

# Ready for Tomorrow: Demand-Side Emerging Skills for the 21st Century

A Report of the New Jersey  
State Employment and  
Training Commission

James E. McGreevey, Governor



Prepared by the  
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## Preface and Acknowledgements

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# Demand-Side Emerging Skills for the 21<sup>st</sup> Century

## Executive Summary

As part of the *Ready for the Job* demand-side skill assessment for the New Jersey State Employment and Training Commission (SETC), the Heldrich Center for Workforce Development conducted an investigation of emerging work and skills that will affect New Jersey's workforce in the next three to five years, focusing on the education and training issues that must



be addressed to prepare current and future workers for these opportunities. Through focus groups and interviews with 25 economic forecasters and key individuals in New Jersey's growth sectors, the Heldrich Center identified five specific areas likely to generate significant new skill demands in the New Jersey labor market within the foreseeable future. By identifying the trends and skill information in these areas, this report provides lead time for the workforce development system to respond to changes in technology and the marketplace.

The analysis identified five New Jersey industry sectors that are established leaders in research and development (R&D) and have demonstrated success in bringing emerging technologies to market. The five areas are:

- biotechnology (including medical devices)
- security (both data and physical)
- e-learning
- e-commerce, and
- food/agribusiness.

Biotechnology (biotech) and food already have significant economic presence in New Jersey, and are now moving into new growth areas. E-commerce, e-learning, and security are emerging in various parts of the country, and New Jersey has a significant infrastructure to support these areas. Each has corresponding occupational areas that are undergoing rapid change, where new skills are or will be required.

## Findings: Skills Trends Across Emerging Work

Economic forecasters and industry experts identified several areas of skills and training that will be in demand by employers in the future. Regardless of the area or industry, experts identified the following as imperative for future workers:



## Emerging Areas of Work and Skills Food/Agribusiness

Emerging Work	Emerging Skills
Domestic/international logisticians Food chemists Packaging materials engineers Developers of food supplements Developers of nutraceuticals Bio-engineers	Automated Plant Operation Packaging Technology/Design Web-based Marketing and Delivery Food Handling/Safety Planning/Design of Web-based Services(especially prepared foods) Food Industry Management Dietary/medical training for food industry <b>Related Knowledge</b> HACCP (Hazard Analysis-Critical Control Points) Environmental Health and Safety Regulations

1. **Strong math, science, and technology base, as well as specialized science skills.** Experts agree that emerging occupational areas will require workers to have a strong math, science, and technology base. In addition, emerging science and technology in New Jersey's growth areas will require new types of specialized science skills for professional workers. For example, in the bio-technology industry new specialized skills center around genomics, bioinformatics, and DNA chip technology.

In addition, New Jersey's food/agribusiness sector industry is dominated by jobs in research and development, packaging, and marketing. The evolution of technology suggests that more of the industry's jobs will require specialized skills in molecular biology, applied chemistry, or the development and design of new packaging materials. The leading edge of the food industry employs a variety of chemists, engineers, logisticians, and electronic marketing experts, to name a few high demand areas.

2. **Teamwork and communication skills.** Modern work, particularly in high-tech and cutting-edge industries such as those in New Jersey, is based increasingly upon the use of project teams.

For example, e-commerce is an emerging integrated approach to marketing, communications, strategy, and business consulting. Both the marketing and information technology (IT) professionals in firms and their partners in ad agencies must work together to produce the best result for the client.

The e-learning and training industry depends heavily on teams to create effective educational tools. Content developers, software developers, and industry specialists work together to develop and deliver useful training to adults in the new economy. Content developers have the knowledge and experience with strategies to help adult learners learn new material. Software developers hold the key to making e-learning programs user-friendly, attractive, and functional.

## Emerging Areas of Work and Skills E-Commerce

Emerging Work	Emerging Skills
Program/Project Managers Web Programmers/Content Developers E-Business Marketing Teams E-Branding Turnkey Software Application Providers	Activity Based Costing Project Management Software Tools Global Workforce Management Outsourced Contract Management Web Service Architects Negotiation/Conflict Resolution Collaboration <b>Related Knowledge</b> XML (Extensible Mark-up Language) SOAP (Simple Object Access Protocol) WSDL (Web Services Descriptive Language) HTTP and TCP/IP (Transmission Protocols) Web-based marketing, fulfillment and back office solutions

## Emerging Areas of Work and Skills E-Learning

Emerging Work	Emerging Skills
Content developers Software developers Network managers Database managers Industry specialists Education specialists Trained instructors	Computer skills for instructors Teamwork Curriculum coordination Monitoring and evaluation of e-learning Network management and technology <b>Related Knowledge</b> Logistics





## Emerging Areas of Work and Skills Security

Emerging Work	Emerging Skills
Logisticians	Analyzing Structure for fire, impact, blast
Structural Designers	Simulation and testing
Structural Engineers	Data integration/fusion
Infrastructure Managers	Platform IT
Researchers/Statisticians	Versatility
IT support	Multidisciplinary ability
Systems development	Entrepreneurial
Sensor development	Related Knowledge
Sensor readers	Statistics
Field testers	Pattern Recognition
Support workers (i.e. guards, call center operators)	Math
Forensic investigators	Phycis
Disaster recovery	

- 3. Entrepreneurship/business skills.** Industries need workers who possess both research skills and the entrepreneurial drive and business acumen necessary for advancement in the marketplace.

In the biotechnology industry, researchers involved in the increasingly competitive area of new product development must possess both strong technical skills and strong project management and business development skills.

Similarly, rapidly emerging security areas require professionals with the technical background to understand and create new technology, as well as the entrepreneurial drive and management skills to make a cutting-edge sector thrive.

- 4. Interdisciplinary knowledge.** Emerging trends will require workers with skills and training across disciplines.

For example, within the biotech industry, highly skilled, hard-to-fill jobs usually require a minimum of a 4-year degree and, in many cases, graduate study as well. Scientists with interdisciplinary skills either within the sciences or in combination with other degrees are particularly hard to find. For example, entrepreneurs and professionals supporting leading edge regulatory or intellectual property endeavors require advanced scientific knowledge in their fields.

## Emerging Areas of Work and Skills Biotechnology/Pharmaceuticals

Emerging Work	Emerging Skills
<b>Scientists/Researchers</b>	Advanced laboratory
Chemists (medicinal, combinatorial, analytical, computational)	Project management/business development
Molecular biologists	Clinical
Chemical engineers	Cross disciplinary skills in science and technology
Pharmacists	Entrepreneurship
Biostatisticians	Computer Applications
<b>IT support</b>	
<b>Regulatory</b>	
<b>Bioinformatics</b>	
<b>Support occupations</b>	
Building maintenance/facilities management	
<b>Planners</b>	
<b>Glass washers</b>	

# Recommendations: Improve Education and Training in New Jersey

The Heldrich Center has identified several strategies to improve student and worker education and training in New Jersey. While some strategies apply to the secondary and post-secondary educational systems, others impact incumbent or laid-off workers in need of retraining.

## 1. Middle school and high school education

- *Accelerate and integrate math and science education.* Math and science need to be accelerated in high school so students have a chance to complete higher-level coursework before they enter college.
- *Expand career awareness.* Middle school and high school students need more direct exposure to the world of work and career awareness education, including career days, industry and occupational descriptions, and career counseling. In addition, student mentoring and summer opportunities will provide them with a better understanding of their career opportunities, of the work they wish to pursue, and of the education and training they need to succeed.

## 2. Post-secondary education—college/university

- *Increase cross-discipline training across majors and across subfields within majors.* Increasing integration of various areas of science, technology, and engineering in the emerging areas will require workers with education and training across a number of disciplines. Colleges and universities should respond to this private sector need and encourage cross-discipline training for their students.

- *Develop applied learning/internships/field projects through partnerships with private industry.* Colleges and universities should develop more internship programs for their students so that they can gain valuable skills before entering the job market. Similarly, field projects and practicums provide students with the opportunity to apply their learning in a controlled environment where faculty and staff can provide guidance and support.

## 3. Public Workforce Development System

- *Initiate sectoral approaches through public/private partnerships.* Only by forming partnerships with firms in growth industries will the public system be able to design and deliver training that will result in stable employment for trainees. These partnerships must have the dual purpose of helping employers to meet their needs for skilled employees and of assisting individuals to obtain employment.
- *Develop a process for updating education and employment information.* Using web-based and other tools, the public workforce development system must develop strategies to continually update and disseminate information on the constantly changing skill needs, education requirements and career opportunities to all students, career counselors, job seekers, and employers.

# Demand-Side Emerging Skills for the 21<sup>st</sup> Century

## II. Introduction and Methodology

To meet employers' skill demands over the next three to five years, it is critical that the state's workforce development system anticipate the emergence of work and skills that will be in high demand in New Jersey's key economic areas. To that end, this report describes several key emerging occupational areas and corresponding new skills. These findings are based on focus groups and interviews with 25 economic and technology forecasters and industry specialists (see Appendix C for a list of contributors).

### Emerging Trends Meeting

In December 2002, the Heldrich Center and the New Jersey Commission on Science and Technology (NJCST) convened a meeting of nine economic and technology forecasters and industry specialists to identify current and emerging trends influencing demand for skilled workers nationally and in New Jersey over the next three to five years. During this meeting, participants identified the fastest growing industrial sectors in New Jersey and the developments in science and technology that will lead to job growth and changes in work.

### Focus Groups

In January 2003, the Heldrich Center and the Commission on Science and Technology convened focus groups to further explore current and emerging trends in biotechnology/pharmaceutical and security (both physical and data) and to identify the skills that these trends may require. The NJCST identified key individuals from these emerging industries to participate in the sessions. Participants were asked to identify the fields within these industries that will be most important, the types of work that will emerge and the required skills, and the preparation that is necessary for these fields. Focus group participants also discussed the challenges and opportunities that employers face in these industries in identifying, recruiting, and hiring qualified employees.

### Telephone Interviews

For the remaining emerging industries discussed during the December forecaster meeting (food, e-commerce, and e-learning), the Heldrich Center conducted telephone interviews to explore further current and emerging trends and to identify the skills that these trends may require. The NJCST identified key individuals from these emerging industries to be contacted for interviews. Interviewees were asked to identify the fields

within these industries that will be most important, the types of work that will emerge and the required skills, and the preparation that is necessary for these fields. They were also asked to discuss the challenges and opportunities that employers face in these industries in identifying, recruiting, and hiring qualified employees.

### Secondary Research

The Heldrich Center compiled background research using the Internet and published research reports on the current and emerging trends identified by participants. This research focused on emerging trends and growth projections in the identified fields. Given the fact that these industries are emerging, the amount of information available varied. In such cases, the Heldrich Center focused on the information gathered from experts in the emerging trends meeting, focus groups, and telephone interviews.

## III. Emerging Skill Needs of Specific Industry Sectors

Five specific areas are likely to generate significant new skill demands in the New Jersey labor market within the foreseeable future, according to economic and technology forecasters and industry specialists. These five areas include biotechnology (including medical devices), security (both data and physical), e-learning, e-commerce, and the food industry. Each has corresponding occupational areas that are undergoing rapid change, where new skills are or will be required.

The emerging skill industries share certain characteristics. They are major research and development (R&D) spenders, and have already introduced emerging technologies to the marketplace. Biotechnology (biotech) and food already have significant economic presence in New Jersey, and are now moving into new growth areas. E-commerce, e-learning, and security are emerging in various parts of the country, and New Jersey has a significant infrastructure to support these areas. Each of the areas except agribusiness is experiencing increasing global outsourcing of knowledge work. Forrester Research, a high technology consulting group, estimates that the overall level of such outsourcing in the service sector will top 3 million jobs by 2015, up from a current total of 400,000. In order to partially balance this trend it is important to maintain a strong emerging skill base in New Jersey. Each emerging skill area is covered in detail in this report, including:

## Biotechnology

New Jersey is headquarters to several of the world's largest pharmaceutical companies and has a strong infrastructure of research labs. According to a recent Standard and Poors study, medical substances and devices are the second largest area of growth and research and development investment in the United States today (VentureSource 2002). In addition, venture capital has taken an interest in the biotech industry and has invested funds in new development, as have government agencies.

## Security

The growth in homeland security interests will lead to growth in several industry sectors. Participants in this study believe that the skilled workforce in New Jersey and the close proximity of the state to many potential terrorist targets should open the possibilities to the growing military/security area. The area encompasses major R&D spending, as well as engineering and production facilities, leaving the industry well positioned to attract federal and state government funding. In addition to physical defense, New Jersey is uniquely positioned, due to its high-tech labor force, to be at the forefront of data/information security.

## Electronic Commerce

Trillions of dollars are currently flowing through business-to-business and business-to-consumer electronic channels, a trend that will continue and accelerate worldwide (E-Volve-or-Die.com 2003). While traditional businesses are developing e-commerce strategies, new service firms, principally in the marketing and IT areas, have sprung up to support the trend. Firms that have embarked on extensive e-commerce strategies have incorporated web-based systems internally and externally, to reduce costs, increase sales, and achieve higher levels of customer service. In many cases, firms cannot afford to ignore the trend toward electronic business because their competitors have embraced it. The value of a firm's e-commerce marketing plans, service strategies, and process improvement is determined by the quality of their plan and execution. Employee skill sets play a crucial role in the firm's transition and successful execution of e-commerce business practices. The location of e-commerce service implementation typically coincides with the departments affected by the change, including IT and headquarters locations. Though design and support for e-commerce applications is part of the growing trend toward services outsourcing overseas, participants in this study remain optimistic regarding job growth. They believe that the local talent base aids New Jersey substantially in implementing e-commerce driven plans and technology.

## E-Learning and Training

Rapid changes in technology and the effects of globalization have created a labor market in which skill demands may alter significantly during the course of an individual's career. The useful life for skills is shortening and increasingly people will need to retool and retrain mid-career. This will pose some challenges for the labor force, including ensuring time for, and access to, training for all workers. This trend—plus a growing incidence of certification and testing—prompts the need for more sophisticated software and delivery mechanisms. Unfortunately, the New Jersey public workforce development system is not equipped to deal with this problem for the entire workforce, particularly high-skilled labor. Participants believe that private industry demands for training services will continue to increase exponentially and private training, both web-based and on site, is an emerging industry with potential for massive growth. Virtual training firms can locate wherever the business climate is most hospitable to them.

## Agribusiness and Food

The food sector is a significant employer and revenue producer in New Jersey, despite the fact that agriculture has been on a steady decline in the state. However, the food industry encompasses more activities than the growing of food and cash crops. In New Jersey, institutions such as Cook College at Rutgers, the State University of New Jersey, are conducting new research on nutraceuticals, the use of foods for health reasons. People interviewed for this report believe that opportunities exist in newer high margin or custom areas, not only as a result of health and nutrition consciousness, but also consumers' increasing preoccupation with convenience and prepared foods. New Jersey's large numbers of moderate to high-income residents are stimulating the demand for high-quality prepared and packaged foods. These trends are fueling a corresponding need for more food research, expanded outlets, and a variety of new packaging alternatives.



## A. Biotechnology

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### Industry Description

The biotechnology (biotech) industry is a key economic development area courted by states and municipalities across the U.S. In last year's Department of Commerce (DOC) survey, 80% of respondents placed biotechnology as their first or second priority for development (U.S. Dept. of Commerce 2001). The industry itself is still in a nascent stage, comprising approximately 180,000 employees in thousands of small firms nationwide (not including start-up divisions of larger, more established firms). The industry's segments are broad, including medical devices, diagnostics, biopharmaceuticals, protein development, and bioinformatics. Biotech employers need workers with an equally broad range of scientific and technology skills. For this reason, the chief draw for biotech divisions or companies is proximity to world-class research universities and hospitals.

In addition to research facilities and personnel, biotech start-ups have responded favorably to locales with established pharmaceutical industries, favorable regulatory climates, and states experienced in attracting new, high-tech firms. New Jersey has maintained its interest and pace of development in biotech thus far, due to its preponderance of research institutions and its pharmaceutical industry.

Employment is not difficult to find in the industry's professional ranks due to the highly specialized nature of the work. Many of the top research and managerial jobs require graduate degrees and continual training. According to a 1999 Virginia survey, the average wage in the industry topped \$54,000 (*New York Times* 4/6/03). This is another reason why the growth of biotech firms seems like a worthy development goal. Yet the rate of failure for new biotech firms is also high. Such firms take an average of fifteen years to become profitable, and many such firms never do so (*New York Times* 4/6/03). Firms with solid government and/or academic partnerships tend to have more staying power, but the crucial factor is often the viability of the technology itself.

For this reason, some states have chosen to specialize in an industry niche, hoping to circumvent the already intense competition for firms, scientists, and jobs. Some of these niches are agricultural and veterinary products, industry-specific bioinformatics, and drug manufacturing for biotech companies.

## Overall Trends

While there are certainly new opportunities opening up in the diverse biotechnology field, the industry finds itself losing qualified workers and struggling to replace them. In some cases, workers are moving to other locations, hoping for a better opportunity within the industry. More risk-averse workers are leaving biotech for other industries. In an industry with failure rates for new companies estimated at 9% per year, and in which many companies need 15 years to achieve profitability, stability is not readily found (*New York Times* 4/6/03). That, plus the drain of graduates seeking careers in academia or returning to their home countries for work, has made the labor market tight for biotech firms.

In addition, training needs are critical at all levels of the industry, due to rapidly changing technology. Employees typically consider ongoing education a benefit, but it is expensive for companies to provide, particularly in a start-up mode. Many companies have tried to nurture academic partnerships to fill the recruiting and training void. At the same time, academic institutions complain that there is not sufficient entrepreneurial talent to commercialize their research.

New Jersey has yet to emerge as a niche market in this broad field. To some degree, New Jersey biotech firms have tended toward therapeutic research and development. Venture capital spending in the biotechnology industry would suggest that biopharmaceutical research and products currently hold the greatest potential, given New Jersey's status in the pharmaceutical industry (Prior and James 2001). However, firms in the growing biotech business are concerned that among the original Fortune 200 pharmaceutical companies in New Jersey, many have retained research in the state but transferred manufacturing and some other functions out of the state. The symbiotic chain of support between large and small companies aids the growth of both pharmaceutical and biotech firms and, arguably, helps attract new business and employees. The large pharmaceutical presence, for as long as it can be maintained, should be viewed as giving New Jersey a key advantage in the competition with other states for biotech business.

Other trends in the industry affecting biotech opportunity are research concerning in utero disease prevention and chronic disease management. The latter also has led to research and innovations in packaging and dosage administration, increasing the science component required for work at almost all levels in the industry. Volume of demand also is increasing due to the aging of the Baby Boomer generation that, in turn, fuels investment in research, treatment, diagnostics, and service products, with corresponding implications for biotech.

## Emerging Work and Skills

### Specialized scientific/technical skills

The hard-to-fill jobs in the biotechnology sector are at the top end of the skill continuum. They often require a minimum of a 4-year degree, and in many cases, graduate study as well. Scientists with interdisciplinary skills either within the sciences or in combination with other degrees are particularly hard to find. Technical employees who possess business skills and understanding are at a premium. Industry leaders believe specialized scientific or other skills are determined very early in a student's educational career. Some technical workers have also found it fruitful to acquire technical writing, illustrating, legal, or regulatory knowledge. Still others have branched out into lab facilities design and management. These subspecialties require growing amounts of scientific and technical background. The industry, including the biotech sector, finds itself at a crossroads where scientists are in heavy demand and require supplemental skills in non-scientific disciplines such as project management. Correspondingly, non-technical business, IT or regulatory/legal workers require increasing amounts of scientific background to excel at their jobs. The competition for these types of workers, who are often trained in the U.S., is global.

### Support Workers

The industry offers technical specialty occupational growth for maintenance and support workers, though they must be trained on the job. Those who work in and around the laboratory environment must be trained in how to handle and dispose of bio-waste, how to clean and maintain the glass and other specialized equipment, as well as other techniques related to making the lab function according to industry and government standards. The standards are constantly evolving. This places a non-negotiable training requirement on the companies, who have mostly been coping with it individually. For very small biotech firms, this is a heavy burden.

### Work Experience

Partly due to training costs, companies are interested in employees at all levels with work experience. For example, when scientists graduate, they often have little applied knowledge or clinical experience. IT professionals, newly trained or migrating from other industries, have little knowledge of state-of-the-art clinical and research systems. Newer disciplines such as bioinformatics, which support industry development, are still emerging on college campuses. Demand in areas like these is hard to quantify, so educators often do not perceive such needs

on a timely basis. Recruiting lecturers from industry and establishing quality internships is also not easily done in today's economic climate.

## Challenges and Opportunities

Many of the challenges facing the industry today are related to finding and retaining qualified employees who possess the emerging skill sets required by the industry. Skills needed to work in health sciences and biotech, in particular, generally are considered non-transferable. This means that unemployed engineering and IT employees cannot readily go to work in the biotech industry without specialized training. Similarly, students coming out of college or graduate school with a degree in an appropriate field need related work experience to increase their value. Industry human resource (HR) managers express little optimism regarding traditional techniques for recruiting. Their biggest gap currently is business skills for technical professionals.

Technical skills in this field change very rapidly. New methods must be adopted to help spread the cost of training and to make training more readily available and convenient for workers. As in many industries featuring high-tech workers, there is a need to increase interpersonal, project management, team, and leadership skills within the scientific context. Separately, there is a deficit of business skills and understanding for technical workers. This requirement is primarily a function of lowering costs and increasing speed to market. Technical workers who have business skills generally make more effective team members, as well. Since most scientific development and prod-

### Biotechnology Emerging Work and Skills

#### Emerging Work

##### Scientists/Researchers

- Chemists (medicinal, combinatorial, analytical, computational)
- Molecular biologists
- Chemical engineers
- Pharmacists
- Biostatisticians

##### IT support

##### Regulatory

##### Bioinformatics

##### Support occupations

- Building maintenance/ facilities management
- Planners
- Glass washers

#### Emerging Skills

Advanced laboratory

Project management/business development

Clinical

Cross-disciplinary skills in science and technology

Entrepreneurship

Computer

uct delivery work is accomplished through project teams, this is an important factor. Learning on the job, flexibility, and management of change or corrective measures for work in progress are directly correspondent to the caliber of teamwork exhibited.

More and more companies are distributing their operations, domestically and overseas. Companies also are outsourcing and working through strategic alliances to a greater degree. This trend requires employees in different departments to acquire skills in managing virtual labor forces, directing teams in different time zones, and capitalizing on cultural differences. At the same time, among support occupations certification credentials are on the rise. This trend should be encouraged, as these credentials are portable and often can be gained on the job.

The speed with which companies must react and the legal/regulatory climate in which they function also has called for closer coordination with medical personnel. Doctors, nurses, dietitians, and other specialists are now more prevalent in biotech and biopharmaceutical companies. Their skills also must be broadened to make them effective contributors in this environment. Functions such as clinical trials may be outsourced. However, IT professionals or statisticians who work in-house must learn specific tools and research systems useful in the biotech environment. It is even desirable in some instances for these professionals to have a working knowledge of chemistry. Another example of specialization is in facilities planning and management. From designers to security personnel to glass cleaners, the needs of the laboratory environment are specialized and trainable.

## Recommendations

Dealing with the issues the industry faces regarding a sufficient, qualified labor pool requires an urgent, systemic approach. Proactive solutions must start in the secondary schools and be applied throughout the college and graduate school level. The image of the industry, and of scientists in particular, must be improved for students. Industry experts suggest the following strategies to do so:

- **Increase awareness of the biotech industry among high school students and career counselors.**

Many high school students demonstrate a lack of clear knowledge concerning both technical work and business aspects of many science fields. Participants cite the need for more information for students and teachers regarding career options in biotech, and the academic requirements necessary for those careers. Programs that involve industry professionals in curriculum development and classroom activities may be effective in engaging students.

- **Educators must strengthen the science/math/technology curriculum in secondary schools.**

Many schools do not have a technology-oriented curriculum. Contributors to this study suggest that these changes ought to be introduced in elementary school. Other participants support the design of a web site for young people to get industry and career-specific information. The website could do everything from promoting health issues to covering job-hunting techniques and unique educational opportunities.

- **Establish structured partnerships among government, academic, and industry players.**

Participants also stress the need for structured partnerships among government, academic, and industry players to support scholarships, mentoring, and internships to expose young people to the biotech field, as well as to provide needed experience. The interdisciplinary approaches and requisite teaming skills should be introduced in college, at the latest. At the same time, firms are clamoring for more specialized training at the undergraduate and graduate levels. Such an approach would require non-traditional approaches to degree programs, an approach that is being tried in other regions. For example, the University of North Carolina at Chapel Hill has developed a program that pays graduate students a stipend for pursuing commercializable research on-campus before completing their degree. This program is meant to simulate career experience.

Participants recommend that a stronger push from the industry sector would make a difference, both in partnering with the academic institutions and in funding the certificate programs. As it stands, the biotech industry in New Jersey faces some daunting challenges. Identifying key skills and proactively assessing workforce development strategies is an essential starting point.

## B. Security Physical/ Infrastructure and Data

The prevalence of homeland security interests will lead to growth in several industry sectors. New Jersey's skilled workforce and close proximity to many potential terrorist targets is likely to generate growth in a number of occupation areas related to security and protection, such as R&D, engineering, and production. In addition to physical defense, New Jersey is well positioned to attract jobs in data and information security.

### Industry Description

As is well known, homeland security is a growth area of federal and state governments. The National Strategy for Homeland Security categorizes the nation's critical infrastructures into the following sectors: agriculture, food, water, public health, emergency services, government, defense industrial base, information and telecommunications, energy, transportation, banking and financing, chemical industry and hazardous materials, and postal and shipping. Maintaining the security of these sectors will be a major challenge, as is evidenced by the size and number of assets within these industries across the United States (see Figure 1). New Jersey has a major stake in this endeavor due to the high concentration of these assets and sectors in the state. For example, New Jersey has a robust agriculture and food industry and a significant percentage of the nation's telecommunications sector. Other areas of importance to New Jersey are oil production and storage, chemical and hazardous materials, and mass transit.

New Jersey's prime location and proximity to New York City and other major areas of national interest will spur growth and expansion of its physical and infrastructure security sectors over the next decade. In addition, New Jersey's history of leadership in the information technology sector and its concentration of high-tech labor make it a player in the information security industry.

With the proliferation of information technologies and increase in information collection, the security of the networks and databases that contain personal information on consumers/citizens has become a vital issue for all private corporations and public institutions. While the IT bust of the last few years has left many technology workers in New Jersey and across the United States looking for work, information security personnel are in higher demand now more than ever. America's Career Information Network estimates that the U.S. will see a 66% growth in annual job openings for database administrators and an 82% growth for network and computer system administrators between 2000 and 2010 (America's Career InfoNet website 2003). While this is a strong indicator of the expansion of this area, the need for increased information security will result in new positions within other industries, such as law enforcement, security engineering, and security devices.

Physical and infrastructure security not only encompasses the highly skilled professional positions such as architectural engineers, but a wide array of protective services such as security guards and transit police, and a wide range of responsive and investigative services such as forensic investigation.

**Fig. 1: The Homeland Security Challenge in the U.S.**

<b>Agriculture and Food</b>	1,912,000 farms; 87,000 food-processing plants
<b>Water</b>	1,800 federal reservoirs; 1,600 municipal waste water facilities
<b>Public Health</b>	5,800 registered hospitals
<b>Emergency Services</b>	87,000 U.S. localities
<b>Defense Industrial Base</b>	250,000 firms in 215 distinct industries
<b>Telecommunications</b>	2 billion miles of cable
<b>Energy</b>	
Electricity	2,800 power plants
Oil and Natural Gas	300,000 producing sites
<b>Transportation</b>	
Aviation	5,000 public airports
Passenger Rail and Railroads	120,000 miles of major railroads
Highways, Trucking, and Busing	590,000 highway bridges
Pipelines	2 million miles of pipelines
Maritime	300 inland/coastal ports
Mass Transit	500 major urban public transit operators
<b>Banking and Finance</b>	26,600 FDIC insured Institutions
<b>Chemical Industry and Hazardous Materials</b>	66,000 chemical plants
<b>Postal and Shipping</b>	137 million delivery sites
<b>Key Assets</b>	
National Monuments	5,800 historic buildings and icons
Nuclear Power Plants	104 commercial nuclear power plants
Dams	80,000 dams
Government Facilities	3,000 government owned/operated facilities
Commercial Assets	460 skyscrapers

U.S. Department of Homeland Security, *The National Strategy for the Physical Protection of Critical Infrastructures and Key Assets*. February 2003.



## Overall Trends

### Information Security

Several key areas are expanding or emerging regarding security in the information technology industry. Education, nonprofit, and private institutions are making data protection, both physical and virtual, a priority. The general public, as reflected in numerous national surveys, are extremely concerned about the privacy of their financial and online identities and information. Furthermore, it is no longer just the privacy of data, but the integrity of data that is at risk. In addition to consumer records, companies are protecting confidential correspondence, financial information, and intellectual property. Each type of data potentially can have a unique strategy and profile regarding the cost and configuration of its security system. The increased commercial need for openness in sharing information with suppliers and customers, often via an Extranet, poses a corresponding risk. Software engineers and security experts are striving to keep up with the rapidly evolving challenges from all corners of the globe. Yet there will always be tradeoffs to be made between degree of security, cost, and ease of use.

Database owners must ensure that their data is not altered or corrupted and that the system is capable of securing the information. For example, there is a growing design shift toward moving more intelligence into the network and making network-based applications accountable for authenticating users, rather than the operating systems behind them. There is a frontier where physical security of information, internal data security, and business ethics meet. The increasing fear and potential incidence of attacks will cause expansion in disaster recovery services and sites to act both as a place to back up information systems, as well as a place to recover lost information in the case of a disaster. Finally, regulatory and legal issues regarding the storage and use of private personal information will result in new industries to consult database owners, monitor systems and usage, and enforce privacy laws.

### Physical and Infrastructure Security

The physical and infrastructure security sector will be influenced by several trends over the coming years. Both architectural engineering and construction will focus increasingly on the integrity and security of structures such as buildings, bridges, and tunnels. The monitoring and guarding of waterways, water transport systems, air transport, and land-based commercial access points will expand.

Prevention and response services will also expand and emerge in this area. Health monitoring and detection will increase in response to threats of bio-

logical and chemical attacks, as well as the systems to inform the public of such threats. The areas of risk assessment and law enforcement will expand and develop as new threats are detected. Human response work will grow within both the public safety and health areas. Finally, forensic investigation has and will continue to grow in response to 9/11 and other similar threats.

## Emerging Work and Skills

### Development and Planning

In the area of security, several new types of work and positions will emerge and several traditional positions will require expanded skills. Structural designers and engineers will be necessary to design structures secure against possible terrorist threat or natural disaster. The increase in the number of such "smart structures" will usher in multiple new positions in information technology. "Smart" buildings have sensors that detect and then communicate systems or security issues back to a security guard or maintenance/monitoring station. In addition, "smart" buildings increasingly will be developed with internal systems to respond to and/or solve such issues. For example, HVAC systems will be built to detect foreign substances in the air circulation systems and respond by shutting down or diverting the threat. As a result, new positions will emerge in sensor development. To install and customize such computerized systems, new positions will emerge in systems analysis and field-testing. Increased security measures for entry into both physical structures and information systems will require new research and development in biometric recognition and integration to develop secure yet convenient ways to determine an individual's identity for password/passcode-protected areas.

Security Emerging Work and Skills

Emerging Work	Emerging Skills
Logisticians	Simulation & testing
Structural Designers	Statistics
Structural Engineers	Data integration/fusion
Infrastructure managers	Platform IT skills
Researchers/Statisticians	Pattern recognition
IT support	Math
Systems development	Physics
Sensor development	Versatility
Sensor readers	Multidisciplinary
Field testers	Entrepreneurial
Support workers (i.e. guards, call center operators)	
Forensic investigators	
Disaster recovery	



The events of 9/11 have increased the demand for several skills, including simulation and testing of the integrity of physical infrastructures and security and response systems against disaster. The analysis of structures for blast, impact, or fire, and the use of statistics to assess the risk and probability of a disaster are emerging skills. To understand and prevent future disasters and security threats, researchers and statisticians in the areas of infrastructure and information security and defense will increase in number. In addition, risk assessment positions will emerge in the security sector as companies and government work to anticipate and plan for response to future incidents. Logisticians will be necessary to plan and prioritize redundant routes to move people, vital material, and supplies in the event of a significant threat or disaster.

Overall, the security area will require workers with a more rigorous math and science background. Professionals in the information and infrastructure security sectors will need to be versatile; they will need to possess strong basic skills in math and science, but they should not be so specialized in their undergraduate education that they cannot adapt to a rapidly changing field. Finally, college students will need to receive a multidisciplinary education within their field to prosper in this arena. For example, engineering students should also be trained in the biological or chemical sciences, as well as information technology. This cross-training will become vital as infrastructures become more complex and the use of sensor systems make “smart” building technology more common.

## Monitoring

Security guard will continue to be a growth occupation as companies in New Jersey, New York, and the rest of the country take steps to protect their assets and employees from threats. The increased utilization of complex security, information, and detection systems will require even entry-level workers to have platform IT skills. Security guards and system monitors will need increased pattern recognition skills to make judgments based upon the output of such systems.

As structures become more complex and incorporate more surveillance and security systems, specialized infrastructure managers will be required to manage buildings, bridges, tunnels, etc. As a result, new positions such as sensor “reader”/analyst will emerge to monitor and respond to computerized sensors that signal a problem with structures and their systems, such as ventilation.

## Response

Finally, prevention and response positions will grow. Support workers, such as call center operators, will increase in number in response to automated sensor systems in infrastructures that alert authorities of problems. The numbers of employees capable of making a “first response” will grow, as will the complexity of gear and duties thrust upon them. Advances in military technology will be transferred into the civilian sector to meet these needs. To prepare for potential attacks, new positions will emerge in disaster recovery and forensic investiga-

tion to assist officials with determining the cause of disaster, as well as how to prevent the loss of life and assets in the future.

## Challenges and Opportunities

During a focus group session, experts in the field identified several challenges for employers in hiring qualified workers. First, over the last decade there has been a lack of U.S. graduates with bachelor’s and advanced degrees in math, science, engineering, and computer science. Employers have responded by looking to foreign workers to fill this gap, using H-1B visas, created by the Immigration Act of 1990 (IMMACT) for noncitizens who sought to work in high skill or specialty occupations. Although H-1B visas have created quite a bit of controversy and have been blamed for “stealing” American jobs, Congress increased the number of H-1Bs available annually to 195,000 with the passage of the American Competitiveness in the 21st Century Act of 2000 (ACWIA 2000). This Act also increased the application fee for employers from \$500 to \$1,000 per visa and dedicated this extra revenue to USDOL’s Technical Skills Training Grant Program (US DOL/ETA, H-1B website 2003). However, the employment of non-U.S. citizens or Green Card holders in certain sectors of the security industry may be politically problematic.

Employers see the response to such a skills shortage as originating in high school education and continuing into American university science and technology programs. Participants cite the need for an acceleration of science and math education in the high schools to prepare students for coursework when they enter college. A recent study by the Heldrich Center found that nearly half of high school juniors and seniors have not taken or plan to take any math or science advanced placement courses (46% and 48%, respectively), a significant identifier of future success in math and science degrees and careers (Heldrich Center 2002). Furthermore, high school students do not have a strong awareness of opportunities in growth areas such as security. Finally, employers are searching for college graduates with interdisciplinary training and applied learning gained through internship or work experience. Most importantly, these emerging areas require professionals with the technical background to understand and create new technology, as well as the entrepreneurial drive and management skills to make a cutting-edge sector thrive.

## Recommendations

New Jersey’s background as a leader in the IT sector and its physical proximity to critical infrastructures opens the possibility for rapid and sustained growth of security industries within the state. However, for this to occur, participants believe that New Jersey must develop a workforce with the skills that employers are seeking. Although New Jersey traditionally has been known for its high-tech labor force, the following recommendations will help to maintain and increase our competitiveness in the security area:

- **Accelerate math and science coursework in high schools.**

For students to develop an interest and then prosper in college math, science, engineering, and computer science departments, they need to have taken high-level math and science in high school. Currently, participants believe that high school math and science education in New Jersey leaves many students unprepared for the demands of a college degree needed to apply for these growing occupations.

- **Increase interdisciplinary training of college students.**

The increasing integration of various areas of science and technology to create, maintain, and monitor modern infrastructures and information systems requires workers with an understanding of multiple disciplines. Rapid changes in the security area requires workers that have a strong platform in their fields but are not so specialized that they lose their versatility as the landscape changes. Finally, the entrepreneurial nature of emerging industries requires professionals with a full grasp of science and technology, but also strong management, communication, and entrepreneurial skills.

- **Increase opportunities for applied learning.**

Employers are looking for college graduates with work experience. Contributors to this study suggest that degree programs should offer more opportunities for applied learning through internships, field projects, or practicums.

## C. E-Learning and Training

Rapid changes in technology and the effects of globalization have created a labor market in which skill demands may alter significantly during the course of an individual's career. The useful life for skills is shortening and increasingly people will need to retool and retrain mid-career. This will pose some challenges for the labor force, including ensuring time for, and access to, training for all workers. This trend—plus a growing incidence of certification and testing—prompts the need for more sophisticated software and delivery mechanisms.

Unfortunately, contributors to this study feel that the New Jersey public workforce development system is not equipped to deal with this problem for the entire workforce, particularly high-skilled labor. Private industry demands for training services will continue to increase exponentially, fueling significant growth in this area. Fortunately, virtual training firms can locate wherever the business climate is most hospitable to them.

## Industry Description

The growth of high-skill industries in New Jersey, such as information technology, pharmaceuticals, biotechnology, and medical devices, means that the provision of effective education and training is of critical importance. Furthermore, the growing number of occupations within these industries that require an integration of traditional IT, science, and business skills exacerbate New Jersey's need for rapid re-tooling of its workforce in new technologies, equipment use, and skills.

This re-tooling will be challenging. Many workers may not be able to come to a central point for training, or they must take advantage of training at hours allotted during or after their regular employment. In addition, a growing incidence of certification and testing in certain industries prompts the need for more sophisticated training software and delivery mechanisms. Unfortunately, the public workforce development system in New Jersey is not equipped to deal with this problem for the entire workforce, particularly high-skilled labor. As a result, private training is an emerging industry with potential for massive growth, as industry demands for training services will continue to increase exponentially. New Jersey has several assets that make it ripe for growth in this area. It has a large number of educational institutions, as well as the headquarters for one of the nation's premier educational testing services (ETS). It also has a significant IT sector and infrastructure, and a high-tech workforce to support the e-learning area. New Jersey's high-tech economy also demands that its workers maintain and upgrade their skills regularly, an endeavor that can be facilitated greatly by the convenience of e-learning.

The demand for education and training among workers and employers has grown over the past decade. Approximately 60 million adults—46% of the workforce—enrolled in one or more adult education programs during 1999, an increase over 1991 when 58 million adults did so (NCES 1999, 1). Public investment in training and education has also grown. Direct federal government outlays and grants for education and training to state and local governments increased from \$38.3 billion in 1990 to \$45 billion in 2000 in constant (FY 1996) dollars—an increase from 2.5% of the total government outlays to 2.8% (GPO, Historical Tables FY 2002). In addition, private firms spend approximately \$50 billion, or 1.8%, of payroll on formal or informal on-the-job training.

However, time, money, and location affect access to continued education and training for adult workers. The challenges of balancing work and home have become increasingly difficult as the number of dual-earner families has risen and the average number of hours worked has increased. E-learning can improve the convenience of learning opportunities. E-learning is education or training delivered through computer technology, including short-term courses to retrain workers in a new technology, process or equipment, and long-term courses aimed at attainment of a degree. E-learning can be delivered in a variety of ways: through the Internet, using real-time chat rooms and on-line examinations; distance learning courses that require assignments to be emailed to an instructor; or work-based training delivered via customized software.

Education and training courses taken at home or work are more likely to be utilized than those that require additional travel and time. A recent study by the American Society for Training and Development (ASTD) and the MASIE Center found that the most successful e-learning courses were ones that were completed during work hours onsite at their workplace (ASTD/The MASIE Center 2001).

## Overall Trends

There are thousands of education and training courses available through the Internet, and the numbers continue to grow. Various institutions, including traditional colleges and universities, virtual universities and learning institutions, and private industry offer these courses. Large corporations, such as Motorola, General Motors, and AT&T, now are partnering with traditional and virtual universities to create customized courses and degrees to keep their employees up to date on new skills and applications. According to the 2002 ASTD State of the Industry Report, the average percentage of training through e-learning has returned to its highest level since 1997. In addition, ASTD states that 2000 marked a new era of growth for e-learning that will only be magnified by cutbacks on travel and enhanced security measures by corporations since September 11, 2001 (ASTD, 2002a).

Over the last several years, the percentage of training time delivered via learning technologies in U.S. companies has held steady at between 8.5% and 9.1%. In 2001, this share increased to 10.5%, and the share of expenditures that went to learning technologies increased from 3.7% to 4.6%. Conversely,

the percentage of training time delivered via the classroom declined slightly, from 79.4% in 2000 to 77.1% in 2001. Technology may be finding its niche as the solution for the problem of how to do more with less in the “Next Economy” (Thompson et. al. 2002).

## Emerging Work and Skills

### Development

Teamwork across several types of work and various positions will be necessary to create and deliver valuable e-learning programs. Content developers, software developers, and industry specialists will have to work together to develop and deliver useful training to adults in the new economy. Content developers have the knowledge and experience regarding strategies to help adult learners learn new material. Software developers hold the key to making e-learning programs user-friendly, attractive, and functional. Employers will look to industry and education specialists to determine the training they require to stay competitive and design the e-learning programs that will meet those demands with quality instruction. All three positions must work together to ensure that the content of e-learning opportunities is accessible and appropriate for today's employers and employees. In addition, the need for coordination of e-learning curricula will require new skills in educational administration. Other IT positions will also emerge with the growth of e-learning, including new positions in network and database management to maintain both the system and student information securely.

**E-Learning Emerging Work and Skills**

Emerging Work	Emerging Skills
Content developers	Instructors need computer skills
Software developers	Teamwork
Network managers	Curriculum coordination
Database managers	Monitoring and evaluation of e-learning
Industry specialists	Logistics
Education specialists	
Trained instructors	

### Delivery

The increased use of technology even in traditional classroom-based instruction has and will continue to require instructors to hold more technological competencies than instructors in the past. Classroom instructors must be proficient in computer software and Internet navigation to gather and deliver instructional materials. They must know how to use email and/or list serves to communicate with their students and send materials as attachments, and often must submit student grades via a web-based reporting system maintained by their educational institutions.

The logistics of distance learning holds the promise of increased opportunities for positions in this area. Individuals and firms will be necessary to coordinate the delivery of e-learning content for both traditional and virtual education institutions and for employer-based training.

The proliferation of e-learning opportunities raises the issue of quality. Many on-line education programs are not accredited by independent academic organizations and there is limited state and federal regulation of the on-line education business. With a modest investment, almost anyone can become an e-learning provider. Unfortunately, "e-diploma mills" have mushroomed in the past several years. The monitoring and evaluation of e-learning will create new work for higher education accreditation institutions, requiring professionals not only with knowledge in educational content but with an understanding of computer technology and guidelines for its use.

## Challenges and Opportunities

Employers face several challenges when employing instructors or firms to deliver e-learning. As stated above, the quality of e-learning providers is not currently monitored or assessed consistently. Employers may find it difficult to determine the quality of the training in which they are investing, and the outcomes they are realizing in the form of increased employee skills, knowledge, or abilities. Furthermore, the lack of a universal credentialing system prevents workers from capitalizing on previous training when changing employers, and prevents employers from hiring the best candidates, due to lack of or unequal information about candidates' training and skills.

Convenience and self-paced learning are the obvious advantages to e-learning. People can blend learning into their schedules, negotiating around busy work and family life. Flexibility saves time, money, and stress related to travel and, in some cases, the need for childcare. Furthermore, this technology holds the opportunity to extend traditional college/university education to new populations, such as people with disabilities or those who live in communities located far from educational institutions.

E-learning holds the opportunity for employers to deliver more training to their workforce in a shorter period of time and at a lesser cost. For example, Motorola, one of the leading companies in employee training, concluded: "More training in less time means smarter workers, faster adoption of new technology and someday, strategically speaking, the ability to turn the company on a dime" (Eure 2001, R33). Motorola requires its employees to participate in a minimum of 40 hours of training per year. These and other training-intensive corporations are learning quickly the benefits of Internet-based education tools to increase the amount of learning in that time and increase the number of workers that may be trained at any given time.

## Recommendations

E-learning holds many opportunities for workers and employers to become more competitive in today's mutable economy. However, industry experts identify the need to address the education and training of the future e-learning workforce:

- **Increase cross-disciplinary training of educators/trainers**

Quality e-learning programs must be based upon proven techniques to assist adult learners. However, if the technology is not functional, accessible, and user-friendly, the e-learning program will be ineffective. Colleges and universities have increased their emphasis on technology courses for education majors over the past decade. Today, most education degrees require several semesters of coursework in using technology in the classroom. As more and more courses are offered through e-learning, cross-training education majors in computer science, website functionality, and software development will be necessary.

## D. E-Commerce

Researchers estimate that trillions of dollars are currently flowing through business-to-business (B2B) and business-to-consumer (B2C) electronic channels (E-Volve-or-Die.com 2003). This trend is expected to continue and accelerate worldwide. While traditional businesses are developing e-commerce strategies, new service firms, principally in the marketing and IT areas, have sprung up to support the trend. Employee skill sets play a crucial role in the firm's transition and successful execution of e-commerce business practices. The location of e-commerce service implementation typically coincides with the departments affected by the change, including IT and headquarters locations. Thus, New Jersey is a prime candidate for implementing e-commerce driven plans and technology.

## Industry Description

Electronic commerce (e-commerce) is not a new industry, although it has spawned its own segments of training, publishing, support, and applications development. It evolved from an earlier era when no businesses reached out to customers on the Web to the present day when many firms build and maintain customer relationships through web-based applications integrated into marketing, operations, and IT. The rapidity with which firms have embraced e-business has made the acquisition of talent with e-business skill sets extremely competitive. Because the trend is so pervasive and growing at such a pace, it is as if a new industry had emerged and e-commerce is creating many new work opportunities.



New Jersey's telecommunications infrastructure can support a thriving e-commerce sector, while the state's large consumer base and relatively high median income can fuel the demand for e-commerce services. To conduct business successfully over the Internet, firms need to adopt a web-based value strategy and place web-based technology at the heart of their IT infrastructure. Another key principle in the e-commerce world is relationship management. This is differentiated from transaction management. The relationship management business is large, with revenues in the trillions of dollars, and is experiencing uninterrupted growth in the B2B and B2C sectors. Currently B2B transactions provide 80% of the traffic. These transactions are expected to increase by 40% in 2004, putting the B2B revenue potential at \$4.2 trillion by 2007 (NJ Business, Nov. 2000). There are other sectors as well, fueling growth in start-up companies and IPOs. Some of the larger segments are: portals, application service providers (ASP), reverse auctions, and consolidators, in addition to the B2B and B2C firms.

When a firm adopts an e-commerce based strategy, it transforms systems, ways of doing business with customers, and its cost structure. Employees then have the choice of whether to acquire the new skills and participate in the evolving culture or opt out. The new skills are initially seen in the areas of marketing and IT. Quickly they encompass new ways of teaming and implementing basic business practices. New skills in such old-line functions as purchasing and customer service are not far behind. Once the capabilities are on-line and the new branding strategy is taking effect, the planners or leaders of the business must devise new ways to continue to exploit the technology and stay ahead of on-line competitors.

## Overall Trends

Websites—originally designed primarily to provide information and/or facilitate customer transactions—have wrought major changes in customer relationships and in major business processes. As firms experiment with new e-technology, based on Internet architecture, they are discovering that they need process change and reintegration to take advantage of all that the Web offers them.

A transformation in IT strategy is underway. It will require the Chief Information Officer (CIO) and his or her team members to become more entrepreneurial, and to be knowledge brokers, negotiators, and relationship managers. While IT managers are becoming more business-focused, they may even lead teams designing services that can be sold to other companies. Simultaneously, they may outsource more traditional IT functions to cost effective third party providers, retaining the most strategic skills and functions in-house.

Existing and new companies are deploying whole new branding programs. The company leadership may introduce or re-launch its brand and build customer loyalty via the Internet. Firms have realized that just putting up a website, however, does not

guarantee success. Depending on the implementation strategy, fulfillment and back-office functions are often linked to the site. The companies decide how to blend their growing list of Internet options with human contact for customers or suppliers. Public and non-profit organizations have also become heavily involved with electronic applications, as well as database analysis and management. As these new ways of doing business take hold, firms report that a change in employee culture begins to emerge. The static command and control techniques and layers of bureaucracy, which characterizes mature companies, do not work as well in the e-business environment. The model of open, real-time communications and prompt delivery of product or service begins to infuse the corporate culture.

## Emerging Work and Skills

### Collaboration

A key skill needed among the e-commerce practitioners is collaboration. E-business is an emerging integrated approach to marketing, communications, strategy, and business consulting.

Both the marketing and IT professionals in firms and their partners in ad agencies require these skill sets to work together to produce the best result for the client. Handling marketing or IT in companies heavily committed to the Web is a subspecialty. These are inter-disciplinary skill sets and employees must possess skills in several disciplines to be an effective team member. Today, many firms are sharing information and automating transactions with customers and suppliers at an unprecedented level. The skills required are the traditional collaborative mix of communications, problem solving, negotiation, and conflict resolution, in addition to the online skills required to perform these functions with partners over the Internet.

The overall opportunity for collaboration is aided by the degree to which each team member understands the other's discipline. Drawn into this mix are other vendors with like skill sets. Often application providers with software skills will supplement what the firm and the agency have. Or the firm may contract directly with the outside application provider. However, absent a larger marketing and media plan aligned with the firm's strategy, this option is likely to fail.

### Adaptability

Internet-based B2B or B2C applications also require flexibility of the employees. The environment, the customer, and the technology change very rapidly. The amount of technology and information available dictates the need for adaptability. Also, database management and database analysis, or mining, are becoming sought after skills. These are ways for firms to cope with the onslaught of information and use it to their advantage. The information created by the trail of Internet and other electronic communications is an asset for the firm, which the skilled professional can turn into profit.



## E-Commerce Emerging Work and Skills

Emerging Work	Emerging Skills
Program/Project Managers	XML (Extensible Mark-up Language)
Web Programmers/Content Developers	SOAP (Simple Object Access Protocol)
E-Business Marketing Teams	WSDL (Web Services Descriptive Language)
Web Service Architects	HTTP and TCP/IP (Transmission Protocols)
E-Branding	Activity Based Costing
Turnkey Software Application Providers	Project Management Software Tools
	Global Workforce Management
	Outsourced Contract Management
	Negotiation/Conflict Resolution
	Collaboration
	Web-based marketing, fulfillment and back office solutions
	Privacy/Intellectual Property Law
	Data Security Applications

## Challenges and Opportunities

Within the boundaries of security and privacy laws, customer data is being gathered via e-mail marketing, on-line surveys, and tracking software. Knowing the customer better through data-mining allows firms to better plan campaigns, target expenditures, and customize offerings. The older the company or the more diverse systems it has, the more difficult it is to link the company's databases effectively. The challenge to IT personnel has been how to develop "open database architecture" to solve this problem. The onset of the Internet has played a key role in fueling the customers' desire for increased customization and just-in-time delivery.

One of the challenges faced by e-marketers is that they can increasingly target their wares, but there is little research or understanding of how consumers will react to the new Web opportunity placed before them. Consumer behavior is well documented in traditional set-

### Project Management

The scope of IT and marketing and back office or branding projects occasioned by the move to e-commerce means that project management skills are also at a premium. There are also large scale management efforts involved in implementing e-business where departments go from isolated functional units to fully collaborative partners with integrated objectives. Project managers are regarded as professionals who increasingly seek certification to enlarge their role and remuneration. Certification entails coursework, work experience, and an exam. Experienced project managers, particularly technical project managers, are in short supply (Spiegel 2003).

### Computer Skills

Traditional software and publishing skills have taken on a new set of tools and vocabulary with the advent of the Internet. Students can learn the languages, programs, and protocols they would need to create websites or manage networks in school. This makes them good hiring prospects who can then learn the details about the firm and the industry on the job. Yet the rapid advance of technology means that IT professionals specializing in e-business programming and systems implementation are constantly learning on the job. Working in-house or for a proprietary firm, they design, integrate, and maintain complex websites. For simpler sites and applications, the skills needed for website administration can be learned by non-technical office staff.

tings. Fortunately, the medium of the Web lends itself well to trial and error applications. Its modularity, when implemented correctly, means that there is little sunk cost in tweaking modules to respond to a perceived customer need. Even vendors and suppliers are sometimes challenged to throw out their old ways of doing business for the new. For the firm with vision, building a new Internet platform can re-vitalize the business proposition, the employees, and the IT infrastructure in one design.

Search engine technology is another Internet sub-specialty. Currently, the most comprehensive "spiders and robots" can sift through less than 50% of the pages on the Web (Siebel 1999). Yet the ability to access and catalogue information for research and commercial purposes, and make it readily usable from multiple high-access locations is one of the primary things that can keep fueling Internet growth. Clearly there are applications being designed that will embark on customized searches and increase interactivity of websites using artificial intelligence.

## Recommendations

In speaking to industry experts, the following recommendations were identified for improving the skills of the workforce to meet the demands of the growing e-commerce industry:

- **Increase technology training in secondary schools**

Currently, secondary school curricula are not strong in technology areas. While conforming to curriculum standards that fill nearly every classroom hour, experts believe that New Jersey schools have generally not been proactive about pursuing the study of technology subjects or creatively applying it in traditional subjects. There are a few cases where technology programs have been experimented with, often funded by a business technology partner. More of these programs need to be implemented with definite goals and evaluative criteria. Perhaps the best among them could be more widely disseminated through the use of government funds, or public-private partnership. In some magnet schools, where technology is embedded in the school's mission, it appears that more progress has been made. Yet these are isolated examples, and lower performing schools may have even less opportunity to pursue technology related curricula. If math/science curricula could be strengthened, it would at least give students an advantage in pursuing technology related majors in college.

- **Institute career awareness education for e-commerce occupations**

Marketing, including graphic design, communications, and consumer research are disciplines not well understood until at least the college level. The best avenue in these areas would be to expose young people, perhaps through innovative websites, to what these fields offer. Before students can be interested in related subjects or work experience, they must first have positive exposure to what the career disciplines are about and how they interact. In the area of e-commerce there are many ways to do this, because the young people are also consumers. They are likely to be aware of the power of the Internet for marketing applications long before they understand how it is constructed, or what its multiple uses are. Many schools miss the opportunity to get students to construct their own websites, thereby learning the rudiments of the technology. Any bias regarding the Internet as a dangerous tool for young people must be overcome, as with the perception that technology is "just another subject" which must be prioritized after the traditional requirements have been met.

- **Increase technology training for teachers**

Teacher training is an area that holds possibilities for affecting worker skills. Teachers and professors in all levels of the educational system have the opportunity through certification and continuing education to upgrade their technology skills. Perceptively, companies have realized the leverage to be gained through imparting knowledge of leading edge technologies to teachers, and have helped the teachers design ways to integrate technology into existing curricula. More research and investment in this area is warranted. Efforts to change state standards only come about through concerted lobbying and typically require public-private partnership as well.

- **Link high school vocational/technical programs to post-secondary education and training institutions**

In the vocational/technical area, there has also been solid progress. As technology has steadily become routine in occupations requiring only a high school degree, public and private training institutions have embraced it, favoring more applied approaches to math and science. Wherever possible, new technology has been used in the training itself, since graduates are supposed to be ready to enter the labor force. Here too, companies have helped to fund these efforts. It might be appropriate to link the efforts of these training institutions with higher education institutions and training organizations providing higher level training opportunities for incumbent or laid off workers. A seamless system for new entrants and upskilling of experienced workers that is based on skill demand by industry sector would be a more efficient way to address the current skill gaps in the labor force.

## E. Food/Agribusiness

The food sector is a significant employer and revenue producer in New Jersey, despite the fact that agriculture has been on a steady decline in the state. However, the food industry encompasses more activities than the growing of food and cash crops. In New Jersey, institutions such as Cook College at Rutgers, the State University of New Jersey, are conducting new research on nutraceuticals, the use of foods for health reasons.

Opportunities exist in newer high margin or custom areas, not only as a result of health and nutrition consciousness, but also consumers' increasing preoccupation with convenience and prepared foods. New Jersey's large numbers of moderate to high-income residents are stimulating the demand for high-quality prepared and packaged foods. These trends are fueling a corresponding need for more food research, expanded outlets, and a variety of new packaging alternatives.

### Industry Description

It may seem surprising to consider the food industry among emerging skill areas since it is surely one of the world's oldest industries. However, its size and criticality within the New Jersey economy are indisputable. With sales of \$5.5 billion and total employment of 313,000 employees, the industry accounts for 12% of the state's gross sales and 12% of its total labor force (The New Jersey Food Industry Summit, 1998). Recent changes in technology, lifestyle, and demographics have fostered significant changes in the industry's profile. Industry proponents are clamoring for the food industry to be viewed as a distinct entity with its own manufacturing, wholesale, retail, and service sectors, as opposed to a conglomeration of businesses sandwiched into other industries. While some sectors are experiencing modest to high growth, manufacturing and retail are more vulnerable. Each of those sectors has experienced a decline relative to other states in the region and the U.S. as a whole. As the "industry" emerges, so do some key trends, the response to which will determine whether the food industry retains its prominence in New Jersey and what its growth rate will be.

The industry's impact on the New Jersey labor force is undeniable. Researchers estimate that 50% of "first jobs" are held in the food industry (The New Jersey Food Industry Summit, 1998). While there are a wide variety of occupations in the industry, the evolution of technology suggests that more of the industry's jobs require specialized skills, and that the current shortfall of skilled employees and targeted training will worsen. The good news is that the growth in regional wholesale business, prepared foods, the service sector, and health-related offerings is spurring new revenue and new employment opportunities.

The New Jersey Department of Commerce and Economic Development lists the food industry as a target for economic performance and investment. Leaders in government and academic institutions like Cook College have called for significant collaboration among public and private institutions to insure that the industry stays competitive and adaptive to meet

emerging market needs. The industry's progress in meeting its new market challenges is based on identifying emerging operations and management skills. Understanding these skills requires corresponding changes on the part of employers and educators to guarantee the labor supply, make productive use of it and anticipate future changes. The leading edge of the food industry employs chemists, engineers, logisticians, and electronic marketing experts, to name a few high demand areas. This brings the industry squarely into competition for qualified employees with other high-tech industries in New Jersey and elsewhere.

The food industry has the corollary problem of high turnover and insufficient skill in the low-skill end of its labor force, which is slowly feeling the effects of newer technology. Labor force issues, coupled with a tight regulatory climate, high costs, and image problems, make it an uphill battle to capitalize on the real opportunities available to the industry. However, its size and the significance of its position in New Jersey insure that every effort is being made to overcome the obstacles and bring the industry strongly into the 21st century.

### Overall Trends

While the trends bringing about the greatest change in the industry effect the entire supply chain, it is clear why the manufacturing and retail sectors are slowing relative to rapid growth in wholesale and food services. Where there is growth and competition, there is likely to be more rapid technological change, with corresponding impacts on the labor force. As in other industries, the technological change has wrought greater need for skills and training, as well as a decline in less skilled jobs.

Probably the most controversial trend in the food industry is the introduction of bio-engineered foods. While these are slowly making their presence felt in the marketplace, each of these products has spent years in development and testing. The impacts of biotech research in the food industry have international implications for all consumers. Bio-engineered products pose special challenges in testing and marketing, as well as policy-making. Yet, industry experts predict that the trend is here to stay; and it requires a combination of skills that are considered to be emerging and necessary if New Jersey is to be a factor in the high-tech sectors of the food industry.

Other key trends impacting the development of the food industry are found in the consumer market. Higher incidences of working women and smaller households have raised the importance of convenience over taking time to purchase ingredients and prepare foods from scratch. Research suggests that today's consumers are taking less time to plan, prepare, and clean up after meals. They are more prone to eat out or carry in. Retail establishments, concerned over the loss of share, have likewise increased the availability of prepared foods. The preponderance of these "new consumers" is not only concerned with convenience, but also with taste and nutrition. The growing number of seniors in the population has contributed to this trend.

Many consumers, led by seniors, have made health a primary criterion in selecting food items. There has been corresponding growth in dietary supplements, medicinal foods, and nutraceuticals. U.S. consumption of these products is rising 11% annually (Lord 1998). These trends translate directly into new R&D and new products or markets for the industry.

The larger numbers of ethnic households have added to the diversity of prepared foods and also heavily influenced the growth of food service establishments, including restaurants and all manner of food outlets. The need to package food to be taken “on the road” or as a substitute for a home meal has been identified as an emerging area. Packaging itself has been revolutionized due to demands for more information, recyclable product, and transportability/ease of use. Taken together, these trends amount to further “outsourcing meal preparation.”

Furthermore, consumers, obsessed with speed and ploys to save time, will likely move toward increased electronic shopping and home delivery, and personalized service around the clock. This trend will cause marketers and operations workers to conceive of their audience—and their means of reaching that audience—in radical new ways. It also means providing an unprecedented opportunity to gather and analyze data on the consumer to support future decisions.

For the wholesale sector, the ability to import food more broadly and distribute it more efficiently has greatly changed the nature of the business. Major logistical challenges are being solved with computer modeling and managed by high tech operations supplying regional outlets on a just-in-time basis. Mergers and consolidation across the industry have magnified this trend, creating greater buying power and larger branding operations while reducing redundant infrastructure. While these moves have helped control costs, they have also made the consumer more dependent on vast amounts of goods coming from outside the local area, resulting in a supply chain vulnerable to disruption.

These are the trends that the industry must cope with and exploit, as its integrated profile takes shape. Traditionally a strong agribusiness state, New Jersey has the R&D strength, the logistical presence, and the demographics to propel the food industry forward as a significant economic contributor. Addressing the labor force shortages and skills issues are key components in making this vision a reality.

## Emerging Work and Skills

Listening to employers in the industry, traditional vocational and social skills appear to be most in demand to support the industry’s growth. This, however, reflects only one segment of the industry that employs the least educated entrants and experiences the highest turnover rates. For this segment, basic skills, literacy, and English as a Second Language (ESL) are key needs. While those areas await attention, industry experts contend that a wide variety of other occupational needs and skill gaps related to the industry are emerging.

## Research & Development

The twin imperatives to market more prepared foods and offer more transportable snacks/entrees, have spurred the need for food chemists, physicists, and engineers who are responsible for developing and testing the product, as well as ensuring it can be produced efficiently. These positions not only require four-year degrees, but also often graduate work and exposure to multiple disciplines. Competing for these graduates is difficult for the food industry because they are in demand by multiple industries and because the food sectors have historically had a lackluster image relative to career mobility and technology, compared to other higher profile industries. Today, government and industry leaders are mounting programs to change the industry’s reputation and to expose more potential candidates to its benefits. Experts cite that internships and other work experiences might help with the labor shortages, as well as addressing the training burden currently faced by the industry. Entrants need specialized training, but many of the small to medium-sized firms cannot afford it. In this instance, states that offer more government subsidies are more attractive to the industry.

### Food/Agribusiness Emerging Work and Skills

Emerging Work	Emerging Skills
Domestic/international logisticians	Environmental Health & Safety Regulations
Food chemists	Automated Plant Operation
Packaging materials engineers	Packaging Technology/Design
Developers of food supplements	Web-based Marketing and Delivery
Developers of nutraceuticals	HACCP (Hazard Analysis-Critical Control Points)
Planning/Design of Web-based Services	Food Handling/Safety (esp. prepared foods)
Bioengineers	Food Industry Management
	Dietary/medical training for food industry



The health-related changes in the industry, which are driven by baby-boomers and seniors, have resulted in increased needs for health professionals. They consult to the industry, as well as support the tests, trials, and marketing efforts targeted at the health-conscious consumer. To boost legitimacy, compete effectively, and reduce the potential for liability, the industry relies increasingly on in-house health professionals. The growth in the nutraceutical market is based on new avenues of research by major companies, as well as small start-ups.

## Packaging

Corresponding trends in packaging have had to keep pace with the demand for prepared foods and “meals-to-go,” and competition has been very keen as myriad companies court the convenience-minded consumer. Packaging specialists require a new array of design and materials skills and knowledge. These needs create greater demand for physicists and industrial design specialties. An offshoot of this is an increased requirement for environmental and safety professionals.

Environmentally sensitive processing and disposability of packaging has become a priority in order to meet tough state regulations. Also, as more foods are being marketed as “ready-to-eat,” increased attention must be paid to protecting consumers from food-related disease, tampering, and spoilage. Thus the industry has increased its need for chemists, testers, and safety personnel. To be cost effective, the industry must be one step ahead of the regulators, spawning heavier R&D budgets and personnel in the front end of the food chain. Their efforts are integrated with the microbiologists who contribute genetic engineering solutions.

## Marketing

In addition, the marketing professionals have had to learn how to utilize the Internet in a variety of ways, varying their channel strategies and following up with requisite customer service options. Data mining and new tools for database management allow industry members to be more competitive and get closer to their customers.

These occupational areas require skills and interdisciplinary approaches which are generally new, but which must also be tailored to the food industry. As these managerial labor force needs are met, there is evidence that a need for more skilled blue-collar workers will not be far behind. Further automation, consolidation, and the ongoing introduction of technology into production and marketing will dictate a necessity for higher skilled workers across the industry.

## Challenges and Opportunities

As stated above, the shortages and gaps in the food industry labor force, as well as the potential for greater demand in highly specialized areas, presents a deepening problem for the industry. At the same time, the industry in New Jersey already struggles with cost competitiveness and a relatively high degree of regulation. Thus, extra dollars from within the industry to address its labor woes are not available. Arguably, what

resources are available have been concentrated on the lower end of the labor pool where employers struggle with demand for workers in need of basic skills, and turnover rates have remained consistently high. Evidence from Cook College, a leader in regional planning for the industry, suggests that priority is shifting to the higher end of the labor pool where the aim is to bolster the image of the high tech industry focusing on demand for highly skilled and multi-disciplined workers.

As other high-tech industries have discovered, this approach demands greater emphasis on cooperative programs, recruiting, and training. It will likely also require a concerted effort on the part of government, employers, and academic institutions that view the industry as a key component of New Jersey's economic growth. The economic numbers describe the industry's impact on the local economy but that strength is based on the industry's traditional image, not the consumer-oriented, high-tech image that must be fostered to keep the industry healthy in New Jersey and attract the requisite talent in the 21st century. Correspondingly, since many workers currently in the industry lack skills to build on, and many of its professionals lack updated skills, industry experts state that there is a serious need to invest in incumbents while focusing on new demand. Complicating the picture are wage levels, particularly in the low to mid-range jobs, that have been viewed as non-competitive. Unions, however, remain a strong presence in the industry.

Finally, many of the academic institutions in New Jersey have not built specialized or interdisciplinary majors that address the industry. Building foundation skills for college-bound youth who might select the occupational areas described in this report does not appear to be a priority of secondary schools in all but a few areas.

## Recommendations

Contributors to this report believe that interventions and investment must start with the education system. Successful efforts by the academic community should be complemented by a good marketing strategy on the part of the industry to positively portray pay and career opportunities, especially in the technology-oriented part of the food industry. While the challenges described affect the entire industry, industry leaders offer recommendations on ways to support the new skills emerging within the industry.

- **Students need more opportunities for applied learning in school and internships within the industry.**

Stakeholders must develop targeted programs to expose students in secondary schools to the potential for meaningful careers in the “new” food industry. The fact that 50% of first jobs come from the industry does not automatically translate to future workers for the professional jobs, as it might in some other industries. It is important to re-define the industry for students and provide robust career paths within the food industry sectors. Increased use of scholarships has also



been mentioned as a strategy to augment the labor pool. Any efforts to strengthen math/science/technology curricula in the schools will benefit this industry.

- **Develop “incubation” models to simultaneously develop technology and worker skills.**

These are typically done in conjunction with existing university facilities or programs set up for this purpose. To target younger talent, the industry might try supporting existing youth clubs where there is a potential to develop the needed skills, as well as investing in sponsorship of science fairs, competitions, and other project-based activities where the industry has traditionally not had a presence.

- **Provide workers with more training opportunities.**

With regard for the need to further train or upskill incumbent workers, a consortium approach to training where design and delivery are shared among trade associations, providers, and employers might work best. E-learning should be fostered within the industry for the cost advantages and flexibility it offers. Active solicitation of government subsidies for workforce development should continue, tying the payoff to economic development in New Jersey. As with other emerging opportunities, the state does not benefit if the high-paying, high-tech jobs are siphoned off by more competitive states and the low-end jobs with which the industry is currently associated are left. While the New Jersey food industry has previously suffered from not being viewed as a consolidated entity, the emergence of new economic opportunity and the corresponding demand for new skills provides the chance to re-focus the entire industry. Highly skilled professionals capable of meeting the industry's unique demands and articulating potential for growth can become a powerful symbol for the industry's future.

## IV. Conclusion and Recommendations

### Skills Trends Across Emerging Work

Through this research, the Heldrich Center has identified several areas of skills and training that will be in demand by New Jersey employers in growing and emerging areas. Regardless of the area or industry, experts identified the following as imperative for future workers in the state:

1. **Strong math, science, and technology base, as well as specialized science skills.** Experts agree that emerging occupational areas will require workers to have a strong math, science, and technology base. Regardless of field, the increasing use of technology in all levels of work demands stronger skills in these areas for all workers, including entry-level positions. In addition, emerging science and technology in New Jersey's growth areas will require new types of specialized science skills for professional workers.
2. **Teamwork and communication skills.** Modern work, particularly in high-tech and cutting-edge industries such as those in New Jersey, is based increasingly upon the use of project teams. The workers of tomorrow must develop their teamwork and communication skills to prosper in this atmosphere.
3. **Entrepreneurship/business skills.** Industries need workers who possess both research skills and the entrepreneurial drive and business acumen necessary for advancement in the marketplace. Often, start-ups do not thrive because their founders are scientists who have little knowledge of private industry. Individuals who can span both the research and development side and the business/market side of industry will allow for new technologies/products to emerge quicker and reach the market faster.
4. **Interdisciplinary knowledge.** Emerging trends will require workers with skills and training across disciplines. For example, IT and medicine are becoming ever more intertwined in the world of medical devices. IT and biology are becoming connected as security systems begin to use biometric recognition (i.e. fingerprint, eye scan). Within fields, such as engineering, workers need an increasing knowledge of multiple specializations (e.g. chemical, electrical, materials).

## Creating a Skill-Based Workforce Development System

These skills demands will necessitate a number of strategies for improving and increasing the pool of skilled workers. The Heldrich Center, through discussion with industry experts, has identified several such strategies within three different arenas for education and training. While some strategies apply to the secondary and post-secondary educational systems, others impact incumbent or laid-off workers in need of re-training.

### Middle school and high school education

#### 1. *Accelerate and integrate math and science education*

For students to succeed in college math, science, engineering, and computer science courses, they need a better grounding in math and science in high school. Math and science need to be accelerated in high school so students have a chance to complete higher-level course work before they enter college. Math and science also need to be integrated to increase comprehensive learning and to develop a platform for students' future coursework and careers.

#### 2. *Expand career awareness education*

Students make important decisions that will affect their future careers during their high school years, including whether or not to go directly to work, to attend college or training, what college/training to attend, and what career path they might pursue. However, students appear to receive very little career education during this time. During a panel at the 2003 American Counseling Association Conference, a participant stated that high school counselors, on average, spend less than 6% of their time on career counseling. A study by the Heldrich Center on workforce supply and demand for New Jersey's pharmaceutical industry found that more than half (56%) of New Jersey high school students are not very or not at all familiar with the types of jobs available in this industry, which is one of New Jersey's largest employers. Middle school and high school students need more direct exposure to the world of work and career awareness education, including career days, industry and occupational descriptions, and career counseling. This exposure should be geared to heighten the relevance of classroom activities. Only then can students make informed decisions about their futures. This can and should be accomplished without invoking the "early tracking" phobia that can be counterproductive to young people's aspirations.

To assist students in making important decisions about their future careers, opportunities should be made available for students to interact with mentors in a chosen field or to participate in summer programs that focus on a specific industry or occupation or science, math, and technology in general. Summer opportunities could take

the form of mini-internships at local companies or summer camps that are sponsored by a company or staffed by industry professionals. Student interaction with professionals will provide them with a better understanding of their career opportunities, of the work they wish to enter, and of the training they need to succeed.

## Post-secondary education—college/university

1. *Increase cross-discipline training—across majors and across subfields within majors*

Increasing integration of various areas of science, technology, and engineering in emerging areas will require workers with education and training across a number of disciplines. Colleges and universities should respond to this private sector need and encourage cross-discipline training for their students. This includes both training across majors, such as computer science and biology or chemistry and business management, but also across sub-fields within majors, such as chemical and electrical engineering. These types of opportunities should become more of a flexible norm, without forcing students to opt for double and triple majors to accomplish the purpose within the existing system.

2. *Develop applied learning/internships/field projects through partnerships with private industry*

As stated above, employers are looking for workers with experience in their particular field. The university is very different from the workplace, and college graduates often leave school without the applied skills of their discipline or the soft workplace skills such as teamwork and communication that employers require. Colleges and universities should develop internship programs for their students where they can gain these valuable skills before entering the job market. In addition, the connections to employers created through internship experiences are an important advantage in the increasingly competitive labor market. Similarly, field projects and practicums provide students with the opportunity to apply their learning in a controlled environment where faculty and staff can provide guidance and support. Field projects and practicums can be designed to utilize and test a targeted group of skills or knowledge. Students learn valuable skills and possibly develop networks that will help them when they enter the labor market, while receiving credit for their effort.

These efforts are possible only where partnerships exist between institutions of higher learning and private industry. Such partnerships are valuable for several reasons. First, they provide the network to establish internship programs for university students that teach valuable workplace and field-specific skills. Second, they can offer feedback to university departments about skill requirements for their workforce that can assist the university in developing curricula. Third, partnerships

with private industry can allow for internship exchange opportunities where faculty can enter the private sector to update their applied skills and/or bring university research to the private sector. Private sector professionals can intern at the university, providing instruction or counseling for students in the field or participate in university research. Finally, partnerships between universities and private industry can allow for increased exchange of information, technology, and research that could benefit both parties. One reason why partnership opportunities are sometimes ignored or short-lived is industry's perception that they are time-consuming and have minimal payback. If "templates" could be provided to lessen the amount of original work for successful internship, and if internships could be better structured to net qualified employees, industry might become a more willing participant.

## Public Workforce Development System

1. *Initiate sectoral approaches through public/private partnerships*

Training for dislocated, incumbent, or unemployed workers by the public workforce development system should be accomplished through use of a more sectoral approach. Working with industries within growth sectors to identify demand occupations, the skills they require, and the education and training necessary to acquire those skills, will substantially help the public system be able to design and deliver training that will result in stable employment for trainees. As a rule, the public system has been seen by industry as "behind the times," training people for obsolete jobs. A stronger sectoral approach will allow the public system to focus its resources and respond to employer demand.

2. *Develop a process for updating education and employment information.*

Using web-based and other tools, the public workforce development system must develop strategies to continually update and disseminate information on the constantly changing skill needs, education requirements and career opportunities to all students, career counselors, job seekers, and employers.

In conclusion, the rapid pace at which science and technology alters growth occupations and skill requirements demands that any endeavor of the New Jersey public and/or private sector to develop a demand driven system be forward-looking. In order to maintain a strong economy and keep up with employers' needs, the state of New Jersey must prioritize the effort to identify and address such areas of emerging skills. Since these will constantly be changing as science and technology advance and industries respond, this effort should be ongoing and the information continually updated. To address this, institutions and/or protocols should be developed to continue the work that has been started with this report.

## APPENDIX A: Contributors

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