Boston Area Advanced Technological Education Connections

BATEC Information Technology Workforce Skills Study

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Prepared for:

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Executive Summary

We hear often that the world of work is changing, that enterprises require more of workers now than in the past (and that workers must give more), and that globalization has changed not only the rules but also the stakes of the effort of finding and keeping a job. For no group is this more true at present than technicians and technologists, those persons who comprise the workforce that installs, maintains, and operates the technology upon which enterprises depend. What educators, employers, and other stakeholders decide about the preparation of the technician workforce may well determine not only whether these workers have employment but will also determine the future viability of technician education and the institutions that provide it.

This study explains briefly the implications of the shift in corporate valuation from physical to intellectual capital for technical workers, and provides detailed suggestions regarding the responses required from education at all levels that educates our technological workforce.

Virtually every enterprise today is "IT – Enabled" which is to say that no matter what its products or services, an organization's ability to execute within its market (whether a region, nation, or the world) is critically dependent on the tools and services of Information and Communications Technology. Moreover, estimates are that at least 3/4 of IT jobs are in these IT-Enabled firms, not in IT-Producing (software and hardware) firms, and in a recent survey by ITAA, US firms cite a shortage of qualified talent as among their greatest barriers to growth.[1] The day of closed-door IT work is largely passed, and it's not too great an exaggeration to say that if you could suddenly switch the IT off at a major airline, their planes would begin falling out of the sky, so critical is IT to their operations.

Many employers also say that US education policies have not kept pace with the rapidly changing needs of the technology workforce.[2] During the data gathering phase of this study, we often heard employers say that although educators were doing an adequate job of preparing students technically they were greatly frustrated that applicants lacked a sufficiently broad spectrum of skills, especially employability skills, necessary to efficiently apply and effectively leverage their technical skills. In short, employers need a different kind of technical worker today than in the mainframe

[1] Information Technology Association of America. www.itaa.org/workforce
[2] ibid.

days when IT was an occult science, or the “go-go” ‘90s, when a few courses or certificates in a narrow skills area would often produce job offers with signing bonuses.

We do not want to imply that singular technical skills are unimportant. However, one significant finding from our respondents is that certain IT skills that may still be prized as achievements by some schools and students are completely assumed by business. In particular, basic user skills and facility with the basics or desktop operating systems are considered in the same way as eating with utensils. No one would think of telling a potential employer they know how to use a knife and fork, yet some students and schools make more of basic IT user skills than appropriate in this day and age.

Whenever we gave employers the chance to tell us what they wished applicants had more of, or what they felt applicants lacked, technical skills were never mentioned first. Without exception, employers responded that applicants needed:

- Communication skills (verbal aptitude)
- Problem solving skills (especially problem definition)
- Greater facility with teamwork and collaboration
- Ability to manage and motivate ones self
- Contextual knowledge of the work – not just the “how” but the “why” and “whom” and “when”

Moreover, employers in this and other similar studies we’ve conducted on other regions of the US tell us, “Skills alone are not enough.” With the global nature of business today, basic IT skills have become ubiquitous throughout the world. Particularly at the technician level, students graduating from traditional skills based technical programs in the US often find they must offer their skills on a global market, where they may compete with persons from other countries willing to offer similar skills for far less.

Good old American “know-how” – for better or worse – is not enough. In IT, many people around the world know *how*. Clearly, US students must offer a better value proposition to employers than skills alone or risk being at a perpetual disadvantage not only initially, but at virtually every decision point during their career. Constantly, enterprises must evaluate the contribution of their workers. Workers who add little value to intellectual capital are always at risk, while workers who can add

value to intellectual capital are more likely to be retained and to advance. In fact, employers say they are looking for more of this type of technical worker.

With many enterprises, from banking to airlines to manufacturing so critically dependent on IT, why does the impression exist that there are few IT jobs? The answer is four-fold:

1. IT has delivered on its promise of scalability; increased use of IT does not automatically create proportional increases in demand for IT workers.
2. Traditional counting methods used to determine openings do not always fully identify openings in IT-Enabled firms.
3. Rote IT skills are globally available.
4. Employers are selective about whom they hire – technical skills are assumed, so employers spend more time searching for the skills that leverage the technical skills.

The third and fourth points are at the heart of this study and report. If the monopoly on know-how has been broken, what can US technicians hope to offer? Industry has already told us – it is the aforementioned employability skills, used to apply and leverage technical skills. To be perfectly clear, we are not suggesting that technical skills be abandoned for employability skills. They are as important as ever.

However, every employer responding to this study said in one way or another that they would willingly remedy any specific technical skills shortage in an applicant who exhibited good employability skills, but they felt at a total loss to remedy deficiencies in employability skills.

These employability skills are vital, because they allow technical workers to use their technical skills in ways that contribute to intellectual capital. What defines the Information Age is the power of ideas. Things can be made anywhere. People increasingly, can contribute anywhere. Whether it's Boeing or the Boston Symphony, the ability to leverage ideas can make or break the enterprise.

The challenge for secondary schools and higher education when dealing with technical workforce preparation is: *How do we provide students the opportunity to acquire and practice these*

employability skills while simultaneously gaining marketable technical skills without adversely affecting time to degree or increasing instructional effort?

The answer lies in improved and more efficient methods of teaching and learning. Classrooms and teaching methods have changed little since the advent of universal public education. Content experts lecture to rows of students after which, in technical programs, students file into laboratory to perform a discrete experiment that is supposed to reinforce a concept presented in lecture.

No business operates that way – at least not for long. One of our focus group respondents put it succinctly (if not somewhat argumentatively): *"You can't prepare the 21st Century workforce with 20th century content presented in 19th century classrooms."*

We believe the answer lies in more holistic methods of teaching – methods that transcend content delivery and that involve students in complex problems developed from industry input. We believe educators must engage industry and potential employers in a more thoughtful and qualitative way than the typical content-focused industry advisory committee. Many businesses say they are willing to help in more substantive ways, and we suggest that the quality of the engagement with industry is therefore crucial. Bringing industry "to the table", inviting them into the instructional process at all critical points (design, activities, assessment) rather than just content, would not only produce students with greater facility with employability skills, but would also strengthen the bond between potential employers and applicants. A secondary, but not unimportant benefit would be to reduce the stress that educators feel from the constant struggle to remain content current.

This study documents how employers view their current and future technological workforce needs, their views of the current state of technical education efforts, and their suggestions for aligning educational effort with workforce needs and trends to develop students who are more likely to be hired, more able to meet the challenges facing today's technical worker, and more able to thrive in the future.

About TSI

TSI is a not-for-profit organization established in 2004 with two main areas of focus:

- Evaluate NSF Advanced Technological Education funded projects and centers
- Perform research into the current and future workforce needs of technology-producing and technology-dependent industries and apply the results to improve the effectiveness of professional-technical programs in community colleges.

TSI's managing principal, Peter Saflund, is a pre-eminent expert in skill standards, technical curriculum design and assessment, and effective methods of delivering professional-technical education and training. His experience in the fields spans two decades in instructional design, classroom teaching, and senior level community college leadership, workforce skills research, job definition, and development of innovative teaching and assessment methods.

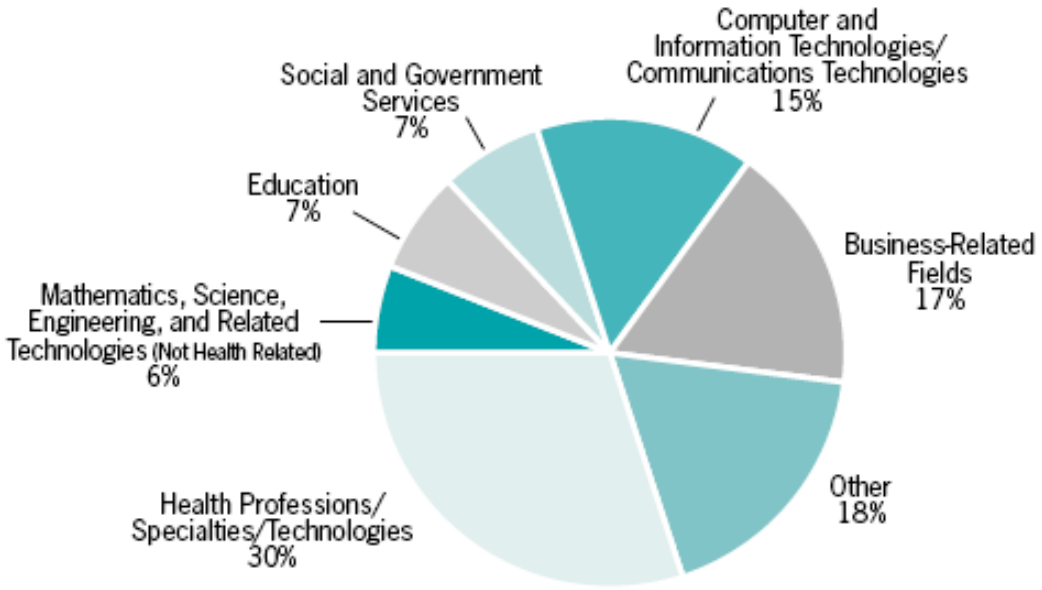
Prior to starting TSI, Peter Saflund was the Associate Director for the National Workforce Center for Emerging Technologies (NWCET), a National Science Foundation funded center of excellence in Information Technology (IT). He was the research director and publisher of the internationally recognized IT Skill Standards "Building A Foundation For Tomorrow". The standards formed the foundation for IT curriculum in many community colleges throughout the United States. They also served to underpin the content and assessment for vendor certifications from Microsoft, Cisco Systems, Apple Computer among others, and for vendor neutral certifications from CompTIA, CIW, and Certiport.

Peter Saflund also collaborated with the US Department of Labor in refreshing and re-writing the IT job descriptions in the Occupational Outlook Handbook. He is the co-author of 'Building a Workforce For The Information Age" published by the National Academies Press in 2000.

While this report is focused primarily for the BATEC constituency, we recognize there may be other audiences for this information that may not be familiar with community colleges. Therefore we offer some information on community colleges:

The three most enrolled topic areas are health, business, and IT. Overall, community college enrollment is distributed across a wide variety of programs that are reflective of current and workforce needs:

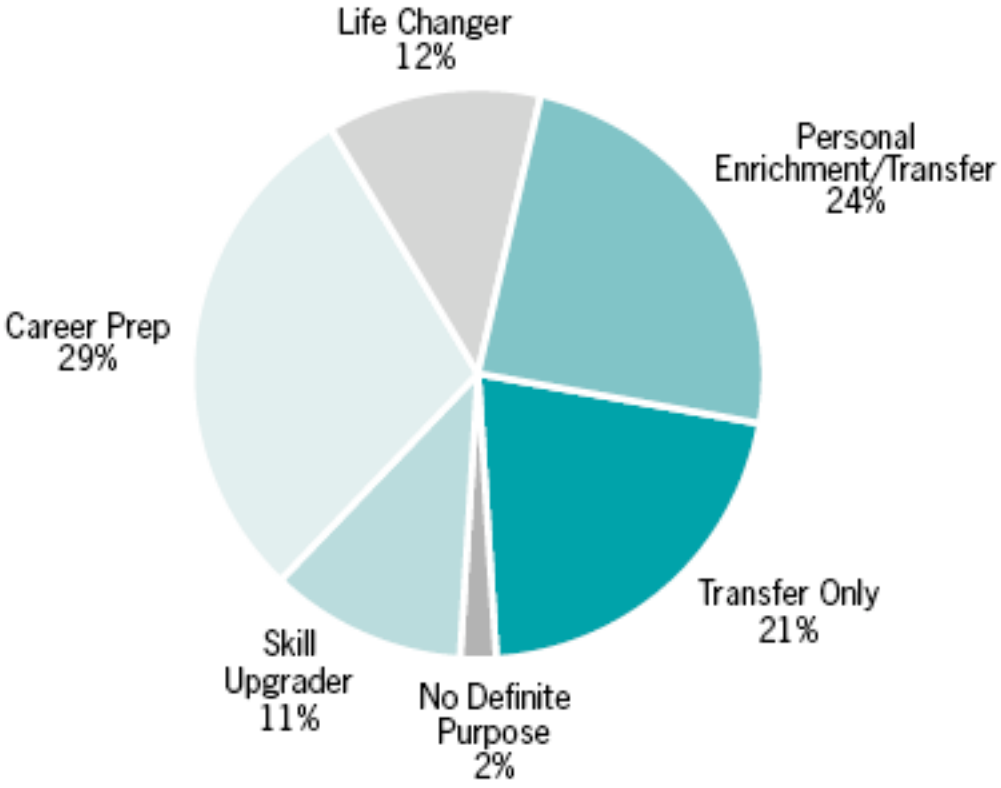
Community College Enrollment Distribution
By Career Cluster



Source: American Association of Community Colleges

Almost one half of all the baccalaureate holders in the United States got started at a community college. This figure includes not only those enrolling with the intent to transfer to a 4-year school, but also many persons in mid-career who return to university to complete a degree. Indeed a challenge faced by community colleges that is not shared by 4-year schools is the diversity of students' reasons for enrolling.

Student Stated Reasons for Enrolling



Source: American Association of Community Colleges

Almost 40% of community college students are enrolled for career preparation and to acquire salable skills. Though 21% of students state they want to transfer, the actual transfer rates are somewhat lower (about 18%) because students find they want or need to go to work.

Community colleges are very efficient and productive providers of educational services. Their direct costs per unit of instruction (normally the credit-hour) is about 65% of comparable (lower division course) costs in a university. The student cost (tuition, fees, books, and related expenses, not including housing and meals) of completing two years at a community college is about 25% - 33% of the equivalent number of credits at a university.

The economic impact of community colleges is often overlooked in discussions of their role and effectiveness. Because of their strong contribution to workforce development, community colleges nationally return $9.30 to the local economy for every $1.00 of state support they receive.

Too often community colleges are unjustifiably criticized for having low transfer rates or poor rates of degree completion. What is often not understood is that about 30% of community college enrollees already have a baccalaureate or other credentials, and come to the college to acquire or upgrade marketable skills. Furthermore, certificates of completion and industry-driven credentials (such as ASE for automotive programs or ADA for dental) often substitute for, and may be more meaningful in the occupation, than the Associate's Degree. Furthermore, 60% of community college students are part-time (fewer than 12 quarter credit hours) --- many more by economic necessity than by choice. Only 11% of lower division university enrollees are part-time.

Many academic-transfer, students leave the community college as soon as they acquire sufficient credits to transfer to university. They often become eligible to transfer while a few courses short of the Associate's Degree requirement, and in many cases this situation is aggravated by the receiving university, which desires to capture the FTE (state support for student enrollment) and local collection (tuition and fees) at the earliest possible moment.

Lastly, it's important to recognize that 45% of all US undergraduates and 45% of all first time freshmen (some 11.6 million students) are enrolled in community colleges.

Forward

The future economic health of state of Massachusetts depends in part on attracting and retaining high-technology industry, and this in turn implies increasing need for highly skilled and knowledgeable workers with Information and Communications Technology education and training. As traditional manufacturing continues to trend downward, the state will face the decision of whether to allow devolution of former manufacturing jobs into low-pay service sector employment, or whether to invest the resources to replace traditional manufacturing jobs with technology based and information based jobs that pay living wages and contribute to economic vitality.

Throughout this report we will refer to *IT workers*, however we specifically include in this broad nomenclature persons with communications technology skills as well. Convergence (merging of technology and telecommunications) has lead most of the EU countries to adopt the term *ICT* (Information and Communications Technology). While the same convergence has occurred in the US, we have been less willing to accept the new term ICT. For brevity and because IT is more universally accepted, we will use the abbreviation IT with the tacit understanding that we can in most instances interchange IT with I***C***T.

This study came about as a result of a National Science Foundation grant DUE 0302912, for a project entitled BATEC (Boston Area Advanced Technological Education Connections) awarded to University of Massachusetts, Boston (fiscal agent) and three Boston area community colleges – Bunker Hill, Roxbury, and Middlesex. This award resulted from an impressive effort by many area businesses that were in agreement that economic development in the region depended on a viable technician workforce skilled in Information and Communications Technology. Because the Boston region is home to what is perhaps the world's greatest concentration of research universities, the importance of community college education and the vital role sub baccalaureate institutions play in developing the region's workforce has been less celebrated here than other regions. The intellectual merit of the original grant proposal therefore included raising awareness of the importance of technological education, technical career awareness, and the important role sub-baccalaureate institutions play in building and sustaining the economy.

From an economic development perspective two year programs are vital in attracting “new economy” (clean, technology-based) enterprises as well as supporting the existing increasingly technology dependent traditional core industries.

In common with other regions the Boston area celebrates the economic development contributions and the importance of R&D capacity as an essential attractor of capital. Often, however, further examination and discussion with business and industry reveals that while R&D capacity may be a worthy goal, improved R&D capacity and the formation of regional concentrations of high tech research oriented firms, does not “grow” the regional workforce. Therefore, one recommendation of this study is to integrate the technical education capacity and leverage the business and education constituencies toward an overall plan for economic development that specifically attracts primary research *and* production enterprises that produce living wage technician level jobs.

The three Boston area community colleges initially involved with the BATEC Center maintain distinct identities and serve students from widely varying socio-economic and ethnic backgrounds. Secondary schools feeding technology students to these colleges are quite diverse in terms of student makeup and offer varying levels of preparation for technology students. A district-funded initiative of Boston Public Schools, Tech Boston, was formed in 1988 to help secondary students prepare for technical careers and become better able to succeed in community college technical programs. The Commonwealth IT Initiative (CITI) a state funded granting program has also provided resources for curriculum development and course delivery. BATEC, however, has provided the ‘big picture’ perspective to the region, and has also garnered enormous industry support. Regional employers not only are keenly aware of the implications of a shortage of technological talent, but also strongly support efforts that produce properly educated and skilled technologists.

Despite the consistent message from business and industry that they need properly skilled technical employees, around the US, two-year colleges see declining enrollment in technology programs (with the exception of health technologies). Using Information Technology as an example, normalizing the curve of IT employment by extracting the “boom” of the late 1990s, employment has been increasing steadily at about 8% a year since the widespread adoption of the microcomputer

desktop workstation in the mid 1980's.[3] This trend is expected to continue if not slightly accelerate, as CIOs are showing more willingness to invest in hardware and networks.[*] The Association for Computing Machinery (ACM) published a report on outsourcing in late 2005 that also found there are more IT jobs now in the US than during the so-called boom.[**] Much of the growth in IT jobs however is in IT – *using* rather than traditional IT - producing sectors. This presents challenges in terms of accurately enumerating current openings as well as forecasting future growth. It also presents challenges for traditional programs and the students typically attracted to them, since faculty must teach and students must learn technology as a means (facilitating other businesses such as gaming, transportation, or finance), rather than an end. Students erroneously believe no jobs are waiting for them. However, as this study shows, educational institutions may be contributing to the problem by not emphasizing the skills potential employees really need to get hired and advance.

Throughout the data gathering process certain key themes were heard over again from virtually every respondent. Employers are emphatic that "skills" as they are traditionally thought of in the narrow "smokestack industry" vocational sense, are not enough. In addition to technical skills, employability skills (communication, teamwork, problem solving, customer service) are required of virtually every IT worker. We also heard that while there are still "entry level" jobs, persons who acquire those positions with only entry-level skills would not advance. Another consistent theme was that office user skills, sometimes referred to as basic "computer literacy" (word processing, e-mail, data entry, elementary spread sheet usage) are assumed, and should not be taught in the credit envelope of an IT curriculum. That is not to say such skills are unimportant, but rather that having those skills is rather like being able to use a knife and fork. Students without basic computer literacy must remediate, however the remediation is just like remedial math or English. From industry's perspective, simply being able to use a computer in this day and age says absolutely nothing about your ability to function on the job in IT.

The following sections of the study report present the data and findings from the regional respondents, the comparison with industry focus groups from other regions, the comparison with BLS and economic development data for the Boston MSA, and conclusions and recommendations.

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[3] BLS

[*] McKinsey Reports

[**] Summary included as an Appendix to this report.

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This study is organized into three main elements:

- Regional and local business / industry stakeholder workforce needs and concerns
- Federal and regional Industry data for comparison
- Conclusions and recommendations

Research Design and Methodology

The original research design for this study planned to gather data from several onsite regional focus groups, each consisting of approximately 15 – 30 industry members, representing first-line hiring managers and also those responsible for strategic planning of current technical workforce capabilities and future workforce needs. For those unable to attend on-site meetings, data would be gathered by a Web survey. In either case, an important feature of the study was (and is) to capture meaning (not just *what*, but *why*), not simply raw data on workforce skills. This study was designed to produce different results than a typical occupational analysis, which focuses on task importance, and time spent performing the task. We believe (and industry data bears this out) that most technology jobs have transcended the old "vocational" approach to job task analysis (JTA) and we see strong indications from industry that older traditional methods of curriculum design based on JTA may part of the problem rather than contributing to a solution.

As we worked through logistics, we learned that the effects of downsizing and time pressures on employers made the anticipated number of face-to-face meetings virtually impossible to schedule. We therefore modified the data gathering and research design in the following ways:

1. Individual telephone interviews were conducted with selected representatives of regional employers who were responsible for the hiring of IT technicians and technologists, or who were otherwise responsible for strategic planning and workforce development. We limited onsite focus groups to one meeting held west of Boston in an effort to include businesses from Rte 128 and the Framingham area.

2. TSI agreed to compare regional data gathered for this study with other regions of the country using our large database of IT workforce data gathered from employers in other MSAs in the US. While minor regional variations always exist, at the macro level, what's important to employers in Boston is also important to similar enterprises whether in San Diego, Las Vegas, Dallas, or elsewhere. This turned out to be an effective and efficient way to analyze the data without having to duplicate effort that showed very similar results in other areas of the US.

3. We also compared the regional data to Federal (BLS) and regional economic development data for the Boston Metropolitan Statistical Area (MSA) to develop a comparison between the "on the street" view and the information furnished by the BLS and regional economic development councils.

In all cases where data was gathered from individuals, we wanted to gather responses in the following topic areas:

- Employer perception of community colleges and community college students
- The importance of employability and business skills for technicians
- Most pressing critical needs for educators to address
- Future workforce demand forecast for technicians and community college level graduates
- Relative importance of certain well-defined technical skills and certifications
- The changed business environment and the implications of that change on workforce development and professional – technical education and training

We also developed recommendations based on the general trend of skills importance indicated by industry, which can inform a critical review of the current program offerings provided by the regional community colleges, and which can allow BATEC to develop strategies to help not only its current members, but any college in its region of influence wishing to offer programs that are responsive to employer needs.

We gathered both quantitative and qualitative data. The results and findings are discussed in detail in the next section. Samples of the data gathering instruments and other relevant exhibits are included in the Appendix section.

We (and BATEC) agreed it was vitally important to find out not just what employers wanted, but why they wanted it. With better understanding, needed programmatic changes could be enthusiastically embraced rather than simply acknowledged, and effective action could result.

Since this is a single sample descriptive study involving a unique population, it is inappropriate to conduct measurements that affirm validity to a general population. However, to affirm the consistency of the Boston data and to ensure it can be relied upon as an accurate reflection of a broader population of IT employers, TSI compared the results of the Boston industry skills, knowledge, and attributes survey to a subset (N>50) of industry respondents who were asked to respond to similar surveys in Fairfax County, Virginia in 2005, Contra Costa County in 2006, and Clark, Carson, and Douglas Counties in Nevada (2006 – 2007). Overall t-values of less than 1.45 ($p<.1$) suggest strong correlation between the data supplied by IT employers responding to this study and those other from regions. We may therefore conclude that the Boston respondents have provided valid information that compares statistically with data provided by a heterogeneous group of US employers and we may conclude with confidence that the Boston data is not spurious or idiosyncratic, and that employer remarks are not merely anecdotal.

TSI administered multi-part surveys by telephone conversations to industry representatives in the Boston MSA and surrounding area. BATEC advisory committee members and organizations referred to BATEC by industry trade organizations and by personal referral comprised the majority of Boston regional respondents. We gathered information on employability (soft) skills, IT technical skills, changes and trends, and recommendations to improve the employability and long term success of community college graduates whether at work or transferring to university.

We also provided analysis of major IT skill sets under each of eight broad IT topic areas to derive a sense of relative importance of skills areas. Community colleges must be responsive to current employer needs and future workforce skill trends. In the past, this has been a simple matter of content updating. Our data from employers strongly suggests that simply updating content will not

do. This is because IT skills, per-se are a globally sourced commodity. There are many reasons for this, principal of which is globalization of business and the trans-nationalization of commerce. Lower cost work offered by other countries play a part as well, but it is eminently sensible to source some IT skills in regions where the enterprise has major presence.

This is both good and bad news for traditional skills based programs such as those offered in community colleges. In the "go-go" '90s, students with a limited suite of technical skills (such as HTML or computer hardware repair) would find multiple offers from which to choose. Newspapers were thick with want ads and IT employers were literally waiting at the classroom door to press business cards into the hands of students taking Web authoring courses. Today, US students graduating with a narrow set of technical skills will often find themselves trading those skills in a global market, and may be disadvantaged in comparison to persons in other countries willing to provide similar skills more cheaply. However, if US students can offer employers something *in addition* to rote technical skills, they often represent a better value proposition than their foreign competitors. We emphasize "in addition" because what is clear in this and other studies we've done is a consistent assertion from employers that they discount basic IT skills (much like being able to use a knife and fork) and that candidates are differentiated by the creativity, passion, and effectiveness with which they apply whatever skills they have. It is these traits employers look for.

In this report, we reflect the consistent theme that instructional methods and outcomes should reflect the reality of the technology workplace – which is to say that contextual knowledge (the broader environment in which work is done) and employability skills (communication, collaboration, resourcefulness, and teamwork) are every bit as important as any technical skill element an employee may possess, and that absent contextual knowledge and employability skills a worker is as ill-equipped to function on the job as if they were deficient in a requisite technical skill. In fact, many employers report that the lack of employability skills and contextual applications knowledge is most severe, because while employers feel they can always send an otherwise worthy employee to a class, they're at a loss when it comes to remedying lack of employability skills and contextual applications knowledge.

We wish to be clear that while we focus on technician workforce development, the perspective of employers is not necessarily focused just on job training or community college education.

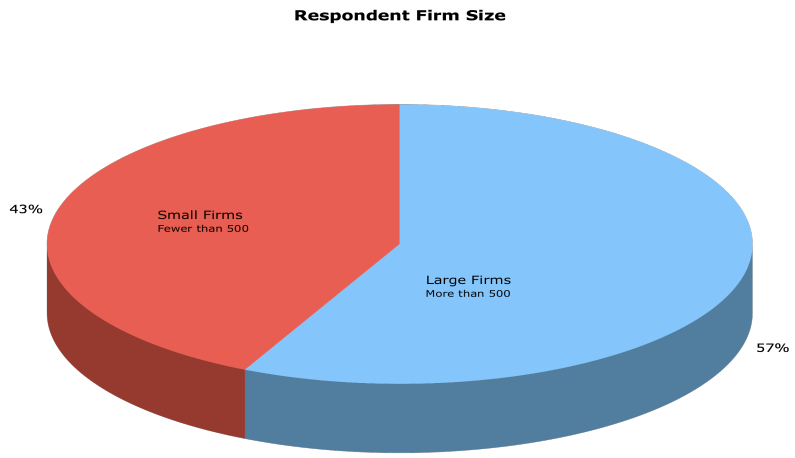
Outsourcing, downsizing, and off shoring is not limited to technicians or hourly wage earners. University educated professionals are not immune. From the employers' perspective, at every level of education, up to and including 4-year professions and beyond, the assembly-line approach to education is not working.

We cannot close this section without a word about the relationship between school and work. The heat of global commerce has evaporated the old hard line separation between "thinkers" and "doers" so common in smokestack industries. Today, employers want both-and, not either-or. Yet, our education system more often than not encourages a hard separation between thinkers and doers. Universities see themselves as heirs to theoretical research and attract and educate thinkers. Community colleges are assigned the role of applied learning and attract the doers. In fact, an entire canonical philosophy of vocational education has underpinned applied learning in the US.

The countries that are excelling economically in the world today do not operate under a framework that separates thinkers and doers. The EU, for example, has long adopted a philosophy of "head and hand in harmony" which has helped sustain a viable and competitive workforce. The Chinese are said to be building hundreds of technical schools that will educate doers who can also think. We recognize the cultural differences between the US and the EU, and China's workforce environment is not an entirely adaptable model either. However, we would do well to understand that employers are still sending jobs to these regions in part because, in their own words, they cannot find the workers they need here.

Data Presentation

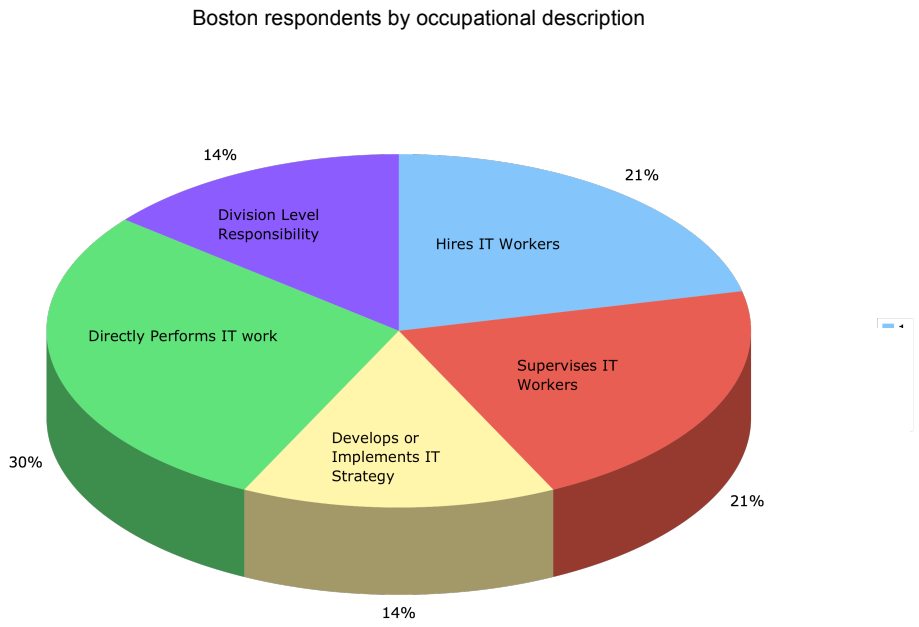
Boston regional employers were ranked according to firm size and we also asked information about the work background of the respondent. Small firms (under 500 total employees) represented 43% of the Boston area respondents, and large firms (greater than 500 employees) were 57%



We asked respondents which of several categories best described their current function or position within their enterprise. We were pleased to be able to get a good cross section of employment:

- Those who directly performed IT technical work
- Those responsible for hiring IT workers
- Persons who develop or implement IT strategies or solutions
- Persons who directly supervise IT workers or staff
- High level managers with division level responsibility for enterprise level IT functions

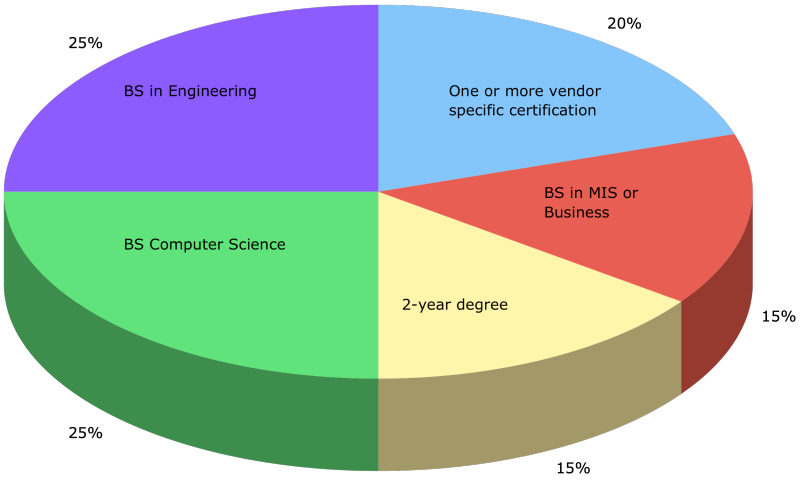
It is remarkable (as later data will show) how consistent the major concerns and desires are among all represented sectors.



All but one respondent reported having worked in IT for seven or more years.

We asked the Boston respondents about the kind of credentials held by IT workers in their respective enterprises. The following chart depicts the distribution of credentials. Note that employees can hold more than one credential – for example a 2-year degree and one or more certifications. We ensured against errors caused by double counting by confirming that respondents believed that about half the IT staff had either a BS in Computer Science or a BS in Engineering, and that about half the staff had combinations of credentials from the remaining areas. This could be interpreted as good news for community colleges. We can interpret this data as suggesting that 35% of the IT jobs are held by persons with 2-year degrees and certifications, and that significant additional opportunities exist for persons with those credentials if they complete a degree that includes MIS content.

Percent distribution of IT credentials



A significant dissuading factor for some students who otherwise might enroll in IT programs in community colleges is the perception that baccalaureate pathways only exist in computer science and engineering. This is too often correct, since few universities accept lower division technology courses (networking, web design, programming) in satisfaction of computer science or engineering degrees. There is a small but growing trend toward completion pathways for technicians and technologists who wish to become advance as technologists, and these persons are critically important in IT dependent enterprises where the only in-house IT expertise resides in the tech support personnel.

It is critical to note that with more IT supporting non-IT firms, those IT workers could conceivably have to function on occasion up to the system architect level and may be called upon to explain, analyze, and help make critical technology decisions for their company.

In fact, a preponderance of our Boston respondents were IT dependent businesses not engaged in the manufacture of IT products or the provision of IT services to their customers or clients:

IT dependent firm	90%
IT producer or service provider	10%

About 75% of the IT effort is performed in firms whose products or services are not IT related, and one of the most identifiable employer clusters with this trait is banking and finance.

Basic User Skills

100% of the Boston area respondents reported that they believed IT technicians and technologists needed a broader skill set now and into the future than in the recent past. When asked what new kinds of skills were needed, respondents uniformly named employability and business (non-technical) skills.

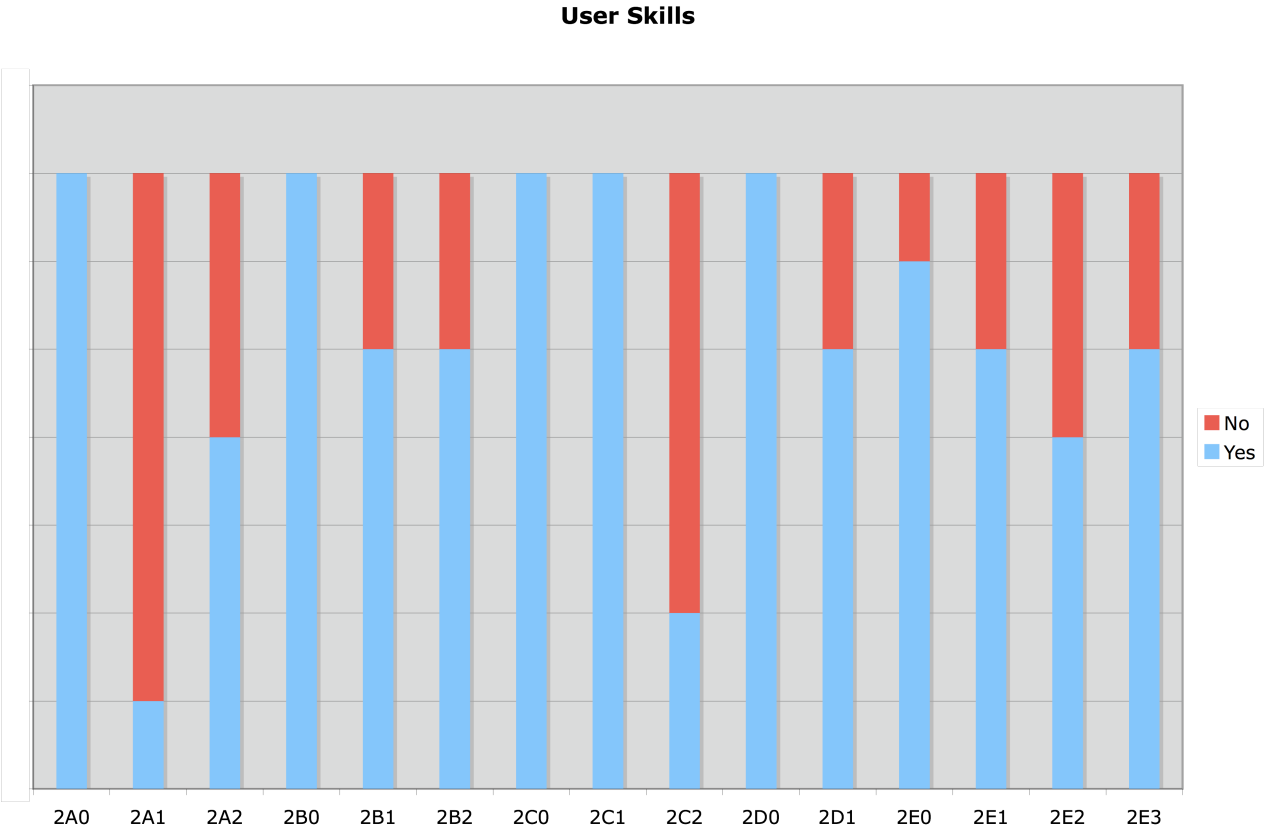
Most employers assume applicants and candidates should possess basic IT skills, sometimes referred to as IT Literacy. We will use the term IT Literacy to include basic skills in the following areas:

- Desktop operating system
- File maintenance – workstation connectivity – storage – remote connectivity
- Word processing
- E-mail, address book, scheduler or calendar
- Data entry and chart preparation using spread sheets
- Ability to create and present a brief informational talk with electronic slides
- Basic nomenclature and hardware identification
- General understanding of ethics, confidentiality, de-minimis use, and IP

Some schools and programs offer discrete courses in one or more of these areas, but business completely assumes these skills, which means students should not assume they know anything about IT because they have Literacy. Clearly any courses in these areas should not displace technical content and if students need to remediate in a class they should not be made to believe

that by doing so they have mastered computer skills in this day and age. Basic IT Literacy is assumed.

Interest in further preparation past the basics of IT Literacy dropped off dramatically. For example, question 2C0 asked about ability to use presentation software to create a brief informational presentation. 100% of respondents said “YES” they believe candidates should have this skill. Questions 2C1 and 2C2 dealt with inserting graphic and active content respectively. 2C1, inserting a table or graph, received 100% YES. For question 2C2, inserting active content (music, video, etc.) only 28% of respondents said “YES”.



The text of each question for this chart is included in the Appendix

Respondents also told us that familiarity with more than one approach to desktops and networks might be of increasing value.

Regarding security, we found that many respondents considered anything beyond basics to be the province of specialists. Entry-level technicians and technologists generally do not have responsibility for system security beyond possibly installing patches or educating users on policies and practices. Beyond being proficient in basic measures, many respondents felt it would be a waste of time to dwell on extensive systems level security skills for technician level employees, especially new hires.

Math and Science

There has been considerable discussion in academe about the type of mathematics skills needed by technicians and what depth of knowledge is required. This discussion is sensitive for several reasons: many students fear math and math content is a powerful dissuader; traditional educational environments insist math be taught as a separate abstract subject rather than applied in context; many traditional academics and even regional accreditation bodies tend to be suspicious of nontraditional approaches to math; software has reduced the need to set up problems and perform calculations; many community college students are math deficient upon entry; academic math course outcomes are perceived by students as irrelevant to the work they are being educated to do.

We recognize two things: first, we may gore an ox or two in solving this problem; second, we are not discussing practitioners of hard science and engineering, where precise calculations are clearly required.

Having said this, we find the Boston respondents very typical in terms of their comments about math and science, relative to other groups with which we have worked. At the technician and technologist level, employers care about and desire some of the benefits of math and science, but are ambivalent about specific math outcomes. For example: employers want workers who can think logically, but can't identify whether a course in logic systems, calculus, or linear algebra is necessary to produce that outcome. Some employers believe it's important for workers to understand light bends when transmitted through a medium (such as a fiber optic cable) but are ambivalent about whether this should be accomplished by learning to calculate the precise index of refraction using Snell's law.

Problem solving and critical thinking are two traits often cited as important for applicants and employees. Employers see the ability to understand similarities and differences, to gather and present data, to chart trends, and understand the seriousness of a problem based on the magnitude and rate of change of certain inputs as common sense skills. To be sure, there are academic courses that can exemplify all of these traits. However, when math or science facts are presented without context, many students demonstrate very low subject matter retention and show frustrating inability to apply concepts in the real world. Even for scientists and engineers, active participation and application-specific presentation improves retention[4]. Too often schools do not present students with clear paths through the typical subject-matter-driven course offerings---paths that would direct students to courses that offer the best chance to connect abstract concepts to contextual problems.

From an employer's perspective for many technical occupations, the process skills of math are at least as important as didactic knowledge. As one focus group respondent said: "*The problems we need to have our technical people solve are not in the back of the book*."

We gave respondents examples of several broad topical areas of mathematics:

Topic Area	Sample Subject Matter	Reaction
Trigonometry	Angles, sin, cosin, tangent, vectors, complex numbers, geometric concepts	Technicians use rarely – but should know about
Advanced Algebra	Imaginary numbers, spherical trigonometry, matrix algebra	Technicians do not use
Calculus	Integration, differentiation, transforms, differential equations	Only required for engineers
Finite Mathematics	Set theory, graphs, descriptive statistics, progressions and series	Will benefit technicians as they advance

We believe employers (and students) want the beneficial *outcomes* of mathematics; especially those that foster analytical ability and critical thinking or that improve the ability to make judgments or draw inferences based on quantitative information. Sadly, few math courses list these traits as outcomes – they are considered at best a byproduct of associating with the subject matter. The persistent disconnect between mathematics as offered by schools and mathematics abilities that

[4] http://icampus.mit.edu/news/.%5Carticles%5Cscientificteaching.pdf

would improve job performance of technicians and technologists continues to frustrate students and employers, and more than a few educators as well.

We are not saying, “Don’t teach math.” There is evidence that many of the benefits claimed for mathematics elude students to the precise extent abstract concepts are not connected to technician level work. The answer seems to lie in *how* we teach, and that is good news because it is completely within our control to change.

We also asked respondents about science, and in particular whether they believed lack of science knowledge put US technicians at a disadvantage when compared to foreign workers. Responses were similar to those obtained for mathematics. It is very helpful for applicants to have the benefits of scientific approach, such as hypothesis formation and testing, but in the context of developing an approach to solving a technical problem, not a science problem. Abstract science courses organized around typical college subject areas such as Chemistry or Physics were not considered very relevant to the daily work of technicians.

There was little variation in responses regarding math and science whether the respondent was a hiring authority, manager, or worker.

Respondents noted that applicants would be helped by increased *breadth* in related technical areas and felt science content could help. For example, the convergence of IT and Communications Technology requires in-depth knowledge of networking *and* technical knowledge of communications (building out WiFi networks implies some knowledge of radio propagation and antennas and coaxial cables).

We argue strongly for a fresh and imaginative look at the issues of math and science and their role in US technical workforce education. Math as it is currently taught is powerful dissuader. Students will avoid programs and courses if they require math.[5] Even worse, cultural biases (“girls don’t do math” for example) contribute to gender and ethnic imbalance in enrollment in technical programs.[6] Often, role models offered to technicians are holders of advanced engineering degrees, and high

[5] NWCET found math aversion directly correlated to student enrollment decisions in IT courses offered by community colleges.
[6] NWCET CyberCareers, 1999 – 2000.

school and community college students (who may be the first in their family to complete high school or go to college) may see their own attainment of those positions as very distal.

We spoke earlier of process -- employers very much appreciate the ability to "think mathematically" when the occasion warrants. When we asked some respondents whether they thought it mattered whether a worker knew the difference between what happens when a quantity (say network traffic at a node) doubles and when it increases by an order of magnitude, they responded that this was the kind of quantitative reasoning ability they think is useful.[7] It appears we fail to teach relevant meaning, with consequent grave implications for critical thinking and reasoning. We have interviewed too many college students who taken and passed required math courses in sequence but could not explain what would result if a quantity increased by a *factor* of three versus what would result if it increased by a *power* of three.

This topic is very important. Math and science are the "900 pound gorilla" in the room, and any clarification and improvement in understanding of the role of math and science in technician education and employment benefits not only BATEC and its constituents, but could also be shared beneficially with educators at all levels anywhere. Educators and employers lament the poor math, science, and quantitative reasoning ability of American students. We could do better, but the answer unquestionably lies in doing things *differently*. Traditional lecture oriented teaching appeals to the 10% or so of learners who are left brain, logical sequential, passive-receptive auditory learners. Our teaching methods, especially of these abstract subjects, almost guarantees that we will miss a large number of potentially great learners (and vital contributors) who just need a different approach. [8]

[7] Though not a part of the data gathering instrument, we were curious whether employers could give some examples of what they wanted.
[8] See for example the work of Felder and Silverman at North Carolina State University on the learning styles of engineering students and the eminent body of work on multiple intelligences of Howard Gardner at Harvard.

Customer Service Skills

We asked respondents about four skill traits in customer service:

1. Ability to access, interpret and apply technical data to troubleshoot systems
2. Ability to document incidents, customer contacts, action, and response
3. Ability perform end-to-end diagnosis and system level testing and restoration
4. Ability to use principals of technical writing, report presentation and information delivery

The numbered list above corresponds to the bar chart:

Industry respondents in the Boston region, very much like other groups across the country, believe that even internal IT support is a customer service. In this sense, IT support for an enterprise puts technicians in front of customers as much as technicians that go onsite to a client premises.

Consistent with the concept of adding value to intellectual capital, many firms are recognizing the value of interactions, and this is not limited to strategists. The value of interactions at every level

produces quantifiable benefits, and the loss of valuable interaction, such as when certain types of customer services are outsourced, can be costly.[9] In a rush to adopt simple solutions, organizations adopted a "core business" orientation that lead to outsourcing of support and customer service functions. This action lead to short-lived decreases in costs and improved short-term profitability which often came at the expense of customer satisfaction and loss of priceless organizational, customer, and market knowledge. In re-thinking this strategy, organizations have now taken time to analyze technical support from a value perspective rather than a purely cost-based view.

As we consider the ways in which technicians contribute to intellectual capital, we are reminded of employer focus groups across the country that say that customer service is not just about fixing a technical problem. The real "fix" becomes apparent only after interaction, after observing and analyzing trends, after listening, and after communicating information effectively and appropriately.

The pioneering work of Dr. John Bransford set forth in *How People Learn* calls this interactive step "Developing Field Insights". Such insights, suggests Bransford, are crucial to proper problem definition.[10] Business concurs. Insight to the true nature of a problem may bring forth more effective, less costly and more lasting solutions, which in turn create more satisfied customers.

[9] The McKinsey Quarterly: The next revolution in interactions, June, 2006.
[10] Brnasford et.al., *How People Learn*, National Academies Press

Employability (soft) skills and non-technical attributes

We find no issue on which there is greater agreement than on the need for employability (sometimes referred to as "soft") skills. The boundaries of the set of employability skills are generally considered to include at least these 8 attributes and skills:

- Communications (oral and written) and ability to converse courteously
- Ability to work productively in teams or groups
- Customer service focus
- Ability to listen and comprehend
- Ability to be resourceful and constructive when solving problems
- Ability to analyze, prioritize, evaluate, and work with minimal supervision
- Ability to comprehend concepts when expressed in quantitative terms
- Ability to develop practical solutions to novel problems quickly

Throughout numerous focus groups we find employers are emphatic about the importance of these skills not only for an applicant to get hired, but also to remain productive and to advance. Most employers cannot afford to keep workers in certain jobs because they suit their temperament. Today's technician must be able, to borrow a sports metaphor, to play any position as needed. In return, the breadth of knowledge and experience thus gained make such an employee a greater contributor to the Intellectual Capital of the enterprise, and therefore more able to advance.

The case for soft skills might appear to be open-and-shut, given industry's strong endorsement. Paradoxically, despite the importance of employability skills, neither educators nor students appear to appreciate them as employers do. Soft skills are measured almost entirely in the affective domain, and therefore are considered difficult to assess, at least by conventional objective methods. Conventional instructional design, which is oriented around instructional elements in the cognitive and psychomotor domains, conforms to conventional and accepted methods of test and measurement. As safe and engrained as these methods are, psychometric measures alone are uncertain predictors of on-the-job success. Indeed, an entire area of cognitive science lumped under the colloquial term "Emotional Intelligence" after the pioneering work of Daniel Goleman and others, has emerged to describe and measure what we refer to for purposes of this study as employability skills.

We must also consider the faculty perspective. Many technical faculty members consider themselves subject matter experts in their branch of technology, but do not feel comfortable or possibly even qualified, to assess soft skills in a fair, uniform, defensible way when grading student work. Many instructors believe (correctly) they were hired because of their content expertise, and sense "scope creep" when asked to teach in a way that includes providing opportunities for students to develop and practice soft skills. In this litigious age, faculty and institutions alike are also rightly concerned about liability arising from seemingly arbitrary grading schemes.

From the student perspective, students are more comfortable with unambiguous assessments using fair and visible indices. Students who put time and effort into mastering a body of knowledge and possibly passing a difficult industry certification could be justifiably upset if they learned they might not pass a networking class because they failed to give a good Power Point presentation.

With all this, we still have the employers' own words: Technical skills are important, but without employability skills, technical skills are merely commodities. Employability skills turn intellectual commodities into intellectual capital. We offer some comments captured from employer focus groups:

- ***Technical skills get you the interview – soft skills get you the job***
- ***Tech employees often advance into jobs needing more soft skills***
- ***They will be even more critical as jobs become more complex***
- ***More jobs today are customer facing so soft skills are must-have items***
- ***We look for them during the interview – they're critical to our work***
- ***I ask "Can I spend 4 hours in a car with this guy"?***
- ***Unfortunately depending on need we will hire without soft skills but individual will not advance***
- ***Real world Is unpredictable – soft skills help you cope***
- ***We assume technical qualifications, almost all our time is spend on "fit" with our organization***
- ***If a person doesn't fit it can ruin the whole team – we need talent to solve problems quickly***
- ***Our IT support people must view and treat everyone as a customer***
- ***More of our jobs are customer facing now – we expect our premises technicians to explain features and even sell products and services to our customers***

Following is data from the Boston respondents:

Soft Skills and Non Technical Attributes

NT8 **Soft skills are critical to the career success of any new hire**

5. Strongly Agree.	4, Agree	3. Don't Know	2. Disagree	1. Strongly Disagree
87%	13%	0	0	0

- 40% of a performance evaluation is soft skills
- Soft skills are critical to success
- Many of our jobs are customer facing – we can't afford people without soft skills
- Professional attitude and being able to work within the corporate culture are crucial skills
- People won't be considered for promotion without soft skills
- Globalization means US employees must offer better value

NT9 **When hiring or specifying a new hire, we specifically look for soft skills**

5. Strongly Agree.	4, Agree	3. Don't Know	2. Disagree	1. Strongly Disagree
75%	25%	0	0	0

- Fewer jobs are "heads down" programming – soft skills are becoming more important
- Many of our IT staff must act as internal consultants – need to listen and communicate
- Advancement is a real struggle for persons without soft skills
- Much of our work is done by project teams – we look for this experience in new hires
- Tough to measure but "can I spend 4 hours in a car with this person?"
- We assume they're technically competent – most of our interview is about employability skills

NT10 **If a candidate does not exhibit soft skills, we will not hire him or her even if they are technically qualified.**

5. Strongly Agree.	4. Agree	3. Don't Know	2. Disagree	1. Strongly Disagree
19%	31%	25%	25%	0

- We consider the financial impact of lack of soft skills – turnover, inability to assign or promote personnel
- There are over 700 folks in IS in our company – soft skills especially ability to communicate is essential
- Most of our jobs involve exposure to customers at some point – our tech staff is the face of our company
- We look for thoughtfulness in addition to cleverness – you have to be able to properly define the problem
- We may hire someone but it's doubtful they'll last without employability skills – you can't stay in one job
- They will churn around the bottom rung jobs in our company and eventually be let go or quit
- Our job is to "deliver quality health care" – that includes every IT / IS technician in all our locations

NT11 **We have an active program to develop and improve soft skills in our technical employees.**

5. Strongly Agree.	4, Agree	3. Don't Know	2. Disagree	1. Strongly Disagree
13%	25%	44%	18%	0

- We hit or miss with professional development
- We train on e–mail etiquette but little else – we really should do more
- It's not specific but employees see for themselves the disadvantage of not having good soft skills
- Virtually everyone is trained in a decision – thinking process approach that has been very cost effective
- Not like a series of courses but it's clear what kind of person gets the plumb assignments
- Even though we call ourselves "geeks" a "geek" would feel very uncomfortable in our work environment

NT12 **Lack of soft skills in our local hiring pool would lead us to consider outsourcing**

5. Strongly Agree.	4, Agree	3. Don't Know	2. Disagree	1. Strongly Disagree
13%	25%	37%	25%	0

- Not specifically but people without soft skills are not worth considering
- It would be another reason to consider outsourcing
- Not the biggest reason but could potentially be one if employees [with soft skills] offered better value

Hiring Manager Response

NT13A **As a person with hiring responsibility, if there were one thing you wish applicants had more of, what would that one thing be?**

Comment:

- Ability to anticipate problems – think about the system as a whole
- Ability to contribute positively and convincingly without jeopardizing relationships
- Develop strategy to approach a problem
- Original solutions to unique problems – not multiple choice
- Desire to learn (said in the context of approach to solving problems)

Career Reflection Response

NT13B **Thinking back on your career thus far, if you could identify one thing that would have better prepared you for work, what would that one thing have been?**

Comment:

- Not all the problems are like the ones in the back of the book
- The love affair with individual achievement fostered in school is very different from what you need to succeed – superstars burn out fast in our organization – you can't make it without teamwork and cooperation
- We train students in school to believe people support machines and technology – they really support other people

Forced Choice Non Technical Skill Prioritization

NT14 **If two *new hire* candidates were in contention for one position and they were both equally qualified technically and had similar experience, what *non-technical* attribute, would "tip the scale" towards one more than the other.**

Comment:

- Which one could explain things most clearly
- The one that had the best approach to a problem given in the interview
- Were they passionate and enthusiastic about the challenges of the position
- For new hires we really look for eagerness to learn and make a career with us – we hire for the long term
- How closely their commitments to themselves mesh with the commitment they must make to the position

NT15 **If two incumbent candidates were in contention for one promotion and they were both equally qualified technically and had similar experience, *what* *non-technical* attribute, would tip the scale towards one more than the other.**

Comment:

- Ability to communicate and work productively with others
- Passion and enthusiasm for the increased challenges and responsibility of the new assignment
- Desire to leverage personal success into helping enterprise succeed
- Which one really wanted to be here
- Are they thinking just of themselves? How have they demonstrated organizational commitment?

We will have more to say in the conclusions and recommendations section about employability skills. The responses here speak for themselves, and are mirrored in similar research we have done with employers and groups all over the country. We have concluded from our work in this area that the single most serious deficiency in the technical workforce today is not lack of technical skills, but lack of the employability skills necessary to leverage those skills in a way that contributes in areas that enterprises need today. Content-driven curriculum and lecture-oriented instruction, at best, turn out technically competent individuals who nevertheless often lack vital skills that industry clearly prizes.

Adaptive Expertise

Employers tell educators they want to hire persons who are problem solvers. We held extensive phone interviews with a subset of Boston area respondents wherein we explained the concepts of Adaptive Expertise[11]. This concept has enormous implications for educators, for both cognitive research[12] and our own work with industry strongly implies that current instructional methods produce students who are good test-takers, but not necessarily good problem solvers. [13]

The term Adaptive Expertise refers to the ability to develop original solutions to novel problems. The term is contrasted with Routine Expertise which may be very complex (surgeon, airline pilot) but nevertheless performed from a known repertoire of learned skills and responses. Routine expertise frequently has been show to be insufficient when novel problems arise that fall outside the normal realm of practice. (An example may be multiple emergencies in an airplane that arise in a way that the normal procedures and checklists do not apply).

NT16. In thinking about Adaptive Expertise as it may apply to your enterprise, do you find Adaptive Expertise exhibited by any employees you can think of? (Y / NS / N)

NT16	Yes	Not Sure	No
	75%	25%	0

NT17 . Do you believe employees who exhibit Adaptive Expertise would contribute more value to your enterprise? (Y / NS / N)

NT17	Yes	Not Sure	No
	93%	7%	

NT18. Do you know of instances where your enterprise detects or rewards Adaptive Expertise? (Y / NS / N)

NT18	Yes	Not Sure	No
	25%	50%	25%

[11] *How People Learn*, Bransford et.al. National Academies Press, 2000
[12] See for example the work of Tom Harris, John Bransford
[13] Objective tests and the teaching methods that are associated with them generally do little to encourage or reward generating ideas and evaluating alternatives, two critical steps of successful problem solving. See www.thecasefiles.org for additional information.

NT19. As Adaptive Expertise is described here, do you think that if more technical personnel exhibited traits of Adaptive Expertise that it would provide an advantage to your enterprise over competing firms whose employees did not have those traits? (Y / NS / N)

NT19	Yes	Not Sure	No
	75%	25%	

NT20. If two applicants are in contention for one position, given a choice between a Routine Expertise with 10 years' experience and an Adaptive Expert with 1 year's experience, which would be more likely to recommend hiring? (Routine Expert / NS / Adaptive Expert)

NT20	R E	Not Sure	A E
		40%	60%

NT21 **If you could make *one* recommendation to the education system as a whole regarding the education and preparation of ICT workers for your enterprise, what would it be?**

Comment:

- Stop teaching course by course. Students loose half their knowledge due to aging factors.
- Everyone is a manager – if only of him or her self. You should be teaching that.
- Get rid of your silos. Today's technical world is not organized by subject.
- Schools are increasingly out of touch with the realities of 21st century work ….. none of our workplaces has tables and chairs arranged in rows with the leader's desk at the front like a classroom.
- Every school feels the need to create its own curriculum and course design. The countries that are beating us use a world-class curriculum. This information is easily attainable. Why do we reinvent the wheel?
- Remediate or fail those who cannot / will not do the work – don't just pass students through the system from middle school on up.

NT22 **If allowed to name *just one thing* that is different regarding hiring of ICT workers now versus 5 years ago, what would that *one thing* be?**

Comment:

- Fewer technical people are doing hiring – more is being done by recruiters or outsourced to management firms.
- You have to be able to sell yourself – a diploma or a few certificates won't cut it now.
- We want fewer employees who can do more, stay longer, and move up faster. We can't rehire our workforce every time we grow, but we can't grow if our people aren't capable and flexible.
- Business internalizes profits and externalizes risks. If employees contribute to growth and profit, they'll stay. This should not be a mystery.

Relative Importance of Technical Skills

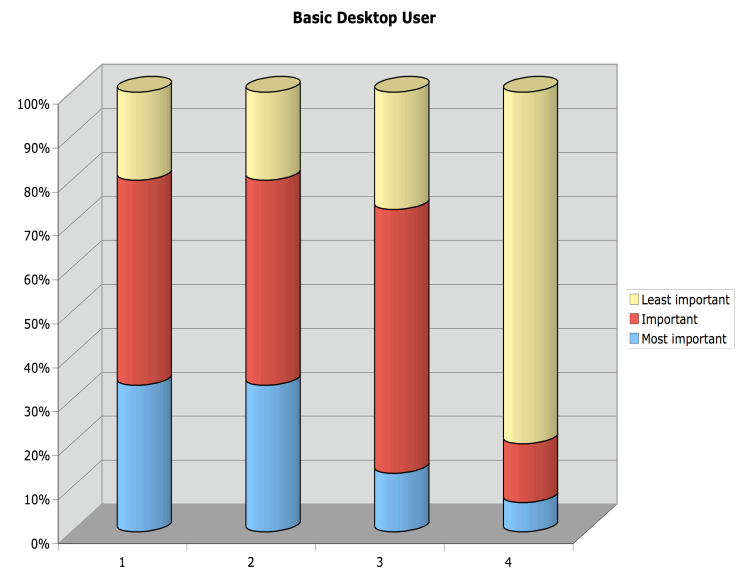
This section contains graphical depictions of major topic areas in IT as presented to industry participants in panels held across the country. Industry participants were asked to rank subject areas the broad topical areas according to their experiential view of whether the subject area was most important, important, or least important. The best meaning comes from analysis of the relative importance of skill areas within IT career clusters. This does not necessarily mean that other topics should not be taught. However, this analysis technique arises from the realization that at least in the short run, we cannot lengthen the day, adjust content to a program or course, or magically create facilities, increase faculty numbers or decrease faculty load.

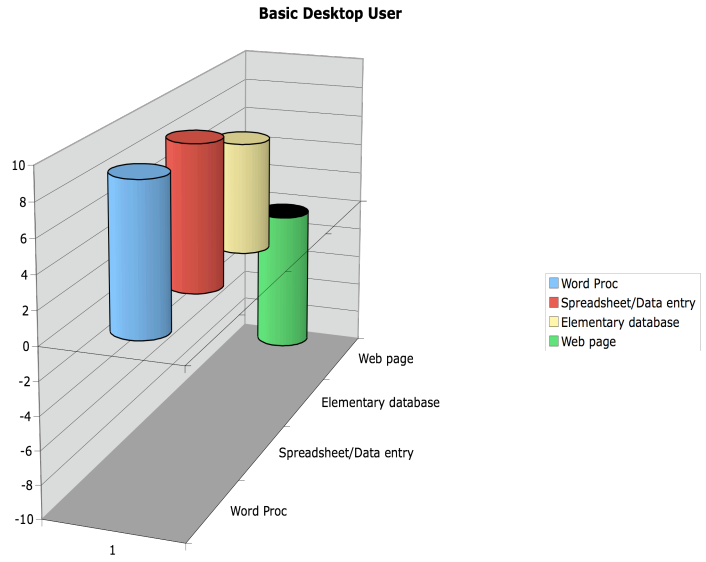
Industry readily provides the data requested. Some respondents comment that the way academics tend to parse IT content into "subjects" is often different from how real-world jobs are classified with regard to skills and job roles. We find that industry comments emphasize the importance of problem solving, analytical and critical thinking, communications, and teamwork rather than discrete technical content. Industry does not see course-by-course content elements and sometimes chafes against the emphasis on grades rather than performance. They tend to be unable to make much meaning of the difference between A- and B+. They see "able" and "not-able" to do the job and thus perceive grades as much as indicators of persistence than of ability.

Data categories are based on the IT skill cluster taxonomy developed under a National Science Foundation grant by the National Workforce Center for Emerging Technologies.[14] This taxonomy provides a rational basis for defining, ranking, and comparing IT work and the tasks performed by individuals in eight IT skills cluster categories. We used sub categories and sample job titles (as validated by employers) to develop the broad tasks within the occupational categories as shown in the following charts. As noted above, in every instance respondents have readily identified and understood the occupational clusters and sub categories. We have tested the understanding of respondents for uniformity with different groups and found no significant variation.

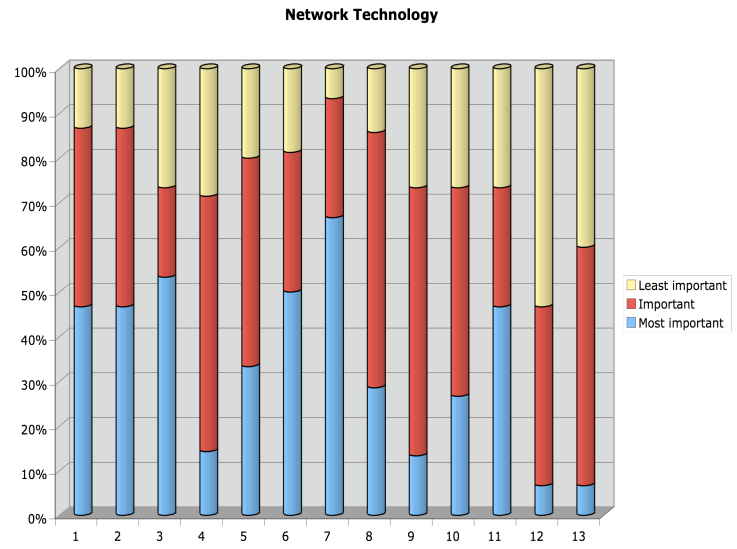
[14] Building a Foundation for Tomorrow – Skill Standards for Information Technology, 2003. www.nwcet.org

Composite IT Skills Data

Desktop User Skills percentage view	
	Responses by percent Legend: 1. Word Processing 2. Spreadsheet 3. Elementary database 4. Web page

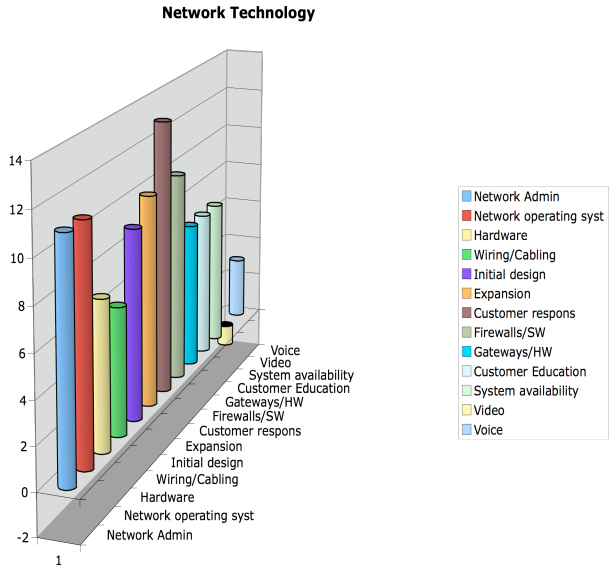
Basic Desktop User Skills – Differential view	
	As this chart and the one above suggest, respondents consider word processing and spreadsheet skills most important. Data base skills are also desirable. However, the below-baseline differential for Web page development suggests strongly that unless one's job specifically deals with Web page development, an even elementary skill with shrink-wrapped products is non-essential. These responses are completely consistent and support industry's view that basic user skills (sometimes referred to as basic IT Literacy) are necessary, these skills are also assumed. While it disqualifies applicants not to have these skills, having them, is not compelling.

Network Technology percentage view



Legend:
1. Network Administration
2. Network operating systems
3. Network hardware
4. Wiring and cabling
5. Initial design
6. Network Expansion
7. Customer response
8. Firewalls and security
9. Customer education
11. System availability
12. Video
13. Voice

Network Technology - Differential view



These charts show that respondents consider several network technology topics important. Those with greatest relative importance were

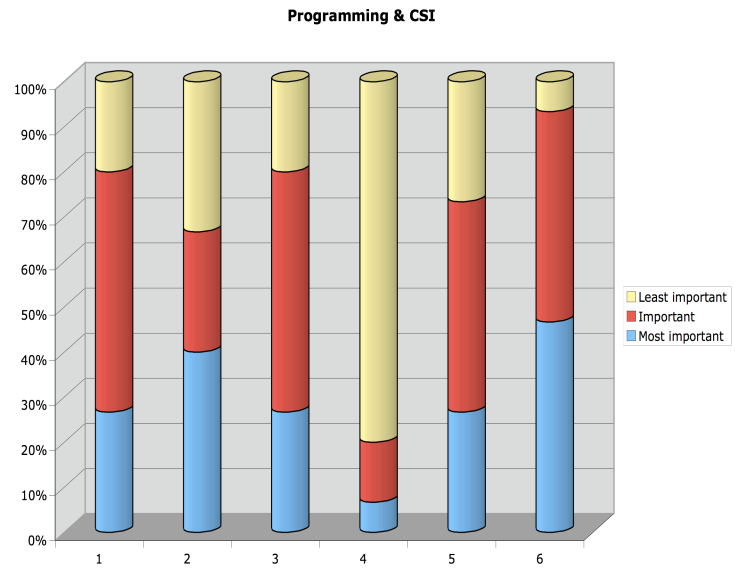
- Customer response
- Operating systems
- Administration
- Expansion
- Firewalls and security
- System availability
- Customer education

Although “hot” in terms of product growth, voice did not show particularly strongly, and video was below the baseline.

This data expression is a good example of the different perspective that can be derived from looking at the relative view versus the percentage view.

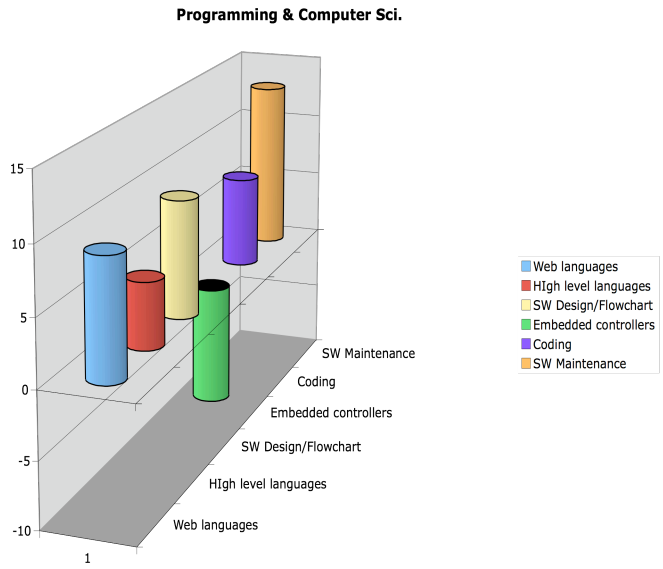
There are strong implications for program emphasis that can be derived from this data.

Programming and CSI - Percentage view



Legend: 1. Web languages
2. High level languages
3. Software design
4. Embedded controllers
5. Coding
6. Software maintenance

Programming and CSI - Differential view

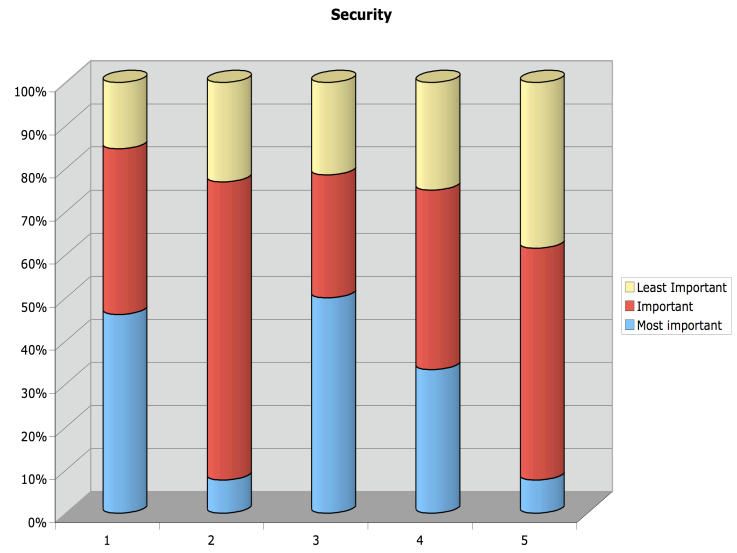


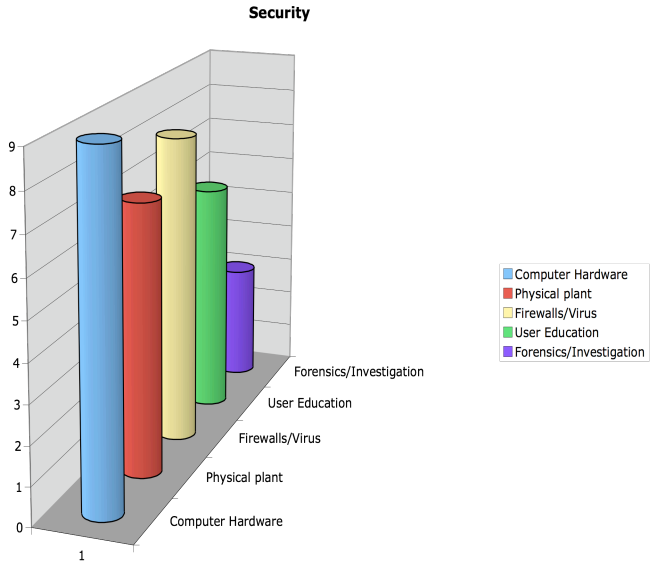
Respondents emphasize software maintenance, software design (flowchart development) high level languages, and Web programming.

The relatively low showing for coding as a stand-alone task reflects the phenomenon that very little software is developed in isolation, and when rote coding is required, the task is easily out-sourced.

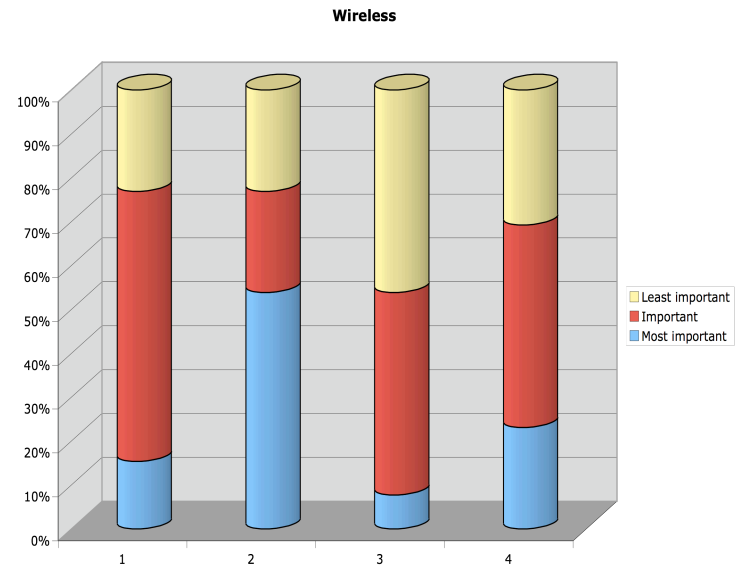
Not atypically, most respondents show little interest in embedded controllers (usually programmed in machine specific development environments or Assembly Language). Except for employers who develop automation systems, robotic controls, process controls, or weapons systems, there is little “street demand” for persons with those skills.

Program implications are self-evident.

Security percentage view	
	Legend: 1. Computer hardware security 2. IT Physical plant 3. Firewalls & virus / worm protection 4. User education 5. Computer forensics & investigation

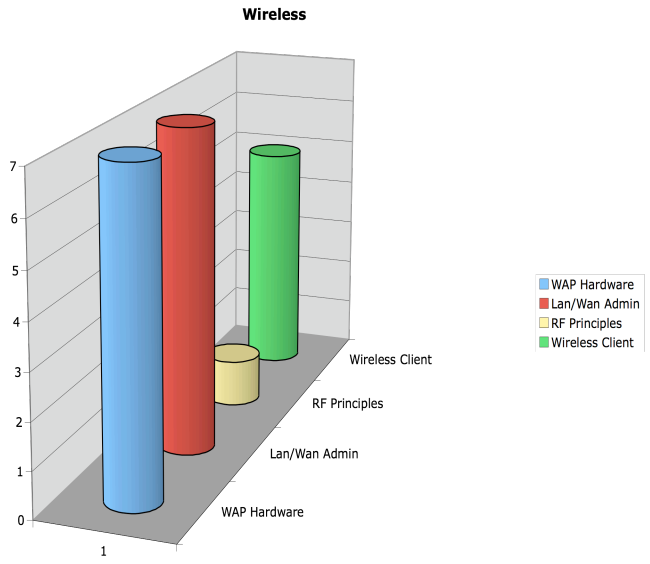
Security – Differential view	
	For several years following 9/11, it seemed like cyber-security was considered only in the context of terrorist attack. Actual experience has shown computer system operators have much to fear from cyber attacks, but the attackers are more likely to be malicious hackers, organized crime, or in rare cases, industrial rivals. The differential view suggests emphasis on the computer or server hardware, firewalls, virus / worm and other protective agents, physical security and user education as the most important topical areas.

Wireless percentage view



Legend:
1. WAP hardware
2. Wireless LAN/WAN administration
3. RF principals
4. Wireless client

Wireless Differential view



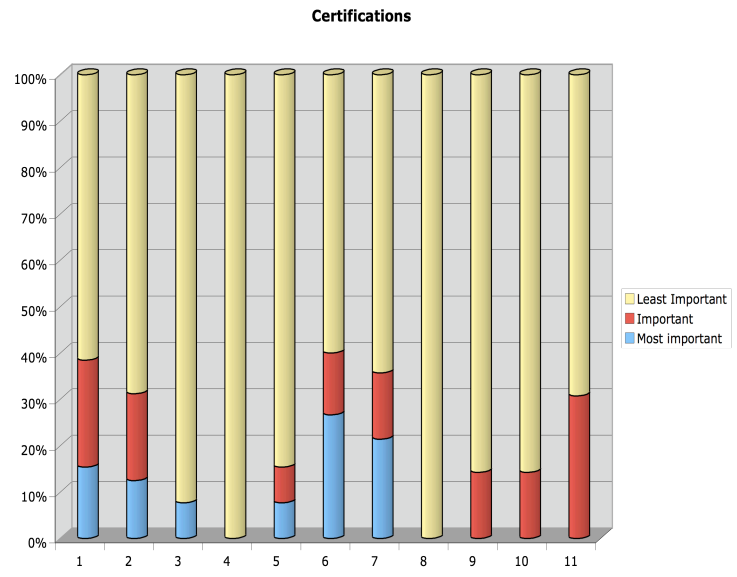
A good deal of hardware growth is due to build out of wireless connectivity for both private and public networks. Wide area (Super Wi-Fi) and Metro Area Networks will deliver signals to a host of new highly integrated portable devices.

Not surprisingly, WAP hardware and wireless LAN administration received the greatest emphasis from the industry respondents.

We note a curious consistency in the lack of interest in RF principles, considering that wide area, Super Wi-Fi, and Metro Networks depend on tightly controlled coverage areas, robust interference immunity, and signal reciprocity with the portable devices, all of which rely on an understanding of antennas and RF propagation.

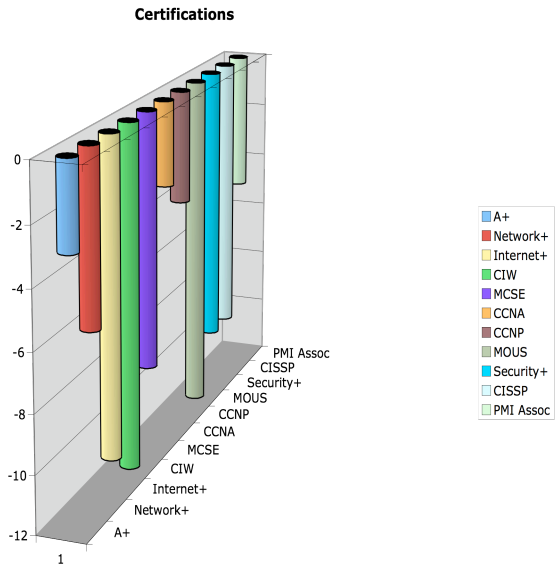
We have tested this question and industry does understand it, but feels that professional engineers specify the system design and components.

Certifications percentage view



Legend:
1. A + (CompTIA)
2. Network + (CompTIA)
3. Internet + (CompTIA)
4. CIW (Profoft)
5. MCSE (Microsoft)
6. CCNA (Cisco)
7. CCNP (Cisco)
8. MOUS (Certiport)
9. Security + (CompTIA)
10. CISSP (NISSTI)
11. PMI Associate (PMI)

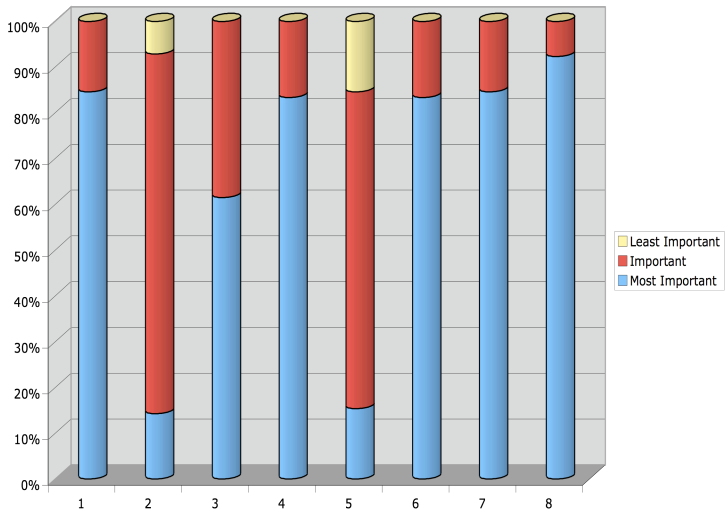
Certifications Differential view

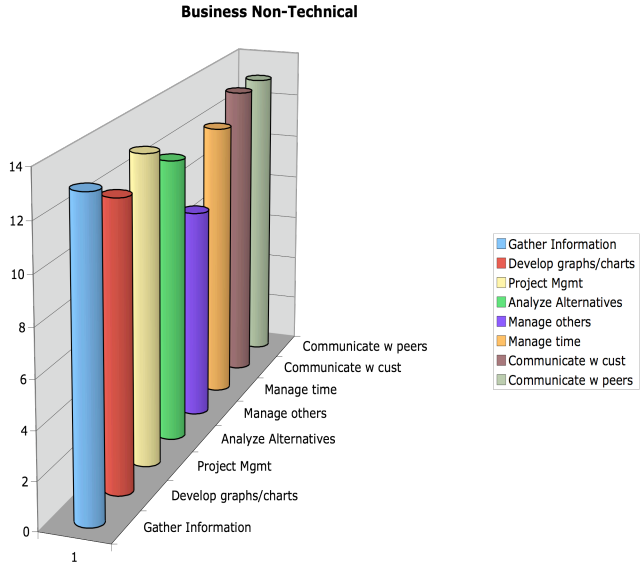


Although the certification providers continue to maintain their credentials are critically important to employment, actual industry data suggests otherwise. This data is similar to that of other industry focus groups – all certifications are below the baseline. This does not necessarily mean they are useless. Rather it means that those employers who may rely on them still value other skills and knowledge more. Based on this data, the four certifications that merit attention are:

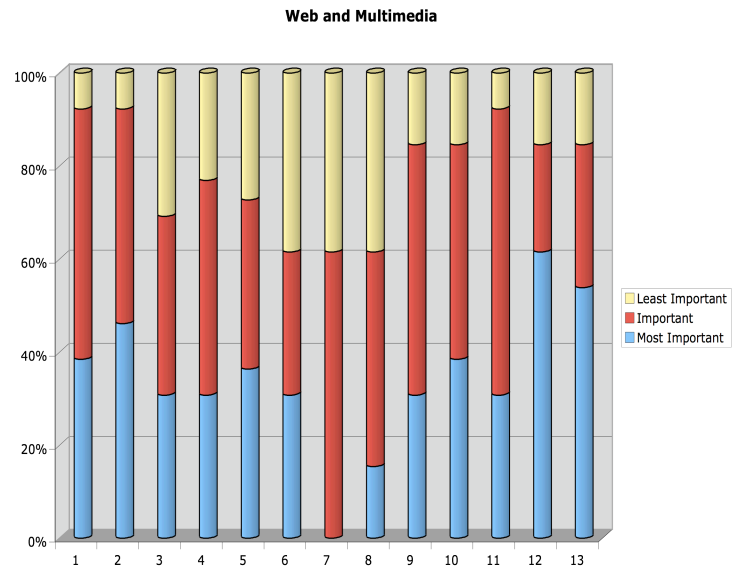
- A +
- CCNA
- CCNP
- PMI Associate

Programmatically, the data imply that educators would be advised not to sacrifice other IT content in order to have students get certified.

Business Non-Technical percentage view	
	Legend: 1. Gather information 2. Develop graphs and carts 3. Project management 4. Analyze alternatives 5. Manage others 6. Manage time 7. Communicate with customers 8. Communicate with peers

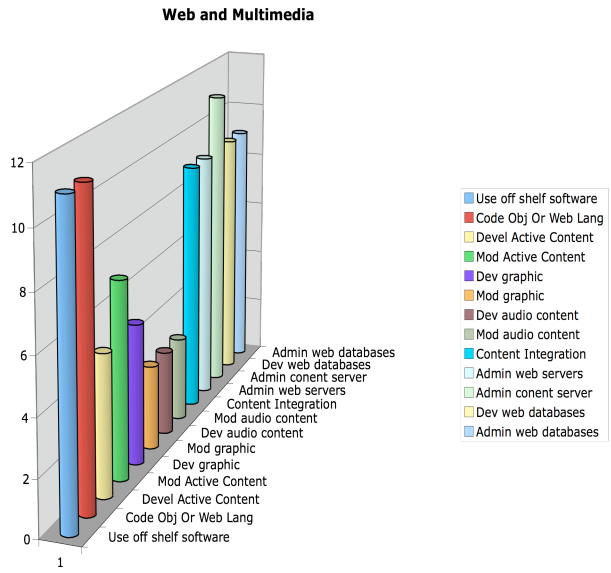
Business Non-Technical Differential view	
	There are no surprises here. This data tracks well with the discussion on employability skills, and taken together, suggest strong emphasis on data gathering, time management, and communication skills. Note the consistent high emphasis on almost all these skills, compared with the consistent ambivalence toward certifications. We again stress that we are not implying that certifications are useless. It is inescapable though that given scarce program and instructional resources, students may be much better served by more emphasis on these skills, and we again conclude that in terms of relative importance, certification content should not be offered *at the expense of* other technical and process content.

Web & Multimedia percentage view



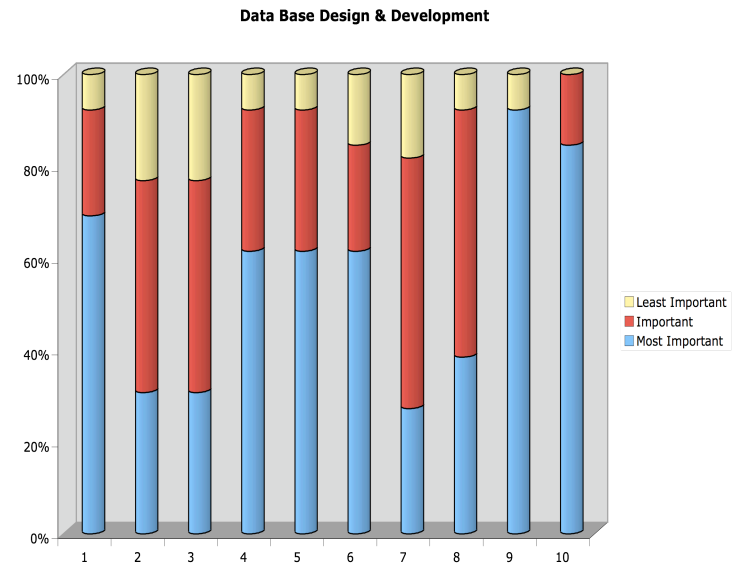
Legend:
1. Use off the shelf software
2. Code object oriented Web lang.
3. Develop active content
4. Modify active content
5. Develop graphic content
6. Modify graphic content
7. Develop audio content
8. Modify audio content
9. Content integration
10. Administer Web servers
11. Administer content servers
12. Develop Web databases
13. Administer Web databases

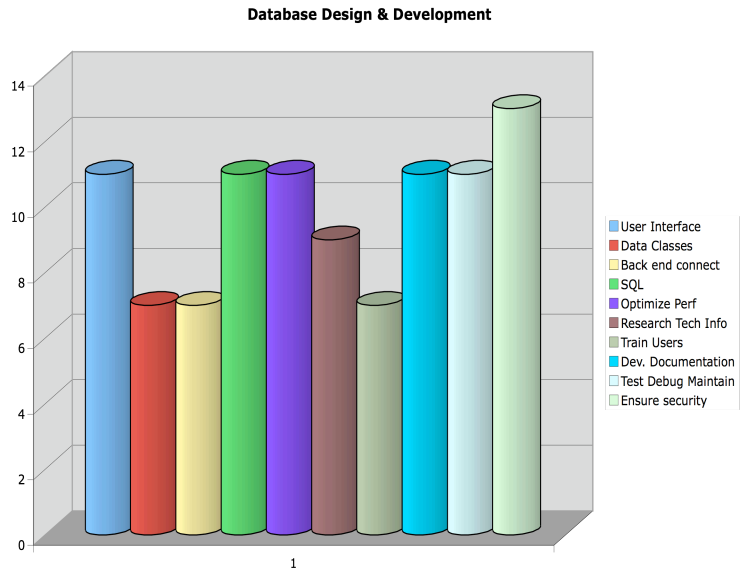
Web & Multimedia Differential view



The complexity of this section arises from the difference in scope of work between smaller enterprises and large enterprises. In small enterprises, the “web person” may be expected to be the “jack of all trades”, developing active content (such as shooting the company picnic), editing the video, and then uploading a several page feature section to the company web site. Large enterprises are more highly specialized, so it is unlikely that the videographer would also develop the Web page and load it on the server. The appropriate level of program detail can only be developed through close relationships with local employers.

Ability to use off the shelf software, code Web languages, and administer Web servers are the top three, and the suite of skills attendant to content integration and Web databases are also strongly emphasized.

Data Base Design and Development percent view	
	Legend: 1. Data base user interface 2. Work with data classes 3. Specify back-end connectivity 4. SQL 5. Optimize data base performance 6. Research technical information 7. Train users 8. Develop documentation 9. Test/debug/maintain data base 10. Ensure data security

Data Base Design and Development Differential view	
	No part of data base design and development is unimportant, and the industry responses bear this out. With the proliferation of databases in every sector of commerce, it is not surprising that ensuring security would receive the greatest emphasis. Other areas include: ○ Testing, debugging, maintaining ○ Performance optimization ○ SQL ○ Development of user interfaces

Discussions about skills and employer needs would be moot if there were no expectation of jobs for students after graduation.

Approximately 8% average annual growth in demand for IT workers is far from stagnation, and while off shoring has impacted some IT jobs, industry is fairly consistent in their desire for a bigger pool of qualified IT workers here in the US. This said, IT delivered on its promises of scalability and efficiency, and it's precisely because IT solutions are scalable that growth in Information and Communications Technology solutions does not result in proportionally increased demand for IT workers.* As IT jobs have been "pushed out" to virtually all economic sectors, the need for skilled and able workers is very strong. For virtually all IT - dependent enterprises, IT is not a luxury, it's a vital necessity. Few businesses could step back even if they wanted to, so thoroughly have converged technologies integrated and enabled all business functions.

Contrast this with the current state of health occupations. Even with advanced technical equipment, most patient services are not very scalable. For a given grade of service, more patients means more nurses, assistants, orderlies, clerks, and even doctors. So, as the demand for health care services increases, so does the demand for health care workers. Technology, despite its contribution to medicine, has not leveraged the health care worker, even in the data side of the business, to anything like the extent it has leveraged the "knowledge worker" in business and commerce.

Even though increased demand for IT services does not create a proportional increase in the need for workers, there are jobs and almost all regions of the US will see continual job growth. One persistent problem is that many employment forecasts and demand measures lack sufficient granularity for educational program planning purposes. We know what a surgical technician does; we know what a carpenter does; we can forecast the demand for both in a straightforward manner. But, what does a Web Developer do? The role is very different in a large commercial enterprise than a small office. A person with the same title may have a very broad role in one type of firm and

* The demand for IT workers can develop more like a series of steps than a straight line.

a very narrow role in another. While it's possible to count the number of openings, translating that number into programmatic recommendations for schools can be problematic.

DOL and BLS Data

The US Department of Labor Bureau of Labor Statistics provides some useful information, however the BLS still tends to look at "smokestack" jobs, which means they look at job *titles* rather than job *roles*. In IT and many other technologies, this is very important for two reasons: First, as suggested, the job of "web developer' may be very specialized in a large enterprise, and much more generalized (in fact a specialist wouldn't survive) in a small concern; Second, IT skills pervade many other occupations – business and finance for example – and the BLS data lacks sufficient granularity to detect and quantify the IT jobs (people hired largely for their IT skills) in non-IT sectors (construction or entertainment, for example) with consistency and reliability.

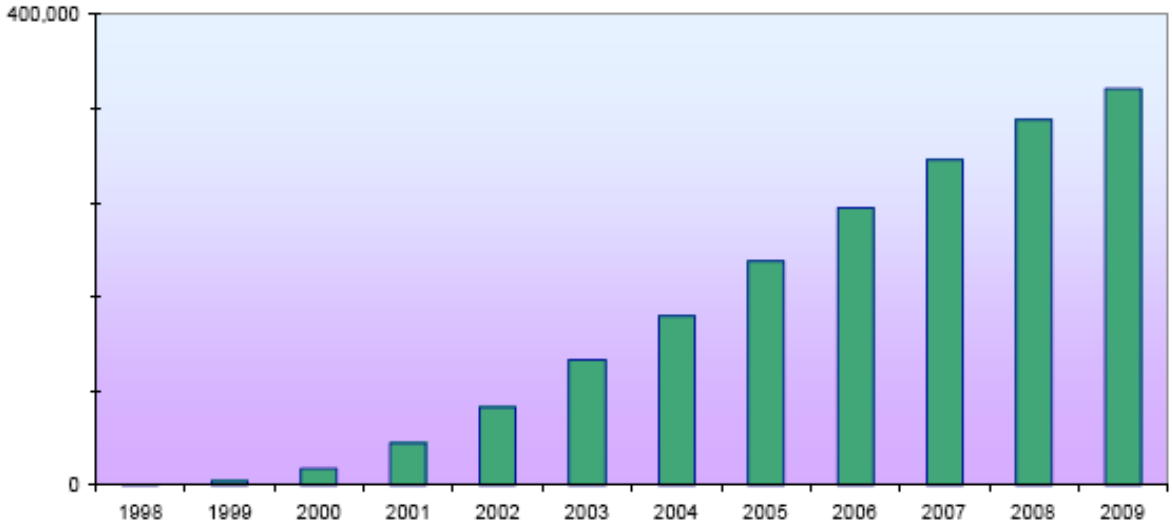
To illustrate issues raised by BLS (and other flat file) data, consider the cable TV 'installer'. In the days of analog video this job was well defined. With cable companies now offering a smorgasbord of digital services from broadband data to voice to video, and supplementary services (home security, remote access), and value-added marketing bundles like family cell phone plans, the old 'installer' now has a far different role: he or she has to make sure all these services work properly and that the customer understands them. The premises technician (as they are now known) must also "sell up" – that is, offer additional services such as cell phones or home alarms, while installing the TV service. As video shifts from vendor - proprietary technology to IP (Internet Protocol), the cable installer of tomorrow will essentially be an IT technician with good problem solving capabilities and excellent customer sales, customer service and on-site training skills, who knows how to string wire when necessary. In this example, the even a new job title doesn't begin to fully describe the emerging the job *role.*

We hear the same thing from wireline carriers. Typically, the job of the customer premises technician was to provide dial tone to "the wall" – the service demarcation point on a building. Prior to 1983 these people only entered a premises to make sure dial tone was heard on the phone. Since 1983, that has been the customer responsibility. Now, the wireline carriers (mainly the former RBOCs -- Regional Bell Operating Companies) compete with cable and satellite TV, offering voice,

video, data, and other services via DSL (Digital Subscriber Line) or fiber to the home. These technicians must also now be able to make sure all the services are operating to the customer's satisfaction, and will also be called upon to "up-sell" services (such as bundling a cell phone or home security system) into the installation package just like their counterparts in cable. DSL service too is essentially a digital data stream, so in this instance also, the job *role* has morphed into that of an IT technician with great problem solving ability and customer service skills. *

Considering the projected growth forecast by both the cable TV and telephone companies for broadband access alone it seems safe to predict the demand for appropriately skilled technicians will grow commensurately even though the BLS says demand for "telephone line installers" will decline. It's about job *roles*, not jobs!

(Global Brodband demand X 000,000)



Source: Juniper Research

* The only way to find this out from employers is to ask them. Comcast, Verizon, others define their needs openly enough but none of their demand information finds its way into BLS data on job growth because it can't be categorized easily within the existing framework. "All Other" is one of the most populated categories.

With this primer, we can look at some BLS data on IT careers. Here are BLS projections for the 8 IT career clusters as identified by NWCET:

Career Cluster	Growth Prediction	Education Level
Database Design and Administration	Much faster than average	AA / BA-BS
Digital Media (Desktop Publisher)	Faster than average	AA
Enterprise Systems Analysis and Integration (Systems Administrator)	Much faster than average	BS or above
Network Design and Administration (Data communications)	Much faster than average	AA / BA-BS/M EE
Programmer	Faster than average	AA / BS
Technical support (help desk / information clerk)	Decline	Certificate or AA
Technical writing / technical trainer	About average	BS + Experience
Web development and Administration	Faster than average	AA / BA-BS

This is a partial list of job roles subsumed under each of the eight NWCET career clusters:

Job roles with * require Associate's Degree or lower to start.

Career Cluster	Representative Job Role
Database Design and Administration	• Database Administrator* • Database Developer • Database Manager* • Data Modeler • Decision Support Specialist*
Digital Media (Desktop Publisher)	• Content Developer* • Writer • Author* • Web specialist* • Creative designer*
Enterprise Systems Analysis and Integration (Systems Administrator)	• Systems Administrator* • Applications Architect • E-commerce / E-business • Systems Integrator • Project Manager
Network Design and Administration (Data communications)	• Network Administrator* • Network Analyst • Network security specialist* • Network Technician*
Programmer	• Programmer* • Software Architect • Coder* • Software Tester* • Software Developer • Programmer / Analyst
Technical support (help desk / information clerk)	• Call Center Staff* • Help Desk Technician* • P C / Desktop Support*
Technical writing / technical trainer	• Content Creator / Manager* • Technical Editor • Instructional Designer • Trainer* • Document Specialist*
Web development and Administration	• Web Administrator* • Web Developer* • Site Designer* • Web Architect • Webmaster*

The BLS provides the following information on fastest *growing* (growth rate, not most jobs) occupations for the five-year period from 2004 – 2009:

Bachelor degree

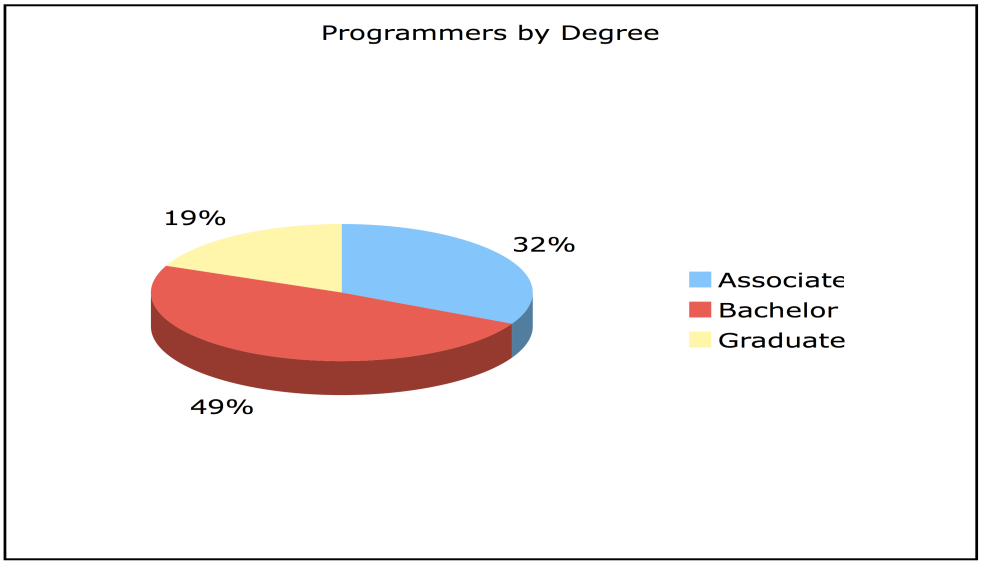
- Network systems and data communications analysts
- Elementary school teachers, except special education
- Physician assistants Accountants and auditors
- Computer software engineers, applications computer software engineers, applications
- Computer software engineers, systems software computer systems analysts
- Network and computer systems administrators
- Secondary school teachers, except special and vocational education

Associate degree

- Physical therapist assistants, registered nurses
- Dental hygienists, computer support specialists
- Forensic science technicians, dental hygienists
- Veterinary technologists and technicians
- Paralegals and legal assistants
- Diagnostic medical instrument operators
- Medical records and health information technicians

Note that although only Network Administration is in the Associates Degree category, this data is about growth rate, not overall growth. Some of the IT jobs making the fastest rate list are in software design at the Bachelor's degree level, and one might be tempted to conclude that future software jobs will require Bachelor's degrees. Not true, according to other BLS data. One third of all persons employed as computer programmers (not coders or testers) have an Associate's Degree.

Programming Employment by Maximum Degree Attainment



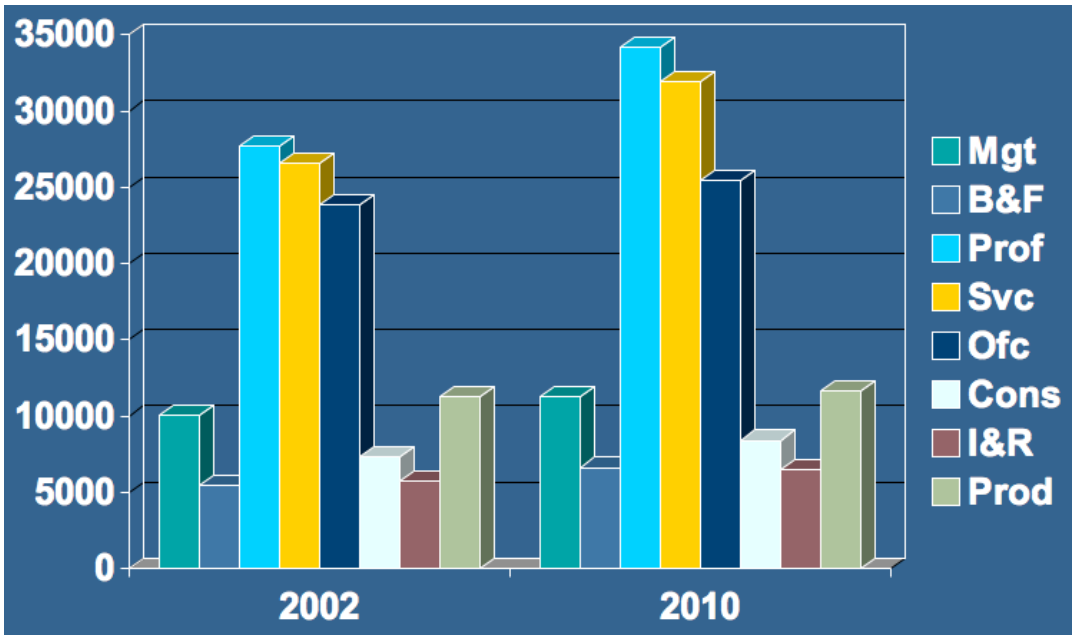
Source: BLS

There is an underlying assumption that workplace changes we observe somehow translate into changes in supersector employment. The following chart shows this is not true. The economy, in terms of super sectors, will change little in terms of sector activity and emphasis according to BLS. In particular, note the I&R supersector (Information Technology and Related Services) is forecasted to grow relatively more slowly than Finance, Business support, and Services. (This is neither bad, new, nor unexpected. And, we don't want everyone to prepare for careers as burger flippers just because it's a high growth rate job.)

What this means is that most of the growth in IT hiring and employment will come from IT dependent sectors rather than IT producing sectors:

- Banking and Finance
- Business support services
- Services sector

and from emerging technologies – bio technology, smart energy, and data driven services such as RFID and GIS.



There will be very little change in the relative size of economic supersectors in the foreseeable future. While this may be bad news for revolutionaries, it is good news from an evolutionary perspective. Not illustrated by charts of this type is the large number of IT workers used in Business and Finance, Professional Services, and Office Work. We reiterate, as other economic sectors become IT dependent, IT jobs will increasingly be found in those sectors as well.

Technician and technologist employment outlook

We are encouraged not only by general employment trends in IT but also by specific data that indicates robust job growth in micro sectors that generate openings and opportunities for technicians.

A study done by Robert Half[15] in June, 2006 asked CIOs which job areas were experiencing the most growth in their organizations. 55% of the job growth --areas such as Help Desk, Networking, Database, and Security – are in areas that offer significant opportunities for technicians and technologists.

[15] *Where are the Hot Jobs?* Robert Half & Associates, Inc.

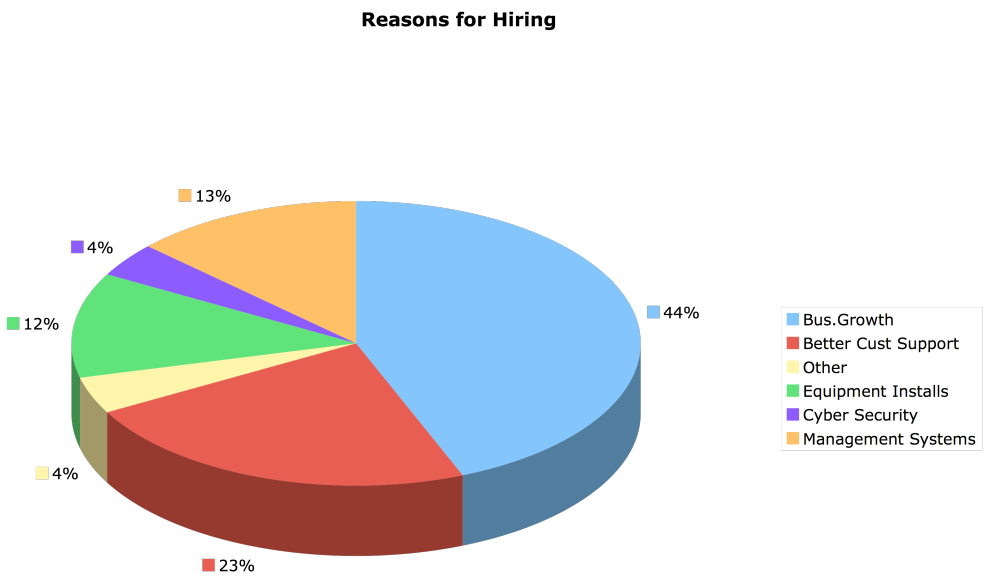
In another study performed about the same time, Robert Half found that 15% of firms surveyed expected to add IT staff during the second half of 2006 while only 4% expected to decrease IT staffing. The remaining respondents expected to maintain about the same level of IT staffing.

We can find confirmation of these national trends in Massachusetts economic development forecast data. The following table forecasts almost 12% growth in employment in the Information supersector through 2014, and an almost 20% increase in employment in professional and business services – heavy users of Information and Communications Technology. Today's students, if properly educated and skilled, will have jobs – over ten thousand by 2014 in the Information supersector alone.

Industry Sector	2004 Jobs	2014 Jobs	New Jobs	Growth Rate
Total, nonfarm wage and salary	3,181,120	3,428,330	247,210	7.8%
Natural Resources and mining	1,900	1,810	-90	-4.7%
Construction	138,400	134,480	-3,920	-2.8%
Manufacturing	312,930	281,210	-31,720	-10.1%
Trade, Transportation, and Utilities	572,110	597,510	25,400	4.4%
Information	87,440	97,820	10,380	11.9%
Financial Activities	219,730	230,590	10,698	4.9%
Professional and Business Services	451,080	538,190	87,110	19.3%
Educational and Health Services	582,210	676,660	94,450	16.2%
Leisure and Hospitality	290,800	325,450	34,650	11.9%
Other Services	116,820	128,230	11,410	9.8%
Government	407,700	416,380	8,680	2.1%

Source: Mass Economic Development Data through BLS

In the course of our workforce research for clients across the US, we asked hiring authorities to rank the principal reasons for adding staff. The following chart shows their responses:



We interpret the 44% response for Business Growth and the 23% response for increased need for customer support as very positive indications of a healthy demand for IT workers in general. It is important to remember these responses come from IT hiring authorities in a wide array of IT-enabled and IT dependent businesses, not primarily from IT producers.

We looked at the Boston region and the BATEC 'footprint', to get some sense of the future demand for IT workers at the technical level. Boston's currently low unemployment rate (under 5%) is generally good news. Furthermore, the Boston region shows robust employment in terms of absolute numbers:

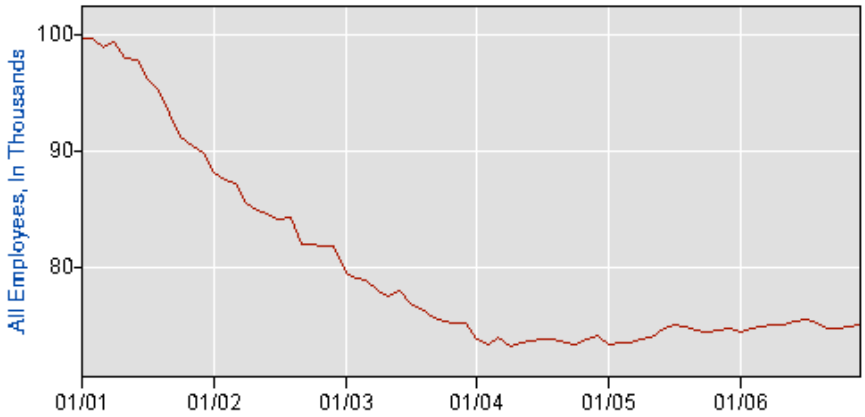
Employment in IT-enabled economic sectors

Sector	2005 Employment
Trade, transportation and utilities	424,100
Information	72,800
Finance	182,800
Professional services	374,200

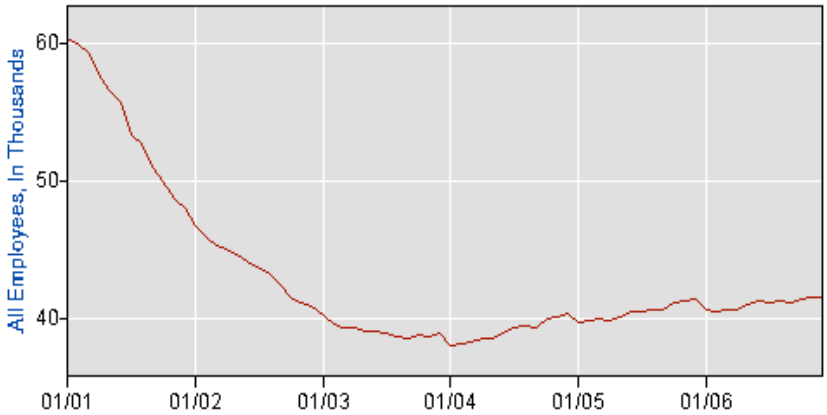
While there is no precise formula for extrapolating the number of IT jobs from overall employment figures, as stated previously, IT is so thoroughly embedded in the activities of these sectors that it is reasonable to suggest that growth in these sectors will create IT technical jobs.

We will temper our enthusiasm by noting that the Boston MSA has lost jobs in the Information and Professional and Business Services supersectors from 2001 through 2005. However these declines are less than in manufacturing, and data from late 2005 to present suggests that the trends hinted at on the very right hand sides of both charts do indeed appear to be upward.

Series Id: SMU25716505000000001
Not Seasonally Adjusted
State: Massachusetts
Area: Boston-Cambridge-Quincy, MA-NH NECTA
Supersector: Information
Industry: Information
Data Type: All Employees, In Thousands

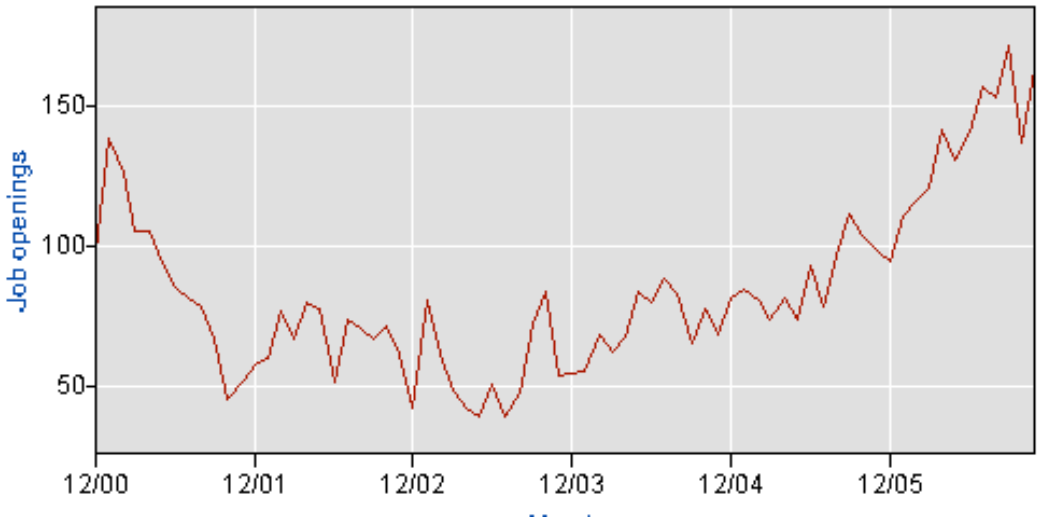


Series Id: SMU25716506054150001
Not Seasonally Adjusted
State: Massachusetts
Area: Boston-Cambridge-Quincy, MA-NH NECTA
Supersector: Professional and Business Services
Industry: Computer Systems Design and Related Services
Data Type: All Employees, In Thousands



Source: BLS

Series Id: JTU51000000JOL (9)
Not seasonally adjusted
Industry: Information
Region: Total US
Data Element: Job openings
Rate/Level: Level - In Thousands



For the US as a whole, employment in the Information supersector shows robust growth, surpassing the level of the year 2000. This correlates well with the continuing spread of IT into business, finance, and professional services sectors as well as health and education. When applied to the Boston major economic sector data, and when considered in aggregate, all the employment data, whether national or regional, conservatively suggests sufficient business and job growth to invest in IT technician program development.

We think there is limited value to attempting to forecast the future passively by analyzing data from the past. These practices have tried to make us understand and accept terms like “jobless recovery” or “jobloss recovery” where jobs are lost and hopes dashed while the economic indicators show positive gains. In post secondary education, especially for technicians and technologists, we are always talking about proximal things: real people and local or regional jobs within 2-5 year timeframes. The people who attend community colleges and the universities that offer applied baccalaureates live on Main Street, not Wall Street.

How will the future be different?

The information driven workplace creates value more through intangible assets than tangible ones. This is the essence of the argument that workers who increase the value of intellectual capital are considered more valuable than those who do not. Most of the physical productivity gains from deployment of IT have been realized – IT is everywhere – the game is now one of making employees more productive by leveraging information to the benefit of the enterprise.

Furthermore, increasing productivity on the physical level (automation, faster machines, etc.) provide short-lived competitive advantages. All enterprises quickly adopt new methodology or face extinction. Take semiconductor manufacturing for example. Any and all manufacturers must respond to each breakthrough in speed, density or yield almost instantaneously. It's the same in almost every field.

McKinsey* postulates that as firms strive to leverage IT to increase the value of intellectual capital (deploying CRM or supply chain tools, for example) more employees are now engaging in "tacit" interactions rather than transactional interactions. Tacit interactions are by their nature more complex, like managing a supply chain, than transactional (maintaining shipping and receiving records). McKinsey notes that these tacit interactions demand judgment, a high level of comfort with ambiguity, and good communication skills because tacit interactions by their nature can have high impact on the organization. This is yet another reason why employability skills are strongly demanded by our study respondents.

It is important to know that tacit interactions are so named because although they may be performed without explicit orders, their impact on an organization may be very great. Consider the decisions made every day in the back office of an airline. The tools of IT enable real time decisions on fuel load, maintenance, aircraft type and routing, and the like – all of which determine whether a flight is profitable or not. Even ticket pricing strategy (time of day, day of week, time of year) are constantly analyzed and adjusted. It's the IT-dependent back office that truly determines profit and loss.

* McKinsey Reports

Inevitably we will see the continued decline of rigid hierarchies in technology enabled and technology dependent organizations. They may be comfortable for managers, but they are deathly inefficient when viewed from the perspective of leveraging information and the tools of IT to increase the value of intellectual capital.

Our research with employers across the country supports what McKinsey and other researchers have found. Smaller organizations especially look for IT personnel who can prioritize and re-prioritize according to changing demands. They also look for "grace under pressure" – the ability to maintain a calm and professional demeanor despite circumstances. A common lament is the lack of "work ethic". Research performed by NWCET[16] found that in many cases, when employers ask for a baccalaureate degree (when the technical demands of the job can be done by a two-year graduate) it is because they feel that university graduates have had more exposure higher quality problems (long-term and real-world), have had to persist longer in completing assignments, have had to work in teams, perform research, and communicate to both develop and to present a solution. This list is remarkably similar to the employability skills enumerated by our respondents.

We interpret this as an opportunity for community colleges to examine learning activities and assessment strategies with the goal of producing student outcomes more consistent with the employability skills so clearly stated by industry.

[16] Upper Division Skill Standards Project. www.nwcet.org

Conclusions And Recommendations

This section relates the quantitative and qualitative data gathered from industry and other sources. The organization is derived in part from recurrence of major issues as heard in numerous prior focus groups in other regions. In this section we also provide insights based on experience and observation.

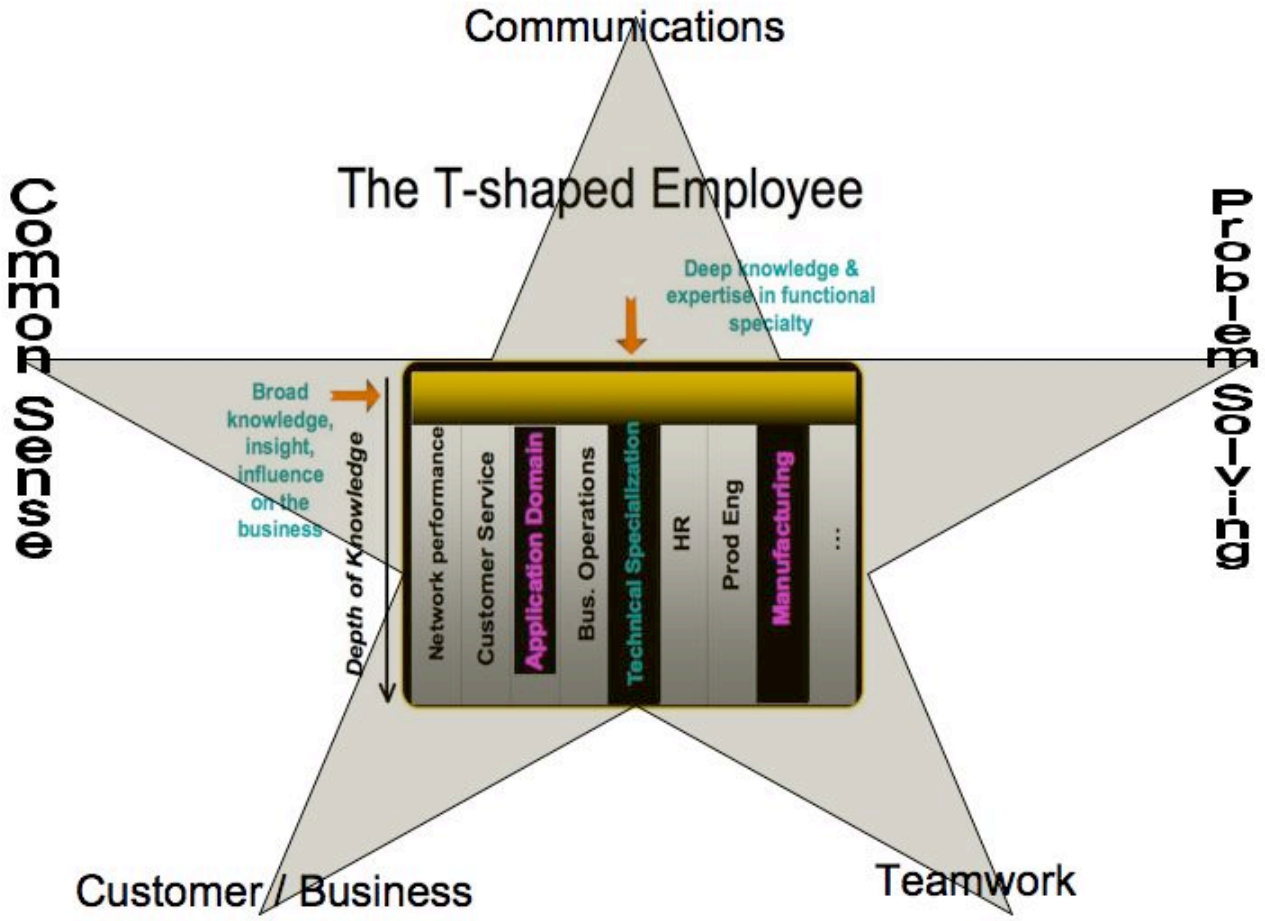
Value Proposition

It is absolutely essential that community colleges and partner universities set strategic goals to improve the value proposition offered to employers by technicians and technologists, and to make certain industry and other stakeholders all recognize this value in the workforce.

Much of this report has reiterated the need for breadth as well as depth. Increasingly, employers say they need applicants with skill in more than one technical area. Examples might be: web and database, or networking and customer service. Complimentary skills begin to allow the type of leverage employers say they want. This makes sense in view of the large amount of IT work performed in non-IT concerns. While a large bank may have a sufficiently large department to allow for specialization, much of the job growth (in all sectors) comes from employers with fewer than 500 employees. In these cases, many workers, not just IT, wear more than one hat. Intel Corporation described a technician with depth in a technical area and complimentary depth ("T Shaped") in a related area in 2004.[17]

As a very large firm and an IT producer, the "T shaped" employee may be adequate for the Intels of the world. However, many employers and virtually all in the IT-dependent sectors, suggest this isn't enough. What this report shows is that in addition to technical depth in more than one area, employees also need a suite of employability skills. It's not an "either-or" situation, but one of "both-and". The following diagram attempts to portray this type of worker – the "star" employee, possessing technical depth in more than one technical area and also possessing employability skills as discussed herein.

[17] The "T Shaped" worker was described in a presentation by Doug Bush of Intel at Synergy 2004 at Nashville State Community College in the context of Intel's perception of the shortcomings of US technology graduates compared to foreign workers.



Are we asking too much of our schools and our students? The point is moot, since business believes not enough is being asked, and by inference as well as by observable acts, is willing to make other arrangements to get the workforce it needs.

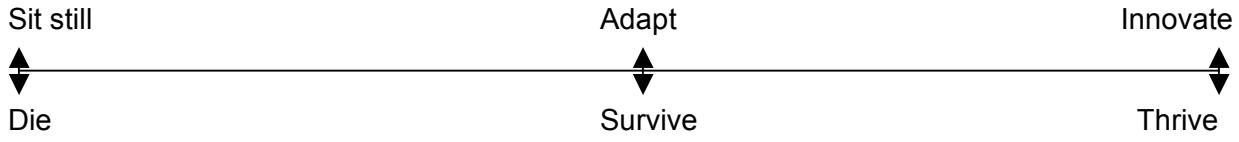
One thing is clear – we cannot teach course-by-course in traditional lecture mode and also develop these traits and characteristics in students, at least not within current constraints. This situation demands that we look at the process of teaching and learning differently. In particular we

recommend a more output-focused model that replaces seat time with performance. Under this type of arrangement, students could be given credit for several courses upon successful completion of industry-derived problem based and case based learning activities that satisfied the outcomes of traditional courses. We often balk at making necessary changes because of the bureaucratic problems involved with course descriptions, catalogs, and curriculum committees. Leave all that alone, and concentrate on learning activities first. We're suggesting nothing revolutionary. We're suggesting the time honored graduate school model of problem-based instruction with applied outcomes be adopted for technological education to provide a continuum of technological education from secondary school through community college to university. Such a model also honors the large majority of learners who are bored and frustrated by the part-to-whole approach (so much a part of traditional education) and who would respond much better to the whole-to-part approach that has made some of America's top graduate schools the envy of the world.

Risk, Innovation, and Change Management

In his book *Serious Play*, MIT Media Lab Fellow Michael Schrage postulates that we 'first make models, then the models make us". Successful innovators never talk of specifications – they talk first of models. We suggest there is a large take-away for educators here. If we continue as we have traditionally, to focus on courses, credits, and bits of content, we focus on specifications. We need to encourage those who would first focus on the model – a program that produces technicians or technologists that industry wants to hire.

One of the few sources of "risk capital", funding needed for innovation, comes from the Advanced Technological Education program of the National Science Foundation – the primary source of BATEC's support. We believe with additional support from the state, the innovative work of BATEC could be leveraged not only within its current footprint but also throughout the state. We acknowledge that educators are a risk-averse group, but for a variety of reasons, incentives to innovate have been few. This needs to change. There is a well-worn illustration from industry that portrays the necessity for innovation and we present it here for its possible value to educators:



To be sure, innovation and change have attendant risks. But so does sitting still. Change management involves getting stakeholders to accept that the rewards of success are greater than the risks associated with change, and that there is no safety in standing still, no matter how solid the tenure or how strong the union. In the end, if there is insufficient enrollment, programs will close and teachers will have no work. That is the likely outcome of failure to act – and it's not just in Massachusetts. Community colleges and even universities across the country are facing the issue of declining enrollment in technology programs, even as industry says they need workers.

A useful approach would include appropriate stakeholders meeting with the legislature, especially those involved with education funding, to find common ground on which to approach this issue. Many of these are already under way as BATEC initiatives, but could be amplified and brought to scale with additional support and attention:

- Ensuring all high school students are IT Literate upon graduation
- Providing support for post-secondary faculty to initiate and sustain high quality relationships with industry and employers
- Providing support to help develop problem based case based instructional methods and to ensure faculty receive necessary coaching and support to employ these methods
- Developing high level program outcomes for post secondary technical programs that can be met by a variety of methods, from traditional course-by-course to full case-based instruction
- Parsing high level program outcomes downward to their corresponding catalog courses to develop course equivalencies for case based modules, courses or full programs
- Encourage and offer applied baccalaureate degrees that allow technicians and technologists to acquire additional technical, analytical, and management skills to continue to offer value to employers

We are unabashedly supportive of applied baccalaureates. University of Phoenix, has developed a thriving and very successful business in baccalaureate completion.

Apollo Group, parent of University of Phoenix has built a $2.5 Billion dollar business as the largest private group of colleges in the US. Phoenix alone has seen average 11% enrollment growth every year for the past 5 years, and now enrolls over 200,000 students, approximately 135,000 of which are completing IT and business related baccalaureates and masters degrees.

This is not the forum to analyze Phoenix's strategies or competence. It's enough to know that Fortune 500 firms pay millions to educate (up-skill) their workforce at UP and similar schools. We must assume they're not thoughtlessly wasting their money or providing a gratuitous benefit to workers. While we neither praise nor condemn UP or its sisters, we commend for practical consideration the fact that they have successfully pursued a business opportunity that most publicly funded universities have consistently ignored. They are open door, as are most community colleges. They take people from where they are and help them get where they want to go, efficiently and effectively. A study performed in 2002[18] showed that major firms whose employees completed baccalaureates at schools like UP did not discriminate in assignment or promotion with regard to whether a worker had a baccalaureate from schools like UP or a traditional institution.

Marketing – Program Perception – Target Audience

The abundance of world-class research universities and prestigious old-line colleges tends to overshadow sub baccalaureate education and institutions in Massachusetts. The attention given to research institutions and the high-technology companies they may spawn tends to make workforce preparation appear pedestrian. Without taking away the well deserved accolades of the Boston area's many fine top-tier schools, we believe that it is necessary to find ways to ensure that the important contributions technicians and technologists make to the region's economy are highlighted and celebrated to a greater extent than they are currently. As is the case in other regions, Boston area employers hire technicians, but do not perceive the community colleges as integral partners in their workforce preparation strategies or as critical components in the supply of trained workers. They are perceived more as vendors than co-developers. We therefore recommend that serious attention be given to the image and position of the region's community colleges.

[18] Internal marketing study performed by a major UP competitor and confirmed by research conducted by NWCET.

It may be constructive to consider effective marketing as the complimentary action of two forces: *push* (advertising, recruitment) and *pull* (mind-share, desire, endorsements). Many community colleges engage in conventional push marketing using billboards, bus placards, start of semester media ads, catalog mailings, recruiting from feeder institutions) with erratic results. Push marketing behaves much more like an expense than an investment. Far less frequently, community colleges develop ways to utilize pull marketing, where the college becomes the natural "go-to" choice. Pull marketing behaves more like an investment -- once established; pull marketing continues to pay dividends.

It was Doc Searles (www.searlsgroup.com) who said. "Marketing is fire. Conversation is arson." Despite the possibly grim analogy, for organizations with limited resources to devote to marketing, investment is a far wiser choice than expense, and taking a strategic view of determining what conversations the institution needs to be a part of and how to join those conversations is the key to establishing the mind-share (fire) that is vital to pull marketing.

Although BATEC has been addressing the serious knowledge gaps on the part of industry regarding the perception of the technical education in general and community colleges in particular, many stakeholders in BATEC's orbit still may not fully appreciate community colleges. Since it appears many employers are not thinking of community colleges as essential partners in their workforce development, then, they're not *talking* about them either – community colleges are not part of their conversation. Therefore we recommend that the substantial work to build and sustain the industry relationships continue to be leveraged to increase mind-share. By providing this list we do not want to imply that BATEC and its stakeholders may not already be doing some of these things. We encourage a coherent and strategic approach that enables BATEC to derive maximum benefit from all these activities:

- Attend and support industry meetings and functions whenever possible
- Join professional organizations (software alliances, etc.) and attend meetings
- Collaborate with employers and other stakeholders on legislative matters of mutual benefit
- Ensure employers are aware of and participate in the development and delivery of credit programs and courses as well as non-credit training and skill building for incumbent workers.

- Actively exploit opportunities to speak at meetings and events
- Utilize the PR and community relations offices of 4-year partners to help spread the message
- Work with local media to gain exposure
- Provide release time and other incentives to increase faculty involvement with local employers for the expressed purpose of informing program development and building community
- Open and maintain dialog with former graduates and alumni
- Use multi-level approaches that involve campus administrators and executives in dialog with their corresponding level in industry.
- Encourage and sustain involvement with local employers in support of community based initiatives to develop workforce
- Utilize industry as stakeholders in applying for Federal and local grants to develop workforce.

Student Populations

With regard to program recruiting and promotion to boost enrollment, it may be helpful segment marketing and messaging so it is more specific to the main segments of community college students:

- Recent high school graduates
- Late bloomers
- Mature adults
- Women, minorities, special populations

With the proviso that all generalizations are inaccurate, here are some identifiable characteristics that differentiate the three groups.

Recent high school graduates are in their late teens or early twenties. The community college may be their first experience with higher education, or some within this group may have had a semester at a 4-year university and returned to community college because they lack social maturity or essential academic skills to succeed in university. These students often declare intent to transfer but may often leave after they acquire some salable skills. These persons are very sensitive to

peer pressure, and may make life-affecting decisions on the basis of scanty or ephemeral inputs. This group also includes university graduates who find themselves unemployable without salable skills. BATEC's unique constituency and its ability to span the distance from secondary school to UMB should be leveraged to focus otherwise goal-diffused secondary school students on the possibility of a technical career that includes the ultimate (if distal) goal of baccalaureate completion.

Late bloomers have a mean age of 29 – 32 and are often the most populous subset of community college enrollees. From a variety of backgrounds, these persons find their responsibilities or lifestyles have outstripped their earning power, or they may be aware of circumstances in their career field that affect future security or employment outlook. They return to community college on what they hope will be a short path to a bigger paycheck or greater job security. They may know little about the details or demands of higher paying careers, but recognize that their current path looks more and more like a dead end. These students have the advantage of maturity and motivation. Few, however, are able to be full-time students. They seek proximate benefit and relevance for everything they do in school.

Mature adults share some characteristics with late bloomers except the age mean is in the mid-40s. These folks often find their career path ended, possibly with little warning, as a result of technology, outsourcing, downsizing, or consolidation. They often have skills, certificates, or other education up to and including college or advanced degrees. They may need the least in terms of employability skills development, but may also have missed opportunities to acquire essential non-technical skills and that may in part be responsible for their need to re-career.

As open door institutions, community colleges have been uniquely positioned to include women, minorities, and special populations in workforce development. Special attention to encouraging women to investigate technical careers, for example, can increase enrollment in technology programs and help improve the diversity of the technology workforce.

The needs and goals of these different populations must be set in relationship to the offerings of BATEC partner community colleges and universities that include courses, programs, institutional

certificates, vendor certificates, vendor-neutral certificates, applied degrees, transfer options, credit for prior learning and experience, and opportunities for skill building or retraining.

Effective marketing should include messages that resonate with the needs of the major target audiences and clear pathways that show potential students how their goals will be met by the community college.

Also needed is a better understanding of past and current students enrolled:

- A thorough analysis on each campus should be undertaken to understand factors bearing on all the following:
    - Recruitment
    - Retention
    - Persistence / Attainment
    - Prior educational history
    - Instructional intent

What happened to students who completed a program? What happened to those who did not? Why did dropouts drop? What could entice them to come back and finish? What is the satisfaction level of students with courses and programs? How satisfied are employers with students who seek or find employment?

Most post secondary schools cannot answer these questions. While we are not in favor of colleges 'acting like businesses' we must stress that any business that fails to conduct market research and to gather customer satisfaction data is on the road to ruin.

Program Structure

For the purposes of initiating case study instruction or ultimately transitioning to a case-based model, it is useful to maintain a relationship to the corresponding course-driven traditional program model. Industry ranking of most important content areas was mapped proportionately into four semesters (using standard ratios for lecture/lab and hour/credit equivalencies) to build a generic two-year general IT program.

Sample 2-year IT program – prepares for work or transfer to applied baccalaureate.

Course	Lect. Units	Lab Units	Total Units	Hrs	Strand	%
Computer Literacy	3.0	1.0	3.5	2.9	Office Tech	5%
Bus Comms 1	5.0		5	4.2	Bus Non Tec	7%
Bus Org/Cust Svc	3.0		3	2.5	Bus Non Tec	4%
Case Study	5.0		5	4.2	Bus Non Tec	7%
Bus Elective	3.0		3	2.5	Bus Non Tec	4%
Cert elect 1		2.0	1	0.8	Cert	1%
Cert elect 2		2.0	1	0.8	Cert	1%
Cisco CCNA		2.0	1	0.8	Certification	1%
Intro to Network	3.0	1.0	3.5	2.9	Networking	5%
Network Admin	3.0	1.0	3.5	2.9	Networking	5%
Advanced Network	4.0	2.0	5	4.2	Networking	7%
Int to logic syst	5.0		5	4.2	PGM/ComSci	7%
High Level Pgm Lang	5.0		5	4.2	PGM/ComSci	7%
Network Security	2.0	3.0	3.5	2.9	Security	5%
Intro to Web	2.0	2.0	3	2.5	Web/Mult	4%
Web Pgmg	2.0	2.0	3	2.5	Web/Mult	4%
Int to Web D B A	3.0		3	2.5	Web/Mult	4%
Wireless Princpls	2.0	2.0	3	2.5	Wireless	4%
			60	50.0		100%
Basic Office	17%		10.2	12.24	**Gen Ed Opt.**	**Units**
Networking	13%		7.8	9.36	Eng Comp	3.0
PGM/ Comp Sci	14%		8.4	10.08	Math	5.0
Security	7%		4.2	5.04	Speech	3.0
Wireless	7%		4.2	5.04	Psy of work	3.0
Certification	3%		1.8	2.16	Fund Econ	4.0
Bus. Non-Tech	23%		13.8	16.56	Tot Xfr Gen Ed	18.0
Web / Multi-Med	16%		9.6	11.52		**Hrs.**
	100%		60	72	**50+22=72**	22.0

It is possible both to develop high-level outcomes for these courses that could map to case based equivalencies, or going the other way; to map high level program outcomes back to these traditional courses. But this model is also useful to build an *outcomes based articulation* to an applied baccalaureate. Such a model could, in addition to problem or case based learning activities, accommodate certifications, corporate training, and challenge as alternatives to traditional seat time.

A high level outcome is specific in terms of student behavior and outcomes. One effective way to write high-level outcomes is to use a "by-or-through" statement. This allows faculty and institutions to determine if student work done in one way at one school is comparable to student work at another institution.

Poorly written outcome:
The student will write a program in C language that prints to the printer.

Better high-level outcome:
Using include, get, rnd, compare, and print(f) functions the student will compile and demonstrate user interfaces ***by*** *demonstrating a C language program that gets user input (whole number) from a keyboard, compares it to a program generated random integer, and outputs the mathematical whole number difference to a system connected printer.*

The mission here is to avoid arguments over whether students who do this as a project are better or worse than those who sit in a programming lecture. The only questions are: Did the student meet the outcome or not, and is the outcome assessable so as to reveal the student's real capabilities?

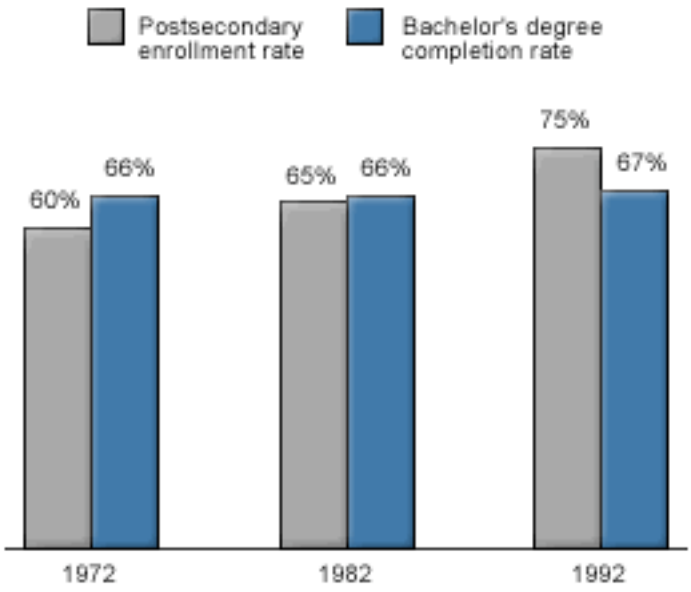
In this manner it may be possible to offer transfer and non-transfer IT courses up to and including a comprehensive applied IT major within current credit envelopes for various credentialing options. One method for not unduly lengthening the program would be to exchange content areas, for instance exchanging 15 technical units for 15 Gen. Ed. Transfer to make a transfer Web Design program that could articulate to a BFA (Bachelor of Fine Arts) using traditional course-by-course, or BT (Bachelor of Technology) using a combination of cases, certifications and challenges. This is important because a substantial number of potential upper division students could be enrolled in an applied baccalaureate using this pathway.

The content proportions were loosely derived from the industry focus groups, but are very flexible also so long as outcomes consistent with those knowledge, skills, and attributes expressed by industry are achieved.

Course / Content Sharing

We believe in localization and abhor the notion that schools should become like fast food with a uniform product from coast to coast. However, BATEC (as a nexus) should examine the possibility of building on the strengths of the individual partners and constituents to support IT offerings throughout its "footprint". Following Metcalf's law, BATEC will increase its value as the number of nodes with which it connects increases. Some schools have difficulty generating sufficient enrollment to operate all the required courses necessary for a degree or certificate. With a well developed statewide electronic infrastructure, BATEC may find that pursuing development of distance and online options may be an efficient way of promoting courses and ensuring student success especially if technicians even at a distance like Western Massachusetts could complete an applied baccalaureate through UMB.

Persistence is a major challenge for community colleges, and community colleges are often criticized unjustly for poor completion rates. There are few studies on persistence and attainment of students in community colleges and fewer still that are useful for professional technical programs. Those studies that have been published by the National Center for Education Statistics are oriented toward traditional transfer programs and baccalaureate completion. One interesting observation is that while post secondary enrollment has increased consistently, baccalaureate completion rates have remained virtually constant.



Inferentially more baccalaureate students start at community colleges, and many community college graduates are successful without Bachelor's degrees.

One study (Houle, 1993) analyzed data from the mid 1980s and determined that scholastic success prior to entering college and ability to obtain and successfully complete courses were major variables that determined persistence and attainment. Allen (1999) found that motivation and persistence (but not performance) were linked. Braxton et. al. (2000) examined the influence of faculty active-learning practices on student departure decisions in the context of Tinto's Theory of College Student Departure. Path analysis results found that active learning ("class activities that involve students in doing things and thinking about the things they are doing" – Bonwell & Eison, 1991) exerts statistically reliable influences on social integration, subsequent institutional commitment, and intent to return.

The research confirms: 1) prior success in school is a predictor of future success; 2) students will not persist in programs where courses are routinely cancelled and offerings or program requirements change; and 3) students are more committed when they're involved in both doing and thinking.

BATEC's leadership has, and should continue to support development of problem and case-based structure for at least some courses that is universally usable and accepted on any campus. Under this scheme, each campus might share resources, faculty expertise, and contribute other resources to develop the cases. At any rate, we must ensure students have more opportunities to succeed,[19] that ways will always be available for students to progress through the program, and that instructional methods are active, involving, whole-brain, challenging, and rigorous.

Certainly sharing in the development of some instructional elements leading to common outcomes (as desired by industry) could be efficient.

The implications for this type of approach are as follows:

1. Agreement on a common core of introductory courses offered by each institution.
2. Acceptance of an outcomes based framework for course comparison and interchange between the campuses. Individual course numbers, titles, descriptions etc. are not as important in this framework as faculty getting together to agree on course outcomes (including a "by or through" statement) that describes skills, knowledge, attributes, and behaviors desired of completers.
3. Acceptance of standards-based design of outcomes, activities and assessments.
4. Adoption of problem-based case-based modalities that enable sharing of courses and resources among the campuses while preserving to the maximum extent possible individual campus identities and programs.
5. Aggressive pursuit of applied baccalaureate alternatives with willing 4-year partners to preserve the longitudinal value of applied associate degrees.
6. Commitment to attainment for all students that includes guarantees that necessary courses (or equivalencies based on outcomes) will be available in sequence to enable program completion.

[19] It is no accident University of Phoenix's motto is "I can do this".

Without compromising the integrity or individual identities and uniqueness of each campus, the solution nevertheless lies with consistency in marketing, full availability of program offerings (especially scope and sequence) clear value proposition to industry, and career focus and orientation based on job roles rather than titles.

Closing Summary

Employers
We face a paradox in that although businesses of all types are now technology dependent, the demand for workers sometimes appears to not reflect this critical dependency. This is because technology solutions are generally scalable (and thus do not create linear demand increases). Also, because technology can often be sourced globally and because to the extent there is a trade off between capital (equipment) and labor, businesses tend to favor investment in capital, technology work can be sent anyplace in the world to be performed. Employers clearly say they are looking for more than "just skills" so students must demonstrate they can contribute more than "just skills". They must be prepared to offer IT Literacy, context knowledge, business environment knowledge, technical expertise in more than one topic area, and a suite of "employability skills" (communications, problem solving, teamwork, plus business and customer service oriented approach to work).

Regional Economy
With respect to IT employment, the Boston area is truly blessed to have both depth and breadth in both IT-dependent and IT-producing organizations. BATEC is uniquely positioned to develop strategic relationships with these firms and to improve the appreciation of two-year graduates and to help develop interest in applied technological baccalaureates. Holders of these credentials will (and must) possess a blend of applied and theoretical technical knowledge and skills in more than one technology domain, as well as the employability skills referred to herein. With successful relationships in place, BATEC can play a strategic role in regional workforce development, partnering with appropriate agencies and initiatives to attract additional high-tech employers to the region – employers who not only need the research capacity of the many fine top-tier schools but who also need the technicians and technologists to extend the fruits of their research to the market.

Programs
The region's community colleges and UMass Boston have the ingredients and most importantly a shared desire for success. The stakeholders need to make sure all educators develop a common and shared vision of success, and a commitment to the steps to be taken to achieve success. Problem based case based instruction based on industry derived outcomes could be a strategic tool to enable a wide ranging program available through the community colleges and UMB. Analysis of program outcomes could facilitate a variety of completion options suitable to the needs of recent secondary school graduates, late bloomers, those in mid career, and incumbent workers. Baccalaureate pathways improve the appeal of two-year programs. Earning an associate's degree and completing a baccalaureate in residence could be a powerful and unique incentive for students and could be a strong component of a comprehensive marketing plan that targets appropriate populations and positions the community colleges as the "go-to" places for initial employment and career advancement, and enhances the competitiveness of UMass Boston.

Appendix

Workforce Skills Research Guide

Purpose of Research

Unprecedented changes have occurred in the field of technology workforce education and employment over the decade 1995 – 2005. In ten years, a remarkably short period of time, the "third wave"[20] of technology education has come and, to a greater or lesser extent, gone. This third wave was the last instance of technology workforce education predicated by the adding of value to physical capital.

Against a dramatic backdrop of fears about outsourcing and off-shoring, the shift in corporate valuation from measures of physical capital to measures of intellectual capital has redefined the value proposition for employees at every level of the enterprise. Perhaps nowhere has this change been more keenly felt than ICT programs in community colleges, which responded en-masse to industry's stated need for newly trained and re-skilled workers capable of designing and implementing ICT systems based on third-wave technology which business in every sector had to implement immediately if they were not to face annihilation from more tech-savvy competitors.

The large-scale adoption of ICT systems throughout the world and the change in the basis for determining corporate value had two effects: First; information and communications technology became a means (an enabling technology rather than an end in and of itself), and second; global adoption of technology and global sourcing of services turned basic ICT skills into commodities.

At its core, this research will attempt to highlight what major shifts have occurred in technical skills factors affecting the hiring of ICT personnel, and what non technical factors may affect hiring decisions.

In summary, the purpose of the research will be two-fold:

- To determine which (if any) of a set of IT skills are assumed to be required (Core Skills) of any new hire or candidate for promotion,

[20] This terminology has been used by TSI to refer to the shift in content and skills in technology education brought about by widespread use of cheap and readily available microprocessors in computing and embedded systems and the concomitant adoption of shared network, client – server, and web-oriented technologies.

- To determine what employability skills, especially in the area of Adaptive Expertise[21], are desired, to what extent they are found, how they are measured, and how (if at all) they are developed by employers

Scope Of Work

TSI will conduct structured research with selected employers as generally set forth in this document. The research shall consist of gathering data from pre-selected individuals responsible either for line hiring decisions or who establish strategic personnel direction for IT (Information Technology) or ICT (Information and Communications Technology).

Both quantitative and qualitative data will be gathered. Quantitative data will be gathered by means of a Web-based form. Qualitative data will be gathered by capturing comments and vocabulary used during the telephone interview. A unique feature of this data gathering is that the respondent will fill out the Web form while talking with the interviewer. The interviewer will capture comments, questions, and vocabulary from the resulting conversation. The interviewer will use a structured set of questions to elicit responses from the respondent.

Each interview is expected to take approximately one hour. During that time the subject will respond to 20 questions on a web based form while the interviewer records any comments or explanations. Approximately 2 minutes will be allowed for each question. During the remaining 20 minutes, the interviewer will probe for comments according to a predetermined conversation guide, or tree. This free response data will be analyzed for common language and recurring themes which will be reported without specific attribution.

A total of 68 employer interviews will be conducted following the sampling plan.

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[21] Adaptive Expertise is a term originated by Dr. John Bransford (University of Washington) to differentiate between routine expertise (expert practitioners) and theoreticians with no applications knowledge. Adaptive Expertise is thought to provide a nexus of skills resulting in greater workplace productivity and creativity. For more information, see http://www.vanth.org/docs/AdaptiveExpertise.pdf

Sampling Plan

SAMPLING PLAN

INDUSTRY CLUSTER	COMPANY SIZE			
		East	**Central**	**West**
Financial Services	Large	7		
	Small	7		
Insurance Services	Large	7		
	Small	7		
Health Care	Large	5		
	Small	5		
Manufacturing	Large	5		
	Small	7		
ICT (Telephony - Cable – Wireless)	Large	5		
	Small	5		
Software Development	Large	3		
	Small	5		
TOTALS		68		

Total = 68 (1 hr. (nominal) telephone interview, directed data gathering, comment capture)

Size Definitions:
Large: Over 500 Employees
Small: Under 500 Employees

Region Definitions:
East: VA, MD, Washington DC, ME, VT, NH, DE, CT, MA, NJ, NY, RI, PA, and possibly NC, SC, FL.

Examples of Companies by Industry
Financial Services: Bank of America, Washington Mutual, Chase, NYSE, Transamerica
Insurance Services: Prudential, State Farm, AMICA
Health Care: Kaiser, Providence, Health South
Retail: Wal-Mart, Nordstrom, Safeway
Manufacturing: Boeing, GM, Ford, Dow Chemical, Monsanto, Dell, Chrysler, Lockheed/Martin
Telephony: Sprint, Qwest, AT&T, Verizon, Cingular
Software Development: Oracle, Microsoft, Symantec, Software Councils and Associations

Other Clusters Considered To Draw From:

- Data Warehousing
- Security and Cyber Security
- Publishing
- Media/Entertainment/Games
- Government: DoD, DoE, State, County, City

Sampling Representation

Ideally, respondents for this project will be drawn from the following general categories in the percentages indicated:

- 10% Operations - VP level - GM level - Division head level
- 10% Hiring managers - HR technical specialists, etc
- 50% Technical Managers - Immediate supervisors - administrators - forepersons -
- 20% Technical Workers - Hands - on techs - server or network administrators -
- 10% Strategists and Architects - CSA, Deloite and Touche, corporate level strategists and architects

Proposed Schedule of Activities

Item Title	Description	Date
Research design and data gathering instruments	Research design paper and sample data gathering questions for the quantitative Web-based questionnaire and for qualitative data collection. Prepare Power Point presentation to send to potential respondents for viewing prior to telephone interview.	28-June-05
Web site	Web-based questionnaire mounted and tested	10-July-05
Identify firms and schedule telephone interview appointments	Using the UMB / BATEC resources, identify target firms according to the sampling plan (Exhibit 2) and schedule interviews. Forward schedule to TSI as developed.	On-going through 24-Aug-05
Interview respondents as identified by client.	Conduct 68 telephone interviews by guiding respondents to the Website, recording comments as they fill out the form, and recording additional comments and remarks in response to questions posed by the interviewer about Adaptive Expertise	On-going through 24-Aug-05
Data analysis	Analyze and organize quantitative data, analyze and categorize qualitative data. Submit draft report.	8-Sept-05
Report	Prepare and transmit final report, present at Boston conference.	22-Sept-05

The schedule will be subject to adjustment based on actual dates when research subjects become available, and by other factors as later determined.

Respondent size and type

We will know the firm for which the respondent works and from this information we will classify responses into the following categories:

Size Definitions:

Large: Over 500 Employees

Small: Under 500 Employees

Type definitions:

ICT service provider (data or telecommunications and related)

ICT enabled service enterprise (e.g. bank, insurance, medical)

ICT enabled manufacturer of non-IT products

ICT product manufacturer (hardware or software)

ICT consulting / strategic planning / systems integration & management

Interview Questionnaire

Prequalification Questions

Interview subjects will be pre qualified through self-assignment into one of the following five categories. In the event a subject is unwilling to classify him or herself into one of the five categories, the interviewer will again ask into which category the subject believes he or she most closely fits. In the event the subject is unwilling to classify him or herself the subject will be asked to supply a category. If the response is evasive or if the category is trainer or teacher, the interview will be terminated.

Question i

Which of the following categories most closely describes your work?

A. A person who hires ICT technical workers

B. A person who supervises and evaluates ICT technical workers

C. A person who has division or enterprise level responsible for ICT systems

D. A person who performs ICT technical work

E. A person who provides ICT strategic solutions for enterprise users

Subjects will also be asked to respond to two questions regarding experience and one question regarding education level.

Question ii

How long have you performed your ***present*** job?

A. Less than one year

B. One to three years

C. Four to seven years

D. Greater than seven years

Question iii

How long have you worked in the ICT field *in total*?

A. Less than one year

B. One to three years

C. Four to seven years

D. Greater than seven years

Question iv.

The ICT technical personnel in this enterprise have (check all that apply)

A. Vendor specific certifications (CCNE, MCSE, etc.)

B. Vendor neutral industry certifications (A+, CIW, CISP)

C. Two-year technical degrees from community college or technical school

D. Baccalaureate degrees in engineering technology

E. Baccalaureate degrees in EE or computer science

F. Baccalaureate degrees in business or management

G. Advanced degrees in engineering, computing, or management

Skills Based Questions

1	In thinking over the past few years, do you believe ICT technicians need a broader set of skills now and in the future than in times past?	Y / N
	2. User skills	
2	Would you expect *any ICT technical person* you hired, even entry level, to have basic familiarity with the following technical skill sets:	
2A	Word processing (composing documents, cutting and pasting, file manipulation)	Y / N
2A1	Word processing (publishing, formatting, typography)	Y / N
2A2	Word processing (producing HTML from text files)	Y / N
2B	Spread sheets (ability to format, put formulae in cells and perform calculations)	Y / N
2B1	Spread sheets (produce graphs, charts)	Y / N
2B2	Spread sheets (Set up forms to gather input)	Y / N
2C	Presentation software (producing a text based presentation)	Y / N
2C1	Presentation software (insert charts, graphs, tables)	Y / N
2C2	Presentation software (insert active content, video, animation)	Y / N
2D	Desktop operating system (file manipulation, network connections, disk utilities)	Y / N
2D1	More than one desktop operating system (Windows XP and Apple OSX, for example)	Y / N
2E	Server operating systems and hardware	Y / N
2E1	File servers	Y / N
2E2	Applications servers	Y / N
2E3	Communications and Internet or Web servers	Y / N
	3. Security	
3	In the past couple of years, there's been a lot of focus on security. On a scale of 5 to 1 with 5 being the highest or most important and 1 being the least, how important is a basic knowledge of computer systems security *when selecting or specifying a new hire?*	Response 1 – 5

3A	If you were forced to choose between an new hire who knew about: A) keeping a system safe from outside attacks; or B) providing maximum speed and availability to authorized users, which skill would be more important?	Response A or B
	4. Math	
4	We hear that foreign workers are better qualified in math, and that engineers in other countries are doing technician level work. On a scale of 5 to 1 with 5 being the highest or most important and 1 being the least, how important are math skills *when selecting or specifying a new hire?*	Response 1 – 5
	Answer 1 proceed to N2	
4A	Beyond basic arithmetic, do you believe any of the following skills areas are of benefit to ICT technicians.	
4A1	Trigonometry (angles, sin, cosin, tangent, vectors)	Y / N
4A2	Finite mathematics (probability, statistics, set theory, graphs of functions, limits,)	Y / N
4A3	Advanced algebra (imaginary numbers, spherical trigonometry, matricies)	Y / N
4A4	Calculus (Integrals, differentiation, transforms, tensors, differential equations)	Y / N
	Science	
5	We hear that lack of science skill is one reason employers look overseas for ICT technical workers. On a scale of 5 to 1 with 5 being the highest or most important and 1 being the least, how important are science skills *when selecting or specifying a new hire?*	Response 1 – 5
	Answer 1 proceed to N3	
5A	Beyond basic science skills do you believe any of the following skills areas are of benefit to ICT technicians	
5A1	Knowledge of sine wave propagation (cables, antennas, etc.)	Y / N
5A2	Knowledge of optical principles (prisms, fiber optics, light wave propagation)	Y / N
5A3	Knowledge of pulse wave characteristics as applied to digital data transmission	Y / N
	Hardware versus software emphasis	
6	On a scale of 5 to 1 with 5 being the most critical and 1 being least critical, please rank how important skills and knowledge in the following areas is *when selecting or specifying a new hire.*	
6A1	Desktop hardware and operating systems	Response 1 – 5
6A2	Network servers and operating systems	Response

		1 – 5
6A3	Web programming languages such as JAVA	Response 1 – 5
6A4	Applications programming languages such as C+ or Visual BASIC	Response 1 – 5
6A5	Network physical layer (routers, switches, WAPs, etc.)	Response 1 – 5
	7. Web, database, hardware, customer service, systems	
7	On a scale of 5 to 1 with 5 being the most critical and 1 being the least critical, please rank how important the following technical skills areas are *when selecting or specifying a new hire.*	
7A1	Ability to build a web page using applications such as Front Page or languages such as HTML	Response 5 – 1
7A2	Ability to query and generate reports from an existing data base using SQL or forms	Response 5 – 1
7A3	Ability to access, interpret, and apply technical data to design or troubleshoot systems	Response 5 – 1
7A4	Ability to document incidents, customer contacts, actions, and responses in written reports	Response 5 - 1
7A5	Ability to perform end-to-end diagnosis, testing, and repair or restoration	Response 5 – 1

Soft Skills and Non Technical Attributes

Skills such as ability to communicate, to work in teams, to have a customer oriented approach to work, are sometimes called “soft skills”. With this definition in mind, please respond to the following questions:

8	Soft skills are critical to the career success of any new hire.									
	5.	Strongly Agree.	4,	Agree	3.	Don’t Know	2.	Disagree	1.	Strongly Disagree
Comment:										

9	When hiring or specifying a new hire, we specifically look for soft skills.									
	5.	Strongly Agree.	4,	Agree	3.	Don’t Know	2.	Disagree	1.	Strongly Disagree
Comment:										

10	If a candidate does not exhibit soft skills, we will not hire him or her even if they are technically qualified.									
	5.	Strongly Agree.	4,	Agree	3.	Don’t Know	2.	Disagree	1.	Strongly Disagree
Comment:										

11	We have an active program to develop and improve soft skills in our technical employees.									
	5.	Strongly Agree.	4,	Agree	3.	Don't Know	2.	Disagree	1.	Strongly Disagree
Comment:										

12	Lack of soft skills in our local hiring pool would lead us to consider outsourcing.									
	5.	Strongly Agree.	4,	Agree	3.	Don't Know	2.	Disagree	1.	Strongly Disagree
Comment:										

If the respondent is hires and / or supervises technical workers, answer question 13A. If the respondent is an ICT technician, answer question 13B.

13A	As a person with hiring responsibility, if you there were one thing you wish applicants had more of, what would that one thing be?									
Comment:										

13B	Thinking back on your career thus far, if you could identify one thing that would have better prepared you for work, what would that one thing have been?									
Comment:										

14	If two new hire candidates were in contention for one position and they were both equally qualified technically and had similar experience, *what non-technical* attribute, would "tip the scale" towards one more than the other.
Comment:	

15	If two incumbent candidates were in contention for one promotion and they were both equally qualified technically and had similar experience, *what non-technical* attribute, would tip the scale towards one more than the other.
Comment:	

Adaptive Expertise

Employers tell educators they want to hire persons who are problem solvers.

The term *Adaptive Expertise* refers to the ability to the ability to develop original solutions to novel problems. The term is contrasted with *Routine Expertise* which may be very complex (surgeon, airline pilot) but nevertheless performed from a known repertoire of learned skills and responses. Routine expertise frequently has been show to be insufficient when novel problems arise that fall outside the normal realm of practice. (An example may be multiple emergencies in an airplane that arise in a way that the normal checklists do not apply).

16. In thinking about Adaptive Expertise as it may apply to your enterprise, do you find Adaptive Expertise exhibited by any employees you can think of? (Y / NS / N)

17 . Do you believe employees who exhibit Adaptive Expertise would contribute more value to your enterprise? (Y / NS / N)

18. Do you know of instances where your enterprise detects or rewards Adaptive Expertise? (Y / NS / N)

19. As Adaptive Expertise is described here, do you think that if more technical personnel exhibited traits of Adaptive Expertise that it would provide an advantage to your enterprise over competing firms whose employees did not have those traits?
(Y / NS / N)

20. If two applicants are in contention for one position, given a choice between a Routine Expertise with 10 years' experience and an Adaptive Expert with 1 year's experience, which would be more likely to recommend hiring? (RE / NS / AE)

	If you could make *one* recommendation to the education system as a whole regarding the education and preparation of ICT workers for your enterprise, what would it be?
Comment:	

	If allowed to name *just one thing* that is different regarding hiring of ICT workers now versus 5 years ago, what would that *one thing* be?
Comment:	

Thank you, do you have any other comments you would like to share before we conclude the interview?

Workforce Study
Industry IT Focus Group

Category	Item		Most Important	Important	Least Important	Comment
Basic Desktop User						
	Word Processing					
	Spreadsheet Data Entry					
	Elementary Data Base					
	Web Page Using Front Page or					
Network Technology						
Admin	Network Administration					
	Network Operating Syst					
	Hardware					
	Wiring/Cabling					
Architecture	Initial Design					
	Expansion					
	Customer responsibility					
Security	Firewalls/SW					
	Gateways/HW					
	Cust. Education					
	Syst Availability					
Other	Video					
	Voice					
Programming & C Sci						
	Web Language Java, Pearl					
	High Level Languages					
	SW Design, Flowcharting					
	Embedded controllers					
	Coding					
	Software Maintenance					

Category	Item		Most Important	Important	Least Important	Comment
Security						
	Computer Hardware					
	Physical Plant					
	Firewalls, virus protection, etc.					
	User education					
	Forensics - investigation					
Wireless						
	WAP Hardware					
	LAN/WAN Admin					
	RF Principles					
	Wireless client					
Certifications						
	A +					
	Network +					
	Internet +					
	CIW					
	MCSE					
	CCNA					
	CCNP					
	MOUS					
	Security +					
	CISSP					
	PMI Associate					
Business / Non Technical						
	Gather Information					
	Develop graphs tables charts					
	Basic project management					
	Analyze alternatives					
	Manage others					
	Manage time					
	Communicate with customers					
	Communicate with peers					

Category	Item		Most Important	Important	Least Important	Comment
Web and Multimedia						
	Use off shelf software					
	Code HTML Java C# PHP					
	Develop active content					
	Modify active content					
	Develop still or motion graphic					
	Modify still or motion graphic					
	Develop audio content					
	Modify audio content					
	Content integration					
	Adminster web servers					
	Adminster content server					
	Develop web data bases					
	Adminster web data bases					
High Performance Computing						
	Cluster design					
	Cluster admin					
	Job control					
	System Optimization					
	Customer Svc					
Database Design & Dev						
	Develop user interface					
	Specify data classes					
	Specify back end connectivity					
	SQL					
	Optimize performance					

Category	Item		Most Important	Important	Least Important	Comment
Database Design & Dev	(continued)					
	Research db technical data					
	Train users					
	Develop documentation					
	Test, debug and maintain					
	Ensure security					

ACM STUDY CITES EDUCATION, R&D INVESTMENT TO ASSURE GLOBAL COMPETITIVENESS

Detailed Offshoring Study Assesses Rapid Changes Driven by Information Technology

New York, NY, February 23, 2006 - In a study released today by ACM, the Association for Computing Machinery, a team of internationally recognized computer scientists, industry leaders, labor economists and social scientists cited educational policy and investment in research and development as critical elements for countries to stay competitive in today's global environment for Information Technology. The study acknowledged that global competition in higher-end technology-based skills, such as research, is increasing. It concluded that policies designed to improve a country's ability to attract, educate and retain the best IT talent are necessary to foster innovation and remain competitive in the global environment.

The study, entitled "Globalization and Offshoring of Software," noted that globalization trends in the software industry have been fueled by rapid advances in information technology itself as well as government action and economic factors. "We changed the world," said Moshe Y. Vardi, co-chair of the study group, and director of the Computer and Information Technology Institute at Rice University, "and now it is changing us." He cited the wide availability of low-cost, high-bandwidth telecommunications and standardized software platforms and applications as well as digitalization of work processes as driving factors. "But we also have identified the keys to continued innovation and invention, which will sustain competitiveness in this global environment," he added. The report is available at http://www.acm.org/globalizationreport.

With a comprehensive approach, the study considered nearly a dozen case studies of diverse firms facing offshoring challenges. The study team members conducted an extensive review of available data and literature on offshoring and outsourcing, and heard in-person accounts from many international experts.

IT Jobs Outlook Brightens The study found that, despite intensifying competition, offshoring between developed and developing countries can benefit both parties. The study cited data from the U.S. Bureau of Labor Statistics (BLS) which indicates that more IT jobs are available today in the U.S. than at the height of the dot com boom. This trend is evident despite a significant increase in offshoring over the past five years. In fact, U.S. IT employment in 2004 was 17% higher than in 1999, and the BLS data reveals that IT jobs are predicted to be among the fastest-growing occupations over the next decade.

The report found that IT workers and students can improve their chances of long-term employment in IT occupations by acquiring a strong educational foundation, learning the technologies used in global software, and keeping skills up to date throughout their careers. Other steps the report deemed necessary for fostering the next generation of innovation include:

✤Sustaining or strengthening technical training and education systems

✤Sustaining or increasing investment in research and development

✤Establishing governmental policies that eliminate barriers to the free flow of talent

William A.Wulf, president of the National Academy of Engineering, noted the unique international perspective provided by the ACM report. "It provides a deeper understanding of the trends and forces driving globalization and offshore outsourcing of software. It also offers significant value for those shaping the policies, priorities, and investments of countries that intend to be part of the global software-systems-services industry," said Wulf, who is vice chair of the National Research Council, the principal operating arm of the National Academy of Sciences and Engineering.

The study also found that global competition in higher-end skills, such as research, is increasing. Many companies, the study reports, have established research centers in multiple countries, although most retain strong research operations in their home country. The report also pointed to an increase in total worldwide investment in research and wider distribution of research activities around the world.

The ACM study cited many reasons for locating certain operations in specific countries, from political to linguistic and cultural to economic. In some cases, the study notes, creating collaborations outside the U.S. is often facilitated by

offshore operations, but offshoring does not always result in downsizing one part of a company and building another. Offshoring can result in growing business worldwide, working globally, and creating a climate of innovation that can produce a substantial number of new jobs, including many that are high on the value chain.

Daniel T. Ling, corporate vice president for Microsoft Research, cited the report's confirmation that the U.S. faces long-term challenges from falling interest and skills in math and science programs in its primary education system. "The perception that employment opportunities in software and related technologies are vanishing has led to a significant drop in enrollment in IT educational programs, which will in turn lead to shortages in highly trained and qualified professionals in the future. This report helps to raise awareness of the realities that face industry, students, educators and policy makers, and is important reading to advance the discussion of these issues."

The ACM report concluded that the future depends on the nation's commitment to acknowledging the challenges of the global environment. The brightness of the future for individuals, companies, or countries, rests on their ability to invest in building the foundations that foster innovation and invention, the report said.

The complete Globalization and Offshoring of Software Report as well as the Executive Summary and Findings, Overview, Bibliography and Task Force Member list are available at http://www.acm.org/globalizationreport.

About ACM ACM, the Association for Computing Machinery http://www.acm.org, is an educational and scientific society uniting the world's computing educators, researchers and professionals to inspire dialogue, share resources and address the field's challenges. ACM strengthens the profession's collective voice through strong leadership, promotion of the highest standards, and recognition of technical excellence. ACM supports the professional growth of its members by providing opportunities for life-long learning, career development, and professional networking.

Employability Skills
TSI Power Point

What Are Employability Skills?
What Industry Says

- Able to Work In Teams
- Customer/Business Knowledge and Focus
- Able to Communicate in Writing
- Able to Communicate by Speech
- Numerate & Literate (Comprehension)
- Able to analyze, prioritize, evaluate
- Respectful of other points of view, cultures, gender, ethnicity
- Resourceful, constructive, able to work with minimal direction
- Able to develop original solutions to novel problems, deal with novel situations

Attributes of Soft Skills

- Enhance employability
- Enhance advancement
- Non-technical
- Retain their value
- Leverage technical skills to provide value to employer

Why Emphasize Soft Skills?

Technology and Globalization Lead the Change to
A Different Corporate Value Basis

Value of a worker is calculated on the degree of
value added to Intellectual Capital.

Intellectual Capital

- Intellectual Capital is about *ideas*
  - Thought leadership
  - Mindshare - Market presence
  - Strategies and growth
  - Learning Organization

Why Employers Value Intellectual Capital

- It's the Pathway To Greater Efficiency
- It Enhances Productivity
- The Cornerstone Of Competitiveness
- Absent I C, there is No Survival

What's in it for the student?

- Tomorrow's worker will be expected to take full responsibility for her/his career path
  - Self assessment for skill and knowledge needs
  - Locate and utilize education and training resources
  - Think outside the silo, and obtain skills in multiple career areas - breadth as well as depth.
  - Assess and anticipate technology shifts, employer and job requirements, market trends, and make appropriate adjustments to enable continuing high value contributions to the enterprise

Vision of the New Technology Worker as a New Professional

- The new technology worker has deep business and technical skills, interdisciplinary experience, emotional intelligence, and the ability to combine those skills to deliver the value of those skills to customers and clients.

Implications for Teaching and Learning

- Build upon a technical core
- Integrate soft and technical skills in context
- Provide opportunities for problem solving that use both soft and technical skills
- Assess constructively - Let students see benefits
- Use Standards for Support
- Integrate and involve other disciplines when able
- Make meaning for all students
- Keep industry involved (contributing stakeholders)

How Soft Skills Contribute to Student Success

- Focus more on process and outcomes
- Focus less on content and product
- From Employers:
  - Constant assessment of what work adds value to the enterprise
  - Constant assessment of the knowledge skills and attributes required to get that work done
  - What resources are available to supply these
  - What are the alternatives

  "We can't prepare a 21st century workforce with 19th century instructional techniques and 20th century content"

How Do We Perform Now?

(Insert Video)

What Have We Tried?

- Classroom courses
- Service Learning
- Mentoring
- Problem Based Modules
- Internships and work-study
- Full - Up PBCBL
  - Business collaborates at these crucial points
    - Content (Technical, Non-technical)
    - Problem Definition and Development
    - Learning Activities (Contextual)
    - Assessment (Authentic)

Implications for Assessment

- Open to a range of assessments
  - Based on learning styles
  - Based on integration of outcomes
  - Involving self, peers, standards
  - Involving industry
  - Using activities
  - Authentic, integrating normative and criterion references

Introducing the new "Star Worker"

- Technical depth in at least 2 areas
- Broader domain knowledge
  - Context knowledge
  - Process knowledge
- Problem solver
- Communication skills
- Teamwork skills
- Common Sense
- Customer focus

TSI Industry Focus Group

Intellectual Capital, Intangible Assets, and the Changing Nature of Work

Focused Conversation

- Brainstorm with a purpose
- Four areas of inquiry:

1. What did you hear? (The facts you heard)
2. What was the main issue raised?
3. What surprised you?
4. What concerned you?

The Changing Value Proposition of Work

The Information Age

Jobs

The Global Economy

- How we think about work is changing quickly
  - What is my role in the tribe?
  - What is appropriate for my gender and class?
  - What jobs can I train for or fit into?
  - Can I inoculate myself against uncertainty?
- Implies career choice based in part on personal efficacy, intrinsic motivation
- Work is often inter-related with lifestyle
- More and more, pay is based on value rather than labor units (hours worked, pieces made, etc.)

The I C T Skills Revolution

- Information technology is now a *means*, it is no longer an *end*
  - IC facilitates other work
  - ICT leverages productivity
  - ICT leverages and enables processes
  - Technology leverages people
- Globalization means that skills in and of themselves are *simply commodities* and to the extent they are freely available on the global market, U.S. students will not be competitive offering just skills alone if workers with identical skills in other countries will work for less.

The Value Revolution

- Throughout the industrial age, the *value* of an enterprise was measured by
  - Tangible Assets
    - Plant and equipment
    - Specialized tooling and fixtures
  - Market Share and production capacity
  - Market capitalization and equity value
    - Based primarily on liquidation values of physical assets, cash, and receivables

Technology and Globalization Force Us To Consider A Different View

Value of a worker is calculated on the degree of *value added to Intellectual Capital*.

The Technology Wedge

Rules of Intellectual Capital

- Enterprise value based on
  - Current market share & position
  - Future market potential & position
  - Specialized *knowledge and abilities*
    - About the market and the customers
    - Ability to predict, forecast, anticipate
    - Broad knowledge of processes and services, (*HOW* does our product get used?)
    - Intellectual capital / intellectual property are the most valuable assets.

Boeing Versus Airbus
A bet on the future of the market

Airbus' bet - the A380
Bigger Planes
- Long haul
- Hub to hub flights
- Concentrated ops

Boeing's bet - the 787
Smarter Planes
- Medium haul
- Point to point direct flights
- Less concentration

What's important about this?

- It's not about "product"
  - Workforce skills (equal)
  - New technologies (equal)
  - Meeting a predetermined need
    (customer doesn't know either)
- It ***is*** about "process"
  - Market and customer knowledge
  - How to sell advantages of your product
  - Correctness of analysis of the future
  - Partnering with your customer for profits
    - (*HOW* will the airplane be used?)

What Does This Change Mean?

- Enterprises value *intellectual capital* more, much more, than physical capital
  - *Employees* are the custodians of the intellectual capital of an enterprise
  - Intellectual capital has replaced physical capital (plant, equipment, inventory) as the most valuable corporate asset
  - Intellectual capital means *know how, know why, know when, know who*, not just know what. It's also *know what's next*!

A Hostile Environment for Traditional Analysis

- Physical Capital Contributions
  - Are easy to measure (quantitative)
  - Are relatively easy to forecast
  - Value is relatively stable over time
- Intellectual Capital Contributions
  - Are more difficult to measure (qualitative)
  - Are difficult to forecast (many variables) and may not arrive on schedule
  - Often change value very quickly

A Hostile Environment for Workers

- The Intellectual Capital Paradox
  - Contributing to Intellectual Capital does NOT necessarily guarantee long term job security
  - Developing Intellectual Capital makes employers more selective about how they invest in employee development
- Ever shorter cycle times produce apparently constant "creative destruction"

  "You're only as good as your last good idea"

It's a Data-Driven World

- Enterprises must transform all activity products goods and services into data at the earliest possible point in an IT dependent process
- Once the process exist as data, it is transmissible and therefore portable and can be easily sent anywhere in the world
- The earlier a process is transformed into data the more vulnerable all related upstream processes and jobs become

What does this mean for tomorrow's skilled technical workforce

- Tomorrow's worker will be expected to take full responsibility for her/his career path
  - Self assessment for skill and knowledge needs
  - Locate and utilize education and training resources
  - Think outside the silo, and obtain skills in multiple career areas - breadth as well as depth.
  - Assess and anticipate technology shifts, employer and job requirements, market trends, and make appropriate adjustments to enable continuing high value contributions to the enterprise

Vision of the New Technology Worker as a New Professional

- The new technology worker has deep business and technical skills, interdisciplinary experience, emotional intelligence, and the ability to combine those skills to deliver the value of those skills to customers and clients.

The T-shaped Employee

6 Forces Acting on Solution Implications for Learners

- Free agency will be more the norm
- Metacognition (knowing "how to know") is a paramount survival skill
- Must "hit the ground running" - no 'trainees"
- Accommodate closer integration of learning, life, and work.

Future Career Paths

- Focus more on process and outcomes
- Focus less on content and product
- From Employers:
  - Constant assessment of what work adds value to the enterprise
  - Constant assessment of the knowledge skills and attributes required to get that work done
  - What resources are available to supply these
  - What are the alternatives

  "We can't prepare a 21st century workforce with 19th century instructional techniques and 20th century content"

Focused Conversation

- What did you hear? (List the facts)
- What was the main issue raised?
- What surprised you?
- What concerned you?

Lunch Assignment

OK, so what are we gonna do about it?

- All lunch tables *should* include a heterogeneous group of educators and business people
- Each table will appoint a reporter
- Discussion topic: *What are the implications of this presentation for our IT and CS programs?*
- Outcome: *A bulleted list of actions that respond to the issue raised in the presentation - reported out to the group at the close of lunch*

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