX Security, Microsoft Security, and Cisco Security. Each is discussed below.

Elective Class #1 – UNIX Security Administration.

This class provides high-end training for UNIX/Linux/Solaris administrators in security operations and administration. The class will go over elements of the basic UNIX kernel system, UNIX protocol security, intrusion and change detection techniques, UNIX routing and firewall techniques, web services security, NIS/NFS security, and IPtables.

This class focuses on senior security administration skills in a variety of generic UNIX environments related to common business environments. This class should be taught as a 400-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

login/storage/printing accounts.

The following are three examples of textbooks that could be used for this class:

- Hardening Linux; Turnbull; 2005
- Practical UNIX and Internet Security; Garfinkel, Spafford, and Russell; 1995
- Guide to Linux Networking and Security; Wells; 2003

Elective Class #2 – Windows Security Administration.

This class provides high-end training for Windows administrators in security operations and administration. This class will include discussion on Active Directory security design, Kerberos security implementation on an Active Directory system, VPN and Extranet communications techniques, access control, domain topology design, and troubleshooting and testing.

As with Elective Class 1, this class focuses on senior security administration skills in a variety of Windows environments related to common business environments. This class should be taught as a 400-level class. This class also makes an attempt at covering major topics in two of Microsoft's security certifications.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable.

This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

The following are two examples of textbooks that could be used for this class:

- MCSE Self-Paced Training Kit (Exam 70-298): Designing Security for Microsoft Windows Server 2003 Network; Bragg; 2004
- MCSA/MCSE Self-Paced Training Kit (Exam 70-299): Implementing and Administering Security in a Microsoft Windows Server 2003 Network, Northrup and Thomas; 2004

Elective Class #3 – Cisco Routing and Firewall Operations.

This class provides training for Cisco administrators in security operations and administration. This class will include discussion and practical experience in basic Cisco IOS operations, implementation of basic LANs and WANs, a discussion of the various routing and routed protocols, setup and configuration of a VPN and firewalls, configuration of Access Control Lists, configuration of Network Address Translation and DHCP, and the setup and configuration of various logging, policy, and auditing systems.

How the design was made of this particular class was somewhat difficult. While it would be much simpler to make this class into one solely discussing the Cisco PIX device and its operations (using the pre-designed 40-contact-hour Cisco curriculum), it would be difficult for a student to become accustomed to the PIX-IOS interface without previous significant experience on other Cisco equipment. On the other hand, to include a full-blown Cisco CCNA program (80-contact-hours using the Cisco curriculum), would be excessive and outside the goals of this security curriculum proposal.

The result is a hybrid class, taking key elements from Cisco's 640-821 "Intro", 640-811 "Interconnection", and 642-522 "PIX Firewall" curriculums. The objective of their class is to develop a student into somebody who is operationally ready for Cisco security environments, but not necessarily as a certified associate, professional, or expert. Ultimately, however, this class will be among the most challenging available in this program, and should be reserved for the most ambitious, skilled, and dedicated students.

As with Elective Classes 1 and 2, this class focused on senior security administration skills in a variety of Cisco environments related to common business environments. Due to the inherent difficulty of the proposal, this class should be taught as a 500-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances.

The following are three examples of textbooks that could be used for this class:

- CCNA: Cisco Certified Network Associate Study Guide; Lammle; 2005
- Cisco ASA and PIX Firewall Handbook; Hucaby and Hucaby; 2005

- Cisco PIX Firewalls: Configure, Manage, and Troubleshoot; Riley et al; 2005

Telecommunications

The following model telecommunications curriculum provides colleges and universities with a basic framework to prepare students with a set of broad perspectives that should enable a student completing this curriculum to obtain and accomplish entry-level employment in the telecommunications specialties. These skills include the basic current and historical uses of Telecommunications, basic and advanced user skills, basic and advanced administration skills, basic and advanced management skills, and coverage and demonstrated competency on the major Telecommunications techniques used in the business world.

The US Department of Labor has defined the skill-sets and the major tasks of major job functions on their O*Net web site. The DoL summary report for this type of certificate diploma/job track can be found in the ""Summary Report for Telecommunication Equipment Installers" (2007). Further justification for the major skill sets presented below as needed for telecommunications specialist can be found in Table 2 as the interrelationship between O*Net-defined tasks and Brainbench certificate offerings. The goal of this portion of the presented curricula is to develop the skills and knowledge needed for telecommunications operator, administrator, and installer candidates.

Having been designed for 4 credit-hours/40 contact-hours per class, this 24-credit program is ideally suited to be used as a core requirement set within a larger network/systems administration degree program. The small survey in table 4 involving local community and technical college programs demonstrate that the proposed program is within collegiate and private training norms. Program lengths vary between 5 and 36

credit hours, with an average of 17 credit hours, and a median of 21 credit hours. The most common components/course titles of these programs include Introduction to Telecommunications, Voice Telecommunications/Telephony, Data Telecommunications, Convergent Technologies, Fiber Optics, Physical Media, and Wireless Media.

It is also evident from the survey referred to above that many of the certificate programs above, the class titles, and the associated prerequisites, assume that the student will also be taking a number of introductory IT related classes as well. These classes include Boolean Logic, Technical Math, Introduction to Networks, and Introduction to Computing. However, it is not believed that these introductory requirements are a hindrance to a stand-alone telecommunications certification or class sequence. The topics involved can be taught concurrent with other topics or made a requirement to entering the proposed telecommunications curriculum.

Outside of the collegiate setting, there are several industry training programs that specialize in entry-level Telecommunications as well. Tonex (2006) offers 8 to 40 hour courses in basic telecommunications, wireless, optical networking, management, and security. Also, Tercom Training (2006) offers multiple 8 hour introductory seminars in telecom, call center operations, wireless, and VoIP.

Core Class #1 – Introduction to Telecommunications.

This class is a basic introduction to communications over a distance. This class will include discussion of the definitions of communications, telecommunications, data communications, voice communications, and convergent communications. It will also

look at giving students introductions into basic electronics, wave theory, modulation, analog signaling and decoding, and digital signaling and decoding. Other descriptions provided will be in the areas of the public phone system, private phone systems, satellite communications, and data networking.

In the programs that were reviewed, a broad-based Introduction to Telecommunications course served as one of the entry-points to the degree program, along with Introduction to Networking. In many cases, this class is supposed to be taken concurrently with Introduction to Networking. Therefore, this class ought to be considered a 100-level class. No prerequisites should be required for this class, other than basic college entrance. The class can be taught to students without prior computer experience.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances. This class also requires a variety of phone equipment.

The following are two examples of textbooks that could be used for this class:

- Guide to Telecommunications Technology; Dean; 2002

- Introduction to Telecommunications; Gokhale; 2002

Core Course #2 – Internet Telecommunications/CompTIA I-Net+ Certification Preparation.

This class further explores a variety of telecommunications topics specific to the Internet. It also serves as a with a variety course for the CompTIA I-Net+ certification. This exam targets individuals who want to demonstrate a knowledge and skills baseline that enables them to pursue a variety of entry level Internet and e-commerce related careers such as participating in the maintenance of Internet, intranet, and extranet infrastructure and services, and participating in the development of Web-related content and applications.

Students in this course will discuss and experiment with Internet site functionality and performance issues, telecommunications programming and development issues, telecommunications networking, security issues, business concepts, and legal issues in telecommunications. This class should be taught as a 200-level class.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable.

This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances. This class also requires a variety of phone equipment. This class also requires a variety of Internet server hardware and software that the student may experiment with loading and using.

The following is an example of textbook that could be used for this class:

- INet+ Certification; Reed; WestNet; 2002.

Core Course #3 – Wireless Telecommunications.

This course reviews wireless telecommunications systems from microcell to global wireless infrastructures. Its purpose is to teach the technology, applications, and limitations of these systems, which have become an essential element of the world information infrastructure. Technology topics covered include cellular communication principles, coding, antenna and propagation effects, channel access schemes, traffic engineering, and wireless network design. The course places emphasis on terrestrial systems such as cellular, personal communication services (PCS), dispatch, wireless local-area networks (WLANs), and wireless data systems. Also covered are the topic areas of specific wireless telecommunication systems, frequency spectrum, cellular radio, troubleshooting, and use of telecommunication test equipment, market trends, regulations, and standards. Students assess the role of wireless systems in comparison with other telecommunications alternatives available to organizations.

The objective is to provide students the opportunities to obtain skills for the ever-expanding wireless telecommunications fields, including consumer products, RF communications for public radio services, police, fire, utility companies, and cellular,

PCS and land mobile services. The emphasis of this program is both hands-on and theoretical.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of phone equipment.

Core Course #4 – Telephony.

This course covers basic telecommunications equipment used by businesses and its connection to a switched public or private network. Subjects covered include electronic key systems, private branch exchange systems (PBX), trunks and associated equipment, and the public telephone system. Analog and digital communications and associated equipment are also covered. This class will also provides hands-on training on a private branch exchange system, user data modification for a central office switch, digital key systems, and associated equipment.

Classroom requirements, beyond the compulsory standard teaching equipment, would include having student computers with both Internet and serial terminal capabilities. The student computers should be able to access a server configured with

Internet servers and student login/storage/printing accounts. This class also requires a variety of telephone equipment.

The following is an example of textbook that could be used for this class:

- Telecom Systems, Pstn, PBX, Datacom, IP Telehony, Iptv, Wireless and Billing; Harte and Ofane; 2006.

Core Course #5 – Fiber Optic Technologies and Repair.

Students will study the properties of optical fibers which include refractive index, attenuation, chromatic dispersion, laser and LED optical repeater design. Fiber optic networks also will be examined, as well as long haul communications systems, local distribution, LANs, and inter- and intra-building applications. This course also covers how to install, repair, test, terminate, and troubleshoot fiber optic cabling. Students will receive a general background in fiber optic theory and learn how to apply structured cabling standards to fiber optic installation, splice and terminate fiber optic cabling to meet TIA/EIA requirements, and use various test tools. This class is designed to meet the O*Net "Summary Report for Telecommunications Line Installers and Repairers" (2007).

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such

as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of Cisco 25xx routers, switches, hubs, and PIX firewall appliances. This class also requires a variety of phone equipment.

The following is an example of textbook that could be used for this class:

- Fiber Optic Cable Installation/Repair; Pearson; 1997.

Core Course #6 – Introduction to VoIP.

A suite of application protocols known as Voice over IP (VoIP) is covered in this program. Important protocols within that suite, including Real-time Transport Protocol (RTP), Session Description Protocol (SDP), Media Gateway Control Protocol (MGCP) and Session Initiation Protocol (SIP), are described and the architecture of various VoIP installations including on-net to on-net, on-net to Public Switched Telephone Network (PSTN) and inter-domain scenarios are described. The functions of the network elements that play significant roles in this architecture are defined. Examples of network elements and test equipment that are currently available as products will be examined and used by students throughout the course of study.

Classroom requirements, beyond the compulsory standard teaching equipment, include having a variety of computer equipment capable of loading and running a variety of Microsoft operating systems. The student computers should also be able to access a server configured with Internet services and student login/storage/printing accounts. Students should also have access to a large variety of computer components, peripherals, and workstations that can be repeatedly disassembled, reassembled, and have operating systems and software loaded on them. A variety of demonstration tools and parts, such

as network diagnostic equipment, wiring, and crimping tools, is also highly desirable. This class also requires a variety of phone equipment.

The following is an example of textbook that could be used for this class:

- Introduction to IP Telephony 2nd Edition, why and how Companies Are Upgrading Private Telephone Systems to Use Voip Services; Hart; 2006

General Studies and Applied General Studies Courses

As mentioned previously, well-rounded general studies and applied general studies courses are a requirement for accreditation of curricula. Further justification for the major skill sets needed for any of the above course tracks can be found in Table 2.

Specific details about the exact mechanics of each class are well beyond the scope of this paper, as well as beyond my personal experience. However, many of the existing curricula reviewed in the preparation of this presentation have many of the elements listed below (see Tables 5 and 6).

Core Class #1 -- Psychology and Sociology on the Job.

This class is designed to meet accreditation requirements for having a humanities course in the general curriculum. However, it has been modified so that it covers topics that will be applicable in the workplace. Topics covered include personal and team motivation, different cultures found in the work place, teamwork, and conflict resolution. Also included are discussions on how to survive interviews, along with a practice interview. This class focuses of the traditional theories of motivation from momentary desires to a process of reasoning throughout a lifetime. Emphasis is placed on Maslow's Hierarchy of Needs, Expectation Theory, Three Needs Theory, and the Goal-Setting and Self-Efficacy Theories.

Core Class #2 -- Writing and Composition.

This class handles the writing requirements of a good curriculum. However, it has been modified to focus more on the specific composition chores done throughout an

IT career. This class presents the fundamental principles of written communications; specifically, it presents issues in resumes, cover letters, common business correspondence, reports, presentations, and minutes. Specific to this course is the review of the steps necessary to produce effective written communications. The types of compositions envisioned for this class include technical papers, how-to instructions, proposals, project summaries, and visual presentations.

Core Class #3 -- American History and Civics.

This course focuses on the history and government of the United States from the American Revolution to the present. An emphasis is placed on the economic, political, and social development of the country, as well as an understanding of the modern functioning of the government.

Core Class #4 – Literature.

This class meets the typical accreditation requirement for a reading class. It aims to explore and critique the works of contemporary authors whose writings portray some insight into today's society. However, instead of the typical American/English-language curriculum, this will be modified by including readings common to the IT profession.

Core Class #5 -- Speech and Debate.

As a complement to the literature and writing/composition courses, a good curriculum should include a speech course. This presents the fundamental principles necessary for the preparation of sound speeches. Students will prepare and deliver

informative and persuasive speeches, participate in group problem solving, and prepare and deliver introductions, welcomes, presentations, acceptances, and tributes. Additional foci of this course are professional communications/presentations and the ability to establish and defend a particular position.

Core Class #6 – Mathematics.

This course focuses on the basic mathematical processes and their application in the day-to-day operation of a business. Emphasis is placed upon sales records, payroll processing, percentages, interest, measurement, Boolean logic, algebraic expressions, graphing, formulas, and algebraic applications.

Core Class # 7 -- General Science.

This class is designed to meet the science recommendations for an accredited curriculum. Because it is only 40 class hours, only overviews of the major IT-related sciences are included; therefore the class tends to focus primarily on the Scientific Method and data gathering issues. The overviews will include introductions in physics, dynamics, motion, electronics, radiation, heat, geology, meteorology, and astronomy.

IMPLEMENTATION

DoL-defined Skills Learned in the Curriculum

This curriculum often references the DoL's O*Net summary reports for major IT career tracks. Table 7 summarizes what I believe are the pairings between the courses and the applicable summary reports.

Student-selected Curriculum

Traditional universities and colleges generally define a set of required classes, a list of electives, and a credit requirement to earn a degree. This provides the student plenty of flexibility in sequencing and credit load. The downside of this approach, however, is that there is no guarantee that the student will get everything he/she needs to be a complete specialist in at least one key track. This curriculum addresses this issue by requiring the student to complete at least three curriculum tracks of his choice, plus the required courses from the other tracks (for generalized exposure to the whole of the IT field), plus general studies.

Tracks Curriculum

Schools such as CollegeAmerica, ITT Technical Institute, and Westwood College (just to name a very few) pre-select classes and perform class scheduling for the student. There are generally no electives, or choice, for the student. The student is also generally required to complete a set number of credits per month. It is generally simple for the school to administer and staff for, however. Such a curriculum offers several options to this type of school. The school can choose to specialize in a smaller number core tracks

for its degree offering (for example: general studies, Microsoft, UNIX, and networking). Alternatively, the school can chose to offer multiple Associates degrees (for instant, one degree in general studies, hardware/software, Microsoft, and UNIX, and another degree in general studies, networking, security, and telecommunications). For schools of this type, the student may be more likely to become a specialist in at least one track; however, the student may or may not become a specialist in the field that most interests him.

Curriculum Summary

Trauth and Hafner (2000) have said that no single individual can possess all the knowledge and skills needed by the IT profession. Similarly, no single curriculum can cover the entire IT educational spectrum. At one end of IT spectrum, some graduates are skilled in software development, systems and network management, and technical trouble-shooting. At the other end, other graduates understand how to achieve business goals and enhance business functions through the application of information resources and technology.

This curriculum offers a compromise between the university-type (student selected) curriculum offerings and the fixed track system. It allows students to choose from a limited number of fixed sub-tracks (divided by specialization) that suit their particular specialization desires as well as optimizing their chances for local employment. Each class is 4 credits (40 credit hours in length), except as noted. All students must take at least 4 credits from each curriculum/certificate for broad knowledge content. Each student gets to choose 3 certificate curriculum, plus the required core classes, for an Associate's degree of at least 105 credits.

FINAL RECOMMENDATIONS AND CONCLUSIONS

There are jobs available for the entry-level, associate's program graduate. Furthermore, there are positions available in six distinct subfields of IT, each one of which can stand on its own as a career, or can be combined by a graduate to promote a particular career preference, specialty, or personality. The tracks presented in this curriculum involve elements of the IT industry that a profitable, expanding, and need additional manpower.

Key elements in curriculum design also include taking advantage of instructor knowledge and experience, as well as using community/industry input. This is so that designers avoid developing curriculum elements that have no real-world use or practicality. A college implementing a curriculum such as this one must take steps to recruit and retain quality instructors that have extensive current and practical experience in the six IT tracks. The community must also be convinced that the curriculum helps them remain competitive in their industries, and thus they will be willing to hire the local IT graduate. Significant efforts should also be made to keep the curriculum current and relevant. This includes keeping textbooks, computer equipment, and supplies on hand and of recent vintage.

"Teaching to the certification" is not an ideal way top train someone for the complexities of the "real" IT world. However, basing an associate's program course or track on the goals and/or curriculum of a certification series is a useful way of quickly building coursework that is complete and will stand up to community and accreditation review. The college that implements this curriculum must hold fast to the ideal that a certification is a starting point and a stepping stone – not the end-all, be-all -- to

knowledge and real world practical performance. This must happen in order for the college to gain and retain a good reputation for providing quality graduates to the local hiring community.

Above all else, the college that implements this curriculum must adhere to standards of quality and professionalism throughout the coursework. This gives students a pride in their work that will show in the working world, and gives the hiring community a sense of trust in both the school and the graduates they hire.

APPENDIX

Table 1—Soft Skills Required of the IT Graduate (Lynch, K., 2004)

Communication

- Accurately observe, note and explain
- Actively listen and express complex ideas in simple terminology
- Written, oral and presentation skills

Interpersonal, Communication and Team Skills

Communication

- Listening, observing, interviewing and documenting
- Written, oral and presentation skills

Interpersonal Relationships

- Effectively work with people of diverse backgrounds
- Effectively work with people at all corporate levels
- Lead and facilitate teams in a collaborative environment
- Empathetically listen and seek synergistic solutions

Interpersonal

- Listening
- Encouraging
- Motivating

Ethics and professionalism

- Operating in a global, culturally diverse environment

Team Work and Leadership

- Building a team
- Trusting and empowering, encouraging, developing and communicating a vision/mission
- Setting and tracking team goals
- Negotiating and facilitating
- Team decision making
- Operating in a virtual team environment
- Being an effective leader

Problem Solving

- Formulate creative solutions to simple and complex problems

Analytical and Critical Thinking

- Organizational problem solving

- Ethics and professionalism
- Creativity

Organizational Problem Solving

- Problem solving
- Personal decision making
- Critical thinking

Professionalism

- Apply personal goal setting and time management techniques
- Apply personal decision making skulls
- Articulate a personal position and respect the opinions of others
- Adhere to ethical standards
- Assess organizational and societal impacts of IS
- Code of conduct
- Ethical theory
- Leadership
- Self directed, leadership and time management
- Commitment to and completion of work

Table 2 – Brainbench Certifications in Relation to Applicable US Department of Labor O*NET Job Classifications in IT (2007)

The job roles included in this table have been developed using the O*NET classification system of the U.S. Department of Labor and Brainbench subject matter experts. Complete job role certifications include a selection of core skills as well as "elective" skills you can choose based on your specific needs.

Computer End-User Support Specialist
Responsible for setting up, configuring, and maintaining the computers used by employees in an organization. A Computer End-User Support Specialist addresses, diagnoses, and troubleshoots end-user computer-related issues, including problems with software, hardware, printers, power supplies, soundcards, and so forth. A person in this position may also be called upon to determine the organization's software and hardware needs, including upgrades, and to train users on new equipment and programs.

Required

- Computer Technical Support
- Customer Assistance
- Information Technology Terminology
- Listening Skills
- Technical Help Desk
- Telephone Etiquette

Elective 1

- Computer Fundamentals (Mac OS 8.6)
- Computer Fundamentals (Mac OS X 10.4)
- Computer Fundamentals (Mac OS X)
- Computer Fundamentals (Win 2000)
- Computer Fundamentals (Win 95/98)
- Computer Fundamentals (Win XP)

Elective 2

- MS Internet Explorer 4.0 Fundamentals
- MS Internet Explorer 5.5 Fundamentals
- MS Internet Explorer 6.0 Fundamentals

Elective 3

- Corel WordPerfect 9.0
- Lotus Word Pro 9.5
- MS Word 2000
- MS Word 2000 Fundamentals
- MS Word 2002
- MS Word 2002 Fundamentals
- MS Word 2003
- MS Word 2003 Fundamentals
- MS Word 97
- MS Word 97 Fundamentals

Elective 4

- Lotus 1-2-3 9.5
- MS Excel 2000

- MS Excel 2000 Fundamentals
- MS Excel 2000 Fundamentals (Interactive)
- MS Excel 2002
- MS Excel 2002 Fundamentals
- MS Excel 2003
- MS Excel 2003 Fundamentals
- MS Excel 97
- MS Excel 97 Fundamentals

Elective 5

- Lotus Freelance Graphics 9.5
- MS PowerPoint 2000
- MS PowerPoint 2000 Fundamentals
- MS PowerPoint 2002
- MS PowerPoint 2002 Fundamentals
- MS PowerPoint 2003
- MS PowerPoint 97
- MS PowerPoint 97 Fundamentals

Information Security Administrator
Responsible for planning, coordinating, implementing, monitoring, and adjusting security measures taken to prevent valuable data stored on computers and transmitted through networks and the Internet from being destroyed, modified, or improperly used. An Information Security Administrator must have a thorough knowledge of networking and the Internet as well as all aspects of security, including authentication, access control, intrusion detection, firewalls, encryption, data integrity, disaster prevention, and disaster recovery

Required

- Disaster Recovery and Planning
- Internet Security
- Network Security
- Networking Concepts
- TCP/IP Administration

Elective 1

- Check Point FireWall-1 Administration
- Check Point Firewall-1 NG Administration
- Cisco Network Support
- Cisco Router Fundamentals
- Firewall Administration Concepts
- MS ISA Server 2000 Administration
- MS Proxy Server 2.0 Administration
- Network Authentication

Elective 2

- Linux Administration (General)
- Linux Administration (Red Hat)
- Linux Administration (SuSE)
- MS Windows 2000 Server Administration
- MS Windows NT 4.0 Administration
- MS Windows Server 2003 Administration
- Novell NetWare 5.0 Administration
- Unix Administration (AIX)
- Unix Administration (General)
- Unix Administration (HP)
- Unix Administration (Solaris 8)

IT Business Analyst
Responsible for completing a thorough analysis of customer business processes and identifying and analyzing business requirements that will potentially be translated into system specifications for applications and automated processes. An IT Business Analyst produces specification documents that define requirements and outline solutions that are used as a communications bridge between the business customer and the groups that will be responsible for designing and developing the technical solution. A person in this position is expected to be familiar with the best practices, procedures and, where appropriate, legal requirements within a particular field (for example, finance, healthcare, insurance, so forth) and have a solid overall understanding of application design, development, and implementation. Other duties may include project management, ing, software quality assurance, data modeling, and/or business process reengineering.

Required

- Business Communication
- Customer Requirements Analysis
- Listening Skills
- Software Business Analysis
- Technical Writing

Elective 1

- Information Technology Security Fundamentals
- Internet Concepts
- Internet Technology Fundamentals
- Networking Concepts
- Systems Analysis
- WWW Concepts

Elective 2

- Client/Server Concepts
- E-Commerce Concepts
- ERP Concepts
- RDBMS Concepts
- Software Quality Assurance
- Software Testing
- Web Development Concepts

Elective 3

- Business Process Reengineering
- Change Management
- Presentation Skills
- Time Management
- Visio 5.0
- Word Processing Fundamentals

Elective 4

- Problem Solving - Qualitative
- Problem Solving - Qualitative (Metric)

Elective 5

- Problem Solving - Quantitative
- Problem Solving - Quantitative (Metric)

Elective 6

- Lotus 1-2-3 9.5
- MS Excel 2000
- MS Excel 2000 Fundamentals
- MS Excel 2000 Fundamentals (Interactive)
- MS Excel 2002
- MS Excel 2002 Fundamentals
- MS Excel 2003
- MS Excel 2003 Fundamentals
- MS Excel 97
- MS Excel 97 Fundamentals

IT Manager
Responsible for directly overseeing and coordinating the information technology-related activities of workers in a given organization or company. Areas under an IT Manager's purview may include requirements definition, design, installation, maintenance, support, and upgrade of operating systems, software, hardware, and peripherals; monitoring and maintenance of network equipment, applications, and security; database design, development, and administration; technical support and troubleshooting; establishment and execution of backup, restoration, and anti-virus strategies; and quality assurance. A person in this position plans and establishes work/project schedules; assigns employees to specific duties; addresses and resolves worker problems; determines equipment needs; and hires, trains, and evaluates personnel. An IT Manager also prepares reports and buds for management and develops methods and procedures to meet customer and internal requirements.

Required

- Business Communication
- Coaching
- Disaster Recovery and Planning
- Information Technology Security Fundamentals
- Managing People
- Technical Writing

Elective 1

- Project Management
- Project Management (2000)
- Project Management (2005)

Elective 2

- Change Management
- Customer Requirements Analysis
- Software Business Analysis
- Software Configuration Management
- Software Quality Assurance
- Software Testing
- Systems Analysis

Elective 3

- Client/Server Concepts
- Data Modeling Concepts
- Data Warehousing Concepts
- E-Commerce Concepts
- ERP Concepts
- Embedded Systems Concepts
- Informatica PowerMart/PowerCenter 6.2.1
- Networking Concepts
- OO Concepts

- Operations Concepts
- Programming Concepts
- RDBMS Concepts
- WWW Concepts
- Web Development Concepts
- Web Services Concepts
- XML Concepts

Linux System Administrator

Responsible for running and maintaining the computer systems in an organization that uses a Linux operating system. A system administrator installs, configures, and maintains computer hardware; deals with system security issues and anti-virus upgrades; troubleshoots and fixes system failures; and handles software and hardware purchases.

Required (Select 4)

- Disaster Recovery and Planning
- Information Technology Terminology
- Networking Concepts
- Server Administration

Elective 1 (Select 1)

- Linux Administration (General)
- Linux Administration (Red Hat)
- Linux Administration (SuSE)

Elective 2 (Select 1)

- Bash Shell Scripting
- C
- Perl
- Perl 5.8
- Python 1.5
- Python 2.4
- Unix Korn Shell Scripting

Elective 3 (Select 2)

- Business Writing
- Customer Assistance
- Listening Skills
- Telephone Etiquette

Network Administrator
Responsible for managing a local area network (LAN) and/or wide area network (WAN) and providing assistance to the network users. Using a variety of tools and devices, a network administrator manages network design and architecture and monitors network stability and activity, making recommendations for additional resources and equipment, as necessary. A person in this position also oversees network security, troubleshoots and fixes network failures, schedules and executes backups, and prepares data restoration/disaster recovery plans

Required
- Disaster Recovery and Planning
- LAN/WAN Communications
- Network Security
- Networking Concepts
- TCP/IP Administration

Elective 1
- Business Writing
- Customer Assistance
- Listening Skills
- Telephone Etiquette

Elective 2
- Cisco Network Design
- Cisco Network Support
- Cisco Router Fundamentals
- Citrix Administration
- Macintosh Networking
- VPN with Windows
- WAN Technologies

Elective 3
- Check Point FireWall-1 Administration
- Check Point Firewall-1 NG Administration
- Firewall Administration Concepts
- IP Routing & Switching
- Internet Security
- MS ISA Server 2000 Administration
- MS Proxy Server 2.0 Administration
- Network Authentication
- Network Monitoring

Elective 4
- MS Windows 2000
- MS Windows NT 4.0 Administration

- MS Windows Server 2003 Administration
- Novell NetWare 5.0 Administration
- Unix Administration (General)

Network Support Specialist
Responsible for providing support to users of a local area network (LAN). A Network Support Specialist sets up, configures, and maintains a LAN and establishes network printing, access rights, firewalls, directory hierarchy, and so forth. A person in this position also addresses, diagnoses, and troubleshoots LAN-related user issues, covering such topics as connectivity, e-mail, and Internet security. A Network Support Specialist might also be called upon to train users in LAN usage.

Required

- Customer Assistance
- Information Technology Terminology
- Listening Skills
- Network Technical Support
- Networking Concepts
- TCP/IP Administration
- Technical Help Desk
- Telephone Etiquette

Elective 1

- Linux Administration (General)
- MS Windows 2000 Desktop Administration
- MS Windows NT 4.0 Workstation Administration
- MS Windows XP Desktop Administration
- Macintosh Networking
- Novell NetWare 5.0 Administration
- Novell NetWare 6.5 Administration
- Unix Administration (General)

Elective 2

- Apache 1.3.12 Administration
- Apache 2.0 Administration
- Lotus Notes 4.0 Administration
- Lotus Notes 6.5 Administration
- MS Exchange Server 2000 Administration
- MS Exchange Server 2003 Administration
- MS Exchange Server 5.5 Administration
- MS ISA Server 2000 Administration
- MS Internet Information Server 4.0 Administration
- MS Proxy Server 2.0 Administration
- MS Systems Mgmt. Server 2.0 Administration
- Network Monitoring
- Novell GroupWise 5.5 Administration

Telecommunications Specialist
Responsible for analyzing, designing, implementing, ing, monitoring, supporting, and evaluating systems that communicate information, including data, voice, text, images, and video, across long distances. A Telecommunications Specialist researches, evaluates, and recommends voice and data communications hardware and software. A person in this position troubleshoots telecommunications problems and identifies areas of operation such as security, faulty trunks or ports, and so forth, that need repair, restoration, and upgraded equipment. A Telecommunications Specialist should be familiar with a variety of telecommunications-related areas such as voicemail, call center systems, videoconferencing, telecommunications vendors, and long-distance providers.

Required

- Business Communication
- Information Technology Security Fundamentals
- Network Monitoring
- Network Technical Support
- Telecommunications Industry Knowledge

Elective 1

- Asynchronous Transfer Mode (ATM)
- Cellular Technology
- Cisco Network Design
- Cisco Network Support
- Cisco Router Fundamentals
- Computer Telephony Integration (CTI)
- Fiber Optics
- IP Routing & Switching
- ISDN (North America/Japan)
- LAN/WAN Communications
- Network Authentication
- Network Security
- Networking Concepts
- SONET
- VPN with Windows
- Voice Over Internet Protocol (VoIP)
- Wireless Application Protocol (WAP)
- Wireless Network Technology

Elective 2

- Customer Requirements Analysis
- Project Management
- Project Management (2000)
- Project Management (2005)
- Software Business Analysis
- Software Configuration Management

- Software Quality Assurance
- Software Testing
- Systems Analysis
- Technical Writing

Systems Architect
Responsible for analyzing user/business requirements and applying best-practice standards, methodologies, models, and technologies in developing and executing recommendations on system architecture and software application design, development, ing, implementation, and improvements/refinements. A Systems Architect participates in all phases of technical solution projects. A person in this position is often called upon to create functional and technical specifications, monitor and evaluate system and software performance and security, select and design system hardware and software, create analysis and architectural documents, perform process and risk analysis, and develop plans and schedules for technical solutions. A Systems Architect provides architectural guidance and may lead development teams, integration teams, and other experts involved in all phases of the development life cycle to ensure business/technical needs or challenges are met.

Required

- Business Communication
- Disaster Recovery and Planning
- Network Monitoring
- Networking Concepts
- Server Administration
- Software Business Analysis
- Systems Analysis

Elective 1

- Customer Requirements Analysis
- Software Testing
- Technical Writing

Elective 2

- Linux Administration (General)
- Linux Administration (Red Hat)
- Linux Administration (SuSE)
- MS Windows 2000 Server Administration
- MS Windows NT 4.0 Administration
- MS Windows Server 2003 Administration
- Novell NetWare 5.0 Administration
- Unix Administration (AIX)
- Unix Administration (General)
- Unix Administration (HP)
- Unix Administration (Solaris 8)

UNIX System Administrator
Responsible for running and maintaining the computer systems in an organization that uses a UNIX operating system. A system administrator configures, installs, and maintains computer hardware; deals with system security issues and anti-virus upgrades; troubleshoots and fixes system failures; and handles software and hardware purchases.

Required

- Disaster Recovery and Planning
- Information Technology Terminology
- Networking Concepts
- Server Administration

Elective 1

- Unix Administration (AIX)
- Unix Administration (General)
- Unix Administration (HP)
- Unix Administration (Solaris 8)

Elective 2

- Bash Shell Scripting
- C
- Perl
- Perl 5.8
- Unix Korn Shell Scripting

Elective 3

- Business Writing
- Customer Assistance
- Listening Skills
- Telephone Etiquette
-

Windows System Administrator
Responsible for running and maintaining the computer systems in an organization that uses a Windows operating system. A system administrator installs, configures, and maintains computer hardware; deals with system security issues and anti-virus upgrades; troubleshoots and fixes system failures; and handles software and hardware purchases.

Required
- Disaster Recovery and Planning
- Information Technology Terminology
- Networking Concepts
- Server Administration

Elective 1
- MS Windows 2000 Server Administration
- MS Windows NT 4.0 Administration
- MS Windows Server 2003 Administration

Elective 2
- BEA WebLogic Application Server 5.1
- Check Point FireWall-1 Administration
- Check Point Firewall-1 NG Administration
- Citrix Administration
- Firewall Administration Concepts
- Lotus Notes 4.0 Administration
- Lotus Notes 6.5 Administration
- MS Exchange Server 2003 Administration
- MS Exchange Server 5.5 Administration
- MS ISA Server 2000 Administration
- MS Internet Information Server 4.0 Administration
- MS Internet Information Server 5.0 Administration
- MS Proxy Server 2.0 Administration
- MS SQL Server 2000 Administration
- MS SQL Server 6.5 Administration
- MS SQL Server 7 Administration
- MS Systems Mgmt. Server 2.0 Administration
- MS Windows 2000 Desktop Administration
- MS Windows 2000 Migration
- MS Windows 98 Administration
- MS Windows Me Administration
- MS Windows NT 4.0 Workstation Administration
- MS Windows XP Desktop Administration

Elective 3
- Business Writing
- Customer Assistance

- Listening Skills
- Telephone Etiquette

Table 3 – UNIX Offerings at Various Institutions and Programs

Program	Credit-hour Range of IT Certificate Programs	Credit-hours for UNIX certificate	Notes
Front Range Community College (2005)	9-20	12	
Aims Community College (2006)	15-25	15	
CollegeAmerica (2005)	n/a*	14*	*CA does not offer any certificate programs. The figure represents the UNIX portion of the associates' degree track.
TechNow (2003)**		6***	** A non-collegiate institution. *** TN advertises their program as 60 contact-hours.
Barker Pacific (2003)**		36****	** A non-collegiate institution. **** BP advertises their program as 360 contact-hours.
Cisco (2005)**		7*****	***** Cisco advertises this course to be 70 hours of online study.

Table 4 – Telecommunications Offerings at Various Institutions and Programs

Program	**Credit-hour Range of IT Certificate Programs**	**Credit-hours for UNIX certificate**	**Notes**
Front Range Community College (2006)	9-20	15	
University of Colorado (2006)		5*	* The figure represents the telecommunications portion another certificate program.
CollegeAmerica (2005)	n/a**	8**	**CA does not offer any certificate programs. The figure represents the telecommunications portion of the associates' degree track.
Pace University (2006)		20	
Skyline University (2006)		36	

Table 5 – General Studies and General Applied Studies Offerings at Various Institutions

School	History	Literature	Speech	Math	Science	Psychology/ Sociology	Writing
CollegeAmerica (2005)	X	X	X			X	X
Aims Community College (2006)	X		X	X		X	X
Front Range Community College (2006)				X	X	X	X
Pace University (2006)	X	X	X	X	X	X	X
Skyline College (2006)	X	X	X		X	X	X
Rio Salado College (2007)	X	X	X	X	X	X	X
Grays Harbor College (2007)			X	X		X	X

Table 6 – Summary of Curriculum Courses and Certificate Tracks

UNIX Certificate (24 credits)

1) Introduction to UNIX Operating Systems **
2) Shell Scripting *
3) CompTIA Linux+ Certification Preparation*
4) Solaris SCSA Prep part 1*
5) Solaris SCSA Prep part 2*
6) Senior UNIX Administration, Internetworking, and OS Systems
7) Linux Business Integration

Hardware/Software Support Certificate (24 credits)

1) Hardware Servicing part 1/CompTIA A+ “Essentials” Prep **
2) Hardware Servicing part 2/CompTIA A+ “602/Troubleshooting” Prep **
3) Software Servicing 1/MCDST-MCP OS Support Certification Preparation **
4) Software Servicing 2/MCDST-MCP Applications Support Certification Preparation **
5) CompTIA Server+ Certification Preparation
6) HP Printer Support Certification Preparation
7) Advanced Desktop Servicing Operations
8) Intro to Mac Operations, Service, and Support

Microsoft Certificate (26 credits)

1) Introduction to Disk Operating Systems **
2) Introduction to Microsoft Office **
3) MCP Windows2000 Professional Certification Preparation

4) Microsoft MOS-Word and MOS/E-Word Certification Preparation (2 credits)

5) Microsoft MOS-Excel and MOS/E-Excel Certification Preparation (2 credits)

6) Microsoft MOS-PowerPoint and MOS/E-PowerPoint Certification Preparation (2 credits)

7) Microsoft MOS-Outlook and MOS/E-Outlook Certification Preparation (2 credits)

8) MCP Windows2000 Server Certification Preparation part 1

9) MCP Windows2000 Server Certification Preparation part 2

10) MCP Windows2000 Network Infrastructure Certification Preparation

11) Advanced Microsoft Server Administration and Internetworking Operations

Network Certificate (20 Credits)

1) Introduction to Networking 1/CompTIA Network+ Prep 1**

2) Introduction to Networking 2/CompTIA Network+ Prep 2**

3) Introduction to Cisco Networking Technologies *

4) Interconnecting Cisco Networking Devices *

5) Storage Area Networking *

Security Certificate (20 credits)

1) Introduction to IT Security/CompTIA Security+ Prep **

2) Principles of Network Security *

3) Disaster Recovery Operations and Management *

4) Computer Forensics*

5) UNIX Security Administration

6) Windows Security Administration

7) Cisco Routing and Firewall Operations

Telecommunications Certificate (24 credits)

1) Introduction to Telecommunications **
2) Internet Telecommunications/CompTIA I-Net+ Certification Preparation*
3) Wireless Telecommunications*
4) Telephony*
5) Fiber Optic Technologies and Repair*
6) Introduction to VOIP*

General Education and General Applied Education Courses (28 credits)

1) Psychology and Sociology on the Job**
2) Writing and Composition**
3) American History and Civics**
4) Literature**
5) Speech and Debate**
6) Mathematics**
7) General Science**

"*" Required for track certificate

"**" Required for Associates Degree

Table 7 – Relationship Between Courses and DoL Summary Reports

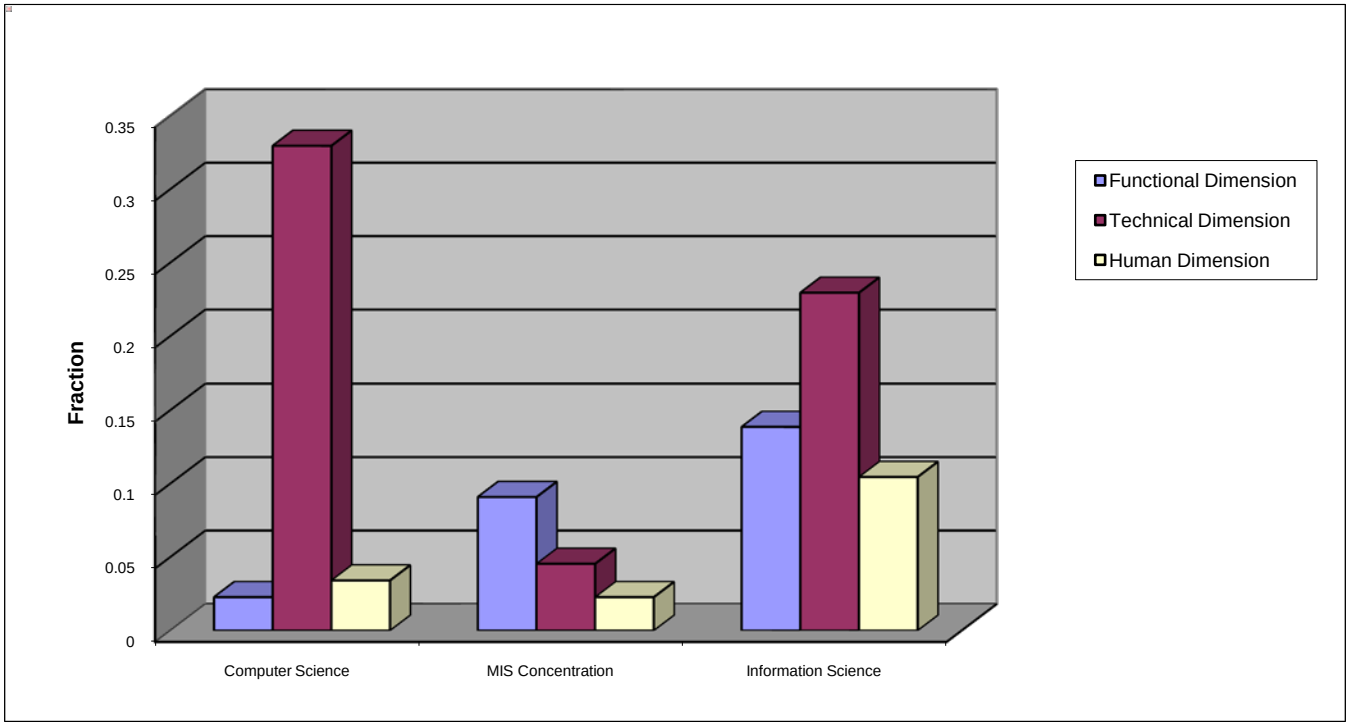
The table shows the relationship between each course described in the proposed curriculum, and the O*Net Summary Report job requirements that they are supposed to meet.

Course	**O*Net Summary Reports***
Intro To UNIX	2, 3, 4
Shell Scripting	2, 3, 4
Linux+	2, 3, 4
Solaris 1	2, 3, 4
Solaris 2	2, 3, 4
Senior UNIX	1,2,3,4,5
Linux Business	1,2,3,4,5
Hardware 1	2
Hardware 2	2
Software 1	2
Software 2	2
Server+	2,3
HP Printer Support	2
Advanced Desktop	1,2,3,4
Intro to Mac	2
Intro to DOS	2
Intro to MS Office	2
MCP Windows 2000 Pro	2
MS Word	2
MS Excel	2
MS PowerPoint	2
MS Outlook	2
MCP Windows 2000 Server 1	2,3,4
MCP Windows 2000 Server 2	2,3,4
MCP Windows 2000 Network	1,2,3,4,5
Advanced MS Server	1,2,3,4,5
Networking 1	2,4
Networking 2	2,4
Cisco 1	1,2,3,4,5
Cisco 2	1,2,3,4,5
SAN	1,2,3,4,5

Intro to Security	1,2,3,4,5,6
Principles of Security	1,2,3,4,5,6
Disaster Recovery	1,2,3,4,5
Forensics	1,2,3,4,5,6
UNIX Security	1,2,3,4
Windows Security	1,2,3,4
Cisco Security	1,2,3,4,5,6
Intro To Telecom	1,2,3,4,5,6,7
Internet Telecom	2,3,5,6
Wireless Telecom	2,3,5,6
Telephony	2,6,7
Fibre Optics	6,7
VOIP	1,2,3,4,5,6,7
Psych/Sociology	1,2,3,4,5,6,7
Writing	1,2,3,4,5,6,7
History/Civics	1,2,3,4,5,6,7
Literature	1,2,3,4,5,6,7
Speech	1,2,3,4,5,6,7
Math	1,2,3,4,5,6,7
General Science	1,2,3,4,5,6,7

*1	“Summary Report for 15-1099.02 -- Computer Engineers/Architects.”
*2	“Summary Report for 15-1041.00 -- Computer Support Specialists.”
*3	“Summary Report for 15-1051.00 -- Computer System Analysts"
*4	“Summary Report for 15-1071.00 -- Network and Computer System Administrators.”
*5	“Summary Report for 15-1099.03 -- Network Designers.”
*6	“Summary Report for 49-2022.00 -- Telecommunication Equipment Installers.”
*7	“Summary Report for 49-9052.00 -- Telecommunication Line Installers and Repairers.”

Figure 1. Comparison of different IT concentrations (Hafner and Trauth**).** The graphic shows a typical Computer Science degree (software development, systems and network management, and technical trouble-shooting), a typical MIS concentration (business goals and function enhancement through IT resources and technology), and a 2000 Information Science degree proposal at Northeastern University. The fraction of each program devoted to each of the three dimensions of IT performance is shown.



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