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## High-tech Industries in Massachusetts: Employment and Wage Trends during the 2001–2009 Period



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The Massachusetts economy and its high-tech industries entered the 21st century on a downward trend. From 2001–2009, total private employment declined by about 141,000 or 4.9 percent; and, collectively, high-tech industries shed 47,000 jobs (14.8 percent of total high-tech employment). Still, high-tech employment remains important to the Massachusetts economy as nearly 1 of every 5 dollars paid in wages in Massachusetts in both 2001 and 2009 were attributed to the high-tech sector.

This report uses two data series from the Bureau of Labor Statistics (BLS): the Quarterly Census of Employment and Wages (QCEW) program to analyze high-tech industries and the Occupational Employment Statistics (OES) program to examine the importance of high-tech occupations and their contributions to the overall economy of Massachusetts. This report examines general employment and wage trends within the specific industries that compose the high-tech sector, beginning in 2001.

The period chosen, 2001–2009, captures two economic downturns (as defined by the National Bureau of Economic Research<sup>1</sup>) the first of which was exacerbated by the dot-com bubble<sup>2</sup> of 2000 and which affected the high-tech industries affiliated with the Internet.<sup>3</sup> The 2009 QCEW employment data referenced are final, annual average data. OES employment and wage data are for May 2009.

For this report, industries have been identified as “high tech,” using

the 2007 North American Industry Classification System (NAICS) codes. An industry is considered high tech if “technology-oriented workers” within an industry, as identified by occupational staffing patterns, account for approximately 25 percent or more of total jobs within the selected industry.<sup>4</sup> Applying this methodology, BLS analysts identified 11 industries from QCEW data.<sup>5</sup> The term “high tech” is also used to describe occupations which may be located in both high-tech industries and non-high-tech industries that employ workers in technical occupations. This report uses the same definition as the one used by Daniel Hecker who classifies 71 specific occupations as high tech in a 2005 BLS article.<sup>6</sup>

## Employment trends in high tech

From the mid 1990s until 2001, Massachusetts experienced rapid

growth within its Internet and computer-related high-tech industries. By December 2000, however, the dot-com bubble had burst nationally, and the negative impact on Massachusetts high-tech firms—coupled with the onset of a national economic recession the following year—contributed to the beginning of a steady overall employment decline that lasted until February 2004. Massachusetts never was able to fully recoup the total job losses of the statewide high-tech sector or for total private employment at large before entering the second economic downturn in December 2007, which led to further declines. (See table 1.)

As noted, in the aftermath of the 2001 recession, the majority of high-tech manufacturing industries saw significant employment declines. Such large drops were caused partly by the increasing globalization

of computer and electronics manufacturing during the early part of the decade.<sup>7</sup> Employment in high-tech goods-producing industries declined 30.5 percent from 2001 to 2009 in Massachusetts and by 23.4 percent nationwide.

Two high-tech industries (one goods-producing and one service-providing), however, were less affected. In the pharmaceutical and scientific research industries, employment grew by more than 20 percent from 2001 to 2009. Despite this specific growth, across all 11 high-tech industry sectors, employment declined 14.8 percent. At the same time, total private employment declined across Massachusetts, as well, down 4.9 percent. Over this same period nationally, employment within high-tech trended down 11.2 percent. Nationwide, the declines were more moderate as total private employment declined 2.2 percent.

Table 1. Total private employment by high-tech industry, Massachusetts and U.S., 2001 and 2009

2007 NAICS	Industry	Massachusetts employment				United States employment			
		2001	2009	Net change 2001–2009	Percent change 2001–2009	2001	2009	Net change 2001–2009	Percent change 2001–2009
	<b>Total private high-tech industries</b>	<b>2,861,824</b>	<b>2,720,758</b>	<b>-141,066</b>	<b>-4.9</b>	<b>109,304,802</b>	<b>106,947,104</b>	<b>-2,357,698</b>	<b>-2.2</b>
		<b>320,186</b>	<b>272,695</b>	<b>-47,491</b>	<b>-14.8</b>	<b>7,374,323</b>	<b>6,550,623</b>	<b>-823,700</b>	<b>-11.2</b>
3254	Pharmaceuticals	7,794	9,706	1,912	24.5	280,665	283,731	3,066	1.1
3341	Computer equipment mfg.	21,632	12,947	-8,685	-40.1	286,233	167,764	-118,469	-41.4
3342	Communications equipment mfg.	15,535	3,354	-12,181	-78.4	236,908	119,537	-117,371	-49.5
3344	Semiconductor mfg.	27,185	17,615	-9,570	-35.2	643,352	377,063	-266,289	-41.4
3345	Electronic instrument mfg.	32,706	26,487	-6,219	-19.0	471,717	417,669	-54,048	-11.5
3364	Aerospace	13,411	12,133	-1,278	-9.5	506,002	491,595	-14,407	-2.8
5112	Software publishers	24,540	22,006	-2,534	-10.3	271,263	255,417	-15,846	-5.8
5413	Architecture	39,807	39,324	-483	-1.2	1,268,354	1,318,139	49,785	3.9
5415	Computer systems design	60,146	55,218	-4,928	-8.2	1,278,831	1,413,022	134,191	10.5
5417	Scientific research	33,319	44,151	10,832	32.5	530,832	611,599	80,767	15.2
( <sup>1</sup> )	Internet, telecommunications, and data processing	44,111	29,754	-14,357	-32.5	1,600,166	1,095,087	-505,079	-31.6

Source: U.S. Bureau of Labor Statistics.

<sup>1</sup> The conversion to North American Industry Classification System (NAICS) 2007 resulted in minor definitional changes within telecommunications. A detailed explanation on series affected by the update is in endnote 5 at the end of the report.





While the private and high-tech sectors in Massachusetts saw employment declines from 2001 to 2009, the overall concentration of high-tech employment, as measured by a location quotient<sup>8</sup> (LQ), remained above the U.S. average, declining minimally from a LQ of 1.97 in 2001 to 1.64 in 2009. With the exception of aerospace (LQ = 0.97), each of the 11 high-tech industries were concentrated more in Massachusetts than in the nation, in both 2001 and 2009. (See chart 1.)

### High tech = High wage

High-tech jobs require high-level skills to perform technology-oriented work. In 2001, the annual wage of a high-tech worker in Massachusetts averaged \$77,314. Compared with the average wage of private industry workers in the state, \$45,561, high-tech wages were 70 percent higher. The same was true in 2009 when

annual high-tech wages averaged \$100,208, compared with wages of \$56,659 for all sectors. In this case, high-tech wages were 77 percent above the average. (See table 2.)

In Massachusetts, average wages in the high-tech industries increased by 29.6 percent from 2001 to 2009, while private sector employment saw an increase of 24.4 percent. Given the degree of difficulty and the large human capital investment needed to attain the skills necessary to work in the high-tech sector, the notable increase of high-tech wages could be attributed to a high-skilled labor shortage or an increase in labor demand.<sup>9</sup> Over the period, the largest wage increases were seen in industries where advanced education and training are required—the scientific research industry, where wages increased 45.0 percent, and in the

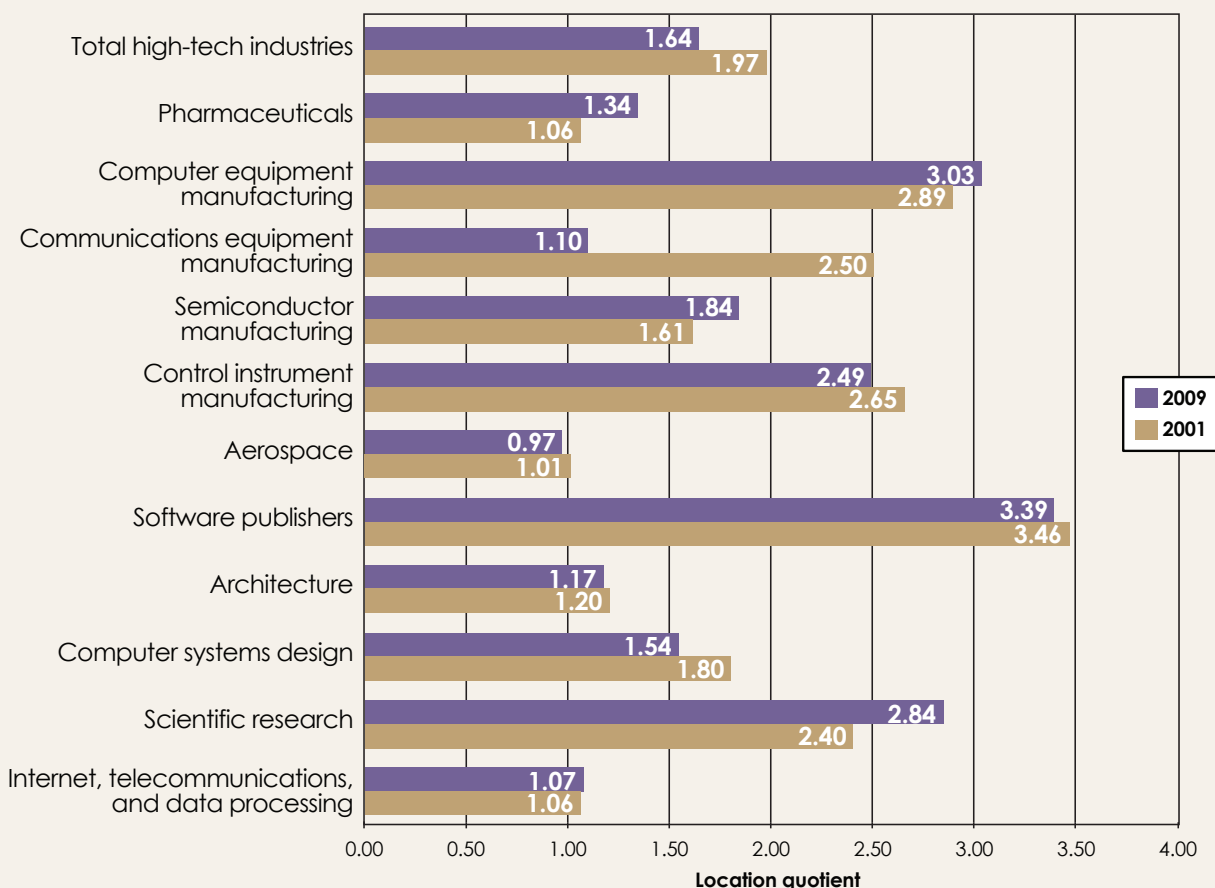
aerospace industry, where wages increased 38.7 percent.

Although the high-tech sector of Massachusetts represents a relatively small share of the state's workforce, the higher-than-average wages associated with high-tech industries affected the state's economy. For example, the overall share of high-tech employment decreased from 11.2 percent in 2001 to 10.0 percent in 2009, while the share of gross total wages paid remained constant (at approximately 18 percent of total private gross wages). Despite the difficult economic climate, gross total high-tech wages increased from \$24.6 billion in 2001 to \$27.6 billion in 2009—a rise of 12.2 percent.

In 2009, the industries contributing the most to gross total high-tech wages were computer systems design (\$6.4 billion or 23 percent), scientific research (\$4.9



Chart 1. Location quotients for high-tech industries, Massachusetts, 2001 and 2009



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.



billion or 18 percent), and architecture (\$3.3 billion or 12 percent). Employment declines withstanding, together these three industries comprised half of all high-tech wages (52.7 percent) and were responsible for 9.4 percent of all private sector wages earned in Massachusetts private industry. The three smallest high-tech industries together contributed more than \$2.5 billion in gross total wages paid to employees in Massachusetts. (See table 2.) These industries—pharmaceuticals, aerospace, and communications equipment manufacturing—made up

3.6, 4.4, and 1.2 percent, respectively, of total high-tech employment in Massachusetts.

### Employment gains over the decade; Scientific research

Bucking the overall trend, from 2001 to 2009, employment in the scientific research sector grew by 32.5 percent in Massachusetts and 15.2 percent nationally. Additionally, Massachusetts was one of the seven states which together account for more than half of all scientific research employment for the nation.<sup>10</sup> In 2001, the LQ for scientific research in Massachusetts was 2.40; and in 2009, it had increased to 2.84.

Currently, scientific research is one of the strongest high-tech industries

in Massachusetts. From 2001 to 2009, average pay increased by 45 percent (the largest increase across all Massachusetts high-tech industries). Including employment increases over the decade, scientific research comprised 16 percent of high-tech employment in the state by 2009, compared with 10 percent in 2001. Additionally, the industry is expected to grow nationwide at an annual average rate of 2.3 percent, outpacing the average for all industries, 1.0 percent, through 2018.<sup>11</sup>

### Employment losses over the decade; Computer systems design

The positive effect of the Massachusetts high-tech wage

Table 2. Average annual wages and total wages by industry, Massachusetts, 2001 and 2009

2007 NAICS	Industry	Total wages (in thousands of dollars)			Average annual wages (dollars)		
		2001	2009	Percent change 2001–2009	2001	2009	Percent change 2001–2009
	<b>Total private</b>	<b>130,387,642</b>	<b>154,154,567</b>	<b>18.2</b>	<b>45,561</b>	<b>56,659</b>	<b>24.4</b>
	<b>High-tech industries</b>	<b>24,598,594</b>	<b>27,604,007</b>	<b>12.2</b>	<b>77,314</b>	<b>100,208</b>	<b>29.6</b>
3254	Pharmaceuticals	663,523	987,965	48.9	85,130	101,792	19.6
3341	Computer equipment mfg.	2,070,893	1,527,601	-26.2	95,732	117,992	23.3
3342	Communications equipment mfg.	1,150,544	310,243	-73.0	74,063	92,509	24.9
3344	Semiconductor mfg.	1,692,871	1,391,740	-17.8	62,272	79,008	26.9
3345	Electronic instrument mfg.	2,258,912	2,492,189	10.3	69,066	94,090	36.2
3364	Aerospace	961,992	1,207,248	25.5	71,729	99,504	38.7
5112	Software publishers	2,333,218	2,626,246	12.6	95,077	119,345	25.5
5413	Architecture	2,645,021	3,319,630	25.5	66,446	84,416	27.0
5415	Computer systems design	5,427,292	6,369,607	17.4	90,236	115,353	27.8
5417	Scientific research	2,526,038	4,854,645	92.2	75,815	109,957	45.0
11th <sup>1</sup>	Internet, telecommunications, and data processing	2,868,290	2,516,893	-12.3	64,885	88,321	36.1

Source: U.S. Bureau of Labor Statistics

<sup>1</sup> The conversion to North American Industry Classification (NAICS) 2007 resulted in minor definitional changes within telecommunications. A detailed explanation on series affected by the update can be found at the end of the report.

premium was explicit in the computer systems design industry, the largest high-tech industry in Massachusetts, employing 60,146 workers in 2001, at an average salary of \$90,236. As such, more than \$5.4 billion was paid from the computer systems design industry in gross total wages (4.1 percent

of total private wages) that year. Unlike employment in scientific research, employment in computer systems design declined by 8.2 percent from 2001 to 2009, a loss of 4,928 jobs. However, over the same period, workers' average wages increased by 27.8 percent to \$115,353; and, correspondingly,

gross total wages paid reached \$6.4 billion in 2009. In the computer systems design industry, fewer employees earned more in gross total wages, in 2009, than a larger workforce did a decade earlier. Seven of the 11 high-tech industries showed increases in gross total wages over the period. Of these, five industries, including computer systems design, saw employment declines.

### Rankings by occupation

Workers in high-tech occupations are correlated with scientific skills and technology-oriented work. Such workers may be located in both high-tech industries and non-high-tech industries that employ workers in technical occupations. High-tech occupations are scientific, leading-edge, and often reduce human involvement, regarding processes. To name a few, computer and information systems managers, biological



technicians, actuaries, and chemical engineers, work in high-tech occupations. In Massachusetts, occupational data show high-tech occupations are both highly paid and heavily concentrated across all industries.

Across states nationally, Massachusetts had the third highest average hourly high-tech occupational wage (\$42.74), behind California and New Jersey. In Massachusetts, high-tech occupational employment represented 7.4 percent of total employment, a larger percentage of employment than in California (5.6 percent) or New Jersey (5.8 percent). In Virginia, 7.6 percent of total occupational employment was in high tech, but average hourly wages in the sector were lower (\$41.71). In 2009, Massachusetts

had the highest high-tech occupational wage among states, with a high-tech occupational concentration of 7.0 percent or greater. (See chart 2.) Across states, the share of high-tech employment in Massachusetts was among the highest, and such workers were among the highest paid across states nationally.

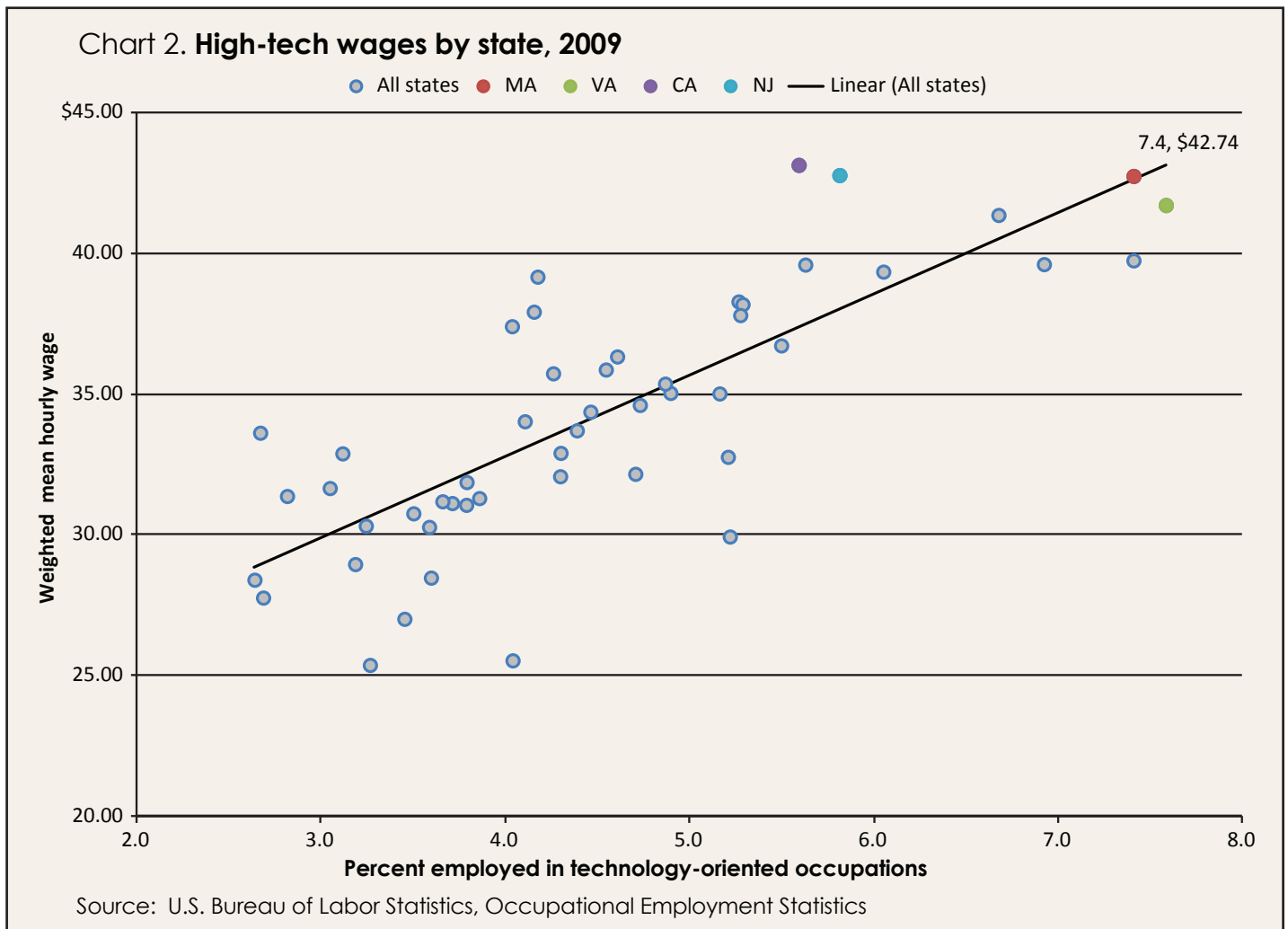
### Conclusion

During the first decade of the 21<sup>st</sup> century, Massachusetts suffered huge job losses in private sector employment and an even larger percentage decline in high-tech jobs. While high-tech jobs accounted for only 1 of 10 workers, nearly 20 percent of all wages in the state were attributed to high tech. In 2009, with the exception of aero-

space, each of the high-tech industries were concentrated more in Massachusetts than found nationally.

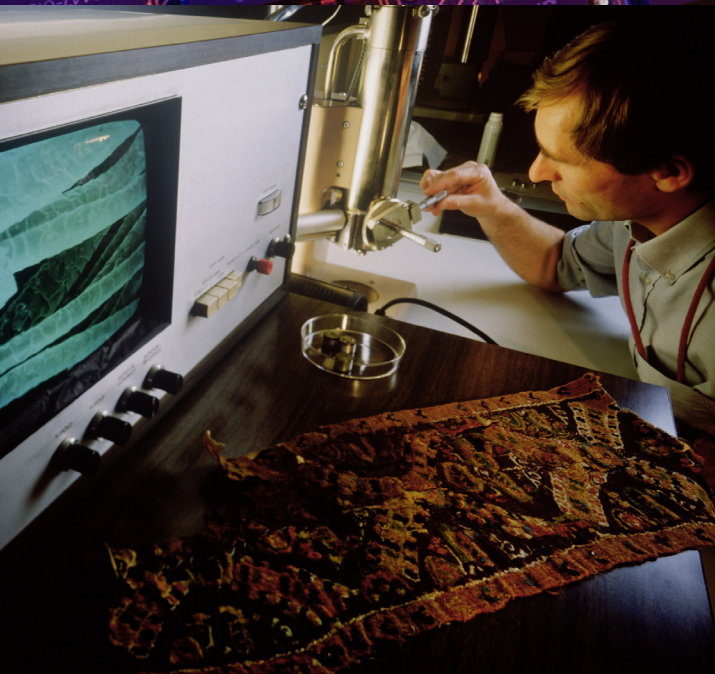
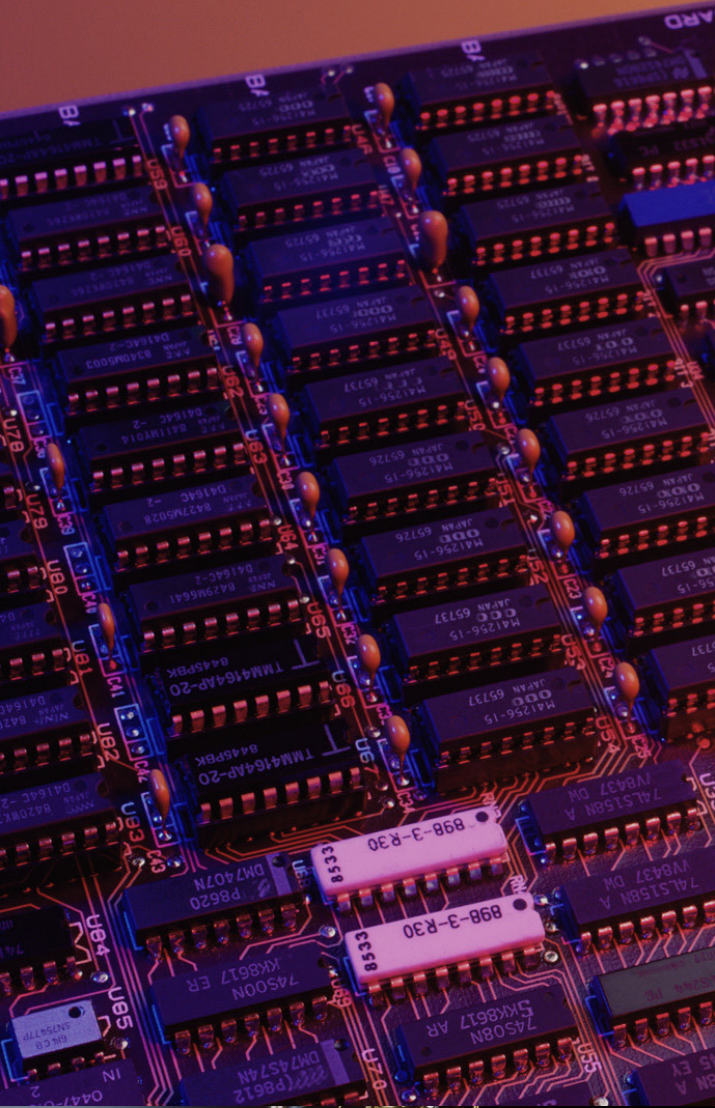
The importance of high-tech occupations in Massachusetts is underscored by their higher wages. In 2009, the average high-tech occupational wage in Massachusetts was \$42.74, more than a dollar above the average high-tech wage in the most occupationally concentrated state, Virginia.

Finally, as the overall economy—as well as the high-tech industries—shift from manufacturing to services, the two largest high-tech industries in Massachusetts are well-positioned service-providing industries—scientific research and computer systems design.





Collectively, high-tech industries, as well as high-tech occupations, should continue to remain significant contributors to the Massachusetts economy. ■





## Notes

<sup>1</sup>The NBER's Business Cycle Dating Committee maintains a chronology of alternating peaks and troughs of economic activity for the U.S. business cycle. The committee defines the period between a peak and a trough as recessionary or nonrecessionary, by examining and comparing the behavior of various measures of broad economic activity, and applies its judgment when defining recessions. The first recession, in the period considered, began in March 2001 and lasted through November 2001. The second began in December 2007 and lasted through June 2009. (See "US Business Cycle Expansions and Contractions" <http://www.nber.org/cycles/>)

<sup>2</sup>A bubble is a situation in which the price of an asset differs from its fundamental market value. See Frederic Mishkin, *The Economics of Money, Banking, and Financial Markets*, Boston, MA, Addison Wesley, 2003, p. 712.

<sup>3</sup>Between 1990 and the peak in mid-2000, U.S. equity prices increased nearly five-fold, known as the "dot-com" bubble. This episode ended with a sharp downward adjustment that started later in 2000. See NBER Working Paper Series, 2005, *The Dot-Com Bubble, The Bush Deficits and The U.S. Current Account*. Cambridge, MA, National Bureau of Economic Research, p. 2.

<sup>4</sup>Daniel Hecker, "High-technology employment: a NAICS-based update," *Monthly Labor Review*, July 2005, pp. 57–72.

<sup>5</sup>Due to minor definitional changes in the conversion to NAICS 2007, for this report employees in telecommunications have been aggregated under one industrial classification, called "Internet, telecommunications, and data processing." The aggregated industry includes data for NAICS codes 516, 5173, and 5175 from the previous classification system and 51913 from the 2007 classification system. These codes were affected by the NAICS update. The aggregate high-tech industry category also includes data from NAICS codes 5171, 5179, and 518, which were not affected.

<sup>6</sup>Hecker, "High-technology employment, 2005."

<sup>7</sup>William Lazonic, University of Massachusetts professor and director of the Center for Industrial Competitiveness, and Steven Quimby, chief information technology officer at the University of Massachusetts, *Transitions of a Displaced High-Tech Labor Force*. Lowell, MA, University of Massachusetts Press, 2006, p. 113.

<sup>8</sup>Location quotient analysis is a statistical measure using ratios that compare the concentration of employment in an industry in a defined area with that of a larger area or base. In this report, location quotients are used to compare the proportion of the Massachusetts workforce employed in high-tech private industry with the proportion of the national workforce employed in high-tech private industry. A high-tech industry with an LQ greater than 1.0 employs a greater concentration of workers in Massachusetts relative to the national share.

<sup>9</sup>Alicia Sasser Modestino, *Mismatch in the Labor Market: Measuring the Supply of and Demand for Skilled Labor in New England*, Federal Reserve Bank of Boston, November 2010, pp. 6–9.

<sup>10</sup>Just seven states—California, New York, Massachusetts, Illinois, Maryland, Pennsylvania, and New Jersey—account for more than half of all employment in the industry. See *Career Guide to Industries*, 2010–11 Edition, "Scientific Research and Development Services," <http://www.bls.gov/oco/cg/>.

<sup>11</sup>*Occupational Outlook Quarterly*, A special issue: Charting the projections: 2008–18, Winter 2009–10, p. 42.

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