

Ready for the Job: Understanding Occupational and Skill Demand in New Jersey's Information Technology Industry

A Report of the New Jersey State Employment and Training Commission



Prepared by the
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With the Assistance of the Workforce Investment Boards of
Bergen, Cumberland/Salem, Hudson, Mercer and Passaic Counties,
and Cumberland County College, Mercer County Community College, and William Paterson University

James E. McGreevey, Governor

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Preface and Acknowledgements

The *Ready for the Job* project was developed by the New Jersey State Employment and Training Commission (SETC) with the New Jersey Departments of Labor and Education. The project was directed by Henry Plotkin, Executive Director of the SETC, and was funded by the New Jersey Department of Education. The research was conducted by the John J. Heldrich Center for Workforce Development at Rutgers, The State University of New Jersey, with assistance from the local Workforce Investment Boards of Bergen, Cumberland/Salem, Hudson, Mercer, and Passaic Counties and from researchers at William Paterson University, Cumberland County College, and Mercer County Community College.

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Project Summary

Economic prosperity for New Jersey, its citizens, and its businesses depends on a well-trained workforce. This joint effort of the New Jersey State Employment and Training Commission, the New Jersey Department of Education, and the New Jersey Department of Labor is designed to collect up to date information from employers on the skill needs of eight key industries in the state. The eight industries that are the focus of this effort are: health care, finance/insurance, construction, utilities/infrastructure, manufacturing, tourism/hospitality, transportation/logistics, and information technology.

The entire effort, led by the local Workforce Investment Boards of Bergen, Cumberland/Salem, Hudson, Mercer, and Passaic Counties and guided by Industry Advisory Groups, involved over thirty focus groups and eighty interviews with employers and educators. The Heldrich Center for Workforce Development at Rutgers, The State University of New Jersey, with assistance from researchers from William Paterson University, Cumberland County College, and Mercer County Community College, conducted this research to identify the skills, knowledge, and educational requirements of seventy-four select occupations and eleven job groups. The Heldrich Center and its research partners also identified the key trends in each industry that affect skill requirements and identified strategies for meeting the key workforce challenges of each industry.

The information collected through this effort will be disseminated through this series of reports and through an Internet website (www.njnextstop.org) that will include a searchable database of profiled occupations. This information will assist a variety of users. Students and job seekers can use this information to make decisions about education and careers. Educational and training institutions can use this information to develop courses and programs of study that will provide individuals with necessary skills. Policy makers at the state level can use this information to ensure that government resources are invested in programs and efforts that will benefit individuals and businesses.

Understanding Occupational and Skill Demand in New Jersey's Information Technology Industry

Executive Summary

The information technology (IT) industry includes workers employed in a wide array of occupations and settings. These workers provide technical support, develop and administer databases, software and websites, and design networks, among other functions. In New Jersey, IT firms develop computer products and Internet websites and provide computer and data processing services to support the technology functions of private and public sector employers. In the majority of organizations, including non technology specific, one or more workers are needed to maintain the company IT system.

In this report, we will refer often to the information technology "industry." However, it is important to note that IT is not a discreet, self-contained industry as is health care or construction, for example. IT activity is distributed throughout nearly all industries in myriad forms. For the purposes of this report, therefore, the IT industry is a set of technology-based occupations that occur in both technology and nontechnology companies.

While the "dot.com bust" of the late 1990s shook the industry, occupational growth is expected to be strong. According to the Bureau of Labor Statistics, the IT workforce in 2002 was comprised of 2.8 million workers,¹ down 1.6% from the previous year.² Hiring, however, is projected to rebound significantly in the coming years. Across the nation, the total number of workers in IT occupations is expected to increase by 106% from 2000 to 2010.³ In New Jersey, approximately 125,000 individuals are employed in IT jobs in 2003.⁴ The number employed in New Jersey information technology jobs is expected to increase by 42.1% from 2000-2010.⁵ Across the nation, the majority (90%) of IT workers are employed by non IT-specific organizations.⁶

This report, based on focus groups and interviews that include over forty-five employers, summarizes the skill, knowledge, and educational requirements of key IT occupations and identifies strategies for meeting the key workforce challenges facing these occupations.⁷



Skill Requirements of Selected Job Groups

The ten selected occupations in the IT industry fall largely into three job groups that share a common set of core competencies, basic educational requirements, and skill sets. These include Computer Science Application, including systems analysts, computer programmers, computer and information scientists, computer software engineers (applications), computer software engineers (systems software), database administrators, and network and computer systems administrators; Customer Service and Support, including computer support specialist; and Management/Supervision, including program/project managers and computer/information system managers.

Computer Science Application

Occupations: systems analyst, programmer, computer and information scientist (research), software engineer (applications), software engineer (systems software), database administrator, network and computer systems administrator

Core Competencies	Sample Skills
Maintain and apply knowledge of current technology, demonstrating ability to troubleshoot malfunctions and resolve them quickly	Math and technology
Initiate innovation in implementing projects or solving technical problems	Problem solving and critical thinking
Ability to secure data competently and with the most advanced technology/methods available	Operations analysis
Demonstrate a concrete understanding of the industry and how technology fits into the operations of the firm	Reading comprehension
	Programming

The skill and education requirements vary somewhat among the occupations in this job group. For example, administrative occupations, such as database administrators, do not require a bachelor's degree, but do require technical knowledge and the ability to learn on the job. In comparison, programmers and

system analysts typically have at least a four-year degree. While degree requirements may vary, the need for good math, teamwork, communications, and organizational skills for all occupations in this job group is universal.

Customer Service and Support

Occupations: computer support specialist

Core Competencies	Sample Skills
Demonstrate emotional maturity when interacting with employers, colleagues and clients	Coordination
Identify and address customer needs quickly and accurately	Communication and teamwork
Introduce and market products persuasively, relying on strong product and firm knowledge	Problem solving and critical thinking
Make referrals appropriately and quickly, relying on strong knowledge of others' roles within the firm	Service orientation
Apply math and finance concepts routinely and accurately	Social perceptiveness
Use technology effectively to complete tasks	
Demonstrate a thorough and consistent awareness of "red flags" indicating fraud	

The demand for IT customer service and support workers has paralleled the growth of the industry over the last decade. The ubiquity of school/home use and the advent of telecommuting have fueled the demand for round-the-clock computer support. Work at the lower end of this job group is dominated by less

skilled IT administrative personnel. Technicians that work on more complex systems with multiple vendors, linking multiple processes (including web-based applications) and geographically dispersed users, require not only sophisticated hardware and software skills and knowledge, but communications and networking expertise, as well.

Management/Supervision

Occupations: project/program manager and computer/information systems manager

Core Competencies	Sample Skills
Use effective judgment and decision making to allocate resources and personnel to meet project budget and deadline	Problem solving and critical thinking
Communicate and coordinate the efforts of multiple project partners, vendors, and workers to share common organizational goals	Entrepreneurship and business skills
Provide technical leadership across projects/disciplines	Communication and teamwork
	Monitoring
	Time management
	Management of personnel resources

The Management/Supervision group includes project/program managers and computer/information system managers. Managers are always in demand in the IT industry, as they are responsible for ensuring that complex projects are completed on time and within budget, as well as facilitating the collaboration of multiple team members (some of whom may be located off site). In addition, they perform traditional managerial functions such as employee development and supervision, administration, planning, and budgeting.

Project managers need an expansive skill set that includes both technical and managerial expertise. While their degree of technical and industry knowledge may vary, all project managers must have excellent organizational, interpersonal, and teamwork skills. Managers typically have a four-year or graduate degree.

Key Workforce Challenges

The IT industry in New Jersey is facing two primary workforce challenges:

Challenge 1: Aligning Education and Training with the Needs of Employers. As a result of the fast pace of technological change, employers must adjust continually the skill requirements of jobs, making it difficult for education and training providers to offer the necessary training.

Challenge 2: Preparing Skilled, Qualified Entry Level Workers. The demand for workers with moderate skill levels in the industry has led to a shortage of entry level workers with appropriate skills and wage expectations.

To address these challenges, the IT industry must work with the public and the private sector, as well as educational institutions, to create and coordinate a comprehensive set of workforce development strategies. Recommendations for doing so must recognize the complex needs of this changing industry.

Recommendations

1. Recommendations to Align Education and Training with the Needs of Employers

Adopt and Promote the Use of Existing Skills Standards

The National Workforce Center for Emerging Technologies, with funding from the National Science Foundation and in partnership with Computing Technology Industry Association (CompTIA) and the National Skills Standards Board, currently is developing skill standards for jobs in information technology. For New Jersey to serve the needs of employers and IT workers, the state must adopt these skill standards and promote their use to educational institutions and employers.

Establish High Skills Partnership Institutes in Higher Education Institutions and Vocational Schools

Stronger connections must be made between the needs of employers and the educational offerings of postsecondary and career-oriented vocational schools. Funds could be allocated for the infrastructure costs of creating new capacity to prepare jobseekers and incumbent workers with the education and skills needed for New Jersey's competitive economy.

Working with New Jersey's community and four-year colleges and other educational institutions, local training centers based on industry-accepted credentials would be created. These centers would target the workforce skill needs of key economic sectors and would work with those sectors to develop appropriate curriculum and training initiatives. These centers also would form the hub of new articulation agreements among educational providers. By emphasizing industry-based credentials, this initiative would create a substantive connection between the higher education and employer communities.

2. Recommendations to Prepare Skilled, Qualified Entry Level Workers

Support the Career Academy Model

Career academies foster a "school within a school" model to teach students how to apply skills in a workplace setting. They combine industry-themed coursework with internships and other opportunities for exposure to the workplace. Employers can use partnerships with career academy schools to directly communicate with educators and potential workers regarding industry skill needs, as well as influence school curricula to enhance the delivery of training and education in many areas, from technical skills specific to certain job areas to workplace readiness skills that may be enhanced when taught in a work-based setting.

Schools benefit from relationships with employers, such as the Bergen Technical School's liaison with Apple, Inc., in which the vendor supplies funds, planning, hardware, and training expertise to the school. Students are encouraged to view the company as a partner in their career exploration. In such cases, the students have the opportunity to earn employment certificates and/or college credits.

Encourage Industry/Education Partnerships

Employers, individuals, and educational institutions all benefit from the development of industry/education partnerships. In such partnerships, employers and educational leaders work together to ensure that the skills needed by employers are taught in the classroom. A variety of successful partnerships exist in the state and efforts should be made to publicize these as models that could be expanded and replicated.

A statewide conference for the IT industry could provide a forum for employers and educators to share information, form partnerships and replicate promising practices. A website also could be developed to act as an information clearinghouse regarding evolving employer skill needs and promising responses being developed within the industry, as well as in the education and workforce development communities.

¹ Bureau of Labor Statistics, United States Department of Labor. *Occupational Employment and Wages, 2002*. USDL 03-741. 19 November 2003. The occupations included in this calculation include: computer and information scientists (research), computer programmers, computer software engineers (applications), computer software engineers (systems software), computer support specialists, computer systems analysts, database administrators, network and computer systems administrators, network systems and data communications analysts, and computer and information systems managers.

Reader's Note

Ready for the Job Identifies Four Skill Types

The *Ready for the Job* project identifies four types of skills that are required by or important to employers. Employers require basic skills and workplace readiness skills for nearly all jobs. Cross-industry demand skills, identified through the focus groups and interviews with employers, are important in a variety of occupations in many industries. Finally, employers require advanced technical and professional skills for many jobs. These skills are job-specific and are typically obtained through post-secondary education and training either provided by educational institutions or by employers.

Type of Skill	Definition	Level of Importance
Basic Skills	Ability to read, write, and perform basic mathematical calculations.	Criteria for most entry level or low-level or low-skilled types of jobs.
Workplace Readiness Skills	Minimum expectations for functioning in the workplace, that include meeting standards for attendance and promptness, reliability and integrity, as well as dress and decorum.	Criteria for all jobs in the workforce.
Cross-Industry Demand Skills	Broader skills sets that are in the highest demand among employers in today's economy, and indicative of success in the workforce. These cross-industry demand skills include: - Math and technology skills - Problem solving and critical thinking skills - Communication and teamwork skills - Entrepreneurship and business skills	Strength in these skill areas can lead to expanded employment opportunities and career success across industries.
Advanced Technical/Professional Skills	Skills acquired through education and training needed to perform specific tasks and succeed in specific jobs.	Criteria for performance in specific jobs. Education and training is provided by post-secondary education institutions and/or employers.

² Bureau of Labor Statistics, United States Department of Labor. *Occupational Employment and Wages, 2001*. USDL 02-619. 6 November 2002.

³ US Department of Labor, Bureau of Labor Statistics, Career Guide to Industries. Computer and Data Processing Services. <http://www.bls.gov/oco/cg/cgs033.htm>.

⁴ Wage and employment data from: New Jersey Department of Labor, *Occupational Employment Statistics Wage Survey 2003 Edition*, January 2003. <http://www.wnjp.in.net/OneStopCareerCenter/LaborMarketInformation/Lmi23/PAGE0006.HTM>

⁵ Projection data from New Jersey Department of Labor. *Estimated and Projected Employment by Occupation, 2000-2010*. <http://www.wnjp.in.state.nj.us/OneStopCareerCenter/LaborMarketInformation/Lmi04/>

⁶ Information Technology Association of America. "Bridging the Gap: IT Skills for the New Millennium." April 2000. p. 10.

⁷ A full discussion of the methodology used for this study is included in Appendix A

Understanding Occupational and Skill Demand in New Jersey's Information Technology Industry

I. Introduction

This report, based on focus groups and interviews that included over forty-five employers, summarizes the skill, knowledge, and educational requirements of key IT occupations and identifies strategies for meeting the key workforce challenges facing these occupations.⁸

In this report, we will refer often to the information technology (IT) "industry." However, it is important to note that IT is not a discreet, self-contained industry as is health care or construction, for example. IT activity is distributed throughout nearly all industries in myriad forms. For the purposes of this report, therefore, the IT industry is a set of technology-based occupations that occur in both technology-specific and nontechnology-specific companies.

The Heldrich Center convened an advisory group of industry stakeholders to guide the effort.⁹ This advisory group, working in collaboration with Mercer County Community College, the DeVry College of Technology and the Middlesex County One Stop Career Center, selected ten key IT occupations for in-depth skill demand analysis and provided input on research, focus group, and interview participants, and recommendations. The Heldrich Center held three focus groups with industry and educational stakeholders regarding industry trends and the skill, knowledge, and educational requirements of selected occupations. The Heldrich Center also conducted fifteen interviews with industry human resource and management personnel regarding education, training, and recruitment issues.¹⁰

II. Profile of IT Occupations and Their Skill Needs

a. *Background of IT Occupations and their Importance to New Jersey*

As the U.S. economy continues its transition from industrial to digital, information technology and the software and hardware that supports it increasingly pervades the workplace. Organizations of all types are integrating technology into their systems and their business practices. Even industries previously untouched by the onslaught of the digital revolution are learning to harness the new technologies to maximize productivity, increase profitability, and remain competitive. Today, occupations and industries that did not exist twenty years ago are major components of the labor market. Both at work and home, computers, the Internet, and other forms of

information technology play an important role in daily life and the economy. New Jersey epitomizes this technological paradigm, host to many technology specific and technology dependent firms and businesses, as well as serving as a center of technological innovation and service.

The IT industry includes workers employed in a wide array of occupations and settings. These workers provide technical support, develop and administer databases, software and web sites, and design networks, among other functions. In New Jersey, IT firms develop computer products including software and hardware, develop Internet web sites, and provide computer and data processing services to support the technology functions of private and public sector employers. In the majority of organizations, including nontechnology-specific, one or more workers are needed to maintain the company IT system. While the "dot.com bust" of the late 1990s shook the industry, occupational growth is expected to be strong. According to the Information Technology Association of America (ITAA), the total national IT workforce totaled 9.9 million workers in 2002, a decline of 5% from the 10.4 million workers in 2001. It should be noted, however, that the size of the IT workforce claimed by ITAA, a leading industry association, far exceeds the number reported by the Bureau of Labor Statistics (BLS). According to BLS, the IT workforce in 2002 was comprised of 2.8 million workers,¹¹ down 1.6% from the previous year.¹² Hiring, however, is projected to rebound significantly in the coming years. Across the nation, the total number of workers in IT occupations is expected to increase by 106% from 2000 to 2010.¹³ In New Jersey, approximately 125,000 individuals are employed in information technology jobs in 2003.¹⁴ The number employed in New Jersey information technology jobs is expected to increase by 42.1% from 2000-2010.¹⁵ Across the nation, the majority (90%) of IT workers are employed by non IT-specific organizations.¹⁶

At the same time, employers are shifting many IT jobs overseas, seeking lower labor costs in countries such as India. In particular, employers have targeted customer service and technical support jobs for relocation, a trend that shows no sign of slowing. A recent Forrester study estimates that 450,000 (or 8%) of computer industry jobs will be sent offshore over the next twelve years.¹⁷ According to ITAA, higher-level programming and software engineering, network design, and web development may be the next exodus of IT occupations.¹⁸

IT occupations vary significantly in terms of skill demands. Forming the large base of the IT "job pyramid" are service positions, such as customer support and call center workers. These jobs typically are characterized by lower wages and high turnover. At the apex of the pyramid are workers such as computer and information research scientists who design and

**Figure 2.1: At-a-Glance:
Information Technology Occupations**

Employment and Compensation: National

Number employed (2002) ²⁰	2,772,740
Average Yearly Earnings (2002) ²¹	\$64,536
Projected Growth in Employment from 2000-2010 ²²	105.7%

Employment and Compensation: New Jersey

Number employed (2003) ²³	125,560
Average Yearly Earnings (2003) ²⁴	\$71,489
Projected Growth in Employment from 2000-2010 ²⁵	42.1%

develop complex technology systems. Significantly fewer in number, these workers earn high wages and move in a tight labor market in which their skills are in great demand. Between the base and the apex are myriad jobs that fall along a continuum of skills, training, and wages.

Earnings for many computer and data processing workers are high relative to those in most other industries. In 2003, the average mean annual salary of IT occupations in New Jersey was \$71,000. This is significantly higher than the average mean annual salary of all other occupations in the state (\$39,135).¹⁹ However, the influx of lower-skilled jobs, such as customer service specialists and call center operators, is exerting downward pressure on average earnings.

IT job opportunities are likely to be abundant in the future. For example, the New Jersey Department of Labor forecasts significant growth in related industries such as media/entertainment, health information, and desktop publishing that will fuel corresponding growth in occupations like database management/administration and network/computer systems analysts between now and 2010.

b. Skill Requirements of Selected Occupational Groups

The IT advisory group selected ten occupations for in-depth skill demand analysis. The advisory group selected occupations that had the largest number of annual openings or that were expected to experience significant growth in openings during the next ten years. The group members used estimates and projections produced by the New Jersey Department of Labor as well as their own knowledge of the occupations. In addition, the advisory group considered occupations with a shortage of qualified workers. Finally, the group ensured that the selected occupations represented a diversity of educational requirements and incomes.

Figure 2.2: New Jersey Employment²⁶ and Earnings²⁷ in Selected Occupations* Throughout All Industries

Occupation	Mean Annual Wages 2003	Estimated Number Employed 2000	Projected Number Employed 2010	Percent Change 2000-2010	Annual Openings (due to both growth & replacement)
COMPUTER SCIENCE APPLICATION					
Computer & Information Scientists, Research	\$87,800	2,700	3,400	26.6%	90
Computer Programmers	\$69,045	26,300	26,600	1.0%	580
Computer Software Engineers, Applications	\$76,100	15,500	25,700	66.1%	1,130
Computer Software Engineers, Systems Software	\$82,565	7,600	12,600	66.1%	550
Computer Systems Analyst	\$75,235	20,400	28,500	39.3%	980
Database Administrators	\$67,770	3,100	4,600	47.6%	160
Network & Computer System Administrators	\$66,125	6,300	10,300	62.6%	420
CUSTOMER SERVICE/SUPPORT					
Computer Support Specialist	\$47,330	18,300	32,200	75.7%	1,460
MANAGEMENT/SUPERVISION					
Computer / Information System Managers	\$101,155	12,000	15,900	32.4%	590
Project / Program Managers	n/a	n/a	n/a	n/a	n/a

* Totals may not add due to rounding. Employment data are rounded to 100. Percent changes are based on unrounded data.

In 2000, 112,200 individuals were employed in nine of the ten selected occupations in the state (Fig. 2.2). Estimates are not available for the remaining selected occupations. The number of individuals employed in the nine occupations is expected to grow by 42% from 2000 to 2010 and produce 5,960 openings each year. The mean annual wages of these occupations ranged from \$47,330 to \$101,155 in 2003.

The ten selected occupations in the IT industry fall largely into three job groups that share a common set of core competencies, basic educational requirements, and skill sets (see Figure

2.3). These include Computer Science Application, including systems analysts, computer programmers, computer and information scientists, computer software engineers, database administrators, and network and computer systems administrators; Customer Service and Support, including computer support specialist; and Management/Supervision, including program/project managers and computer/information systems managers. A description of these selected occupations, their skill requirements, and key workforce issues can be found in Appendix D. A searchable database of all selected occupations in the eight industries is available at www.njnextstop.org.

Figure 2.3: Profile of Information Technology Industry Job Groups

Job Groups	Description of Job Group	Occupations Included in Job Group	Education/Training Required or Preferred by Employers	Core Competencies ²⁸	Sample Occupational Skills
Computer Science Application	Computer networking and data software systems.	Systems analyst Programmer Computer and information scientist (Research) Computer software engineer (applications) Computer software engineer (systems software) Database administrator Network and computer system administrator	HS Diploma/GED Bachelor's degree preferred Often, technical/vocational certification required Work experience	Maintain and apply knowledge of current technology, demonstrating ability to troubleshoot malfunctions and resolve them quickly Initiate innovation in implementing projects or solving technical problems Ability to secure data competently and with the most advanced technology/methods available Demonstrate a concrete understanding of the industry and how technology fits into the operations of the firm	Math and technology Problem solving and critical thinking Operations analysis Reading comprehension Programming
Customer Service and Support	Interacting with customers on the front line. Technical tasks vary by organization, but generally include fielding customer concerns and inquiries. Increasingly, these workers must market and sell company products or services.	Computer support specialist	HS diploma/GED	Demonstrate emotional maturity when interacting with employers, colleagues, and clients Identify and address customer needs quickly and accurately. Introduce and market products persuasively, relying on strong product and firm knowledge Make referrals appropriately and quickly, relying on strong knowledge of others' roles within the firm Apply math and finance concepts routinely and accurately Use technology effectively to complete tasks Demonstrate a thorough and consistent awareness to "red flags" to prevent fraud	Communication and teamwork Problem solving and critical thinking Service orientation Social perceptiveness

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Figure 2.3: continued

Job Groups	Description of Job Group	Occupations Included in Job Group	Education/Training Required or Preferred by Employers	Core Competencies ²⁸	Sample Occupational Skills
Management and Supervision	Supervising, coordinating, and planning work of site and staff.	Program / project manager Computer / information systems manager	HS diploma/GED Work experience. Bachelor's degree preferred for managers, especially among those applicants who do not have prior experience. Associate's degree preferred for supervisors.	Use effective judgment and decision making to allocate resources and personnel to meet project budget and deadline. Communicate and coordinate the efforts of multiple project partners, vendors, and workers to share common organizational goals. Understand and adhere to safety precautions with consistency. Provides technical leadership across projects/disciplines.	Problem solving and critical thinking Entrepreneurship and business skills Communication and teamwork Monitoring Time management Management of personnel resources

Within each job group the level of skill mastery required may vary. However, the occupations within the job group share a common continuum of competencies and tasks. In a dynamic and fluid economy, the definitions and requirements of occupational titles change often and can vary from one employer to another. The grouping of occupations minimizes the effect of these differences. Employers and educators can utilize the job groups to identify core skills and competencies that facilitate hiring, movement, and training.

Computer Science Application

Description and Skill Requirements

Seven of the ten occupations included in this study fall in the Computer Science Application job group. They include systems analysts, programmers, computer and information scientists, and computer software engineers and systems administrators. Five of the seven jobs in this group are projected to grow more than 35% in New Jersey over the next decade (see Figure 2.2), with the number of software engineers alone expected to grow by 66%.

The skill and education requirements vary somewhat among the occupations in this job group. For example, administrative occupations, such as database administrators, do not require a bachelor's degree, but do require technical knowledge, plus an ability to learn on the job. In comparison, programmers and system analysts typically have at least a four-year degree. While degree requirements may vary, the need for good math, teamwork, communications, and organizational skills is universal for all occupations in this job group.

Similarly, the job tasks among Computer Science Application occupations differ. Engineers focus on systems (hardware, software and communications) and the environment or interfaces required to make systems work. Programmers, also known as developers, engage in both entry level programming and advanced applications, with varying degree of skill required. System analysts translate the users' nontechnical description of their needs into reliable designs that could be implemented as functioning systems. Analysts also coordinate implementation, testing, and revisions, often at a highly technical level, and must be well versed in the most current versions of hardware and software. In addition, employers tell us that they prefer analysts that are familiar with business concepts and have extensive industry knowledge. They must have good teamwork and interpersonal skills. System analysts significantly influence how an IT organization will meet its competitive or service goals.

Emerging Skills

Emerging skills in the Computer Science Application job group are concentrated in several disciplines: security, database architecture, and related fields, voice-activated computing, and network-based computing. In addition to commercializing applications in these areas, Computer Science Application workers need to hone business and entrepreneurial skills, as well as maintain knowledge of current products in their areas. Examples of these are the use of XML (Extensible Mark-up Language) and related tools to create business-to-business web applications. Employers tell us that increased customer service and the ability to design and produce reports or summaries of user data and analysis to support departmental decision making are increasingly desirable skills for many workers in this job group.

Workforce Trends and Issues

The labor market for experienced developers and engineers, particularly those with industry experience, is highly competitive and global. Employers note that signing bonuses and other incentives are common, as is competition between industry and academic institutions. Demand for professionals in this category tends to weather economic downturns and technological shifts better than most occupations.

More analysts will be needed to support the increasing prevalence of data systems and users' reliance on them, and job creation in this occupation is projected to grow significantly over the next decade. The position is evolving to include a much closer relationship with the increasingly sophisticated—and demanding—user community.

Customer Service/Support

Description and Skill Requirements

The demand for IT customer service and support workers has paralleled the growth of the industry over the last decade. The ubiquity of school/home use and the advent of telecommuting also have fueled the demand for round the clock computer support. The location and nature of the support also has become more varied, along with the skill and training required. Prior to the 1990's, many technicians focused on internal or field support (installation and maintenance, primarily hardware), while others focused on systems support (installation and maintenance of systems central to operations). Today, systems have become "smarter," with many aspects of installation and troubleshooting tasks now simplified or automated.

Work at the low end of this continuum has been taken over by less skilled IT administrative personnel. Technicians that work on more complex systems with multiple vendors, linking multiple processes (including web-based applications) and geographically dispersed users, require not only sophisticated hardware and software but communications and networking expertise, as well. Employers noted that interdisciplinary knowledge sets or multiple credentials have become more valuable among technical workers. Many technician jobs today require interdisciplinary skills in computers, telecommunications, engineering, and mathematics that extend beyond the entry level. Noted one employer, "Technicians are the life blood of an IT department. Their service connection and frequent communication with customers can spell success or failure for internal IT performance."

If technicians are the lifeblood of the IT industry, customer service support workers, such as those located in offsite call centers, are its face. Or, with increasing frequency, its voice. These workers must have excellent communication, problem solving, and interpersonal skills. They need also to be able to readily incorporate information on new products and processes. Often the tools or time allotted to do this are less than ideal, placing an additional requirement on the support person to be a quick learner with positive initiative. While a college degree is not required, extensive and ongoing training is the norm.

Emerging Skills

Computer support specialists must be able to keep up with the latest technology and products used by customers, which requires frequent on-the-job training and product testing. Emerging skills in the customer support area include the ability to troubleshoot a customer's problem remotely (through several tiers of support personnel), using software that replicates the customer's system at the technician's or help desk site.

Workforce Trends and Issues

Today, computer support specialists must have a diverse set of technical and business skills. These workers also are being asked to develop or demonstrate more customer service. Much of this knowledge is developed by the enterprising individual on the job, supplemented by training. In some cases, employers explain, they can accept reliable portable credentials as a criterion for employment (such as A+ certification), a practice begun by the hardware companies that essentially "franchised" their training as a means of meeting demand.

Management/Supervision

Description and Skill Requirements

Managers are always in demand in the IT industry, as they are responsible for ensuring that complex projects are completed on time and within budget, as well as facilitating the collaboration of multiple team members (some of whom may be located off site). In addition, they perform traditional managerial functions such as employee development and supervision, administration, planning, and budgeting.

Project managers need an expansive skill set that includes both technical and managerial expertise. While their degree of technical knowledge and industry knowledge may vary, all project managers must have excellent organizational, interpersonal, and teamwork skills. Typically, their education and experience levels are high. A higher degree of current technical knowledge usually correlates with higher responsibility and pay. Managers typically have a four-year or graduate degree.

Emerging Skills

Managers in the IT industry are experiencing a shift in the key performance components of their job. These shifts are being driven by the need to control costs and leverage more out of each employee's performance. The emerging skills in the managerial area include: technical project management, activity-based cost accounting, and contract negotiation and management for outsourcing deals.

Workforce Trends and Issues

Increasingly, project team members, particularly outside contractors, are geographically dispersed. As a result, managers must be facile in planning, negotiating, and managing their sometimes global work team.

III. Key Workforce Challenges

Despite an uncertain economy, employers report that they are experiencing a shortage of qualified workers. Employers and educators face two primary workforce challenges.

Challenge 1: Aligning Education and Training with the Needs of Employers. As a result of the fast pace of technological change, employers must continually adjust the skill requirements of jobs, making it difficult for education and training providers to offer the necessary training.

The market for IT work will continue to fluctuate due to economic, structural, and technological factors making it difficult for government, educational institutions, or industry associations to predict employment levels in specific occupations or the skill requirements of those occupations. For example, five years ago, the web-related occupations were not well recognized and the occupations and skills that were created by the explosion of database applications were not predicted. The factors that materially affect IT labor market and skill predictions are technology, industry structure, geography, technology absorption by other industries, and occupational clustering.

Challenge 2: Preparing Skilled, Qualified Entry-Level Workers. The demand for workers with moderate skill levels in the industry has led to a shortage of entry level workers with appropriate skills and wage expectations.

Despite the growth in global outsourcing, domestic job creation is expected to continue. The operational and administrative tier of the IT market is exhibiting a healthy growth rate, with four of its key professional categories representing 300,000 of the 425,000 available IT jobs in 2001.²⁹ Yet workers in training or in transition who could fill these posts have work and wage expectations that are excessively high, employers report, stemming from the condition of the industry several years ago. While there is a shortage of entry level workers, the most advanced positions increasingly are hard to fill as the qualifications and strategic nature of the work increase. Women and minorities are underrepresented in the field across the spectrum of available positions, particularly in highly skilled positions.

IV. Meeting the Challenges

Employers, industry groups, government, and the educational community in New Jersey and across the country have developed a number of responses to the challenge of aligning education and training with the needs of employers and with the demand for skilled and qualified entry level workers.

Strategies to Align Education and Training with the Needs of Employers

Efforts have been made to ensure that educational institutions have accurate information on the skill demands of employers. Some studies conclude that the traditional means of gathering labor market information for IT provides too static a view of current and future demand. According to the Computing Research Association, the use of new categories and methods of data collection, which supplement the traditional sources, would help alleviate the problem and enhance current planning.³⁰ Industry associations such as the Computing Technology Industry Association (CompTIA) and ITAA have attempted to segment the IT market and provide annual survey data. They also have undertaken occupational and skill categorization in partnership with industry and research organizations.

The National Workforce Center for Emerging Technologies (NWCET), with funding from the National Science Foundation and in partnership with CompTIA and the National Skills Standards Board, currently is developing skill standards for jobs in information technology.³¹ These skills standards will provide employers, workers, students, and educational institutions with information on the skills needed in IT occupations. These standards will be available free of charge. In addition, NWCET has developed an IT career website—or “E-Portal”—that disseminates important IT education information and job resources. The E-Portal is a clearinghouse for both IT workforce development research and best practices in IT training programs, stressing the connection between these educational programs and business. Finally, NWCET works with community colleges, secondary school districts, and four-year universities to develop partnerships with business and industry and provides professional development opportunities for high school and college instructors.

Some educational institutions and training providers in New Jersey have made a commitment to communicating with employers about their changing skill needs. For example, the faculty of one proprietary training school stays linked to employers by convening a Board of Industry Advisors for each of its academic IT programs. The Industry Advisors, often alumni, provide information on evolving work and technology, and occupational demand. They facilitate collaboration by sponsoring partnerships and mentoring opportunities in the areas of engineering and computer technology. Thus, the training organization was able to anticipate the downturn in the local telecom industry and the impacts of ongoing volatility in the IT labor market.

Strategies to Prepare Skilled, Qualified Entry-Level Workers

In New Jersey, several community colleges, including Camden, Mercer, and Brookdale, as well as proprietary schools, have created IT degree programs based on direct industry input regarding current demand. In addition, several high schools throughout the state have developed career academies that provide college credits and recognized certifications in the IT and other industries.

For example, Bergen Technical School has developed the Bergen Academies to train students for college and work opportunities. Among the eight academies are those that specialize in computer technology, based on an applied model of learning and utilizing state-of-the-art technical equipment and applications. Bergen developed these academies in partnership with companies such as Verizon, Dell, Apple Computer, SAP, and Cisco. The business partners provide onsite “learning labs,” as well as opportunities to experience the workplace environment. All graduates participate in mentoring and internship opportunities and complete a senior project to prepare for college and employment.

In a similar program, the National Academy Foundation (NAF) has established many Academies of Information Technology (AOIT), particularly in California and Rhode Island. For example, in California, approximately forty high schools function as IT career academies using the standard NAF guidelines and curriculum.

To access untapped labor pools to expand the IT workforce, Mercer County College—in partnership with its local WIB and the Chamber of Commerce—developed a new program to train low income and dislocated workers for entry level positions in the IT field, such as call center operators. Entrants into the twelve-week intensive program require applicants to have a high school degree. They finish with a certificate that qualifies them for occupations such as network administrator and web developer. In some cases, dislocated workers enter the program to update their existing IT skills. Some students also obtain college credit for their coursework.

The original impetus for these and similar grant initiatives has grown from the Central New Jersey IT Centers for Workforce Excellence at Mercer and Middlesex Community Colleges. These colleges work with businesses and individuals to strengthen the qualified IT workforce in Central Jersey. Once the grants are obtained through local public-private partnership initiatives, the colleges administer the training and track the workforce results.

V. Recommendations

1. Recommendations to Align Education and Training with the Needs of Employers

Adopt and Promote the Use of Existing Skills Standards:

The National Workforce Center for Emerging Technologies, with funding from the National Science Foundation and in partnership with Computing Technology Industry Association (CompTIA) and the National Skills Standards Board, currently is developing skill standards for jobs in information technology. For New Jersey to serve the needs of employers and IT workers, the state must adopt these skill standards and promote their use to educational institutions and employers.

Establish High Skills Partnership Institutes in Higher Education Institutions and Vocational Schools:

Stronger connections must be made between the needs of employers and the educational offerings of postsecondary and career-oriented vocational schools. Funds could be allocated for the infrastructure costs of creating new capacity to prepare job-seekers and incumbent workers with the education and skills needed for New Jersey’s competitive economy.

Working with New Jersey’s community and four-year colleges and other educational institutions, local training centers based on industry-accepted credentials would be created. These centers would target the workforce skill needs of key economic sectors and would work with those sectors to develop appropriate curriculum and training initiatives. These centers also would form the hub of new articulation agreements among educational providers. By emphasizing industry-based credentials, this initiative would create a substantive connection between the higher education and employer communities.

2. Recommendations to Prepare Skilled, Qualified Entry-Level Workers

Support the Career Academy Model: Career academies foster a “school within a school” model to teach students how to apply skills in a workplace setting. They combine industry-themed coursework with internships and other opportunities for exposure to the workplace. Employers can use partnerships with career academy schools to directly communicate with educators and potential workers regarding industry skill needs, as well as influence school curricula to enhance the delivery of training and education in many areas, from technical skills specific to certain job areas to workplace readiness skills that may be enhanced when taught in a work-based setting.

Schools benefit from relationships with employers, such as the Bergen Technical School’s liaison with Apple, Inc., in which the vendor supplies funding, planning, hardware, and training expertise to the school. Students are encouraged to view the company as a partner in their career exploration. In such cases, the students have the opportunity to earn employment certificates and/or college credits.

Encourage Industry/Education Partnerships: Employers, individuals, and educational institutions all benefit from the development of industry/education partnerships. In such partnerships, employers and educational leaders work together to ensure that the skills needed by employers are taught in the classroom. A variety of successful partnerships exist in the state and efforts should be made to publicize these as models that could be expanded and replicated.

A statewide conference for the IT industry could provide a forum for employers and educators to share information, form partnerships, and replicate promising practices. A website also could be developed to act as an information clearinghouse regarding evolving employer skill needs and promising responses being developed within the industry, as well as in the education and workforce development communities (see Figure 5.1).

Figure 5.1: Recommendations by Stakeholder

	State Government	Workforce Investment Boards	Secondary Education	Post Secondary Education	Employers/Associations
Recommendations to Align Education and Training with the Needs of Employers					
Adopt and Promote the Use of Existing Skills Standards	x	x	x	x	x
Establish High Skills Partnership Institutes in Higher Education Institutions and Vocational Schools	x		x	x	x
Recommendations to Prepare Skilled, Qualified Entry-Level Workers					
Support the Career Academy Model	x		x		x
Encourage Industry/Education Partnerships Through Conferences and an Information-Sharing Web Site	x	x	x	x	x

VI. Conclusion

As the U.S. economy continues its transition from industrial to digital, information technology and the software and hardware that support it increasingly pervade the workplace. As businesses of all types—both technology- and nontechnology-specific—depend increasingly on IT products and applications, so too do they depend on skilled IT workers. Unlike more self-contained and slower paced industries, information technology occupations are difficult both to quantify and predict as a uniform industry. As a result, supply and demand have fluctuated widely, as the industry underwent a rapid expansion, a “dot.com bust,” and a nascent recovery all in the space of little more than a decade.

Despite changes in supply and demand, the integration of information technology at work and home will only increase, fueling a demand for skilled, qualified workers. However, IT stakeholders struggle with the challenge of staying abreast of this constantly evolving industry. Issues such as the outsourcing of labor and the global nature of many aspects of the industry make a cogent strategy for labor market analysis even more problematic.

Employers in the IT industry are engaging in a number of initiatives to increase the supply of skilled workers and to align education and training programs with the needs of employers. The industry should continue and expand upon these efforts, partnering with educational institutions to develop much needed curriculum and degree and certificate programs and working with high school and college students to prepare them for careers in the industry. Skill standards are needed to guide employers and educators, and industry/education partnerships are the best vehicle for adopting such standards. To facilitate these partnerships, the New Jersey IT industry should provide a forum for employers and educators to share information, form partnerships, and replicate promising practices. By working together and creating initiatives that allow IT stakeholders to keep abreast of new technology, occupations, and skill needs, the IT industry can maximize New Jersey’s workforce and maintain a vibrant, economically powerful presence in the state.

⁸ A full discussion of the methodology used for this study is included in Appendix A

⁹ A full list of advisory group members is included in Appendix B.

¹⁰ A full list of focus group and interview participants is included in Appendix C.

¹¹ Bureau of Labor Statistics, United States Department of Labor. *Occupational Employment and Wages, 2002*. USDL 03-741. 19 November 2003. The occupations included in this calculation include: computer and information scientists (research), computer programmers, computer software engineers (applications), computer software engineers (systems software), computer support specialists, computer systems analysts, database administrators, network and computer systems administrators, network systems and data communications analysts, and computer and information systems managers.

¹² Bureau of Labor Statistics, United States Department of Labor. *Occupational Employment and Wages, 2001*. USDL 02-619. 6 November 2002.

¹³ US Department of Labor, Bureau of Labor Statistics, Career Guide to Industries. Computer and Data Processing Services. <http://www.bls.gov/oco/cg/cgs033.htm>.

¹⁴ Wage and employment data from: New Jersey Department of Labor, *Occupational Employment Statistics Wage Survey 2003 Edition*, January 2003. <http://www.wnjp.in.net/OneStopCareerCenter/LaborMarketInformation/lmi23/PAGE0006.HTM>

¹⁵ Projection data from New Jersey Department of Labor. *Estimated and Projected Employment by Occupation, 2000-2010*. <http://www.wnjp.in.state.nj.us/OneStopCareerCenter/LaborMarketInformation/lmi04/>

¹⁶ Information Technology Association of America. "Bridging the Gap: IT Skills for the New Millennium." April 2000. p. 10.

¹⁷ NYT, 7/22/03, IBM Explores Shift of White-Collar Jobs Overseas, Greenhouse, Steven.

¹⁸ Information Technology Association of America. "Demand for Workers at Historic Lows, More Positions Outsourced Overseas." May 2003. p. 1.

¹⁹ Wage data from New Jersey Department of Labor, *Occupational Employment Statistics Wage Survey 2003 Edition*, January 2003. <http://www.wnjp.in.net/OneStopCareerCenter/LaborMarketInformation/lmi23/TOC001.htm>

²⁰ Bureau of Labor Statistics, United States Department of Labor. *Occupational Employment and Wages, 2002*. USDL 03-741. 19 November 2003. The occupations included in this calculation include: computer and information scientists (research), computer programmers, computer software engineers (applications), computer software engineers (systems software), computer support specialists, computer systems analysts, database administrators, network and computer systems administrators, network systems and data communications analysts, and computer and information systems managers.

²¹ Ibid.

²² US Department of Labor, Bureau of Labor Statistics, Career Guide to Industries. Computer and Data Processing Services. <http://www.bls.gov/oco/cg/cgs033.htm>. This figure reflects projected growth for the combined group of the following IT occupations: computer programmers, computer and information scientists (research), computer systems analysts, computer software engineers (applications), computer software engineers (systems software), computer support specialists, database administrators, network and computer systems administrators, network systems and data communication analysts, all other computer specialists, and computer hardware engineers. Computer information and systems managers is not included in this group; their projected growth over the same period (and from the same source) is expected to be 81.3%.

²³ Wage and employment data from: New Jersey Department of Labor, *Occupational Employment Statistics Wage Survey 2003 Edition*, January 2003. <http://www.wnjp.in.net/OneStopCareerCenter/LaborMarketInformation/lmi23/PAGE0006.HTM>

²⁴ Wage and employment data from: New Jersey Department of Labor, *Occupational Employment Statistics Wage Survey 2003 Edition*, January 2003. <http://www.wnjp.in.net/OneStopCareerCenter/LaborMarketInformation/lmi23/PAGE0006.HTM>

²⁵ Projection data from New Jersey Department of Labor. *Estimated and Projected Employment by Occupation, 2000-2010*. <http://www.wnjp.in.state.nj.us/OneStopCareerCenter/LaborMarketInformation/lmi04/>

²⁶ New Jersey Department of Labor, *Occupational Employment Projections, 2000-2010, November 2002*, <<http://www.wnjp.in.net/OneStopCareerCenter/LaborMarketInformation/lmi04/state/index.html#occ>> (21 August 2003).

²⁷ New Jersey Department of Labor, *Occupational Employment Statistics Wage Survey 2003 Edition*, January 2003, <<http://www.wnjp.in.state.nj.us/OneStopCareerCenter/LaborMarketInformation/lmi23/index.html>> (21 August 2003).

²⁸ Core competencies are a cluster of skills, knowledge, and abilities a worker needs to master to perform these jobs.

²⁹ "Gap in 4 Key Professional Categories Represents \$2.9B", Lifelong Learning Market Report 10887512, 8/8/2001 Vol. 6 Issue 15

³⁰ The Supply of IT Workers in the U.S., Freeman, Peter, and Asprey, William, Computing Research Assoc. 1999, p.121

³¹ National Workforce Center for Emerging Technologies, Bellevue Community College. Accessed at <http://www.nwct.otg/About/Current.aspx>.

Appendix A: Methodology

Methodology for Industry Reports

The Workforce Investment Boards of Bergen, Cumberland/Salem, Hudson, Mercer, and Passaic Counties, in partnership with the New Jersey State Employment and Training Commission, selected the industries for study based on their prevalence in the state and regional economies, their current employment rate, and their potential for job creation.

The Heldrich Center, with input from each WIB, conducted a thorough literature search, or “knowledge inventory,” for each industry. The Heldrich Center compiled background research using the Internet and published research reports on the current and emerging national and state trends, and focused on emerging trends and growth projections in the selected industries. The knowledge inventory formed the basis of the industry reports.

The Heldrich Center utilized New Jersey Department of Labor Labor Market Information (LMI) data to create a list of occupations for each industry. The primary criterion was gross openings and expected growth. The secondary criterion was occupations with a shortage of qualified workers and those that displayed a diversity of income and educational levels. The Heldrich Center created a ranking of occupations for review by the WIBs. The WIBs, based on input from each Industry Advisory Committee, selected a subset of occupations for study that represented the above criteria and/or their own experience within the industry.

The WIBs convened an advisory group for each industry to guide the project. The advisory group consisted of employers and other key industry stakeholders. The advisory group aided in the selection of occupations for study and provided input regarding report recommendations. The groups met twice throughout the project.

The Workforce Investment Boards, with assistance from the Heldrich Center, Cumberland County College, Mercer County College, and William Paterson University, convened four or more focus groups for each industry. These focus groups were facilitated by the Heldrich Center, and included industry and educational representatives. In addition, the Heldrich Center and its research partners conducted ten or more phone interviews per industry with human resource or key operations managers regarding current and future skill issues and requirements.

Appendix B: Advisory Group Members

Jack Black	Extel Communications
Roger Carey	Middlesex One-Stop Career Center
Dan DeMarinus	Mitre Corporation
Aubrey Hewitt	AT&T
Ray Ingram	Mercer County Community College
Vickie Pecchioli	Ocean County Workforce Investment Board
Joan Raiss	New Jersey Technology Council
Sharon Rosengart	DeVry College of Technology

Appendix C: Focus Group and Interview Participants

Frank Albuquerque	Rudolph Technologies
Maxine Ballen	New Jersey Technology Council
Tracy Bauer	AT&T
Peter Berry	BP Natural Gas
Marlon Browne	Duke Energy
Diane Campbell	Mercer County Community College
Ed Condiracci	Electronics Design Group, Inc.
Dan DeFrancesco	Hudson County Community College
Paul DeShane	Raritan Community College
John Drury	Cortland Technologies
Tom Flynn	Electric Vine Interactive
Mark Heim	Independent Consultant
Ray Ingram	Mercer County Community College
Craig Lambert	McCann Erickson Worldwide
Arnold Mercer	New Jersey Highway Authority
Paul Morin	Cisco Systems
Diane Nerby	Unleash, Inc
Joe Nigro	Canon Business Solutions
Sarah Lee Pindar	Independent Consultant
Richard Pucciarelli	CRT Support Corporation
Tom Richie	Extel Communications
Barbara Ryder	Rutgers University
Ken Saloway	Society for Information Management
Lou Samara	Laboratory Management Systems, Inc.
Tino Sigismondi	Powerware Global Services
Gale Tenen-Spak	New Jersey Institute of Technology
Mark Tomaino	Quest Communications
Chungli Tsai	Panasonic

Appendix D: Profile of Selected Occupations

1. SYSTEMS ANALYSTS

Systems analysts translate the needs of users into systems requirements for architects and programmers to utilize in system design and implementation. The systems analyst serves as a liaison between the users who can describe processes and applications they need to operate, and the technical community who may purchase, integrate, design, or enhance software to meet the users' specific needs. Analysts prioritize or resolve conflict among user needs, relate applications to existing systems and helps resolve process issues hindering automation. Analysts develop appropriate models or tools that may be used to describe the requirements. Once the systems are implemented, analysts may help with the test or training phases. Finally, they are called in when upgrades or new releases are contemplated.

To perform these functions, analysts typically have a two- or four-year degree and on-the-job training. They often are specialists in particular types of software or systems, and they must maintain current knowledge in their special discipline. Additional desired skill sets for the analyst include critical thinking, teamwork and interpersonal skills, good written and oral communications, and knowledge of the industry or discipline their systems support. In an environment where more IT work is farmed out to contractors, the analysts may work in-house or for the contractors. They still retain the central role of deriving and validating a set of requirements that truly reflect the client organization's needs and which can be clearly communicated to one or more vendors.

2. PROGRAMMERS

Programmers typically translate specifications from analysts and others into detailed logical flowcharts that are used to write computer software. The software is designed to process, store, and retrieve information. The title Programmer describes the function of original software development in its most advanced state, using a variety of languages and tools. Or at the entry level, it may describe a relatively simpler function of coding according to a well-articulated design or script, where knowledge of the coding language is the primary skill. In either case, programmers will write, compile, and debug programs that meet the predetermined user needs. They institute quality assurance procedures and test phases to guide implementation of specific pieces of software or for entire new systems.

Programming usually requires a two- or four-year degree with on-the-job training and specific technical training on various languages and tools. Excellent math skills, problem-solving ability, and conceptual ability are key skills for programmer occupations. Programmers are called upon to synthesize information well and to exhibit good reasoning skills. Knowledge of systems technology or architecture such as mainframe, distributed or web-based computing and networking also are considered important by employers hiring programmers. Software developers or programmers must also maintain current knowledge of relevant software languages and tools as they evolve, even though newer releases of software seek to automate some of the lower level programming and test functions.

3. COMPUTER AND INFORMATION SYSTEMS SCIENTISTS, RESEARCH

Computer scientists need a four-year degree, often including graduate, work as well. These scientists work on engineering, design, and problem solving relative to hardware, firmware, and software, usually for large and critical systems. They increasingly work on problems of system integration and security-related issues. Their original or conceptual work may be done in a research firm or as part of the IT or R&D department in a business. In addition to related math and science knowledge, key skills for this type of occupation are considered to be decision making, teamwork, innovative thinking, and attention to detail.

Employers believe that the computer science function is a strategic one, which can help new or existing firms develop a competitive edge. Especially valued are computer scientists who can understand business, industry, or process concepts and solve problems or tailor innovative solutions that exploit the commercial value of their work. Entrepreneurial or risk taking qualities are important in computer science research. Increasingly, computer scientists are not simply researchers who work alone for years on abstract concepts that may eventually become useful. They are team members who possess special knowledge and expertise that must be integrated with the firm's output on an ongoing basis. Computers scientists with proven industry experience are in demand worldwide in the private and the public sector.

4. COMPUTER SUPPORT SPECIALISTS

ment regarding when to escalate to a higher level of expertise. Some employers believe that support specialists are key to maintaining customer loyalty and they look for good interpersonal skills and a high degree of initiative in support specialist recruits. They also maintain that competent support specialists can aspire to positions in the sales or managerial ranks.

5. PROGRAM/PROJECT MANAGERS

Project manager are responsible for planning, executing, and closing out major projects. Program managers are responsible for results from groups of projects in related areas. While all staff may perform some degree of project management work, those who are responsible for critical, large, or complex projects are designated full time project manager and learn specialized project management skills. In technical areas, such as information technology, full time or specialized project management is common. The management skills project managers need are time/budget management, quality and risk analysis, communications, and procurement. In addition, they need technical skills related to the discipline of the project such as design, development, engineering, or system integration/implementation. Project managers require team leadership and facilitation skills.

Most employers agree that effective project managers should possess a four-year college degree, relevant work experience and technical training in their related discipline. It is important for the project manager to possess business and industry knowledge, to interact with the customer and insure a cost effective outcome. Many installations of IT products and services are large and complex. Projects often involve lengthy periods of conceptualization and positioning. They also require extensive planning, coordination, and execution on the part of multiple organizations. Seasoned program/project managers are highly valuable to their organizations. They may progress to more senior managerial or technical positions following successful program management work.

6. COMPUTER AND INFORMATION SYSTEMS MANAGERS

Computer and information systems managers supervise analysts, engineers, developers, sales, and support personnel. These managers must have a technical background and experience comparable to those they supervise. The manager's job involves leadership and employee development supporting technical work. The manager typically is responsible for quality and timeliness of project output, schedules, budgets, and interaction with senior management regarding the department's work. The manager participates in staffing and promotional decisions and disciplines workers. Frequently, the manager will interact with customers to insure resolution of problems and customer satisfaction. Managerial potential is assessed separately from technical acumen. Computer and information systems managers often are recruited from the technical ranks. However, not all high performing technical workers have the desire or ability to make the transition to supervisory work, since it involves a set of skills and tasks that are primarily managerial, rather than purely technical, in nature.

Managers are typically required to have four-year college degrees and significant on-the-job experience (three to five years), before assuming their positions. They must keep current with technical developments in their field to interact with employees and customers, as well as to assess project proposals and feasibility. Their key skills include vision, planning, and leadership, as well as good interpersonal understanding and advanced communication skills. Good managers rely heavily on analytical skills and the ability to be assertive and decisive in their interactions with team members, employees, and customers.

7. DATABASE ADMINISTRATORS

The database administrator manages the database application for users. This involves planning, implementation, testing, updating, and training with regard to one or more database applications. Database administrators play a crucial role in understanding and implementing procedures to maintain database security. In addition, the administrator may write database descriptions, code parameters for the database, and specify identifiers used to access or report out information from the database by various users or user groups. Database administrators receive and process requests for changes to the database information. The administrator is responsible for fine tuning and managing database performance. From a user's perspective, it is the database administrator who specifies definitions, insures data integrity, and is responsible for determining and implementing levels of system access.

Typically, database administrators have a two- or four-year college degree plus technical training on database applications, which may be obtained on the job. Key skills for this position include: mathematical reasoning, needs analysis, technology design and troubleshooting, data-driven decision making, and, in some cases, instructional ability.

8. NETWORK AND COMPUTER SYSTEMS ADMINISTRATORS

The network and computer systems administrator manages the network applications and interfaces for users. This involves planning, implementation, testing, updating, and training with regard to one or more network applications. Network administrators play a crucial role in understanding and implementing procedures to maintain network security. In addition, the administrator may describe and code parameters for the network and specify identifiers used to access the network by various users or user groups. Network administrators receive and process requests for changes to application or network access. The administrator is responsible for fine tuning and managing network performance. Network administrators monitor and address security risks to networks, including the use of preventive measures. They must remain up to date on security threats and software interventions, as well as their effects on downstream systems. When network changes are made, the administrator communicates the appropriate requirements to other analysts or systems administrators.

Generally, network administrators will attain a two- or four-year college degree plus technical training on networks and applications, which may be obtained on the job. Key skills for this position include: mathematical reasoning, needs analysis, risk assessment, technology design and troubleshooting, data driven decision making, and, in some cases, instructional ability. The network administrators help to determine the need for and implementation of firewall technology, or interaction between Internet, Intranet, and Extranet applications.

9. COMPUTER SOFTWARE ENGINEERS, APPLICATIONS

The computer applications engineers devise or analyze software requirements. The requirements are used to test and integrate system components in conjunction with the software to insure system operation and maintenance. Engineers project and balance system capability, specifically volumes and workload handling, which they optimize for the applications and the environment, insuring overall system performance. The software applications engineer may plan the layout or modification of new and existing systems, usually working closely with teams of managers, analysts, developers, and other engineers. Engineers estimate and calculate costs associated with system performance variables. They may be involved in formulating software designs, using mathematical models to predict and measure the outcome of the design. Engineers help supervise installations, monitor system functions, and troubleshoot problems. They also may advise customers on proper system maintenance, including setting up an appropriate environment for the system installation. Engineers help integrate and implement web-based applications or enterprise architecture.

Engineers require a four-year college degree, and possibly graduate work, as well. Much of their learning also takes place on the job, and through ongoing technical training. Key skills for the applications software engineer is: mathematical reasoning, information gathering and ordering, teamwork skills, evaluation and analytical thinking, problem solving, and decision making. Engineer's database and software tools are becoming increasingly sophisticated, allowing the engineers to apply more creative and analytical skill to their work.

10. COMPUTER SOFTWARE ENGINEERS, SYSTEMS SOFTWARE

The computer systems software engineers devise or analyze system software requirements. They work in conjunction with the systems architects to determine how processes will be automated and/or interact with existing systems platforms and networks. The requirements are used to test and integrate system components in conjunction with the software to insure system operation and maintenance. Systems software engineers project and balance system capability (specifically volumes and workload handling), which they optimize for the application and the environment, insuring overall system performance. The systems software engineer may plan the layout or modification of new and existing systems, usually working closely with teams of managers, analysts, developers, and other engineers. Engineers estimate and calculate costs associated with system performance variables. They may be involved in formulating software designs using mathematical models to predict and measure the outcome of the design. Engineers help supervise installations, monitor system functions, and troubleshoot problems. They also may advise customers on proper system maintenance, including setting up an appropriate environment for the system installation, and user access.

Engineers require a four-year college degree, and possibly graduate work, as well. Much of their learning also takes place on the job and through ongoing technical training. Key skills for the engineer is: mathematical reasoning, information gathering and ordering, teamwork skills, evaluation and analytical thinking, problem solving, and decision making. Engineer's database and software tools are becoming increasingly sophisticated, allowing the engineers to apply more creative and analytical skill to their work.