Economic Planning Initiative

TECHNOLOGY
FACT SHEET

Boston Redevelopment Authority
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I. Sector Description and Definition

Technology is the practical application of science to commerce or industry. High technology is only the technology that is still relatively new. These obvious definitions are important because of the role high tech has played in the region's economy from colonial times to today and into the future.

There is no *Technology Industry* in the way that there is a banking industry, but there are industries such as information technology (IT), life sciences, and biotech that collectively are known as the tech sector. Boston is rich in these companies and institutions that *develop and provide* technology instead of just having companies that *use* technology. This economic sector initiative team focuses on companies and institutions that are involved in the development and sale of technology. Less emphasis is given to sectors that merely utilize high technology goods and services, even when many people are employed to operate the technology the sector uses. However, job training and readiness issues are addressed for these industries.

II. Job Opportunities and $alaries

It is impossible to determine the number of technology workers in Boston because technology workers are scattered across all industries. The data show that roughly 20,000 workers are employed in industries typically considered high-tech. However, many of these jobs are service, sales, or management/administrative jobs. Anecdotal research indicates that 30% of a software company's workforce are engaged in sales, while 45% are technical workers. Similar percentages apply to engineering firms. Nearly two-thirds of the workers in manufacturing companies are assemblers, laborers, and materials handlers.

Industry	Jobs	Payroll ($1,000)	Avg. Salary	Estab's
Professional Services (engineering, consulting, data processing)	7,759	$ 539,944	$ 69,589	524
Telecommunication carriers	5,977	395,204	66,120	118
Electronic/computer/communications equipment manufacturing	**2,500	*	N/A	23
Internet Service Providers (ISP)	**1,750	N/A	N/A	47
Software publishers	1,560	113,314	72,637	69
Pharm. Medicine Manufacturing	950	61,744	67,672	4
Medical equipment manufacturing	186	8,253	44,370	18

Source: County Business Patterns
*Indicates that data are suppressed for reasons of confidentiality
**Number of jobs was expressed as a range for reasons of confidentiality. Midpoint of range noted in this table.

TECHNOLOGY & INNOVATION

- *Manufacturers*—computers, servers, networking equipment, fiber optic—Dell, Compaq, HP, IBM, EMC, Avaya (Lucent), Cisco, 3Com, Corning
- *Software design & manufacturing*—Microsoft, IBM, Adobe
- *Telecom service providers*— RBOC's (regional Bell operating companies, such as Verizon), Comcast, Sprint
- *Internet service providers & portals*—AOL, Earthlink, Microsoft, Yahoo
- *Internet infrastructure companies*—Akamai, the RBOC's, Genuity
- *Consultant services*—databases, web design, network support, data security, telecom Bio-tech
- *Pharmaceutical research, development, and production*—Merck, Genzyme, Massachusetts Biological Labs
- *Medical devices*—from cutting edge imaging equipment to refurbished autoclaves
- *Clinical research, drug & device trials*—conducted in Boston's hospitals

Table of Contents

III. Major Employers

*None of the area's 25 largest bio-tech companies are based in Boston.
*Companies in **bold** are located in Boston.

Bio-Technology	Medical Device	Software	Venture Capital
Biogen	**NMT medical Inc.**	EMC Corp	**Atlas Venture**
Millennium Pharm	Boston Scientific	Lotus Development	**TA Associates**
Mass Biologics Labatory	Agilent Technologies	**Keane, Inc.**	**BankBoston Venture & Capital**
Genzyme			**Advent International Corp.**

IV. Related Industries & Sectors

Health Care & Medical. It is dependent upon the technology and innovation in the Boston area. The bio-tech industry and health care industry work together to invent new diagnostic and therapeutic devices and drugs.

Manufacturing. It uses the technology developed in Boston and also commercializes the technology by turning a discovery into a marketable product. Nowhere is this more evident than in the medical device industry.

Education. It is the foundation of the technology sector. Universities are the recipients of Federal R&D money, attract engineering students from around the country, and make discoveries that become everyday products or change the way we live.

Professional Services. It develops and uses technology to improve the way companies conduct their business. From the invention of the telephone in Scollay Square to the invention of the internet at MIT, Boston-based innovation has changed the way companies operate.

Venture Capital. VC enables companies to conduct research, make discoveries, and then bring them to market. New England and the Boston area in particular attract more VC than any other region except Silicon Valley.

V. TGH Closes the Digital Divide

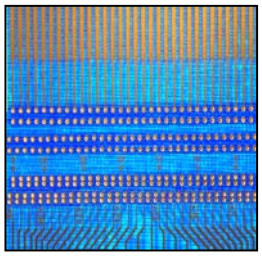
The Boston Digital Bridge Foundation was created to coordinate the City's efforts in addressing the technology gap, and subsequently it established two training programs. Technology Goes Home (TGH) a ten-week, inter-generational technology training program, teaches people the basics of computer usage - Microsoft Word, Internet surfing, and sending email, in addition to hardware and software specifics. TechBoston (TB), the second program, was established in the Boston Public School's and is geared towards giving high school students a direct pathway to careers in advanced technology with companies such as Microsoft Certification, Web Master, Data Base Networking, Robotics, and others.

Looking Back…

In 1996, the City of Boston's school system was suffering from insufficient technological capabilities and it lacked resources for obtaining them. There was no Internet access in the school system, libraries, or community centers. The student to computer ratio was 63:1, only 5% of teachers had computers, home computer penetration rates among Boston Public School (BPS) families were less than 10%, the BPS curriculum did not offer advanced technology courses, and computer literacy rates were low. Additionally, parent involvement in the public school system needed to increase dramatically. TGH has accomplished a great deal to bring technology skills to Boston residents.

Additionally, 135 schools, 35 libraries and 100 community centers were wired with high-speed Internet access. The student to computer ratio has improved to 5:1. Nearly 95% of BPS teachers and administrators have computers – and each has received approximately 50 hours of training. TGH is available in the six most underserved communities in the city, training nearly 300 families per year. A survey administered by the Office of Instructional Technology indicates that BPS family computer penetration rates are now 30%. The TB curriculum is now offered in every high school and 10 middle schools. TechBoston Academy (TBA), a technology-focused high school, has recently opened within the BPS.

VI. Education and Training Issues



Observers and industry insiders often cite the lack of an adequately skilled workforce as the Achilles heel of the region for high technology economic development, but the city is taking positive steps to remedy this. *Tech Boston*, the vocational division of the Boston public schools, and *Bunker Hill Community College* have excellent IT and computer training programs. *Technology Goes Home* has helped over 300 families gain computer skills that improve the learning of the students and employment opportunities of the parents. The Mayor's Office of Jobs and Community Services (JCS) has trained people though Department of Labor (DOL) grants for jobs in computer set-up, maintenance and support, networking, and web design, and has submitted a $2.4 million grant to train area residents in high-level IT skills. Organizations training for IT jobs include a growing number of community-based organizations, local four-year colleges and universities, two-year colleges, and proprietary schools. Challenges to build this workforce include:

Requirements. Despite Boston's technology-heavy industry base, relatively few Bostonians are seeking or finding technology jobs. Many technology positions require advanced or specialized degrees, but there are many opportunities to enter the workforce and use technology in a non-tech industry or participate in the development of new technologies. Also, IT positions require fewer formal credentials than many other tech industries.

Lack of Availability of Comprehensive Training. Community-based trainers have had difficulty getting the equipment and teaching staff needed to compete in this area. The proprietary and higher education schools do not draw heavily from local working-class residents, and are not always well equipped to work with "non-traditional" candidates or to place graduates in jobs.

Pipeline Projects

Project	Location	SF
Under Review		
Beth Israel Deaconess Medical Center	Longwood Medical Area	400,000
BioSquare Phase II	South End	540,000
Blackfan Research Center	Longwood Medical Area	450,000
Approved		
BioSquare Phase I	South End	640,000
Joslin Diabetes Center	Longwood Medical Area	490,000
Under Construction		
176 Lincoln Street/Boston Tech Ctr.	Allston	350,000
Charles River Plaza	West End	387,000
Children's Hospital Research Building	Longwood Medical Area	245,000
Harvard Research Building	Longwood Medical Area	435,000
Massachusetts Biologic Laboratory	Mattapan	87,000
Completed		
Building 114	Charlestown Navy Yard	146,800
Media and Technology Center HS	Allston	31,200
Merck	Longwood Medical Area	300,000
Tufts Medical Research & Nutrition Ctr.	Chinatown	146,800

Minorities Under-Represented. A survey conducted by CitySkills.org conveyed that three-quarters of employers reported "personal networks/friends/colleagues" or "word of mouth" as the primary way to find new hires. Since Blacks and Hispanics have not been as well-represented in the IT industry as whites, the personal networks are harder to forge, making finding IT employment more difficult.

Lack of Interest among K-12. While Tech Boston and the TGH program have done excellent jobs of improving technical literacy, this disinterest among students is proving difficult to overcome. In MA, only 6% of students taking the SAT intend to major in engineering and another 6% in computer or information science. Fortunately, 56% of Massachusetts' engineering graduates stay in the state, but this does little to increase the employment prospects of current Massachusetts and Boston residents.

Lack of Strong Job Development. Despite the academic strength of such training programs as Tech Boston and local higher education programs, many programs fall short in providing adequate assistance in locating and securing IT jobs. There is a need for better career counseling, understanding of industry trends, jobs and career ladders, and for better individual and group matching of job seekers and employers' openings in IT.

Breaking News!

On October 1, the National Institutes of Health announced that Boston University Medical Center will be the recipient of a $120 million grant to build the National Bio-safety Laboratory. As a result of this victory, Boston will be in a position to win millions in NIH grants to study new infectious diseases and protect the nation from bio-terrorism agents. The project is expected to provide 1,300 construction jobs and, once completed, will employ 660 full time workers.

VII. Sector Trends and Issues

Federal R&D. Massachusetts ranks 6th among all states in the amount of Federal R&D funding with $3.6 billion in grants, payments, and in-house federal research. Of this, Boston received $1.1 billion, nearly all from the Department of Health and Human Services (HHS) for medical and healthcare research. Using the REMI economic model, the BRA;s Policy Development and Research (PDR) division has determined that R&D funding generates 17,160 jobs in Boston alone. Other states and cities are realizing that Federal R&D is a powerful economic development tool and have begun to lobby, usually successfully, to obtain a more equitable distribution of Federal R&D money.

Venture Capital. Venture capital remains scarce due to the economic slowdown. In 2002, $21.2 billion in VC was invested nationwide, down significantly from over $40 billion in 2001. In New England, over $2.2 billion has been invested over the first three quarters of 2002. Of this, $1.965 billion was in Massachusetts. Despite the downturn, some good news for the area is to be had. VC investments in the life sciences are up 15% over the past year, the only industry to see an increase nationally. The Boston area is rich in these companies and the upturn in VC investment is both an indicator and a stimulus for growth.

Research Space. Kendall Square, Cambridge, is the center of the world's biotech. There are opportunities to expand the biotech presence as the expense and lack of availability of lab space in Cambridge has prompted companies to move or expand elsewhere. The real estate community is crediting the strong demand for lab space for keeping the Cambridge commercial real estate market afloat. Some companies, unwilling to relocate but in need of more space, are splitting their operations. By keeping research facilities in Cambridge, they are able to move the production facilities to space where land and labor costs are lower. However, Genzyme is expanding their operations in Allston, proving that Massachusetts and Boston are competitive sites for pharmaceutical manufacturing. As the market for new drugs continues to increase, demand for lab and production space will remain strong.

Workers (H1-B). During the height of the Internet boom, Internet companies were lobbying the federal government for more H1-B visas for workers with programming skills. Demand for such workers has cooled over the past year or two, but the industry is estimating that about half of the 1.15 million IT positions nationwide will go unfilled due to lack of qualified workers.

Emerging Technologies

The face of technology is ever-changing. Ideas that are outlandish today will become the commonplace products of tomorrow.

Consider nanotechnology, the development of machines, molecules, and devices by manipulating matter at the atomic level. Imagine a cellular-sized machine that could identify and destroy cancer cells while leaving others alone.

The National Science Foundation is the primary funding source for companies working on nanotechnology, but as the technology progresses and marketable applications of the technology become closer to fruition, venture capitalists and companies will begin to invest more of their own money to stay ahead of the curve. MIT and Northeastern University are both involved in this field as are several Boston area companies.

Renewable energy technology is being pursued in the Boston area. Fuel cells, solar and wind technology, and biomass are all being developed in the area, in large part due to the Massachusetts Technology Collaborative, a quasi public agency.

VIII. In the Neighborhoods

Allston/Brighton. Genzyme operates a pharmaceutical production in this area. 176 Lincoln Street was supposed to be an internet hotel, but Globix backed out and now it is being reconfigured into lab space. The Media and Technology Center High School will also be located at 1001 Commonwealth Avenue.

Charlestown Navy Yard. Home to MGH research facilities.

Downtown. Massachusetts General Hospital is one of the largest recipients of NIH grants in Boston. Partners Health Care, which runs MGH, is investing $50 million in Genetics research with Harvard University. MGH is the largest employer in the city, in any industry. Telecommunications and internet facilities are scattered throughout the downtown area. One at Post Office Square, another on top of Macy's, and one in Chinatown.

Fenway/Kenmore. The Longwood Medical Area is the hotbed of biotechnology research in Boston. Over half of the city's NIH funding goes here. In addition, Merck is opening a pharmaceutical research facility on the Emmanuel campus. The Boston University Photonics Laboratory is also here.

Jamaica Plain. Massachusetts Biologic Laboratories is one of the two labs in the country that produces the tetanus vaccine. This facility, operated by UMass, making so-called orphan drugs. Orphan drugs are those not profitable enough to attract the attention of pharmaceutical companies, because the disease so rare or the price of the vaccine is so low. The university wants to move this lab to the Boston State Hospital in Mattapan.

From Petri Dish to Pharmacy

Bringing a new drug to market is truly an expensive, risky, and lengthy process, fraught with legal, regulatory, and financial pitfalls that have nothing to do with whether or not a drug will actually work. The good news? Boston is perfectly positioned to capitalize on the process.

DISCOVERY. Most drugs have their genesis in a discovery of a new compound, gene, or technology. Boston's hospitals, universities, bio-tech companies, and research institutions are hotbeds of discovery, largely due to the more than $1 billion of NIH funding received in Boston alone.

NIH funding

The discoverer decides whether or not to go through a patent process that can cost $250,000 and take 3 years to complete. Lawyers are involved from "Eureka!" until the expiration of the patent. They negotiate the terms of the patent by defining what is infringement and what is not, and they defend the patent against infringement. This defense is ongoing and expensive, yet very necessary because a patent gives the discoverer a 17-year monopoly on marketing.

Most major law firms in Boston have patent and intellectual property lawyers.

Often, a patent is awarded to a university who will license the technology to a company to bring the discovery to market. These technology transfers can be very lucrative to universities and other research institutions, and very risky for companies and venture capitalist who often provide the money to purchase the technology.

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Boston is a center of venture capitalist firms, providing the money needed to purchase the rights to a discovery and move discoveries into production.

After a patented discovery has been licensed to a company, development of a drug or other product that uses the technology can begin. Most of this is done by the large pharmaceutical companies such as Merck, Eli Lilly, or Novartis. Venture capital or money from stock sale is used in this phase.

After a company has developed a drug, it is time for animal testing and clinical trials. Of course, Boston, with its world-class hospitals, is also one of the best places to conduct this final stage in a drug's development.

FDA approval and marketing

The Other Development Pipeline

The economic slowdown combined with the dizzying pace of breakthroughs has created a backlog of unlicensed discoveries in Boston's universities and hospitals. Venture capitalists and drug-makers are more risk-averse, reducing funding. Therefore, companies can't develop marketable products at the pace that scientists make new discoveries. Children's Hospital has 77 unlicensed discoveries, Beth Israel has 42 and the Dana Farber has 25.

Source: Boston Business Journal, *In Hub, Biotech Discoveries Outpace Demand*, June 7-13

Boston Redevelopment Authority
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The Economic Planning Initiative's nine interdepartmental teams connect the BRA to industry leaders, issues, and the latest trends in the greater Boston area.

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Financial Services, Insurance, Real Estate
Health & Medical
Hotels
Industrial
Professional Services
Retail
Technology
Culture, Sports & Recreation

IX. What the Experts are Saying

Massachusetts and Boston in particular are well poised to continue their dominance in the new economy. For example, the Milken Institute ranks Massachusetts first among all states in their *State Science and Technology Index*, which measures R&D inputs, Risk Capital and Infrastructure, Human Capital Development, Technology and Science Workforce, and Technology Concentration and Dynamism.

The Progressive Policy Institute also ranks Massachusetts tops in their *New Economy Index*. Transformation to a digital economy and technological innovation capacity both figure strongly in this index.

The Boston Metro area had to share top honors with the San Francisco Bay area for top bio-technology centers in a Brookings Institute study. The region's strong research base and the ability to convert research into commercial activities are seen as two advantages to keep this sector of the economy strong.

The Massachusetts Technology Collaborative's *Index of the Massachusetts Innovation Economy* points out that the state can lean on its concentration of scientists and engineers, federal and private R&D investment, and patent creations to maintain its position as a leader in the high-tech economy, but reminds policy makers that national and international competition, out-migration, and the uncertainty of healthcare funding are threats.

Research

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BRA Research Reports are available free of charge on the BRA website:
www.bostonredevelopmentauthority.com