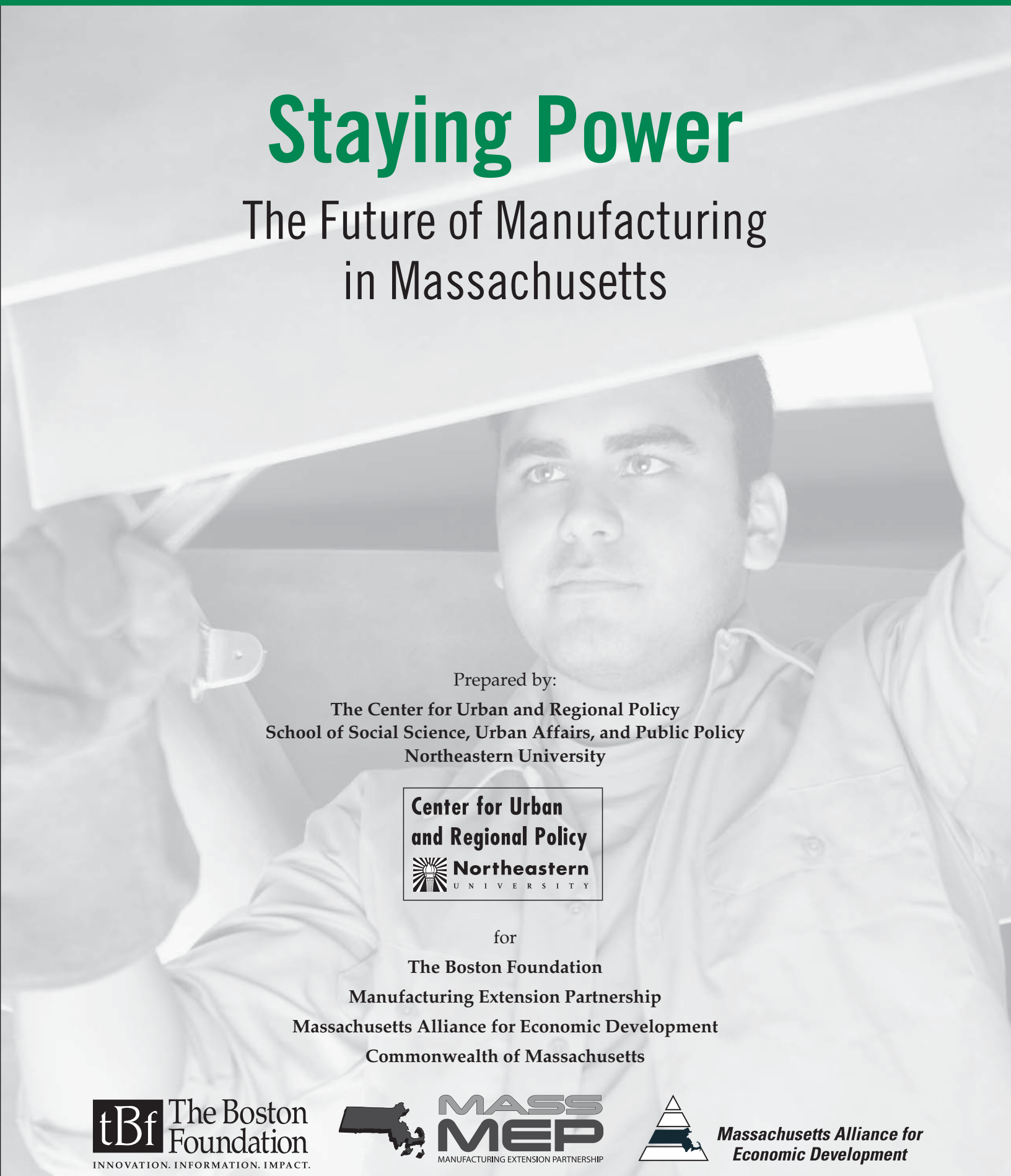
Staying Power

The Future of Manufacturing in Massachusetts



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for

The Boston Foundation

Manufacturing Extension Partnership

Massachusetts Alliance for Economic Development

Commonwealth of Massachusetts

The Boston Foundation
INNOVATION. INFORMATION. IMPACT.

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MANUFACTURING EXTENSION PARTNERSHIP

Massachusetts Alliance for Economic Development

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The Boston Foundation, Greater Boston's community foundation, is one of the oldest and largest community foundations in the nation, with assets of almost $900 million. In 2007, the Foundation and its donors made some $92 million in grants to nonprofit organizations and received gifts of more than $90 million. The Foundation is made up of some 850 separate charitable funds established by donors either for the general benefit of the community or for special purposes. The Boston Foundation also serves as a major civic leader, provider of information, convener, and sponsor of special initiatives designed to address the community's and region's most pressing challenges. For more information about the Boston Foundation, visit www.tbf.org or call 617-338-1700.

About the Center for Urban and Regional Policy

The Center for Urban and Regional Policy (CURP) within the School of Social Science, Urban Affairs, and Public Policy at Northeastern University, was founded in 1999, as a "think and do tank"—a place where faculty, staff, and students pool their expertise, resources, and commitment to address a wide range of issues facing cities, towns, and suburbs with particular emphasis on the Greater Boston region. CURP staff are involved in a wide array of projects, all aimed at helping policymakers and citizens better understand the dimensions of urban issues. Projects currently under way address housing, workforce development, economic development, education, information access, and more. For more information, visit www.curp.neu.edu.

About the Massachusetts Alliance for Economic Development (MAED)

MAED is a private nonprofit partnership of business, industry leaders, and government dedicated to fostering economic growth in the Commonwealth. The Alliance markets Massachusetts by providing information services to companies seeking to expand within or relocate to Massachusetts. The Alliance's products and services include www.massachusettssitefinder.com, developed in conjunction with the Commonwealth, a statewide Site Finder Service; the Research & Information Service; and the Massachusetts Ambassadors program. For more information, visit www. massecon.com.

About the Massachusetts Manufacturing Extension Partnership (MassMEP)

MassMEP assists organizations make the transition from traditional to world-class manufacturers that are equipped to compete in a global economy. MassMEP is able to leverage a vast array of public and private resources and services that are available to every manufacturing enterprise in the Commonwealth. The nationwide system of MEP centers is linked through the U.S. Department of Commerce. For more information, visit www.massmep.org.

UNDERSTANDING BOSTON is a series of forums, educational events and research sponsored by the Boston Foundation to provide information and insight into issues affecting Boston, its neighborhoods, and the region. By working in collaboration with a wide range of partners, the Boston Foundation provides opportunities for people to come together to explore challenges facing our constantly changing community and to develop an informed civic agenda. Visit www.tbf.org to learn more about Understanding Boston and the Boston Foundation.

Staying Power
The Future of Manufacturing in Massachusetts

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Dear Friends,

The Boston Foundation is proud to publish this detailed and illuminating report on the state of manufacturing in Massachusetts. We have titled it "Staying Power" because of the continued vitality of the manufacturing sector in the Commonwealth and across the country. Nationally, manufacturing generates $1.6 trillion in revenue—and manufactured goods make up more than 60 percent of U.S. exports.

In Massachusetts, this highly productive sector employs almost 300,000 people in thousands of companies across the state. And while that represents a significant decline from job levels in the 1940s, the Commonwealth's manufacturing output has increased over the last decade to stand at close to $40 billion.

Yet here, as elsewhere in this country, manufacturing often is perceived as emblematic of an 'old' economy. Not true. As this report makes clear, manufacturing continues to be a dynamic and healthy part of our economy, offering solid, well-paying jobs. According to the *Boston Indicators Report,* the average weekly wage for jobs in manufacturing is $1,273, much higher than many jobs in other sectors. Nationally, manufacturing jobs pay on average 25 percent more than other jobs.

Massachusetts always has been a source of innovation in science and technology. From the first steam-powered looms in the 1800s to the first telephone, sewing machine, modern typewriter, jet engine, microwave—and, of course, computer-related advances too numerous to list here.

It makes obvious sense for us to manufacture products invented in our state so that we can reap the full benefits of the jobs those inventions generate. But it also makes sense to encourage manufacturing here because it can inspire and spark invention and innovation. One of the most exciting and promising sources of manufacturing jobs is in the area of clean energy. Already, there are 10,000 jobs involving clean energy in Massachusetts and that sector is growing fast—with many more potential jobs in manufacturing.

There are numerous ways that we can encourage manufacturing in Massachusetts. For instance, our approach to education can be geared toward jobs in manufacturing by emphasizing STEM (Science, Technology, Engineering and Math) on all levels along with improvements in vocational education in high schools, in community colleges and in workforce training programs.

Maybe the most important thing we can do is give credit where credit is due. Manufacturing always has been—and will continue to be—an important part of the Commonwealth's economy because, as this important report informs us, it is a sector that has real staying power.

Paul S. Grogan
President and CEO
The Boston Foundation

Preface

In the spring of 2007, the Commonwealth of Massachusetts—through 2006 legislation designed to stimulate and promote job creation—commissioned Northeastern University's Center for Urban and Regional Policy (CURP) to undertake a new study of the state's manufacturing sector. With the sharp decline in employment experienced over the past two decades in the industries that encompass the state's manufacturing base, the Commonwealth was particularly interested in gathering information on what is still produced in Massachusetts, where it is being produced, the challenges facing manufacturers in their attempts to sustain or expand their in-state operations, and, perhaps most important of all, what the state might do to support this sector to assure that it continues to provide a large number of good jobs at good pay for Massachusetts men and women.

Ultimately, the study would involve a major survey of all manufacturing establishments in the state along with interviews of over one hundred CEOs, owners, and managers in this sector. To carry out such a massive effort, CURP enjoyed not only support from the Commonwealth, but additional financial assistance from the Massachusetts Manufacturing Extension Program (Mass MEP) and the Massachusetts Alliance for Economic Development (MAED). We especially appreciate the effort of state Sen. Jack Hart who saw the importance of conducting this research so that economic stimulus funding in the Commonwealth can be targeted to have the greatest impact on retaining and attracting business investment and jobs. We also want to acknowledge the key role the Boston Foundation played in publishing and helping to disseminate this report.

In the course of this research, CURP has partnered with many of the state's leading economic development organizations to ensure that regional considerations would not be ignored and that the various concerns of particular industries would be addressed. These organizations helped develop the survey instrument and interview protocols we used to gather new data about this sector. The Patrick administration was particularly helpful in encouraging manufacturers to participate in the survey.

All of the following organizations provided active support, advice, or personal contacts with manufacturers. We appreciate the enormous assistance they provided this project.

Associated Industries of Massachusetts
Berkshire Chamber of Commerce
Berkshire Council Economic Development Corporation
Boston Redevelopment Authority
Boston Tooling and Machining Association
495/Metro West Corridor Partnership
Massachusetts Biotechnology Council
Massachusetts Business Roundtable
Mass Insight
Massachusetts High Technology Council
MassMEDIC
Massachusetts Taxpayers Foundation
Merrimack Valley Economic Development Council
MetroWest Chamber of Commerce
Neponset Valley Chamber of Commerce
New England Council
North Central Massachusetts Economic Development Council
Quincy 2000
Regional Employment Board of Hampden County
South Coast Development Partnership
Taunton Development Corporation
University of Massachusetts
Western Massachusetts Economic Development Council

To set the context for this study, CURP began by analyzing historical data available from the U.S. Bureau of Labor Statistics and the from the U.S. Census Bureau on the state's manufacturing sector going back to World War II. These data provided detailed information on which manufacturing industries operate in the Commonwealth, on what products have been produced in the state, on the number of workers employed in the sector, and the regional dispersion of individual firms within the state.

While these government data were being analyzed, CURP worked with its partners to construct a survey of manufacturing firms which contained a comprehensive set of questions aimed at gaining a better understand of the key factors driving this sector. The survey was designed to answer the "why" questions that are not always attainable from existing published data.

Using a commercial data base, a survey questionnaire was mailed to virtually every manufacturing enterprise in the state. Of the more than 9,600 surveys mailed, 870 were returned as "undeliverable" and 706 completed surveys were returned to CURP. We found from an analysis of the returned questionnaires that our sample of firms was reasonably representative of the entire population of manufacturing firms in the state in terms of firm size, geography, and specific industry sector.

CURP and our partners recognized that even the survey might not provide as full or as detailed a story of Massachusetts manufacturing as we desired, so the survey was augmented with more than 100 personal interviews with manufacturing executives from the firms which returned our mailed survey. These interviews permitted CEOs, owners, and managers to tell their companies' individual stories and to elaborate on their survey responses where

necessary. Assisting CURP in conducting these interviews were consultants Frank Buda, Russ Eckel, Greg Sheldon and Don Zizzi.

Finally, CURP and our partners reviewed the CURP analysis of the data and collectively prepared the Executive Summary and policy recommendations that follow. What we have found in our research is not an industrial sector that is hemorrhaging, disappearing or dying, but a sector that has weathered many a storm and now has the technological prowess, efficiency, and product to provide good and often exceptional employment opportunities for more than 260,000 Massachusetts workers well into the future. Improving the odds of fulfilling this bullish forecast for manufacturing in Massachusetts can be fostered by the Commonwealth if it considers implementing a set of prudent state and local policies that can help meet some of the remaining challenges facing this important sector.

Chapter 1

Manufacturing in Massachusetts

"The King is dead; long live the King."

In 1974 Harvard University's Daniel Bell published his most renowned work, *The Coming of Post-Industrial Society* in which he predicted the decline of the manufacturing sector, the rise of the service economy, and the globalization of commerce.[1] Rising productivity in the manufacturing sector would mean that fewer and fewer workers would be needed to produce physical goods while falling transportation costs would make it ever easier for the production of goods to move to lower wage regions of the country and to low wage countries around the world. It was a prescient forecast and one that is today taken much for granted.

Barry Bluestone and Bennett Harrison added a great deal of empirical evidence to the Bell thesis in their 1982 book, *The Deindustrialization of America*. They called attention to what they termed the "hypermobility" of capital leading to massive losses of manufacturing jobs in America's northeast and mid-west.[2] The subtitle of their book, *Plant Closings, Community Abandonment, and the Dismantling of Basic Industry*, suggested a litany of stories about the hemorrhaging of both jobs and hope in older industrial cities throughout the so-called "rustbelt." Detailed regional statistics on both the creation and destruction of jobs demonstrated a massive relocation of production work to the south and out of the country.

Analyzing industry data from Dun & Bradstreet, Bluestone and Harrison found that

the chances of even a large, established manufacturing plant closing down within a given seven-year period (1969-1976) exceeded 30 percent. Moreover, they found that

> As a result of plant closings in New England industries such as shoes and apparel, anywhere from two to four jobs were eliminated for every single new job created by new capital invested elsewhere in the region. And this disinvestment phenomenon was hardly limited to the old mill-based industries. In the New England aircraft industry, 3.6 jobs were destroyed for every new one created; in the metalworking machine industry the ratio was 1.6 to 1.0.[3]

This was in line with the economist Joseph Schumpeter's early hypothesis of a "process of creative destruction" where older industries die out only to be replaced by newer ones. But in this case the number of jobs being created fell well short of the number destroyed.[4]

Some twenty years later in 2005, the *New York Times* journalist Thomas Friedman provided copious first-hand evidence of how the "flattening of the world," achieved through outsourcing and offshoring, was on the verge of finishing off the possibility of manufacturing goods in the United States, and even threatened the continued production of many "post-industrial" services.[5]

Not surprisingly, those regions experiencing the worst of deindustrialization are now putting their faith in new industries composed of biotechnology and nanotechnology firms that are being spawned in sophisticated university research laboratories and funded by venture capital. In this context, writing off the "old" industrial base — the "old king" — seems not only warranted, but prudent, while focusing economic development efforts on attracting new 21st century industries appears to be sensible. As a corollary, boosting college attendance and expanding graduate training to prepare the workforce for these post-industrial workplaces is offered as a critical element if states like Massachusetts are to succeed in the new economy.

Yet before we accept the thesis that manufacturing is essentially dead — or very soon will be — we need to examine just what is happening in the manufacturing sector. Is the old king still alive? Does he have much strength left?

This new study demonstrates that while manufacturing may have been dethroned as the premier industrial sector in the Commonwealth, it is by no means dead and indeed has quite a bit of life left in it. By surveying more than seven hundred manufacturing establishments in Massachusetts and following up with more than one hundred in-depth interviews, we have been able to discern a very different picture of the manufacturing sector than the one described in the early writings of Bell, Bluestone and Harrison, or Schumpeter, and even the more recent work of Thomas Friedman.

Before we consult these new survey and interview data, however, it serves us well to examine a large amount of existing statistics to situate today's manufacturing sector in historical context. We begin just before World War II.

The Rise and Fall of Massachusetts Manufacturing

In one of his most famous fireside chats broadcast on radio nearly a full year before Pearl Harbor, President Franklin Delano Roosevelt referred to Detroit as the "Arsenal of Democracy."[6] He was referring to the auto industry, which was gearing up to produce aircraft, tanks, half-tracks, jeeps, and guns first for the lend-lease program to England and for what later would become America's entry into World War II.

Roosevelt could just as easily have been referring to Massachusetts. Manufacturers throughout the Commonwealth were converting to a war-time footing as rapidly as were Detroit automakers, and they were greatly expanding their production capability. Firms like

the Springfield Machine and Foundry Co. were producing huge engines for Liberty ships; General Electric in Lynn was producing aircraft engines for bombers and fighter planes; Bethlelem Steel was producing around the clock in Quincy. The Cabot Corporation in Boston was the largest producer of carbon black for use in synthetic rubber, a critical need during the war when natural rubber supplies from the Far East were interrupted by the Japanese. The Charlestown Navy Yard employed 47,000 workers in 1944 building, repairing, and outfitting ships. Sprague Electric of North Adams was building electric components for high tech weapons including the atom bomb. Firms which seemingly had no capacity for war production converted as well. Guyot Brothers Co. of Attleboro, a manufacturer of jewelry and decorative stampings began producing first aid kits for the military. The Gift Wrap Co. of Lawrence and Revere converted its looms to the production of khaki webbing for parachute harnesses and chemical warfare hoods. Even the Necco Wafer Co. turned over a portion of its Cambridge confectionary plant for the production of war materiel.[7]

With all of this activity, the number of manufacturing jobs in Massachusetts increased by more than 125,000 in just two years, from an estimated 534,000 in 1939 to nearly 661,000 in 1941. By 1943, the Commonwealth could boast of 801,000 manufacturing jobs, an increase of 50 percent over pre-war levels.[8] During the war, nearly 45 percent of all jobs in the Commonwealth were found in the manufacturing sector — significantly more than the 38 percent nationwide. With less than 3.3 percent of the nation's population, Massachusetts claimed nearly 5 percent of the country's manufacturing employment. Indeed, the Commonwealth was an arsenal of democracy with a manufacturing sector as healthy as that of any state in the country.

Manufacturing Employment 1939-2007

With the U.S. and its allies victorious in 1945, the production of war supplies declined dramatically. As a result, employment in Massachusetts manufacturing shrank by more than 100,000 by 1947. War production during the Korean conflict saw another increase in manufacturing employment, but with the end of open hostilities employment in the Commonwealth's plants and factories began a slow but relatively steady decline. By 1967 total manufacturing employment stood at 660,000, down nearly 18 percent from its World War II peak.

During the following twenty years from 1967 to 1984 Massachusetts manufacturing employment was volatile, but Vietnam War spending at the beginning of the period buoyed production. In addition, the introduction and rapid expansion of the mini-computer industry built around the Digital Equipment Corporation (DEC), Data General, Prime Computer, and Wang, helped keep employment above 625,000 through the end of this period. Essentially, Massachusetts had reinvented itself as a high tech manufacturer. Route 128 became almost as famous as Silicon Valley.

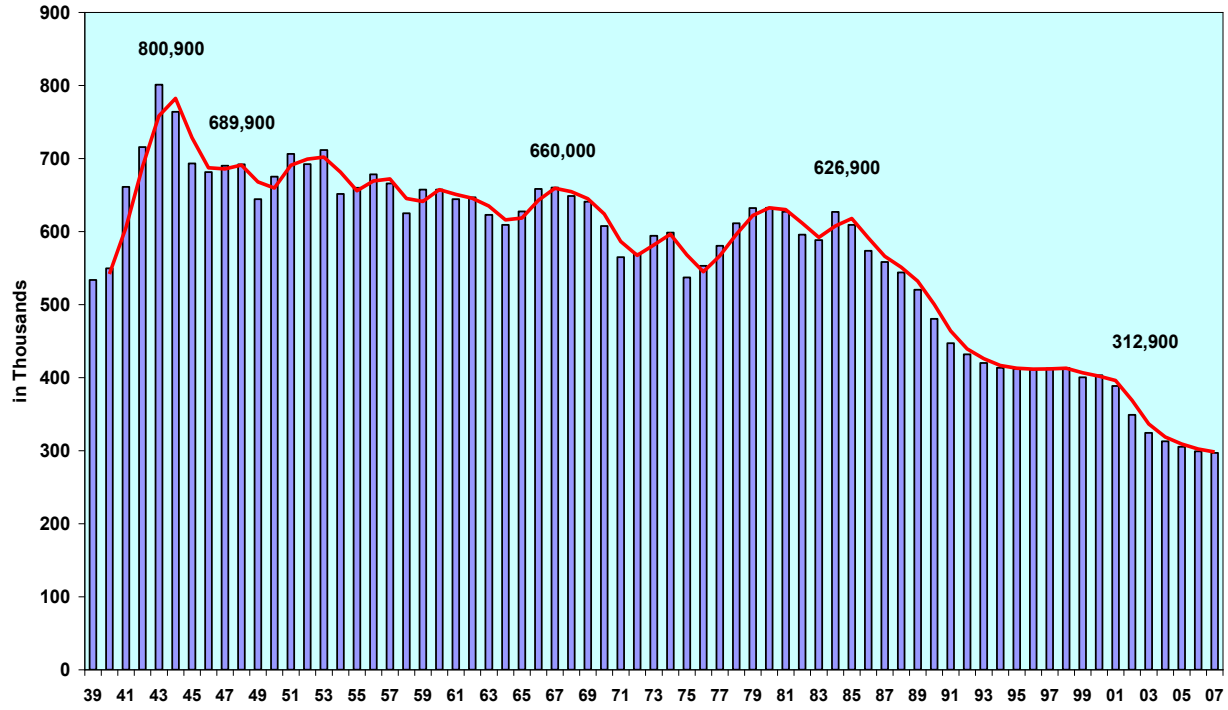
The good times were not to last, however. After 1984, the Commonwealth's manufacturing sector began to crumble as federal defense spending declined and as desktop computers produced in other states became increasingly prevalent. The new desktops were almost as powerful as the mini-computers and they sold for a fraction of the price. Unable to compete with IBM, and later with Dell, Gateway, and Apple, employment in the state's mini-computer industry collapsed.

But this was only part of the problem. Contributing to manufacturing's sharp decline was a huge increase in out-of-state competition for the production of goods once produced in-

state and the outsourcing of parts supplied by large in-state manufacturers to low-wage countries. Improvements in productivity kept many in-state firms competitive, but resulted in widespread job loss. Key Massachusetts manufacturing sectors including fabricated metal products, machinery manufacturing, chemicals, plastic products, electrical equipment, and textile mill products experienced sharp declines in employment. The result was that in a period of just twenty years the number of manufacturing jobs in the Commonwealth declined by half. By 2004, employment stood at just 313,000.

This history of manufacturing employment is summed up in **Figure 1.1**. Essentially, with the exception of business cycle fluctuations, we see three distinct periods in the data. A sharp decline from the World War II peak, a slow more or less steady decline over the next three and half decades (1947-1984), and then a very sharp decline in employment over the next twenty years through 2004. Between 1945 and 1984, *annual* job losses averaged 1,700 per year; between 1984 and 2004 they averaged more than 15,000.

Figure 1.1 Massachusetts Manufacturing Employment (1939-2007)
(with 2-Year Moving Average)



Source: U.S. Bureau of Labor Statistics, State and Local Employment Series (adjusted for change from SIC to NAICS industry code definitions).

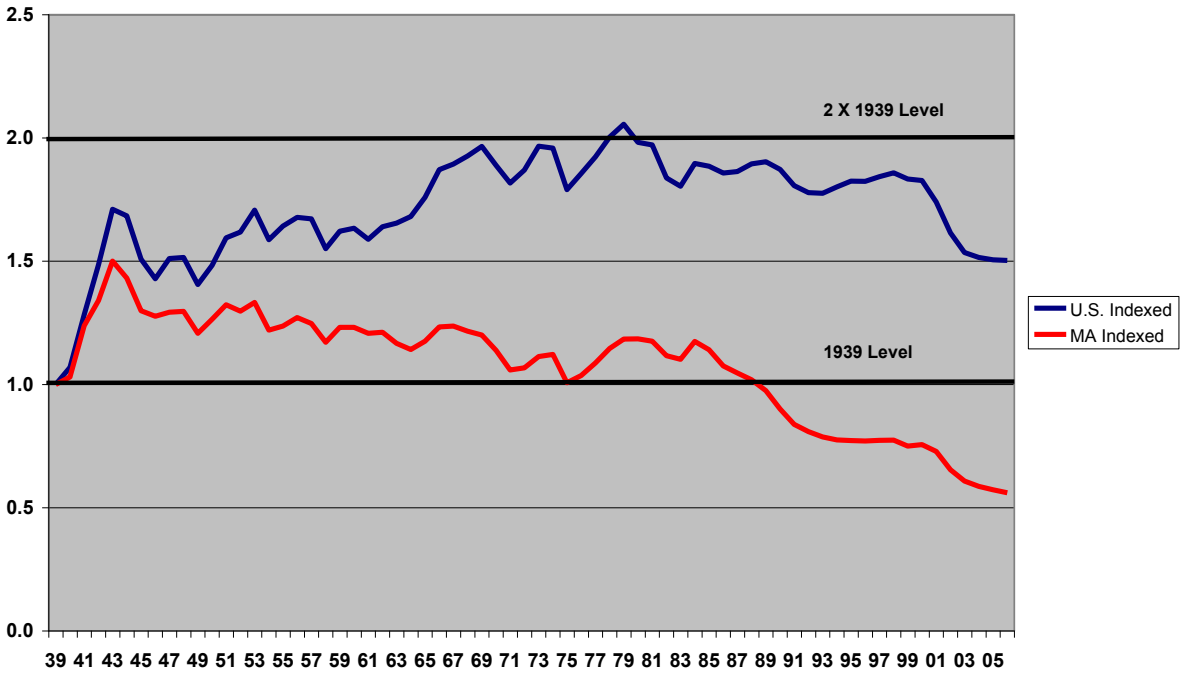
Manufacturing Employment Trends: Massachusetts vs. U.S.

An alternative way to consider the employment trend in Massachusetts manufacturing is to compare it with the trend for the United States as a whole. Nationally, the U.S. added more than 6.7 million manufacturing jobs between 1939 and 1943. At the peak of war production, there were more than 16 million workers in this sector. The total number would fluctuate over the next 36 years, but outside of the short-term business cycle there was a rising trend such that by 1979 the U.S. could boast of more than 19.4 million manufacturing workers. This would be the high-water mark, however. From 1979 on, the national trend has

been downhill with a collapse in employment beginning in 2001. By 2006, only 14.2 million remained in manufacturing.

Figure 1.2 permits us to compare the Massachusetts trend with the U.S. trend over the entire 1939-2006 period. We do this by indexing both series to their 1939 employment levels.

Figure 1.2 Manufacturing Employment: Massachusetts vs. United States (1939-2006) (1939=1.00)



Source: U.S. Bureau of Labor Statistics, State and Local Employment Series (adjusted for change from SIC to NAICS industry code definitions).

This figure suggests that Massachusetts manufacturing has generally obeyed the same short-term business cycle fluctuations as the U.S., but until quite recently the long-run trend in employment has generally been in the opposite direction from that of manufacturing employment nationwide. By 1979, manufacturing employment for the country as a whole was *double* its pre-World War II level while in Massachusetts it was just 18 percent higher. A decade later the number of Massachusetts manufacturing jobs was lower than it had been fifty

years earlier before the World War II mobilization, while nationally, manufacturing employment was 90 percent higher. Not surprisingly, many took such evidence as proof that Massachusetts was destined to become a less and less important player in the nation's manufacturing sector. At the rate that it was deteriorating, it would not be too long before manufacturing would be a trivial sector within the Massachusetts economy.

What Figure 1.2 tends to hide, however, are short term trends that tell a much richer story about the fate of manufacturing in the Commonwealth. **Figures 1.3a through 1.3e** provide another way at looking at the data. These five charts suggest six distinct eras in manufacturing history rather than the three noted earlier.

The first two (in **Figure 1.3a**) refer to the World War II mobilization and the post-war demobilization beginning in 1943. During the mobilization era (1939-1943), U.S. manufacturing employment increased by 71 percent. Massachusetts employment soared as well, but increased by only 50 percent. In the immediate post-war period, the gap between the two actually diminished a bit. By 1947, the U.S. still had 51 percent more workers in the manufacturing sector than before the war; Massachusetts had nearly 30 percent more.

Figure 1.3a

Manufacturing Employment: U.S. vs. Massachusetts: 1939-1947

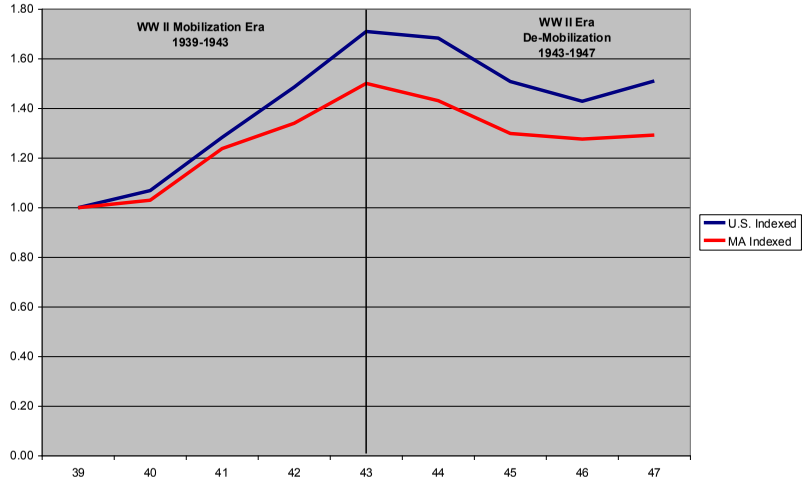


Figure 1.3b

Manufacturing Employment: U.S. vs. Massachusetts (1947-1970)

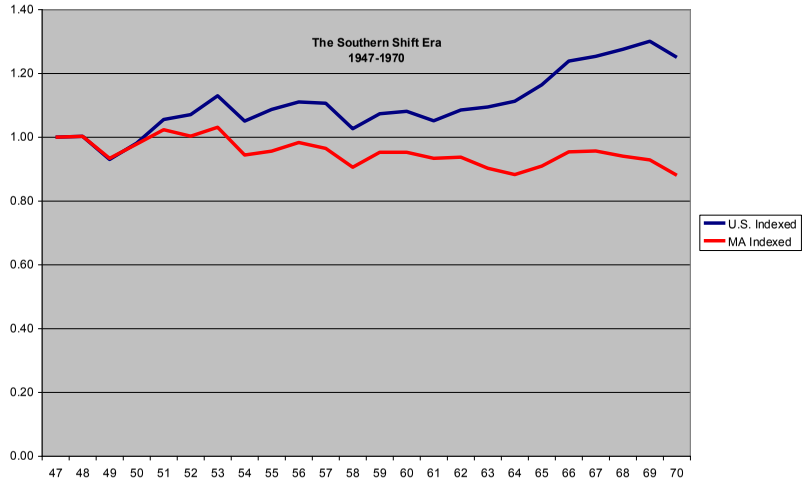


Figure 1.3c

Manufacturing Employment: U.S. vs. Massachusetts (1970-1984)

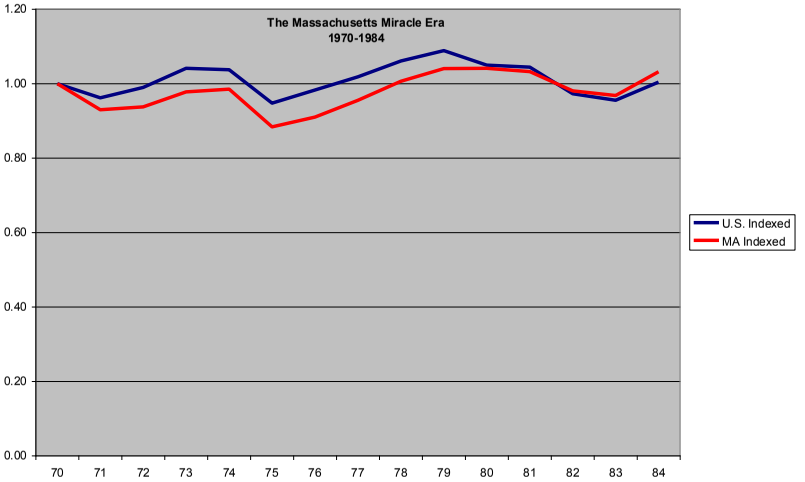


Figure 1.3d

Manufacturing Employment: United States vs. Massachusetts (1984-2000)

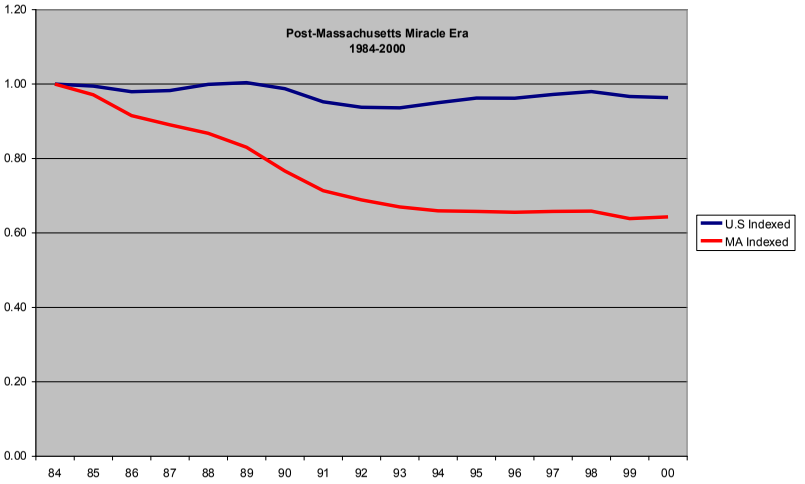
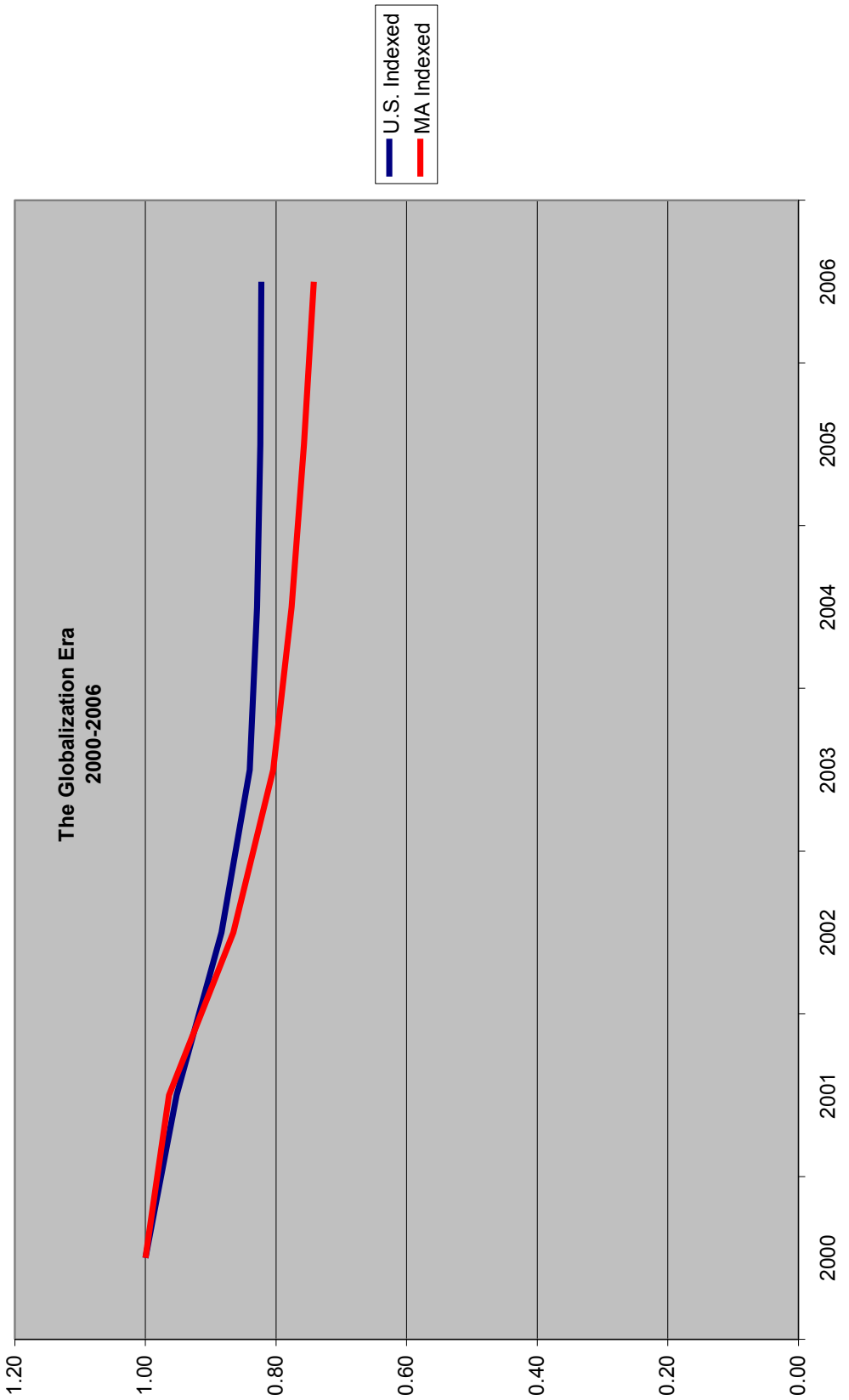


Figure 1.3e Manufacturing Employment: United States vs. Massachusetts (2000-2006)



The third era we detect began around 1947 and continued through 1970 (see **Figure 1.3b**). During this period, total manufacturing employment in the U.S. increased by about 30 percent. In sharp contrast, employment in the Commonwealth shrank by 13 percent. This was the era of the "Southern Shift" when many manufacturers moved out of the northeast and the mid-west seeking cheaper labor and weaker unions in the southern states. It was a period of region-specific "deindustrialization." Overall, manufacturing employment increased, but mostly in the south.

Figure 1.3c reveals a revival in the Commonwealth's manufacturing process that took place during the fourth era, popularly known as the "Massachusetts Miracle." For nearly a decade and a half, from 1970 through 1984, total manufacturing employment in Massachusetts stabilized and indeed performed as well as the U.S. as a whole. Much of this economic potency was driven by the mini-computer boom mentioned above.

With the demise of the mini-computer, Massachusetts manufacturing employment plummeted. As **Figure 1.3d** shows, the number of jobs in the U.S. manufacturing sector was nearly constant from 1984 through 2000. By contrast, during the very same period the Commonwealth experienced a nearly *40 percent drop* in employment in this sector.

The final period — from 2000 to 2006 — witnessed another decline of more than 20 percent in the Massachusetts manufacturing employment base, but this was not far different from the U.S. trend which, beginning with the 2000-2001 recession, was sharply downward as well (see **Figure 1.3e**).

Table 1.1 summarizes all of this information for Massachusetts. Note particularly the annual change in employment during each of these periods. Only during one era — the four-year build-up before and during World War II — was there a manufacturing boom in the Commonwealth with employment growing at nearly 11 percent per year. That took place

more than 65 years ago. In the subsequent four-year demobilization, manufacturing employment fell by an annual rate of nearly 4 percent. From 1947 through 1970, Massachusetts suffered a slow, but nearly continuous, deindustrialization with employment declining at a rate of 0.55 percent per year. The Massachusetts "Miracle" provided a temporary reprieve from job loss, but beginning in 1984 manufacturing began an accelerated collapse. Increasing productivity, the transfer of production to other parts of the country, and global outsourcing have all contributed to the decline in the manufacturing workforce since then. For the most recent era (2000-2006), the Commonwealth was shedding manufacturing jobs at a rate of 5 percent a year.

From World War II, when more than 45 percent of the state's workers could be found in manufacturing facilities, manufacturing's share of total employment has fallen to less than 10 percent today. In 2006, manufacturing made up just 9.2 percent of the Massachusetts employment base; by comparison, this sector was responsible for 10.4 percent of employment across the entire nation.

All of these statistics would suggest a grim picture of the state's manufacturing base. If past trends are any indication of what might happen over the next 5-10 years, one would have to conclude that this once proud industrial sector will all but disappear in the Commonwealth. Indeed, if the rate of job loss experienced over the period 2000 to 2006 were to continue, the very last manufacturing job in Massachusetts would vanish before 2025.

Table 1.1 Massachusetts's Modern Manufacturing Eras

Era	Years	Initial Massachusetts Employment	Ending Massachusetts Employment	Change in Massachusetts Employment	Percentage Change	Annual Percent Change	Share of All Mass Jobs at End of Era
I	1939-1943	533,700	800,900	+267,200	+50.1%	+10.7%	45.6%
II	1943-1947	800,900	689,900	-110,000	-13.9%	-3.7%	39.9%
III	1947-1970	689,900	607,500	-82,400	-11.9%	-0.55%	27.1%
IV	1970-1984	607,500	626,900	+19,400	3.2%	+0.22%	22.0%
V	1984-2000	626,900	403,200	-223,700	-35.7%	-2.8%	12.1%
VI	2000-2006	403,200	299,200	-104,000	-25.8%	-5.0%	9.2%

Source: U.S. Bureau of Labor Statistics, State and Local Employment Series (adjusted for change from SIC to NAICS industry code definitions).

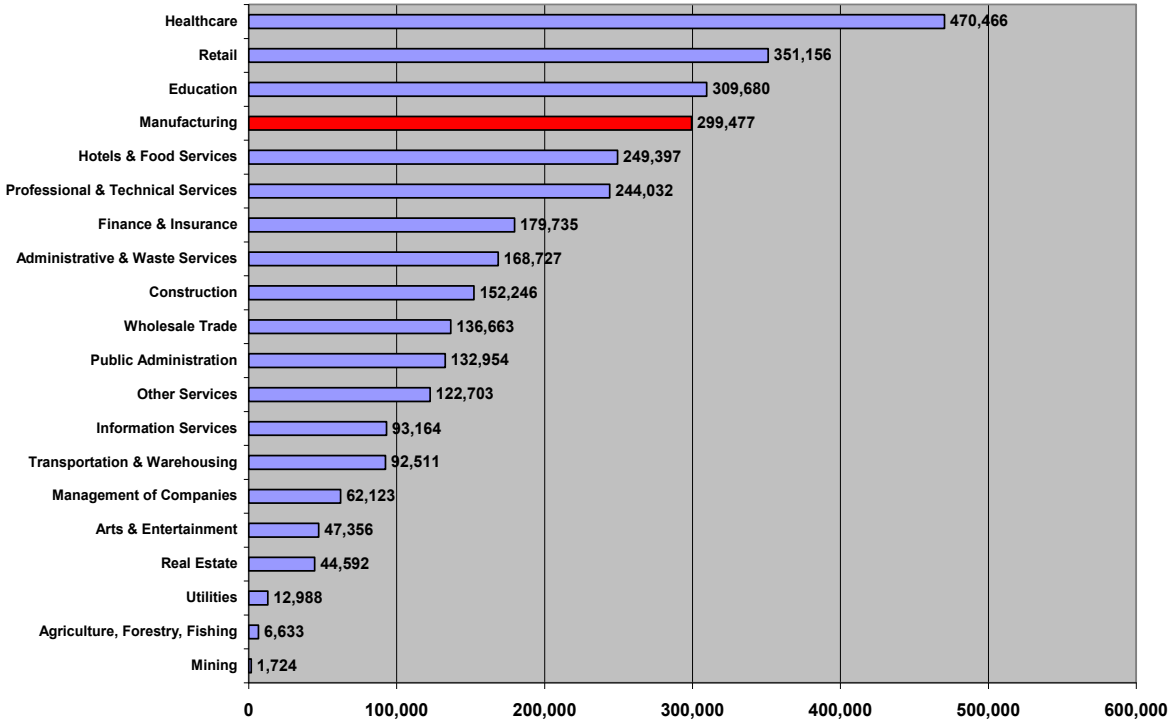
The Future of Manufacturing in Massachusetts

This pessimistic conclusion, however, may not be warranted. As the rest of this chapter and the chapters to follow will reveal, there is good reason to believe that the worst of the manufacturing collapse is over and that much of the manufacturing base that we have left will remain as a vibrant component of the state's economy. This may be surprising given the sharp declines in the sector the Commonwealth has experienced so recently.

To begin to understand the future role of manufacturing in Massachusetts, it is important to recognize that even after such sharp declines, the manufacturing sector in Massachusetts is still the fourth largest employer statewide. As **Figure 1.4** reveals, only the health care, retail trade, and education sectors employ more workers than does manufacturing. Manufacturing still employs more than all those working in hotels, restaurants, and bars. It employs 50,000 more workers than companies that offer professional and technical services

— from architects and accountants to lawyers and surveyors. It employs nearly four times as many workers as all of the state's highly vaunted biotechnology companies put together.[9] Despite the Commonwealth's reputation for being a finance capital, manufacturing employs two-thirds more workers than all of the state's banks, brokerage houses, and insurance companies put together. And it employs twice as many workers as the construction sector. Manufacturing is still large enough that if somehow every manufacturing job had suddenly disappeared in 2006, the state's unemployment rate would have instantly jumped from 5.0 to 13.8 percent.

Figure 1.4 Employment in Massachusetts by Sector, 2006



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

Manufacturing Births and Deaths

It is also important to recognize that despite the loss of manufacturing firms in the state, there are still a substantial number of new manufacturing establishments that are created each year. The statistics in **Figure 1.1** and **Table 1.1** might give the impression that manufacturing in the Commonwealth has been on a continuous path of decline with little new manufacturing activity taking place. This would be an erroneous conclusion. Both the table and figure provide data that represent the *net* change in employment levels. In every year and in every era, the net change is actually the result of four distinct phenomena: (1) new jobs created by new firms entering the sector (2) additional jobs generated by existing firms (3) job loss in existing firms, and (4) job loss due to the cessation of local production by firms going out of business or relocating out-of-state. These four can be referred to, respectively, as "births," "expansions," "contractions," and "deaths."

A closer look at these components of net change from one year to the next reveals that the short-term picture is quite dynamic. As **Table 1.2** demonstrates, even in the recession years of 2000-2001, there was an average of 500 new establishments created each year. The total loss of 1,423 establishments between 1995 and 2003 was the result of more than 4,200 new establishment births offset by more than 5,600 deaths. Some of these births were new manufacturing facilities constructed by existing firms; others represented totally new companies.

What conclusions about manufacturing operations can we draw from these data? For one, despite all the news about the loss of manufacturing prowess in the state, there are still many investors who view the state as a good location for starting up new manufacturing operations. Another conclusion is that the growth of manufacturing in Massachusetts is elastic over the short term, responding to external shocks and the overall health of the national

economy. The short-term variability in the number of establishments ranges from positive growth in one year to a 5 percent loss in the next.[10] In the nationwide recession of 2001, 804 establishments ceased production in Massachusetts — almost double the number of births that same year — but by 2002 the birth/death ratio was already climbing back to pre-recession levels, suggesting that manufacturing has the ability to rebound, at least partially, from a recession-induced contraction.[11]

Table 1.2 Number of Manufacturing Establishments in Massachusetts, 1995-2003[12]

Year	Initial Year Establishments	Births (Adjusted)	Deaths (Adjusted)	Birth : Death Ratio
1995	9,544	584	691	0.85
1996	9,437	722	686	1.05
1997	9,473	419	876	0.48
1998	9,016	481	701	0.69
1999	8,796	523	646	0.81
2000	8,673	546	612	0.89
2001	8,607	454	804	0.56
2002	8,257	486	622	0.78
2003	8,121	N/A	N/A	N/A
Total		**4,215**	**5,638**	

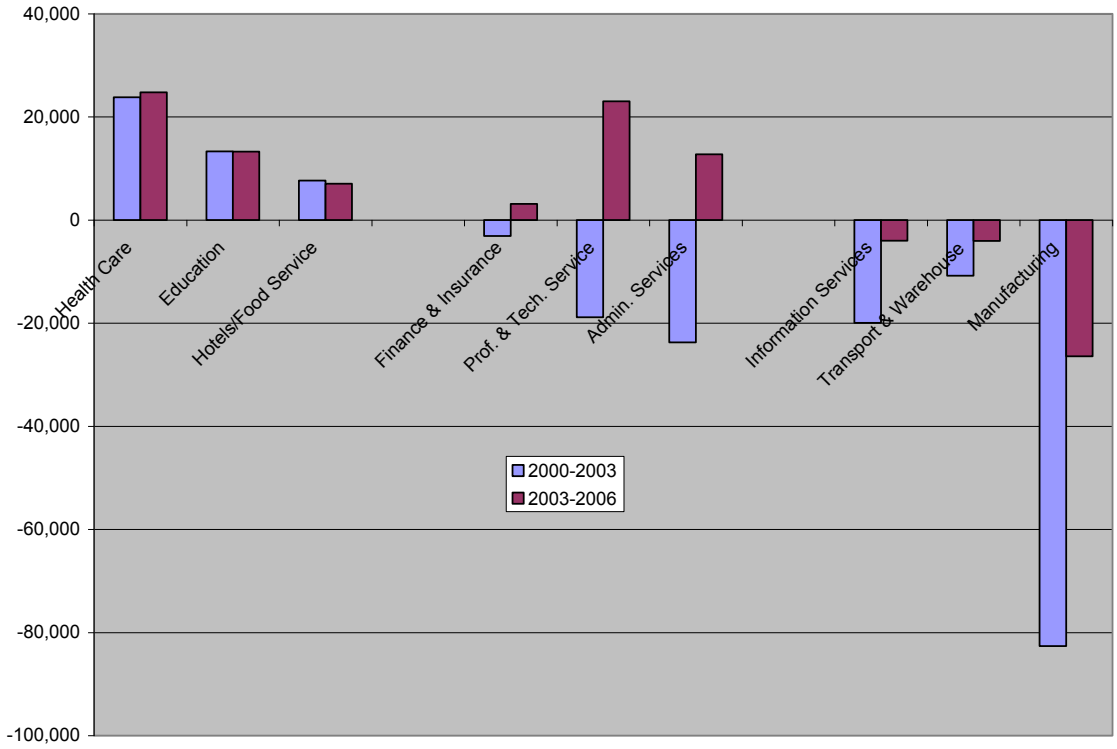
Net Change -1,423

Source: U.S. Census Bureau, *Statistics of U.S. Businesses,* 2008

Unlike other sectors, however, and despite the new company start-ups, manufacturing in the Commonwealth continued to lose jobs even after the 2000-2001 recession was over. Other industries, as **Figure 1.5** demonstrates, appear to be virtually recession-proof. The health care sector added about as many jobs during the 2000-2003 recession as it did during the 2003-2006 recovery. Similarly, the private education sector and hotels and food service

expanded at just about the same rate regardless of the business cycle. Other sectors lost employment during the last recession only to expand afterwards. These included finance and insurance, professional and technical services, and administrative services. Manufacturing more closely resembles information services and transport and warehousing. Each of these sectors continued to lose employment even after the recession had ended, although the losses were sharply attenuated in each case.

Figure 1.5 Recession & Recovery: Industry Employment in Massachusetts 2000-2006



Source: Commonwealth Corporation, *Massachusetts Manufacturing Chartbook,* 2007

Massachusetts's Key Manufacturing Industries: 1947-1975

Just as the establishment births/deaths data suggest that simple employment level information masks much of what is happening to manufacturing in the Commonwealth, the fate of individual industries is often masked by data on manufacturing as a whole. Since World War II, what is actually produced in the state has changed dramatically.[13] In 1947, according to the U.S. Department of Labor, there were 730,700 workers employed in manufacturing establishments in the Commonwealth. Of these, more than 60 percent (451,100) were employed in non-durable manufacturing, with the largest concentrations in textile mill products, leather & leather products, apparel, and food & kindred products. The remaining 279,600 employees were concentrated in such durable goods industries as non-electrical machinery, electrical equipment and supplies, fabricated metal products, and primary metals production. **Table 1.3** provides a list of all the major manufacturing industries in Massachusetts with their 1947 and 1975 employment levels.

As the table indicates, even as late as 1947, more than 300,000 workers were employed in some form of industry dealing with fabrics, leather goods, apparel, or food production, with textiles standing as the largest manufacturing industry in the state. Meanwhile, only about two-thirds as many workers (206,800) were employed in the production of machinery, electrical equipment, and metals fabrication. More than five people were involved in the production of clothing for every two employed in the production of instruments and related products.

Table 1.3 Manufacturing Employment by Industry in Massachusetts (1947-1975)

Non-Durable Goods Industry	1947 Employment	1975 Employment	Percent Change
Textile Mill Products	122,100	25,700	-79.0%
Leather & Leather Products	74,300	23,200	-68.8%
Apparel	52,800	43,500	-19.5%
Food & Kindred Products	51,700	30,100	-41.8%
Printing & Publishing	36,200	39,400	+ 8.8%
Rubber & Plastic Products	35,100	30,300	-13.7%
Paper & Allied Products	34,400	28,600	-16.9%
Chemicals & Allied Products	16,800	18,700	+11.4%
Durable Goods Industry			
Machinery, except Electrical	81,100	78,100	- 3.7%
Electrical Equipment & Supplies	60,000	87,700	+46.2%
Fabricated Metal Products	40,900	40,000	- 2.2%
Primary Metals Industries	24,800	17,700	- 28.6%
Transportation Equipment	19,900	21,000	+ 5.5%
Instruments & Related Products	19,600	38,100	+94.4%
Furniture & Fixtures	10,600	8,800	- 17.0%
Stone, Clay, and Glass Products	9,400	12,700	+35.1%
Lumber & Wood Products	8,800	3,800	- 56.8%
Ordnance & Accessories	4,500	20,600	+357.7%

Source: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, States and Areas 1939-75 (Washington, D.C.: Government Printing Office, 1991) Bulletin No. 1370-12.

Between 1947 and 1975, most of these industries underwent large changes in employment. Only two of the non-durable industries experienced increases in the number of workers they employed (Printing & Publishing; Chemicals & Allied Products). The other six major non-durable industries experienced job losses. Textile production collapsed, with the loss of nearly 100,000 jobs — about 80 percent of its 1947 total. Similarly, leather goods firms shed more than 50,000 jobs – two thirds of their 1947 base.

In general, the durable goods industries fared much better, with half increasing their employment. Proportionally, the biggest winner was ordnance and accessories, which nearly quadrupled its employment base to more than 20,000 workers. The electrical equipment

industry expanded by more than 25,000 employees (46%) while the instruments industry nearly doubled in size, adding more than 18,000 jobs. Meanwhile, some industries shrank dramatically, including lumber and wood products (-57%), primary metal operations (-29%), and furniture (-17%).

Massachusetts Manufacturing Industries Today

What do we produce in the Commonwealth today? In order of their current employment levels, the top twenty products made in Massachusetts are:

- Computer and Electronic Products
- Navigational, Measuring, Electromedical, and Control Instruments
- Semiconductor and Other Electronic Components
- Other Miscellaneous Manufacturing (e.g. medical devices, jewelry, sporting goods, and toys)
- Plastic Products
- Printing
- Medical Equipment
- Communications Equipment
- Converted Paper Products
- Industrial Machinery
- Machine Shop Products
- Pharmaceuticals
- Aerospace Parts
- Bakery Products
- Architectural and Structural Metal Products
- Chemical Products and Preparations
- Fabrics
- Metalworking Machinery
- Cutlery and Tools
- Apparel

Source: U.S. Census of Manufacturers (2006)

The first three of these (computer and electronics products; navigational, measuring, electromedical, and control instruments; and semiconductor and other electronic components) employ roughly 76,000 workers in the Commonwealth. This is equal to 22 percent of all manufacturing employment in the state. The production of fabricated metal products of all

kinds employs another 39,000 or 11 percent of the state total. Miscellaneous manufacturing, including medical devices, employs still another 33,000. The top four represent highly sophisticated manufacturing in cutting-edge industries, as do a number of other products in this list (e.g., medical equipment, communications equipment, pharmaceuticals, and aerospace parts.)

A complete listing of manufacturing industries with at least 1,000 employees — at the more detailed 4-digit NAICS Code Level — is found in **Table 1.4** along with their employment levels for 2006.[14] There are fifty-one such industries in the Commonwealth. Not counting the "catch-all" miscellaneous manufacturing sector, the 4-digit industry with the highest employment is navigational, measuring, medical, and control instruments (NAICS 3399). It provides jobs for more than 27,000 workers in Massachusetts. Next in order are semiconductor and other electronic component manufacturing, plastic products, printing activities, and medical equipment production. Machines shops, pharmaceutical production, converted paper operations, industrial machinery manufacturing, and communications equipment manufacturing round out the top 10. Perusing the full list of industries in Table 1.4 suggests that Massachusetts still manufactures a broad range of products even after suffering substantial cutbacks in employment. A significant proportion of the largest industries in the state are producing what are today highly sophisticated products.

Table 1.4 Massachusetts Manufacturing Industries (4-Digit NAICS) 2006

		Employment
31-33	**Manufacturing**	**283,141**
3399	Miscellaneous mfg	33,531
3345	Navigational, measuring, medical, & control instruments mfg	27,351
3344	Semiconductor & other electronic component mfg	16,295
3261	Plastics product mfg	15,127
3231	Printing & related support activities	14,921
3391	Medical equipment & supplies mfg	14,236
3327	Machine shops, turned product, & screw, nut, & bolt mfg	10,637
3254	Pharmaceutical & medicine mfg	9,020
3222	Converted paper product mfg	8,719
3332	Industrial machinery mfg	8,108
3342	Communications equipment mfg	7,719
3339	Other general purpose machinery mfg	6,544
3118	Bakeries & tortilla mfg	6,527
3359	Other electrical equipment & component mfg	6,330
3329	Other fabricated metal product mfg	6,215
3259	Other chemical product & preparation mfg	5,262
3323	Architectural & structural metals mfg	4,999
3364	Aerospace product & parts mfg	4,523
3322	Cutlery & hand tool mfg	3,982
3328	Coating, engraving, heat treating, & allied activities	3,915
3119	Other food mfg	3,669
3335	Metalworking machinery mfg	3,419
3333	Commercial & service industry machinery mfg	3,401
3219	Other wood product mfg	3,200
3133	Textile & fabric finishing & fabric coating mills	3,183
3121	Beverage mfg	3,100
3353	Electrical equipment mfg	2,910
3371	Household & institutional furniture & kitchen cabinet mfg	2,892
3132	Fabric mills	2,886
3321	Forging & stamping	2,706
3273	Cement & concrete product mfg	2,678
3117	Seafood product preparation & packaging	2,539
3341	Computer & peripheral equipment mfg	2,511
3221	Pulp, paper, & paperboard mills	2,439
3152	Cut & sew apparel mfg	2,425
3169	Other leather & allied product mfg	2,185
3116	Animal slaughtering & processing	2,144
3314	Nonferrous metal (except aluminum) production & processing	2,110
3372	Office furniture (including fixtures) mfg	2,042
3279	Other nonmetallic mineral product mfg	1,853
3149	Other textile product mills	1,776
3255	Paint, coating, & adhesive mfg	1,677
3351	Electric lighting equipment mfg	1,669
3334	Ventilation, heating, AC, & commercial refrigeration equip mfg	1,608
3336	Engine, turbine, & power transmission equipment mfg	1,452
3363	Motor vehicle parts mfg	1,404
3315	Foundries	1,104
3256	Soap, cleaning compound, & toilet preparation mfg	1,087
3252	Resin, synthetic rubber, & artificial synthetic fibers & filaments mfg	1,086
3141	Textile furnishings mills	1,021
3251	Basic chemical mfg	1,004

Source: U.S. Census of Manufacturers (2006)

Employment Concentrations in Manufacturing: Massachusetts vs. U.S.

While Massachusetts still manufacturers a broad range of products, the state has become a national center for the production of particular goods. According to the 2002 *U.S. Economic Census*, conducted by the U.S. Department of Commerce, there were 349,000 manufacturing workers in Massachusetts. With a population of 6.4 million, there were 5,432 manufacturing workers per 100,000 residents in Massachusetts. The corresponding concentration for the U.S. as a whole was 5,095 manufacturing workers per 100,000 residents. This means that the proportion of the population engaged in manufacturing was 7 percent higher in Massachusetts than in the U.S. $\left(\frac{5{,}432}{5{,}095} = 1.07\right)$. Using such a relative concentration measure, one can identify those manufacturing sectors for which Massachusetts has a greater presence than the country as a whole, in terms of having a higher share of the population engaged in that activity. The results are found in **Table 1.5**.

Among the 3-digit NAICS code industries, the proportion of workers employed in producing computer and electronic equipment is nearly three times higher in Massachusetts than in the U.S. as a whole. At the somewhat more disaggregated 4-digit NAICS code level, the proportion of workers making industrial machinery and communications equipment is three times higher than the corresponding national proportion, while the proportion for semiconductor and medical equipment manufacture is twice as high. At the finer 5- and 6-digit NAICS code level, Massachusetts is a leader in the manufacture of telephone apparatus, navigational and measuring equipment, and aircraft engine and engine parts production. These are Massachusetts star industries.

These industries continue to have a disproportionate share of production in Massachusetts for a variety of reasons:

- The industry originated here, and such long-established firms have retained a presence here because specific knowledge, skills, and techniques have been passed down through generations of owners and workers in Massachusetts. The textile and machinery industries remaining in the Commonwealth are good examples of this phenomenon.

- There are agglomeration factors that make location here advantageous. The existence of a web of suppliers to an industry, one or two large consumers of an industry's products, or a supply of specialized workers in close proximity gives the region a cost, efficiency, or technological advantage. Good examples in Massachusetts include the aircraft engine and medical device industries. General Electric's aircraft engine plant located in Lynn, Massachusetts and Pratt & Whitney's aircraft turbine plant in East Hartford, Connecticut rely on a network of metal fabricators, plastic extruders, and other small scale suppliers located in the Commonwealth.

- Manufacturers enjoy close proximity to key inputs, such as fish or dairy products for certain food products industries.

- For high-tech industries, the presence of labor with specific knowledge or skills offers a distinct advantage, as does their proximity to research universities and medical centers.

Table 1.5 Massachusetts Leads the Nation in Key Manufacturing Industries

NAICS Code	Industry	Massachusetts Employment, 2002	Concentration Ratio (MA vs. U.S.)
3-Digit NAICS Industries			
334	Computers and Electronic Product Manufacturing	76,000	2.7
339	Miscellaneous Manufacturing (incl. medical devices, jewelry, toys)	34,000	2.0
313	Textile Mills	10,500	1.8
4-Digit NAICS Industries			
3332	Industrial Machinery Manufacturing	10,500	3.1
3342	Communications Equipment Manufacturing	12,500	3.0
3344	Semiconductor and Other Electronic Component Manufacturing	21,000	2.2
3391	Medical Equipment and Supplies Manufacturing	15,300	2.1
5-Digit NAICS Industries			
33421	Telephone Apparatus Manufacturing	5,700	4.0
33451	Navigational, Measuring, Electromedical, and Control Instrument Manufacturing	34,300	3.6
33329	Other Industrial Machinery Manufacturing	9,200	3.3
6-Digit NAICS Industries			
333295	Semiconductor Machinery Manufacturing	4,800	6.4
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	4,400	4.9
335412	Aircraft Engine and Engine Parts Manufacture	7,100	4.4

Source: U.S. Census of Manufacturers

Massachusetts Manufacturing: Low-Tech, Middle-Tech, and High Tech Sectors

Dividing the manufacturing sector into non-durable and durable goods industries and disaggregating industries according to the NAICS system is a crude method for distinguishing among the types of industries in the manufacturing sector. A more useful disaggregation is based on the level of technology utilized in each industry as this provides a gauge of the sophistication of both products and production methods. The Organization for Economic Co-Operation and Development (OECD) based in Paris has created just such a taxonomy.[15]

The OECD uses the concept of "technology intensity" where the level of technology specific to an industrial sector — measured by the ratio of research and development (R&D) expenditure to value-added in an industry and the technology embodied in purchases of intermediate and capital goods — is the critical factor in classifying industrial sectors as:

- Low-technology
- Medium-low-technology
- Medium-high-technology
- High-technology

Applying the OECD methodology to the 22 broad manufacturing industries in the International Standard Industrial Classification (ISIC), they conclude that four industries fall into the high-technology sector; six in the medium-high sector; eight in the medium-low sector; and four in the low-technology sector. **Table 1.6** lists these industries.

Table 1.6 OECD Manufacturing Industries Classified According to Their Global Technological Intensity (ISIC Revision 2)

High-technology
1. Aerospace
2. Computers, office machinery
3. Electronics-communications
4. Pharmaceuticals

Medium-high-technology
5. Scientific instruments
6. Motor vehicles
7. Electrical machinery
8. Chemicals
9. Other transport equipment
10. Non-electrical machinery

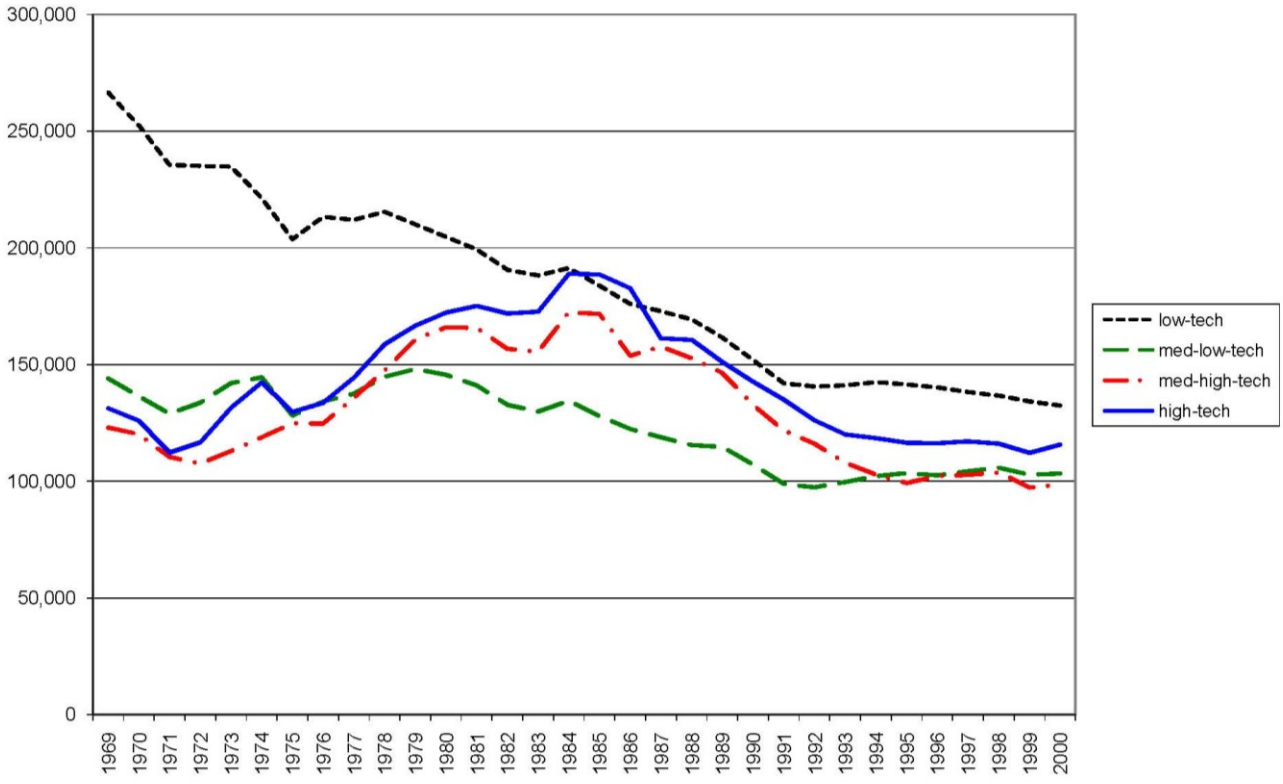
Medium-low-technology
11. Rubber and plastic products
12. Shipbuilding
13. Other manufacturing
14. Non-ferrous metals
15. Non-metallic mineral products
16. Fabricated metal products
17. Petroleum refining
18. Ferrous metals

Low-technology
19. Paper printing
20. Textile and clothing
21. Food, beverages, and tobacco
22. Wood and furniture

Source: Thomas Hatzichronoglou, "Revision of the High-Technology Sector and Product Classification," STI Working Papers 1997/2 (Paris: Organization for Economic Cooperation and Development, 1997).

Using this four-category classification system, we can trace employment trends within the Massachusetts manufacturing sector by allocating the employment in each of the fifty-one industries in Table 1.4 into the 22 broad OECD manufacturing categories. Aggregating over the four OECD tech sectors, **Figure 1.6** provides employment trends for the period between 1969 and 2000. With the shift from the U.S. Standard Industrial Classification (SIC) system that aligned well with the ISIC to the current NAICS classification system, it has not been possible to follow the same industries beyond 2000 without distorting individual industry trends.

Figure 1.6 **Massachusetts Manufacturing Employment by Technological Intensity, 1969-2000**

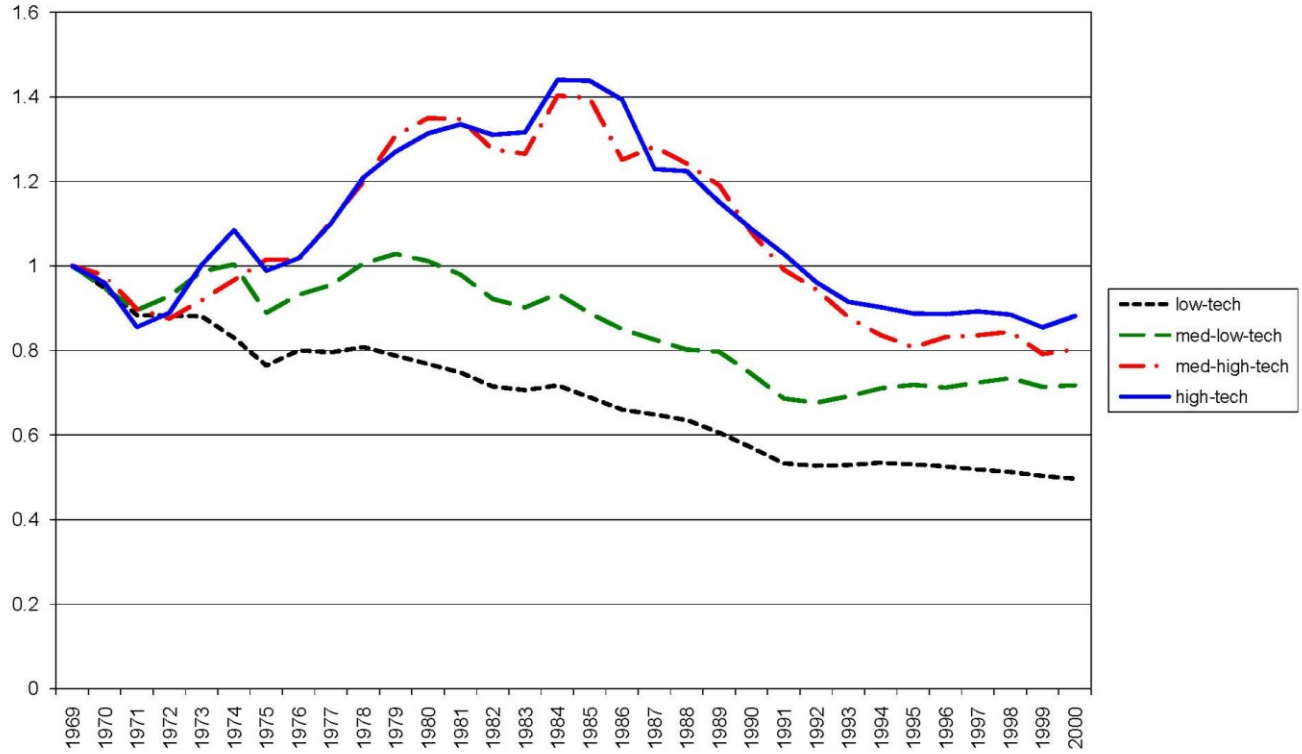


Source: Authors' calculations based on U.S. Bureau of Labor Statistics data, using OECD categories reported in Hatzichronoglou (1997).

As Figure 1.6 demonstrates, *low-tech employment* in such industries as textiles, clothing, and food has fallen precipitously in Massachusetts from 266,000 workers in 1969 to 132,000 in 2000, although most of this reduction occurred before 1991. *Medium-low-tech* industries, including rubber and plastic products and fabricated metal operations, began with 144,000 workers in 1969, maintained that level for the most part through 1984, and then declined to about 100,000 by 1991. For the next decade, this sector remained relatively stable and actually grew slightly. *Medium-high-tech* industries, including motor vehicle parts, scientific instruments, and electrical equipment, experienced an employment boom between 1969 and 1984, increasing from 123,000 workers to 172,000. From then on, however, the sector sustained high employment losses through 2000. By the end of this period, Medium-high-tech firms employed 99,000 workers, about the same as Medium-low industries. *High-tech* companies in such industries as aerospace, electronics, computers, and pharmaceuticals had a more precipitous rise between 1969 and 1984, but since then have sustained a sharp contraction. From a peak of 189,000 employees in 1984, this sector employed 116,000 in 2000.

Relative to where each of these four technology-specific subsectors was in 1969, however, the decline in employment has been sharpest for the low-tech industries and least for the high-tech sector (although, given the rapid increase in high-tech employment between 1969 and 1985, it has experienced the sharpest decline since then). **Figure 1.7** converts these absolute employment levels to indexes with employment in 1969 set to 1.00 for each industry sector.

Figure 1.7 Massachusetts Manufacturing Employment by Technological Intensity, 1969-2000 (Indexed to 1969 Level)



Source: Authors' calculations based on U.S. Bureau of Labor Statistics data, using OECD categories reported in Hatzichronoglou (1997).

Between 1969 and 2000, the low-tech sector declined by 50 percent; the medium-low sector by 29 percent; the medium-high sector by 20 percent, and the high tech sector by 12 percent.

As a result of these subsectoral employment trends and extending the series to 2006, the high tech sector has increased its share of total manufacturing employment from under 20 percent to more than 30 percent. Almost all of this has been at the expense of the low tech sector which moved from a 40 percent share of the manufacturing workforce to 30 percent, with the two medium tech sectors holding steady (see **Table 1.7**).

Table 1.7 Shares of Manufacturing Employment by Technological Intensity (1970-2006)

	1970	1980	1990	2000	2006
Low-Tech	**39.8%**	**29.7%**	**28.4%**	**29.4%**	**30.6%**
Medium-Low-Tech	21.5%	21.1%	20.1%	22.9%	20.4%
Medium-High-Tech	18.9%	24.1%	24.8%	21.9%	18.3%
High Tech	**19.8%**	**25.0%**	**26.7%**	**25.7%**	**30.6%**

Source: Authors' calculations based on U.S. Bureau of Labor Statistics data, using OECD categories reported in Hatzichronoglou (1997).

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Real Output and Productivity in Massachusetts Manufacturing

Employment levels have certainly contracted in manufacturing, not only in Massachusetts but nationwide. But this does not mean that manufacturing itself has declined. Manufacturing output has actually been rising in the Commonwealth over the past decade, along with productivity. Indeed, not only has gross manufacturing output increased in the Commonwealth, but according to **Table 1.8** it has actually risen faster than the all-industry output in the state. On average, then, manufacturing output is now growing at a faster rate than other sectors.

In 1997, real manufacturing output or gross state product (GSP) originating in the manufacturing sector amounted to $24.7 billion (in year 2000 dollars). By 2006, output had increased by an extraordinary 61 percent to nearly $40 billion. During the same 10 year period, Massachusetts real gross state product increased to $300 billion, but this represented only a 32 percent increase. As a consequence, manufacturing output represented 13.3 percent of total state output in 2006, up from 10.9 percent in 1997.

Table 1.8 Real Output and Productivity in Massachusetts – All Industries vs. Manufacturing (1997-2006)

Massachusetts	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total Real Gross State Product (GSP) (in millions)	$227,074	$240,617	$255,189	$274,949	$276,634	$274,997	$280,881	$289,295	$292,225	$300,753
Manufacturing Real GSP (in millions)	$24,737	$27,912	$30,126	$37,204	$35,011	$35,376	$38,071	$37,103	$37,761	$39,957
Manufacturing GSP/Total GSP	10.9%	11.6%	11.8%	13.5%	12.7%	12.9%	13.6%	12.8%	12.9%	13.3%
Productivity - All Private Industries ($000/worker)	$72.923	$75.571	$78.695	$82.586	$82.843	$84.374	$87.820	$90.548	$90.992	$92.730
Productivity - Manufacturing ($000/worker)	$59.975	$67.592	$75.252	$92.283	$90.099	$101.412	$117.385	$118.590	$123.678	$133.561
Productivity Growth, All Private Industries		3.6%	4.1%	4.9%	0.3%	1.8%	4.1%	3.1%	0.5%	1.9%
Productivity Growth, Manufacturing		12.7%	11.3%	22.6%	-2.4%	12.6%	15.8%	1.0%	4.3%	8.0%

Note: All dollar figures are chain-weighted based on prices in year 2000

Source: U.S. Bureau of Economic Analysis, *Gross State Product Series*
U.S. Bureau of Labor Statistics, *Current Employment Survey*

This extraordinary performance is due to an impressive increase in productivity growth in the state's manufacturing sector. While productivity growth — as measured by real dollar output per worker — grew by anywhere between 0.5 percent and 4.9 percent each year in the private sector as a whole, it grew by as much as 22.6 percent in manufacturing. Such a sterling performance is due primarily to the rapid shift in the composition of the manufacturing sector from such low-productivity industries as textiles, apparel, and leather goods to high-productivity industries including instruments, electronic components, and pharmaceuticals. As an illustration, consider that when an industry with per worker output of $45,000 per year sheds an employee and an industry averaging $90,000 per worker adds a new employee, productivity resulting from that "transaction" doubles.

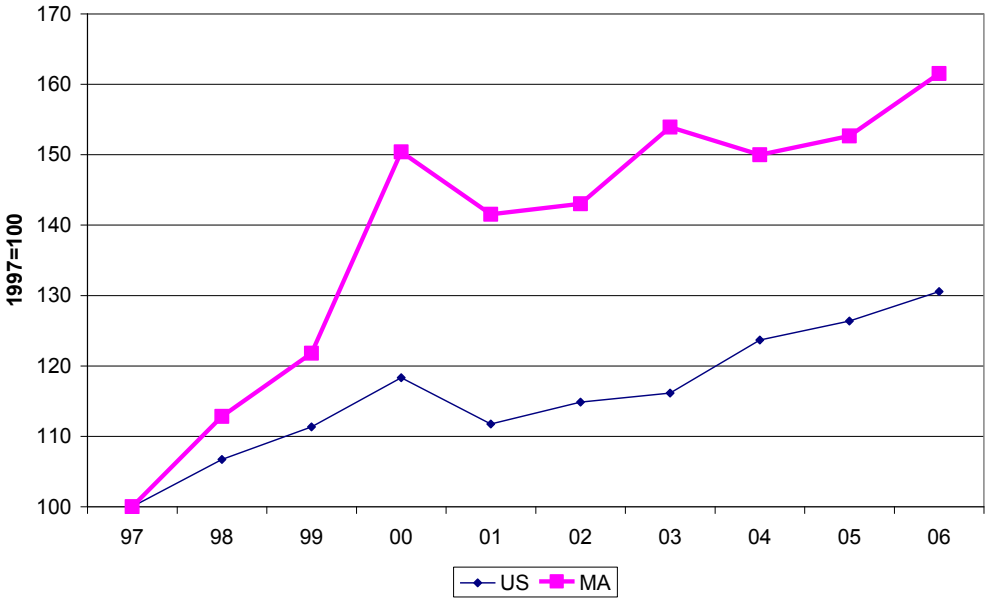
Not only did manufacturing in the state do well relative to all state industries; it did extremely well against its U.S. counterparts, as **Figure 1.8** reveals. Between 1997 and 2006, real GDP originating in the U.S. manufacturing sector increased by 30 percent in contrast with the 60 percent increase in the Commonwealth. Once again this trend likely reflects the substitution of high-productivity industries for low-productivity firms in Massachusetts.

Figure 1.9, depicting the growth in output per worker in the U.S. and Massachusetts manufacturing sectors, confirms the assertion of high productivity. Note that Massachusetts surpassed U.S. productivity in the year 2000 and has continued to increase its lead.

All of this could only have occurred if the Commonwealth had rapidly shed its low-productivity industries in favor of much more highly productive ones. Put another

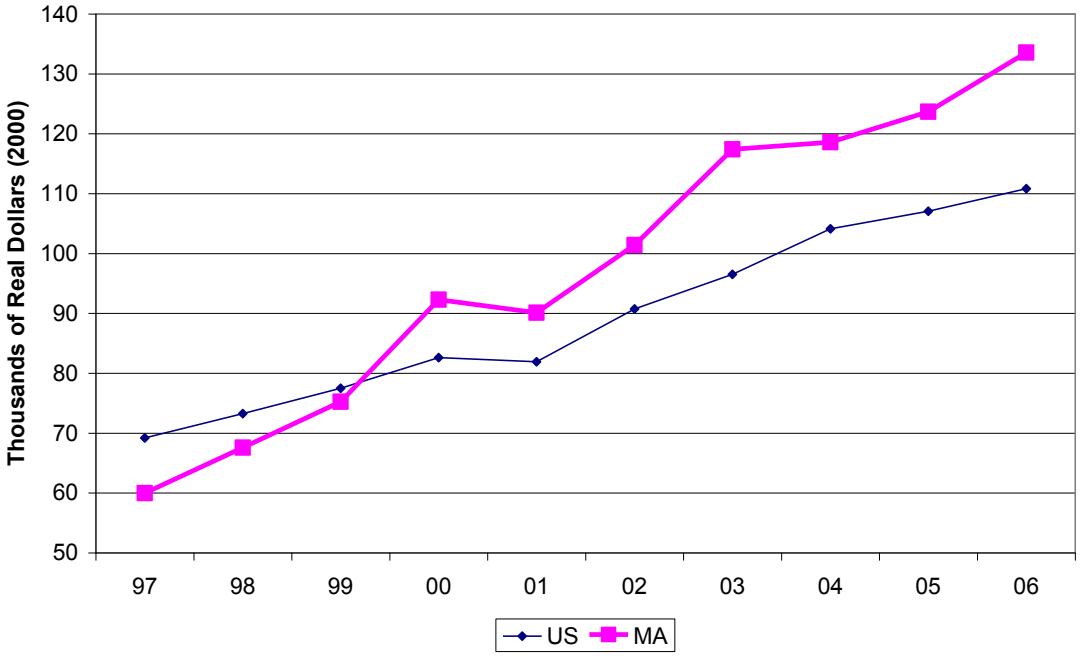
way, this kind of productivity explosion could only have happened as the result of the state's manufacturers abandoning products that could be produced more cheaply somewhere else.

Figure 1.8 Real GDP Originating in Manufacturing



Source: BEA *State Product* and *Gross Domestic Product* data

Figure 1.9 Output per Worker, Manufacturing

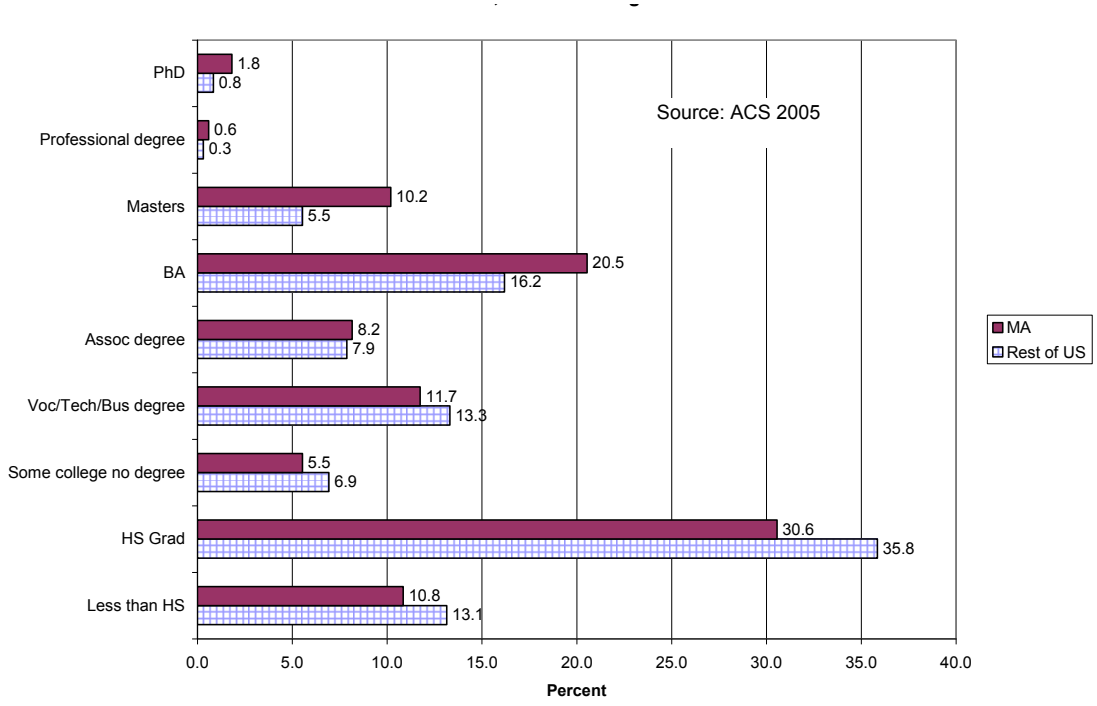


Source: U.S. Commerce Department, Bureau of Economic Analysis, *Gross Domestic State Product*, BLS *Establishment Employment*

The Massachusetts Manufacturing Workforce

The extraordinary improvement in manufacturing output and productivity in Massachusetts owes in part to the relatively well-educated employees that work in these industries (see **Figure 1.10**). According to the 2005 *American Community Survey* conducted by the U.S. Census Bureau, nearly a third (33.1%) of Massachusetts manufacturing workers have a college degree or more education. The comparable share for the U.S. is just over one fifth (22.8%). At the other end of the education spectrum, about 41 percent of the Commonwealth's manufacturing workforce has no more than a high school degree, while nearly half (48.9%) of the U.S. manufacturing workforce have at most the high school diploma.

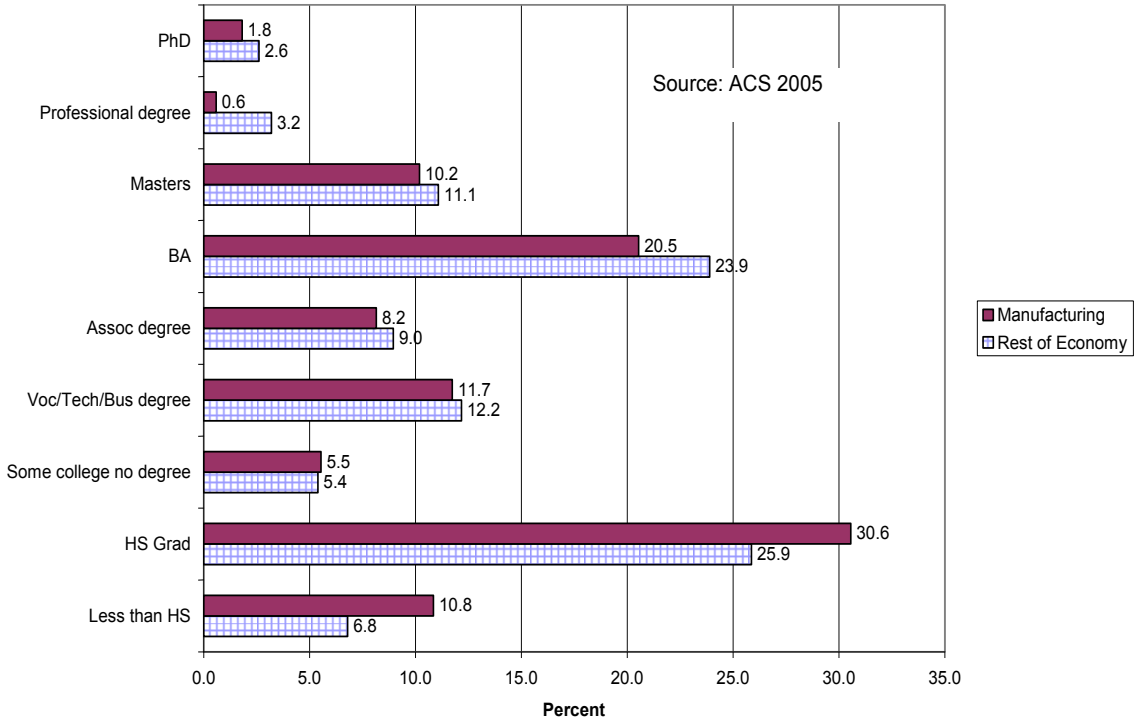
Figure 1.10 Educational Attainment, Manufacturing Full-Year Workers



Source: U.S. Census Bureau, *2005 American Community Survey*

Nonetheless, manufacturing still provides more opportunities for workers with limited education in Massachusetts than other industries, as **Figure 1.11** indicates. Only 32.7 percent of the workforce outside of manufacturing has a high school degree or less, compared with the 41.4 percent in manufacturing.

Figure 1.11 Educational Attainment, Massachusetts Full-Year Workers, Manufacturing vs. Rest of Economy

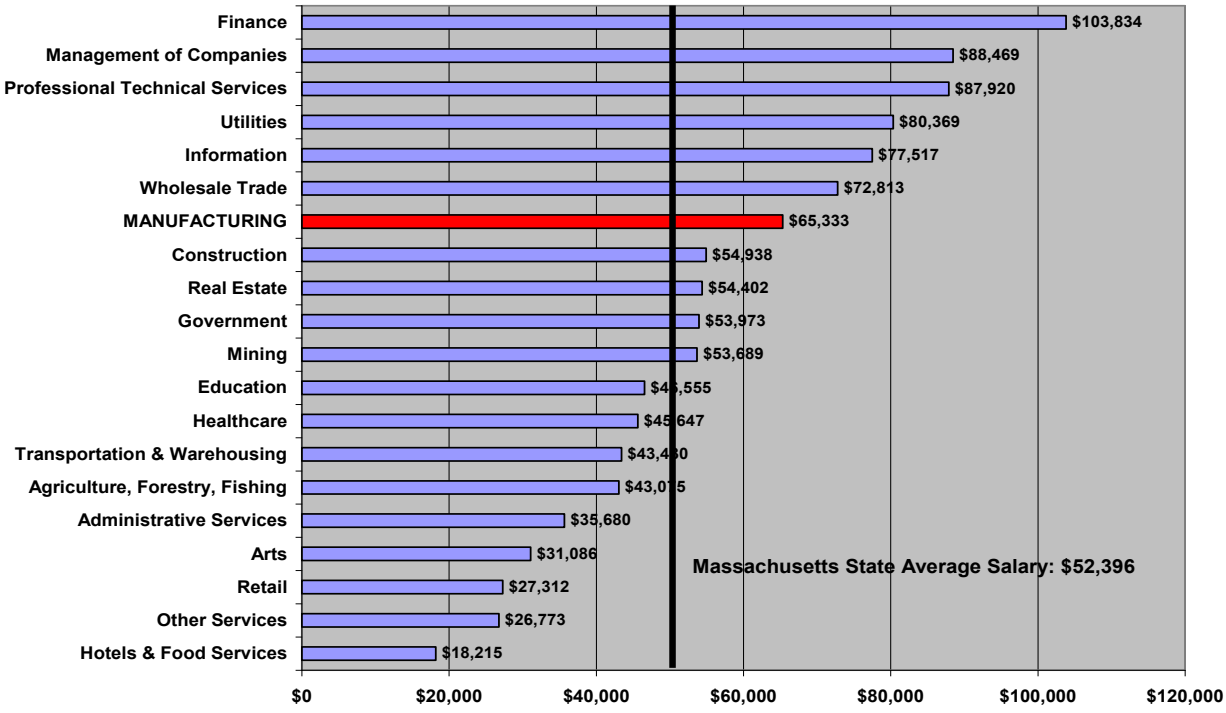


Source: U.S. Census Bureau, *2005 American Community Survey*

Normally, because wages are generally positively associated with education, we would expect the higher average education outside of manufacturing to lead to higher wages in the non-manufacturing sector. Because of the high productivity of manufacturing and the special skills of the manufacturing labor force, however, average wages in 2006 were actually higher in this sector than in other industries. Higher unionization rates also contribute to better wages and benefits in some of these industries. Across the state, the average annual salary was $52,396; in manufacturing it averaged nearly 25 percent higher at $65,333.[16] **Figure 1.12** compares the average 2006 salary across leading Massachusetts industries. On average manufacturing pays 3.6 times as

much as the typical hotel & food service job, 2.4 times as much as the typical retail trade job, and even 18 percent more than the average salary in construction.

Figure 1.12 Average Annual Salaries for Massachusetts Industry Sectors, 2006



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

Within the Massachusetts manufacturing sector, the highest salaries paid are in computers and electronics ($88,900), the chemical industry ($85,612), and in the transportation equipment industry ($82,204). The lowest-wage industries are apparel ($30,286), textile mill products ($33,104), and furniture and related products ($44,825). Hence, even the poorest paying manufacturing industry provides an annual average salary that exceeds the salaries in retail trade, hotels and food services, and the arts.

Because of its relatively high wage, manufacturing accounts for a higher share of total employee wages in Massachusetts than its share of total employment. While 9.1 percent of state's workforce in 2007 was employed in the manufacturing sector, the workers in this sector earned 11.5 percent of total state-wide annual wages. As such, the manufacturing sector contributes more to total payroll than any other sector in Massachusetts save the health care industry. While manufacturing has fewer employees than either the education sector or retail trade, its payroll is higher than both (9.9 percent and 3.9 percent, respectively) and nearly as high as the 13.2 percent share of total wages earned in the health care sector (see **Table 1.9**).

Table 1.9 Share of Massachusetts Payroll (2006) – Top 4 Sectors

	Total Employment	Percent of Massachusetts Workforce	Percent of Massachusetts Total Payroll
Health Care	470,466	14.3%	13.2%
Retail Trade	351,156	10.7	3.9
Education	309,680	9.4	9.9
Manufacturing	299,477	9.1	**11.5**

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

The relatively high wage in manufacturing is shared by a workforce that is more diverse than the Commonwealth's workforce as a whole. Nearly a quarter (24.4%) of the manufacturing workforce is foreign-born, compared to just 15.9 percent elsewhere in the state's economy. Nearly 6.5 percent of the workforce is Asian, compared with just 4.1 percent outside of manufacturing. Hispanics account for 8.3 percent of the manufacturing workforce in contrast to 5.8 percent of the Massachusetts workforce as a whole. Only African-Americans are underrepresented in this sector, making up only 3.5 percent of the sector's total workforce despite the fact that they represent 4.9 percent of the state's employment base (see **Table 1.10**).

Table 1.10 Massachusetts Manufacturing: A Diverse Workforce

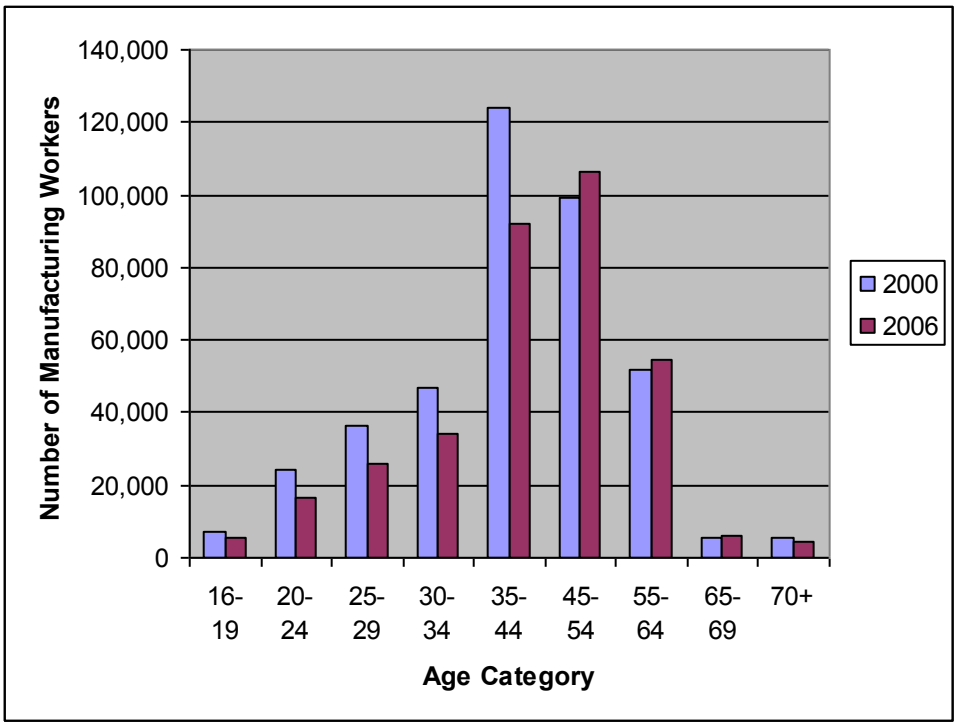
	Share of Non-Manufacturing Workforce	**Share of Manufacturing Workforce**
Foreign Born	15.9%	24.4%
Hispanic	5.8	8.3
Asian	4.1	6.5
African-American	4.9	3.8

Source: U.S. Census Bureau, *2005 American Community Survey*

What is most distinct about the Massachusetts manufacturing workforce is its age. Manufacturers employ an aging workforce, many of whom will face retirement in the coming decade. In 2006, according to the *American Community Survey*, nearly half (49.6%) of the Massachusetts manufacturing labor force was 45 years old or older. This compares with just two out of five (41.1%) workers outside of manufacturing. Fewer than one out of seven (13.8%) manufacturing workers is under the age of 30 compared to nearly one fourth (24.4%) of non-manufacturing workers.

Figure 1.13 portrays the age distribution of all manufacturing employees in Massachusetts in 2000 and 2006. As we know from the employment data presented earlier, the entire employment base shrank over this period, yet the employment decline has not been evenly distributed across age groups. In fact, while there are fewer employees today than in 2006 in every age group up to the 35-44 category, there are actually more employees between the ages of 45 and 69 working in manufacturing today than in 2000. In just six years, the modal age category for manufacturing employees has shifted up a whole decade.

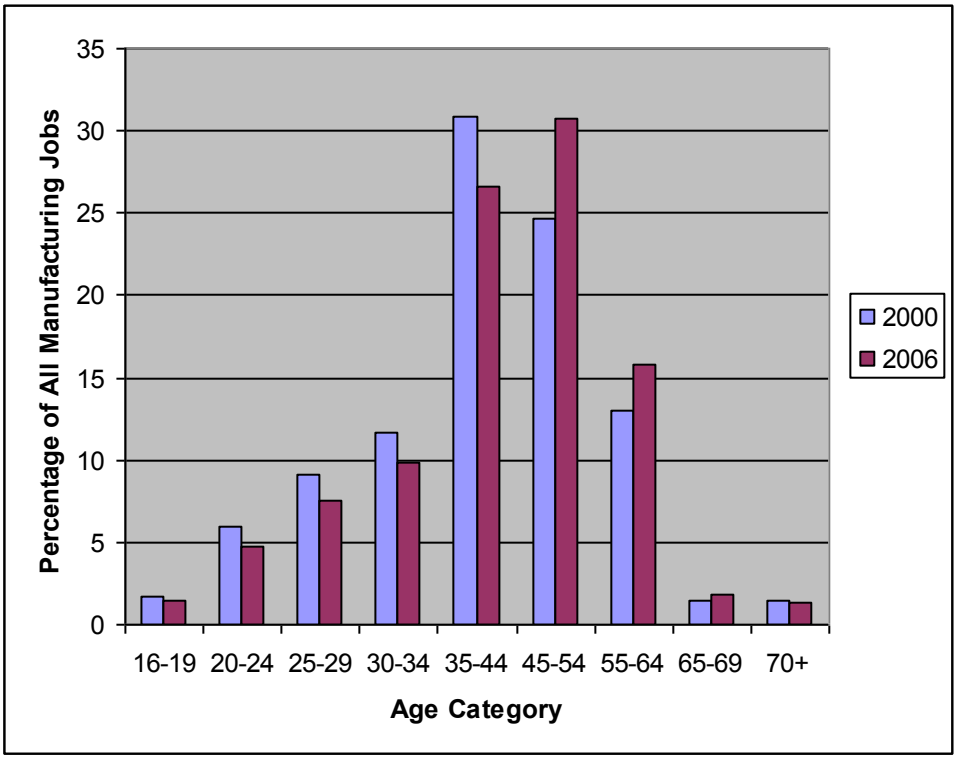
Figure 1.13 Massachusetts Manufacturing Employment by Age Group, 2000 and 2006



Source: U.S. Census of Housing and Population, 2000; American Community Survey, 2006.

Comparing the two sets of bars in Figure 1.13, one detects a rolling (i.e., aging) wave of workers. The huge bloc of middle-aged manufacturing workers at the crest of the wave is steadily approaching retirement, and as it stands now the young cadre of employees at the wave's trough will not be sufficient to fill all of the ensuing vacancies. This crashing wave is shown even more clearly in **Figure 1.14**, which disaggregates age-specific employment into proportions of total manufacturing employment. If we assume that most people will retire by age 65, then we can expect nearly half (48%) of current manufacturing employees to leave this industry over the next twenty years simply as a result of retirement.

Figure 1.14 Shifting Distribution of Massachusetts Manufacturing Employment, 2000-2006



Source: U.S. Census of Housing and Population, 2000; American Community Survey, 2006.

Table 1.11 presents more precise estimates of just how many retirements we can anticipate in the coming decade. Data from the *American Community Survey* were used to break down the state's manufacturing employment by sex. Using sex-specific retirement rates estimated by Georgetown University demographers Murray Gendell and Jacob Siegel, we estimated what proportion of current manufacturing employees within each age category will likely retire within the next 10 years.[17] Of the nearly 150,000 current manufacturing employees over age 45, we estimate that less than two thirds (98,000) will continue working for the next 10 years; by extension, more than 50,000 jobs could open up due to the retirement or death of current manufacturing workers.

Table 1.11 Projected Employment of Older Manufacturing Workers in Massachusetts, 2016

Age Group	Total Number of Employees, 2006	Number of Men, 2006	Number of Men, 2016 (Projected)	Retirements and Deaths among Men, 2016	Number of Women, 2006	Number of Women, 2016 (Projected)	Retirements and Deaths among Women, 2016	Total Number of Employees, 2016 (Projected)	Total Projected Retirements and Deaths, 2016
45-54	91,831	64,283	55,227	9,056	27,548	22,518	5,029	77,745	**14,086**
55-64	47,232	31,902	11,954	19,948	15,330	5,635	9,695	17,589	**29,643**
65-69	5,365	3,786	1,238	2,548	1,579	351	1,228	1,589	**3,776**
70+	3,933	1,986	565	1,421	1,947	324	1,623	889	**3,044**
Total	148,361	101,957	68,983	32,974	46,404	28,829	17,575	97,812	**50,548**

Note: Data on 2006 employment by age and sex are taken from the American Community Survey, 2006 and adjusted to reflect the manufacturing employment totals reported by the Bureau of Labor Statistics. Projections are based upon retirement rates reported by Gendell and Siegel, "Trends in Retirement Age by Sex, 1950-2005," Monthly Labor Review (July 1992), pp. 22-29. Assistance in collecting ACS data was provided by Ishwar Khatiwada, Center for Labor Market Studies, Northeastern University. Data are available upon request.

The total number of job vacancies in the manufacturing sector will, of course, be much higher since many workers separate each year from manufacturing firms to take jobs in other companies. Nationally, according to the U.S. Bureau of Labor Statistics, the annual voluntary separation rate from manufacturing establishments was 16.5 percent in 2006.[18] Some of these workers move from one manufacturing company to another; some move from manufacturing to other industrial sectors; and some leave the labor force altogether. In each of these cases, however, unless a firm is downsizing, it needs to replace those workers who leave. This turnover rate is *not* especially high. The voluntary separation rate for the U.S. labor force as a whole was more than 23 percent in 2006. Only wholesale trade, finance and insurance, and educational services boasted lower turnover rates than manufacturing.

The combination of retirement and natural turnover of younger workers will likely mean that *manufacturing employers will need to hire more than 100,000 replacement workers over the next decade* even if total employment shrinks from its current level.

Aging, retirement, and natural turnover of the manufacturing labor force may pose significant challenges to the continued strength of this sector in Massachusetts if a sufficient supply of younger well-trained workers is not available to take the large number of expected vacancies. As we will see later in this report, manufacturers are keenly aware of this problem and consider it a major challenge looming in the very near future.

Generating a new workforce for manufacturing must take heed of this sector's particular occupational distribution. The types of jobs in manufacturing differ strikingly from those in the rest of the Massachusetts economy. As **Table 1.12** demonstrates, production occupations dominate manufacturing and manufacturing has a slight edge in its share of managers, engineers, and scientists. Most notably and not unexpectedly,

production workers account for more than a third of the manufacturing workforce (36.6%), compared with just 1.8 percent in non-manufacturing. Perhaps more surprisingly, manufacturing today boasts a higher proportion of workers in computing, engineering, and science (18.4% in manufacturing vs. 6.9% in non-manufacturing) and a higher proportion in management (14.3% vs. 11.0%).

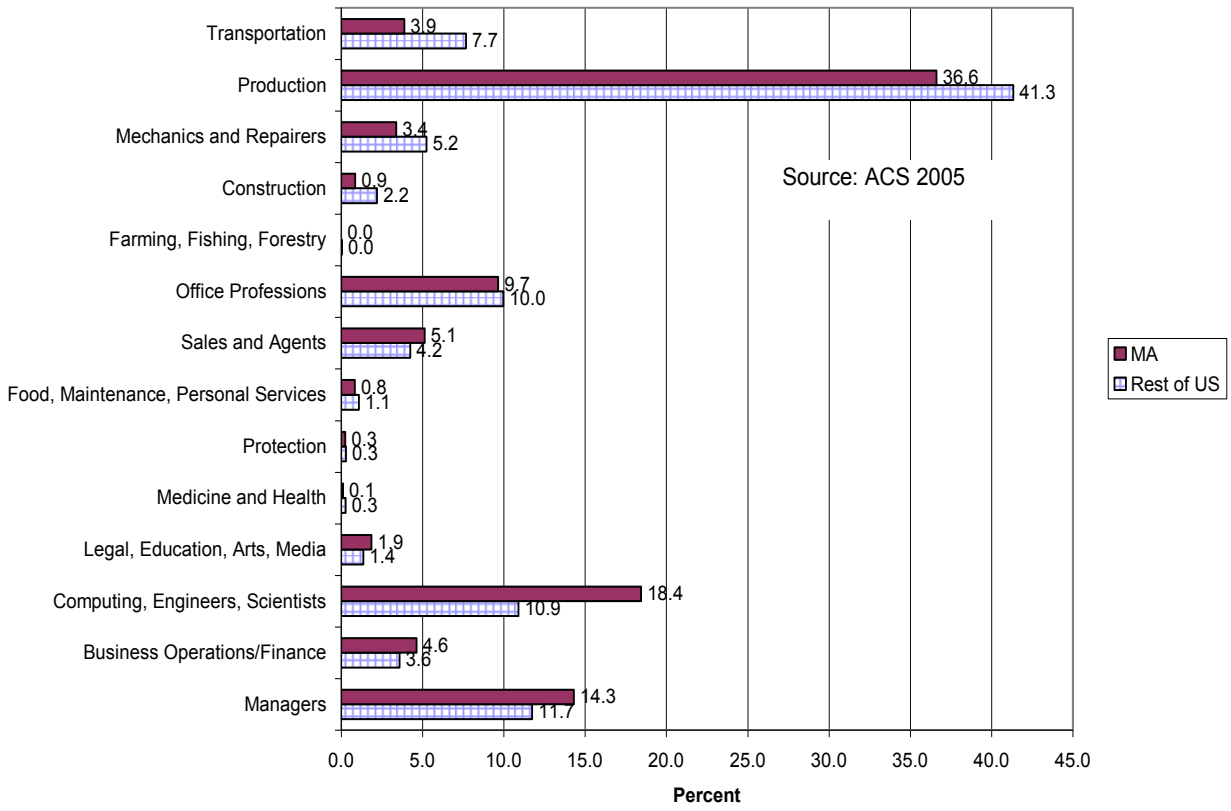
Comparing the occupational distribution of Massachusetts versus the rest of the U.S., Massachusetts manufacturing workers are more concentrated in computing, engineering, and science (18.4% vs. 10.9%), more concentrated in management occupations (14.3% vs. 11.7%), and less concentrated in production (36.6% vs. 41.3%) and transportation (3.9% vs. 7.7%). (See **Figure 1.15**).

Table 1.12 The Occupational Distribution of Massachusetts Manufacturing

	Rest of Economy	Manufacturing
Managers	**11.0%**	**14.3%**
Business Operations/Finance	5.9%	4.6%
Computing, Engineers, Scientists	**6.9%**	**18.4%**
Legal, Education, Arts, Media	10.9%	1.9%
Medicine and Health	9.7%	0.1%
Protection	2.5%	0.3%
Food, Maintenance, Personal Services	11.0%	0.8%
Sales and Agents	12.1%	5.1%
Office Professions	14.8%	9.7%
Farming, Fishing, Forestry	0.1%	0.0%
Construction	5.8%	0.9%
Mining and Extraction	0.0%	0.0%
Mechanics and Repairers	3.0%	3.4%
Production	**1.8%**	**36.6%**
Transportation	4.4%	3.9%
Military	0.1%	0.0%
TOTAL	100.0%	100.0%

Source: U.S. Census Bureau, 2005 *American Community Survey*

Figure 1.15 Manufacturing Occupations, Massachusetts vs. Rest of U.S.



Source: U.S. Census Bureau, 2005 American Community Survey

In general, then, manufacturing in Massachusetts provides well-paying jobs to workers who often have limited formal education, but also employs its share of highly skilled, highly educated individuals in key occupations in key industries.

Where is Manufacturing Located in the Commonwealth?

As noted above, Massachusetts ranked slightly above the national average in terms of the concentration of manufacturing employment in 2002, with 54.3 manufacturing workers per 1,000 residents vs. 51.0 for the nation as a whole. As such, the Commonwealth continues to be a center for manufacturing in the United States.

Across the country, states range from a low of 3.5 manufacturing workers per 1,000 residents in the District of Columbia to a high of 92.6 workers in Wisconsin (see **Table 1.13**). The states with the highest concentrations tend to be located in the mid-west and southern regions of the U.S., with the top 10 states — in descending order of concentration — being Wisconsin, Indiana, Arkansas, Ohio, Iowa, North Carolina, Michigan, Vermont, Tennessee, and South Carolina. With respect to the other New England states, Massachusetts has a lower concentration than all but Maine, with concentrations ranging from a high of 71.1 manufacturing workers per 1,000 residents in Vermont to 52.3 in Maine.

Within Massachusetts, manufacturing employment can be found in many parts of the state, with the greatest concentrations in the eastern half. In the western part of the state, there is a large concentration around Springfield and Holyoke. **Figure 1.16** provides a map indicating those communities where there is a relatively large ratio of manufacturing employment to population.

Table 1.14 provides the same data in tabular form. Manufacturing concentrations in Massachusetts municipalities range from a high of 380 manufacturing workers per 1,000 residents in Wilmington to a low of 8.2 in Quincy.[19] The top 10 municipalities on this measure, in descending order, are Wilmington, Andover, Canton, Clinton, East Longmeadow, Hudson, Bedford, Franklin, Westborough, and Danvers.

Table 1.13 Manufacturing Employment Concentration by State, 2002

State	Manufacturing Employment per 1,000 Residents		
Wisconsin	92.6	South Dakota	48.6
Indiana	91.8	Utah	47.5
Arkansas	77.6	Delaware	46.2
Ohio	76.1	California	46.0
Iowa	75.9	Idaho	45.9
North Carolina	74.9	Washington	43.7
Michigan	73.3	New Jersey	43.0
Vermont	71.1	Oklahoma	42.9
Tennessee	71.0	Virginia	42.7
South Carolina	70.6	Texas	39.3
Minnesota	70.1	West Virginia	37.4
New Hampshire	65.5	North Dakota	36.9
Kansas	65.5	Louisiana	33.6
Kentucky	64.3	New York	33.5
Mississippi	63.7	Colorado	33.0
Alabama	63.3	Arizona	30.8
Connecticut	62.1	Maryland	27.7
Nebraska	59.6	Florida	22.6
Illinois	58.9	Montana	20.4
Rhode Island	58.2	Nevada	19.6
Pennsylvania	58.0	Wyoming	19.3
Missouri	56.4	New Mexico	17.8
Massachusetts	**54.3**	Alaska	17.0
Georgia	52.9	Hawaii	10.6
Maine	52.3	District of Columbia	3.5
Oregon	52.3		
		U.S.	51.0

Source: U.S. Census Bureau, Economic Census 2002

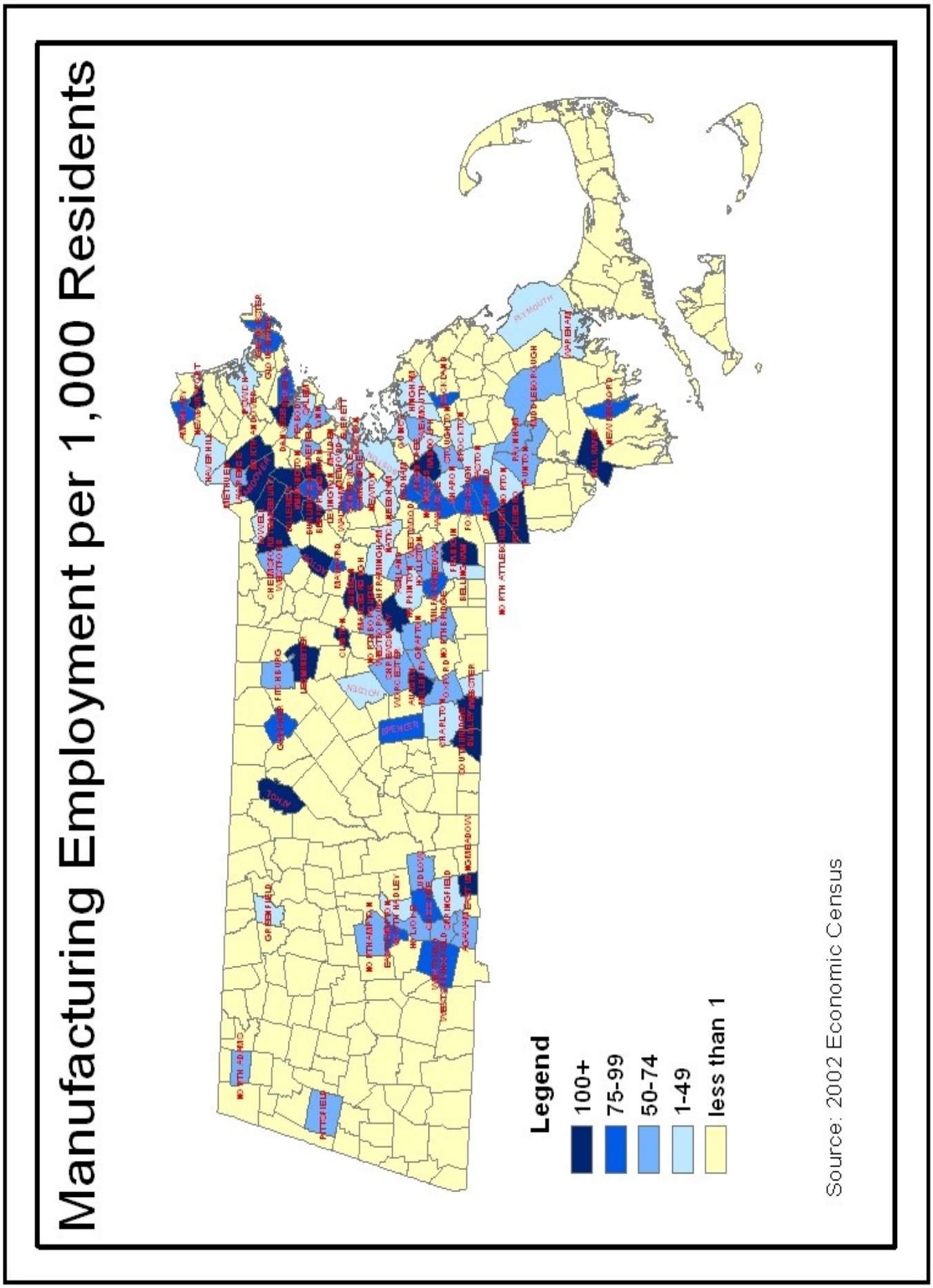


Figure 1.16 (Source: U.S. Census Bureau, Economic Census 2002)

Table 1.14 Manufacturing Concentration by Municipality, Massachusetts 2002

Place	Manufacturing Employment per 1,000 Residents
Wilmington	380
Andover	351
Canton	265
Clinton	260
East Longmeadow	215
Hudson	211
Bedford	199
Franklin	179
Westborough	162
Danvers	162
Attleboro	154
Marlborough	141
Woburn	141
Newburyport	141
North Andover	133
Chelmsford	130
Fall River	126
Billerica	118
Dudley	115
Tewksbury	114
Leominster	110
Southbridge	108
Auburn	108
Acton	107
Athol	103
North Attleborough	103
Spencer	98
Gloucester	98
Chicopee	97
Maynard	97
Easthampton	96
Foxborough	95
Amesbury	94
Beverly	94
Waltham	92
Westwood	91
Burlington	91
Balance of Middlesex County	90
Mansfield	85
Balance of Norfolk County	83
Westfield	83
Walpole	82

Balance of Franklin County	81
Milford	80
New Bedford	79
Norwood	78
Watertown	76
Rockland	76
Gardner	75
Taunton	74
Holyoke	73
Lawrence	73
West Springfield	72
Peabody	72
Lynn	72
Wakefield	72
Agawam	72
Holliston	71
Ashland	66
Middleborough	61
Pittsfield	61
Oxford	61
Medway	61
Grafton	58
Ludlow	58
Westford	57
Worcester	57
Raynham	56
Fitchburg	56
North Adams	55
Braintree	54
Northbridge	54
Northborough	53
Cambridge	51
Northampton	51
Stoughton	50
Millbury	50
Balance of Berkshire County	50
Chelsea	50
Lowell	49
Needham	49
Lexington	48
Methuen	47
Haverhill	45
South Hadley	44
Natick	44
Hopkinton	43
Charlton	43
Balance of Worcester County	43
Easton	41
Everett	41
Sharon	41

Webster	40
Hingham	40
Ipswich	39
Springfield	39
Randolph	39
Greenfield	38
Wareham	37
Shrewsbury	37
Bellingham	36
Holden	35
Norton	34
Salem	31
Brockton	31
Balance of Bristol County	29
Balance of Plymouth County	29
Balance of Essex County	27
Somerville	27
Boston	27
Malden	27
Dedham	25
Framingham	25
Plymouth	22
Newton	22
Balance of Hampden County	20
Balance of Hampshire County	19
Barnstable Town	19
Weymouth	17
Medford	12
Quincy	8
Acushnet	NA
Palmer	NA
Sudbury	NA
Wilbraham	NA

Source: U.S. Census Bureau, Economic Census 2002

Manufacturing's Future in Massachusetts

It is always difficult to predict what may happen in the future, and it is especially challenging to project what manufacturing will look like 10 years from now in a state where the sector has alternated between periods of more or less steady employment (e.g., 1970-1984) and periods of sharp decline (e.g., 1984-2000). Moreover, comparisons between Massachusetts and the rest of the nation prove tricky, given the Commonwealth's unique history of early deindustrialization and its advanced present-day high-tech sector. Taking account of what sets the state apart, though, we can estimate, given the current composition of industries in Massachusetts's manufacturing sector, what the sector might look like down the road.

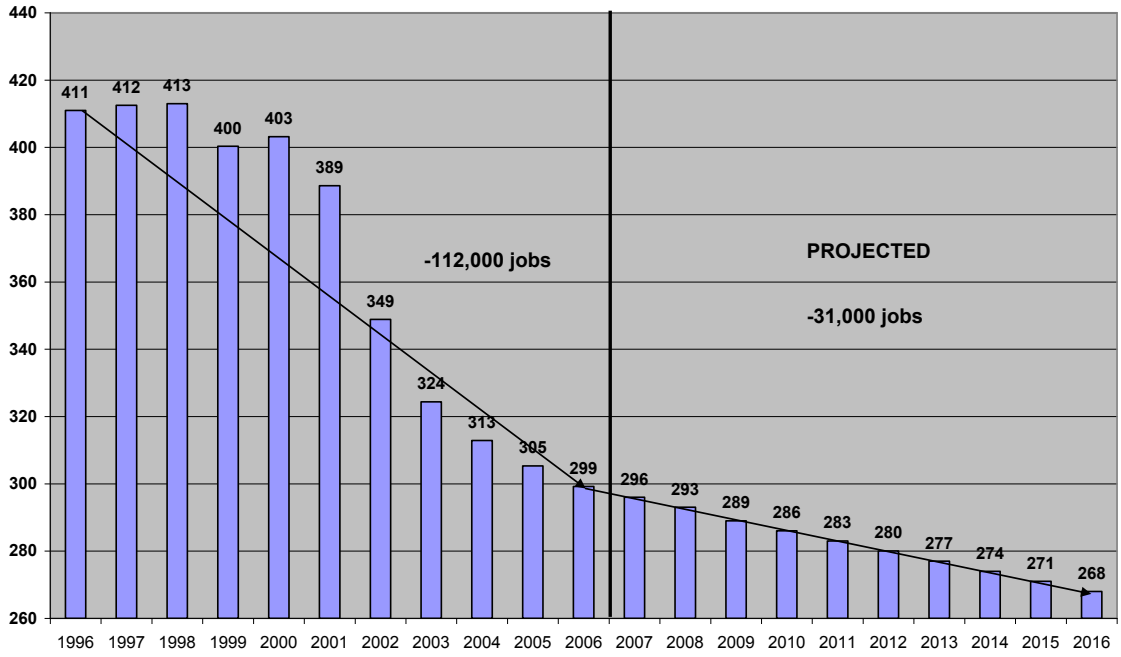
We base our Massachusetts projections through 2016 on estimates of manufacturing employment and output prepared by the Bureau of Labor Statistics for the nation as a whole.[20] BLS provides industry projections by 2-, 3-, and 4-digit NAICS code. To approximate projected employment growth in the Massachusetts manufacturing sector, we conducted a "shift-share" analysis, using the BLS projections for each 4-digit code and multiplying the projected annual rate of growth for each national industry by the number of Massachusetts manufacturing employees in each industry in 2006. The assumption behind this projection is that individual manufacturing industries in Massachusetts will grow at the same rate as the industry nationwide.

While the employment trend continues downward as in the past, this exercise suggests that in Massachusetts the worst of the industrial flight may be over. We estimate that, altogether, the manufacturing sector will lose about 1.1 percent of its

jobs each year over the next decade (2006-2016), or 10.5 percent of its total workforce by 2016. This represents an additional loss of about 31,300 jobs. Despite differences in the industry composition in the U.S. vs. Massachusetts, these losses mirror the nationwide projection almost exactly.

Neither the state figure nor the national figure is a cause for celebration, but they indicate that the hemorrhaging of jobs that took place for decades may slow dramatically, leaving the Massachusetts manufacturing employment base at no less than 268,000, nearly 90 percent of the current level. Recall that between 1996 and 2006, total manufacturing employment in the Commonwealth fell by 112,000. Hence, the job loss projected for the *next* decade is only a little more than *one-fourth* (28%) of that experienced during the *last* decade. **Figure 1.17** provides a visual display of this slowdown in the rate of decline in the Commonwealth's manufacturing sector. This trend may provide little comfort to those who will lose their jobs in this sector, but it still represents a significant improvement over past performance. It marks a transition to a more stable manufacturing base for Massachusetts.

Figure 1.17 Projected Massachusetts Manufacturing Employment (1996-2016) (in 000s)



Source: U.S. Bureau of Labor Statistics (1996-2006); Projected figures (2007-2016) based on Eric B. Figueroa and Rose A. Wood, "Industry Output and Employment Projections to 2016," *Monthly Labor Review,* November 2007.

The overall trend in the number of manufacturing jobs in the Commonwealth masks wide variation in projected employment by individual industry. Several industries are projected to lose an additional 30 percent or more of their remaining employment base. These include traditional industries like cut and sewn apparel manufacturing (NAICS 3152) which is forecast over the next decade to shed almost sixty percent of its remaining 2,400 jobs, and textile and fabric finishing mills (NAICS 3133), projected to lose more than forty percent of its Massachusetts employment base (see **Table 1.15**). Other traditional industries that may lose more than thirty percent of current jobs include fabric mills (NAICS 3132); other leather and allied products (NAICS 3169); pulp, paper, and paperboard mills (NAICS 3221); and non-ferrous

metal production (NAICS 3314). One high-tech sector also has large projected employment losses: computer and peripheral equipment manufacture (NAICS 3341). This is primarily due to continuing extraordinary rates of productivity improvement that exceed projected output growth.

Other Massachusetts manufacturing sectors are projected to experience much less job loss and a few may even increase their employment according to this analysis. In general, food processing will experience very little loss. This is also true of communications equipment manufacture (NAICS 3342) and medical equipment and supplies manufacture (NAICS 3391). Meat processing (NAICS 3116) may see almost a 12 percent increase in employment with bakeries (NAICS 3118) and beverage manufacturers (NAICS 3121) also increasing employment slightly. Plastic products (NAICS 3261), cement and concrete product manufacturing (NAICS 3273), and architectural and structural metals fabrication (NAICS 3323) are all expected to employ more workers by 2016, as should aerospace products and parts (NAICS 3364). But the largest gains, by far, are expected to come in the pharmaceutical manufacturing industry. Here we project an increase of nearly 2,200 jobs – twenty-four percent more than the current employment level.

Table 1.15 Projected Manufacturing Employment in Massachusetts (2006-2016)

NAICS CODE	4-DIGIT INDUSTRY	ACTUAL EMPLOYMENT 2006	PROJECTED EMPLOYMENT 2016	CHANGE 2006-16	PERCENT CHANGE 2006-16
3113	Sugar & confectionery product mfg	1,075	878	-197	-18.3%
3115	Dairy product mfg	2,890	2,776	-114	-3.9%
3116	Animal slaughtering & processing	2,144	2,392	248	11.6%
3117	Seafood product preparation & packaging	2,539	2,250	-289	-11.4%
3118	Bakeries & tortilla mfg	6,527	6,593	66	1.0%
3119	Other food mfg	3,669	3,743	74	2.0%
3121	Beverage mfg	3,100	2,804	-296	-9.6%
3132	Fabric mills	2,886	1,959	-927	-32.1%
3133	Textile & fabric finishing & fabric coating mills	3,183	1,906	-1,277	-40.1%
3141	Textile furnishings mills	1,021	896	-125	-12.3%
3149	Other textile product mills	1,776	1,558	-218	-12.3%
3152	Cut & sew apparel mfg	2,425	1,008	-1,417	-58.4%
3169	Other leather & allied product mfg	2,185	1,322	-863	-39.5%
3219	Other wood product mfg	3,200	3,013	-187	-5.8%
3221	Pulp, paper, & paperboard mills	2,439	1,690	-749	-30.7%
3222	Converted paper product mfg	8,719	7,124	-1,595	-18.3%
3231	Printing & related support activities	14,921	11,703	-3,218	-21.6%
3251	Basic chemical mfg	1,004	846	-158	-15.8%
3252	Resin, syn rubber, & artificial synthetic fibers & filaments mfg	1,086	861	-225	-20.8%
3254	Pharmaceutical & medicine mfg	9,020	11,213	2,193	24.3%
3255	Paint, coating, & adhesive mfg	1,677	1,548	-129	-7.7%
3256	Soap, cleaning compound, & toilet preparation mfg	1,087	1,003	-84	-7.7%
3259	Other chemical product & preparation mfg	5,262	4,085	-1,177	-22.4%
3261	Plastics product mfg	15,127	15,432	305	2.0%
3273	Cement & concrete product mfg	2,678	2,871	193	7.2%
3279	Other nonmetallic mineral product mfg	1,853	1,928	75	4.1%
3314	Nonferrous metal (except aluminum) production & processing	2,110	1,447	-663	-31.4%
3315	Foundries	1,104	814	-290	-26.3%
3321	Forging & stamping	2,706	2,058	-648	-23.9%
3322	Cutlery & hand tool mfg	3,982	2,936	-1,046	-26.3%
3323	Architectural & structural metals mfg	4,999	5,255	256	5.1%
3327	Machine shops, turned product, & screw, nut, & bolt mfg	10,637	8,515	-2,122	-19.9%

3328	Coating, engraving, heat treating, & allied activities	3,915	3,134	-781	-19.9%
3329	Other fabricated metal product mfg	6,215	5,453	-762	-12.3%
3332	Industrial machinery mfg	8,108	6,625	-1,483	-18.3%
3333	Commercial & service industry machinery mfg	3,401	2,984	-417	-12.3%
3334	Ventilation, heating, AC, & commercial refrigeration equip mfg	1,608	1,454	-154	-9.6%
3335	Metalworking machinery mfg	3,419	2,794	-625	-18.3%
3336	Engine, turbine, & power transmission equipment mfg	1,452	1,211	-241	-16.6%
3339	Other general purpose machinery mfg	6,544	5,918	-626	-9.6%
3341	Computer & peripheral equipment mfg	2,511	1,669	-842	-33.5%
3342	Communications equipment mfg	7,719	7,719	0	0.0%
3344	Semiconductor & other electronic component mfg	16,295	14,009	-2,286	-14.0%
3345	Navigational, measuring, medical, & control instruments mfg	27,351	26,014	-1,337	-4.9%
3351	Electric lighting equipment mfg	1,669	1,206	-463	-27.8%
3353	Electrical equipment mfg	2,910	2,354	-556	-19.1%
3359	Other electrical equipment & component mfg	6,330	5,667	-663	-10.5%
3363	Motor vehicle parts mfg	1,404	1,113	-291	-20.8%
3364	Aerospace product & parts mfg	4,523	4,754	231	5.1%
3371	Household & institutional furniture & kitchen cabinet mfg	2,892	2,669	-223	-7.7%
3372	Office furniture (including fixtures) mfg	2,042	1,903	-139	-6.8%
3391	Medical equipment & supplies mfg	14,236	14,379	143	1.0%
3399	Other miscellaneous mfg	16,077	13,407	-2,670	-16.6%
31-33	**Total Manufacturing**	**299,200**	**267,900**	**-31,300**	**-10.5%**

Source: Projections based on Eric B. Figueroa and Rose A. Woods, "Industry Output and Employment Projections to 2016," *Monthly Labor Review*, November 2007.

Note: Total manufacturing employment is greater than the sum of employment in each of the 4-digit industries because 4-digit industries that have a small number of firms are not reported by the U.S. Bureau of Labor Statistics to protect the confidentiality of data from individual companies. For 2006, about 30,000 manufacturing jobs at the 4-digit level are not reported.

As with any set of projections, these estimates are tentative and subject to the effects of any number of unpredictable economic phenomena over the next decade. Especially with a looming threat of recession, we cannot be certain about what the economy will look like in Massachusetts or in the nation as a whole 10 years from now.

Encouraging as this forecast may be, there are a number of reasons why it may still prove to be too conservative.

1. Already by 2007, in a slowing overall economy, the projected employment loss in manufacturing was greater than what the Commonwealth actually experienced. In 2007, Massachusetts manufacturing declined by 2,600 jobs, about 900 fewer than our BLS-based projection.
2. Manufacturing nationwide, and by extension in Massachusetts, may do substantially better than projected because of the declining value of the dollar in foreign markets. The weaker dollar makes U.S. exports cheaper and foreign imports more expensive. Just in the past year (March 2007-March 2008), the dollar has dropped in value by 15 percent against the euro, 14 percent against the Japanese yen, and 8 percent against the Chinese yuan.[21] Since manufactured goods are likely to be subject to foreign trade, this will benefit domestic manufacturers, presumably including those in Massachusetts.
3. Finally, productivity growth could be slower than projected since much of the extraordinary growth has been due to the substitution of high-productivity industries for those with much lower productivity. With this transition nearly complete, aggregate productivity growth could slow in the decade ahead.

On the other hand, the losses could be greater than expected if any of the following dominate:

1. The current slowdown in the U.S. economy could turn into a full-blown recession weakening employment in all sectors.
2. The continued spread of out-sourcing to other countries could lead to greater employment losses.
3. Productivity could increase more rapidly than expected.
4. Competition within the U.S. across states could increase. The impact of greater competition will depend on the relative cost of living in Massachusetts compared to competitor regions and the level of aggressiveness with which the Commonwealth and local jurisdictions work to retain existing firms and attract new ones.

On balance, we believe that there are good reasons to believe that the sharp declines in manufacturing of the past are now behind us and that manufacturing is poised to continue to provide more than 250,000 jobs throughout the Commonwealth for years to come. What we seem to have lost are jobs in industries where standardized production could be outsourced to other states or other countries or where productivity growth has been so rapid as to eclipse the rate of output growth. The industries that appear poised to remain in the state are industries producing products that are costly to import (e.g., processed fresh food and cement), industries that produce highly sophisticated products (e.g., aerospace parts and architectural metal products), and emerging industries, particularly in the pharmaceutical sector and medical device industries.

This all bodes well for the future. As we see shall see in the following chapters, though, the continued health of the manufacturing sector will depend on whether the key challenges facing goods producers in Massachusetts can be addressed in a timely manner.

Chapter 2

A New Massachusetts Manufacturing Survey

The story of manufacturing in Massachusetts cannot be told simply by focusing on existing published statistics. The U.S. Census Bureau, the U.S. Bureau of Labor Statistics, the Massachusetts Executive Office of Labor and Workforce Development, and other government agencies provide a wealth of information on manufacturing in the Commonwealth. But in order for the manufacturing story to be told fully and accurately, we need to probe more deeply into the dynamics of manufacturing firms. We can only do this by gathering additional information from the manufacturers themselves.

Our goal in this research was to probe how business owners and managers view the prospects for their firms in light of existing and future competition, the challenges they encounter in terms of the cost structures they face in the state, and the types of assistance they believe could help them sustain their operations in Massachusetts or expand them.

To accomplish this goal, we set out first to survey a large number of the state's manufacturing establishments using a survey instrument that could be completed and returned by mail or filled out electronically. We followed this up with personal interviews with owners, executives, and managers from a subset of the surveyed establishments. Working from a full universe of all manufacturing concerns in the Commonwealth, we succeeded in surveying 706 of them using the survey instrument and conducted interviews in a subset of 104 of these. We took steps to compare the sample of establishments we surveyed with the entire array of manufacturers in the Commonwealth to assure that the information we are presenting from the survey sample and personal

interviews is generally representative of the entire population of Massachusetts manufacturers. In this chapter, the methodology we used to gather establishment level data will be outlined along with details of the final samples we surveyed and interviewed.

Survey Design

With the intent of creating a survey instrument that encompassed all the important characteristics and factors that could be related to production in Massachusetts, a group of researchers from the Center for Urban and Regional Policy (CURP) at Northeastern University met in January 2007 with representatives from a large number of economic development and manufacturing industry organizations to "brainstorm" about a set of survey questions that could be used to gather information on what manufacturers make in Massachusetts, where they make it, why manufacturing is still carried on in the state, what the challenges are to operating in Massachusetts, and how state and local government might help to preserve manufacturing operations in the Commonwealth. The organizations which participated in brainstorming sessions included:

- Associated Industries of Massachusetts (AIM)
- Massachusetts Alliance for Economic Development (MAED)
- Massachusetts Executive Office of Housing and Economic Development
- Massachusetts Manufacturing Extension Partnership (Mass MEP)

In addition, all of the organizations mentioned in the preface contributed to the study by reviewing drafts of the survey instrument and encouraging their members to participate.

Each of the organization representatives we conferred with had extensive experience in manufacturing and general business issues and was well-versed in the language of manufacturers in the Commonwealth. Several representatives at the brainstorming session had a detailed understanding of specific industry concerns. We were also fortunate to be able to utilize recent research published by CURP on firms' site location decisions and local economic development in order to formulate survey questions.[22]

Based on these consultations, a set of open- and close-ended questions were pretested by mailing the survey to a subsample of 100 manufacturers, of which 20 were returned. The final questions were organized into eight thematic categories.

- *Company profile:* name, industry sector, primary products, year established and location, ownership structure, location of headquarters and manufacturing facilities, number of employees, annual gross revenue, and peak employment
- *Workforce information:* education requirements for employment, ease of recruitment, hourly pay
- *Manufacturing process:* nature of labor and machinery, production methods, changes in labor and technology
- *Marketplace:* location of competitors, suppliers, and customers, sources of competitive advantage
- *Supply chain:* use of various supply chain initiatives, key barriers to supply chain performance, satisfaction with supply chain
- *Real estate:* square footage of manufacturing facilities, anticipation of change in space needs, satisfaction with real property for those companies that have recently moved into the state, changes in space requirements
- *Factors driving operations:* factors affecting the decision to continue to operate manufacturing facilities in Massachusetts, use of state/local incentive programs, outsourcing practices, effect of state and local public policy on firm

- *Expectations for the future:* projected production and employment levels, anticipation of new products, likelihood of merger and acquisition activities

These particular categories were selected to provide appropriate data about the nature of production, employment practices, industry competition, and information about the attitudes and opinions of executives and managers in the state's manufacturing sector. The complete survey instrument can be found as an **Appendix** at the end of this report.

Sample Design

The sample of manufacturing firms for this study was procured from a commercial database available from *InfoUSA.com*.[23] For the year 2006, the database contained information on 9,630 manufacturing establishments in Massachusetts. Because the resources were available and we wished to have the largest sample possible from this population of manufacturing establishments, we chose to mail the survey questionnaire to the CEO, president, or executive manager of all 9,630 establishments.

Included in the mailed package to each manufacturer were the survey questionnaire, an introductory letter from the Commonwealth's Secretary of Housing and Economic Development Dan O'Connell, a letter from either the appropriate regional economic development organization or the appropriate industry association, and a stamped return envelope. The letters outlined the goals for this project and requested that the manufacturer return a completed survey to CURP. The letters stressed the state's interest in obtaining better information on the manufacturing sector as well as the inherent self-interest that manufacturers should have in providing their input on state economic policy.

Additionally, because many of the manufacturing firms in Massachusetts operate in high-technology environments, the letters referenced a website address providing the option of completing the survey electronically for those preferring to respond on-line. The online survey used *Zoomerang*, a commercial web software product that provides the ability to create custom surveys online.

Of the mailed surveys, 870 were returned undelivered, a nine percent undeliverable rate, standard for commercial databases. Altogether, 706 useful surveys were returned and these became the sample we analyzed for this study. Of this total, 604 surveys were returned via U. S. mail and 102 responded through the online web survey. Our final sample of 706 represents 8 percent of the 8,760 mailed questionnaires that reached their destinations.

Representativeness of the Survey Sample

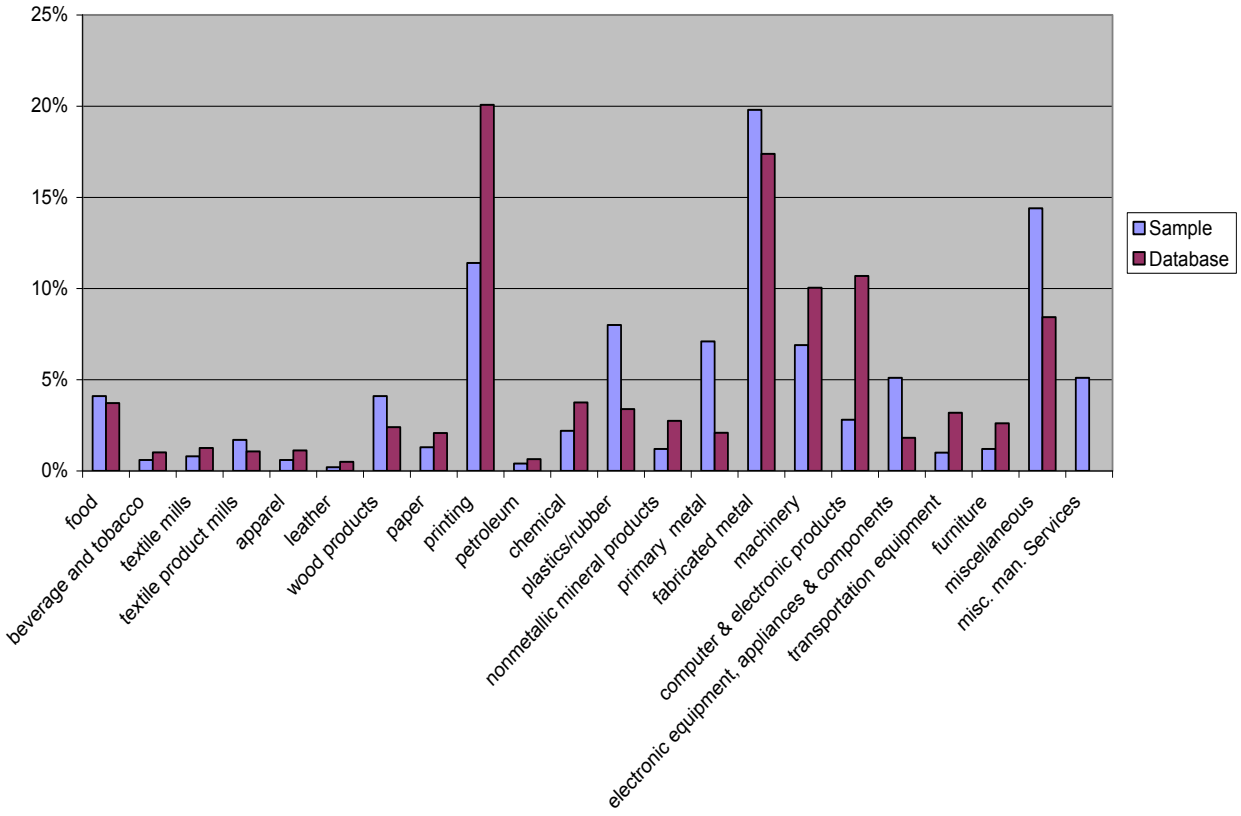
While the response rate was low, the final sample is generally representative of the *InfoUSA.com* data base establishments. We checked the sample to see how well it represented the distribution of manufacturing industries in the Commonwealth and the distribution of firms by sales volume, employment level, and geographic location. With few exceptions, the distribution of the sample by industry sector, sales volume, employment, and geography was consistent with the distribution of those found in the database.

Representativeness by Manufacturing Industry (NAICS categories)

As **Figure 2.1** reveals, the sample does a reasonably good job of capturing the industry composition of the state's manufacturing sector. Manufacturers of food products, beverages and tobacco products, textile mills and fabric mill products, apparel,

wood products, paper, petroleum-based products, chemicals, metallic and mineral products, fabricated metal, transportation equipment, and furniture manufacturers participated in the study at a level proportionate to their percentage of the total population of manufacturers in the Commonwealth.

Figure 2.l Industry Distribution: Info USA Database vs. Survey Sample



However, some categories do reveal differences between the size of the manufacturing establishment population and our final survey sample. Printing and computer and electronic products were the two industries that responded to the survey at a much lower rate than would be expected given their percentage of total firms in the establishment population. We believe that the discrepancy in the printing industry may be due to the large number of small retail printing establishments found in most commercial areas. These operations, many of which are parts of large franchised chains such as Kinko's and Sir Speedy, are classified as manufacturers because they do produce copies. Such establishments have so proliferated that they now represent, according to the *InfoUSA.com* data base, nearly 21 percent of the total population of all Massachusetts manufacturing establishments. Many of the managers of these print shops failed to participate in the survey, perhaps because they themselves do not consider their businesses to be in the manufacturing sector.

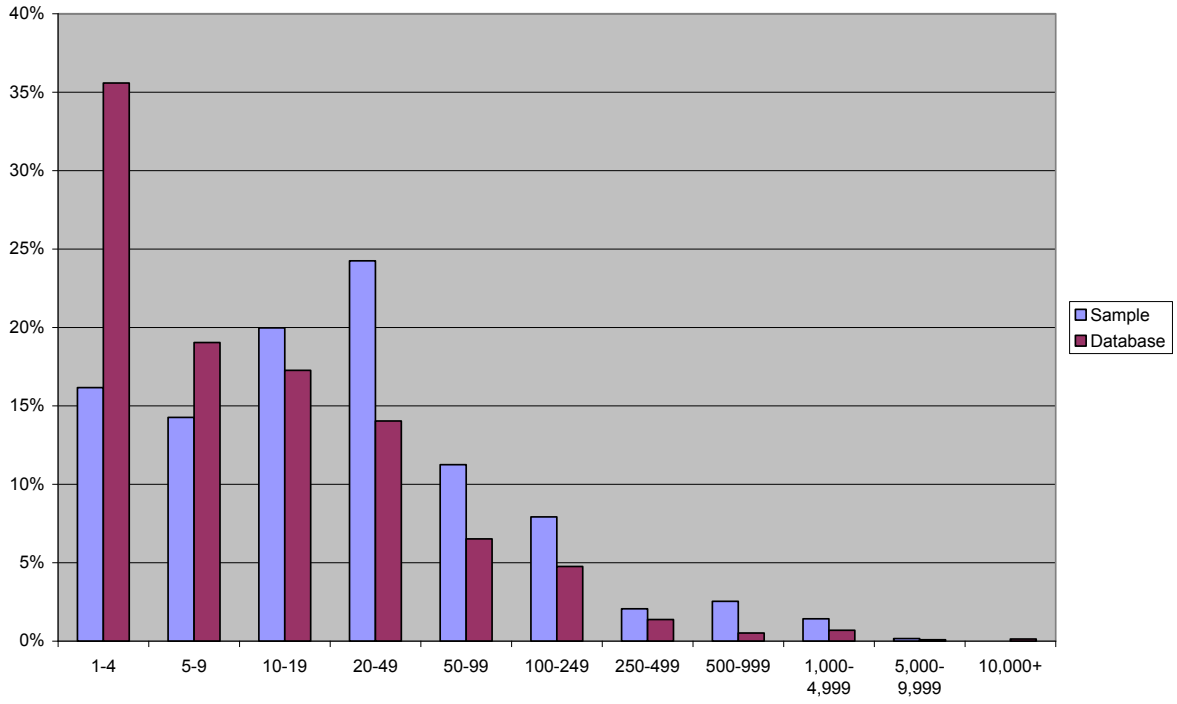
The category of computers and electronics is also somewhat underrepresented in our survey data (3 percent of the survey respondents versus 11 percent of the total population of manufacturing establishments). This difference could be related to what appears to be an oversampling in the electronic appliance and component category. Since the classification of computers and electronics and electronic appliances and components is self-reported, there could be some overlap in products made by companies in these categories. Indeed, adding the two industry categories together yields a survey proportion of total manufacturing establishments which is not far off from the proportion in the data base (8 percent vs. 12 percent).

With these exceptions, the distribution of industry categories found in our survey follows the pattern of the overall Massachusetts population of manufacturers.

Representativeness by Employment Size

In terms of employment size, our sample was again fairly consistent, as shown by **Figure 2.2**. With one exception, there is remarkable consistency between the survey and the data base for the number of employees by establishment.

Figure 2.2 Size of Establishment: InfoUSA Database vs. Survey Sample



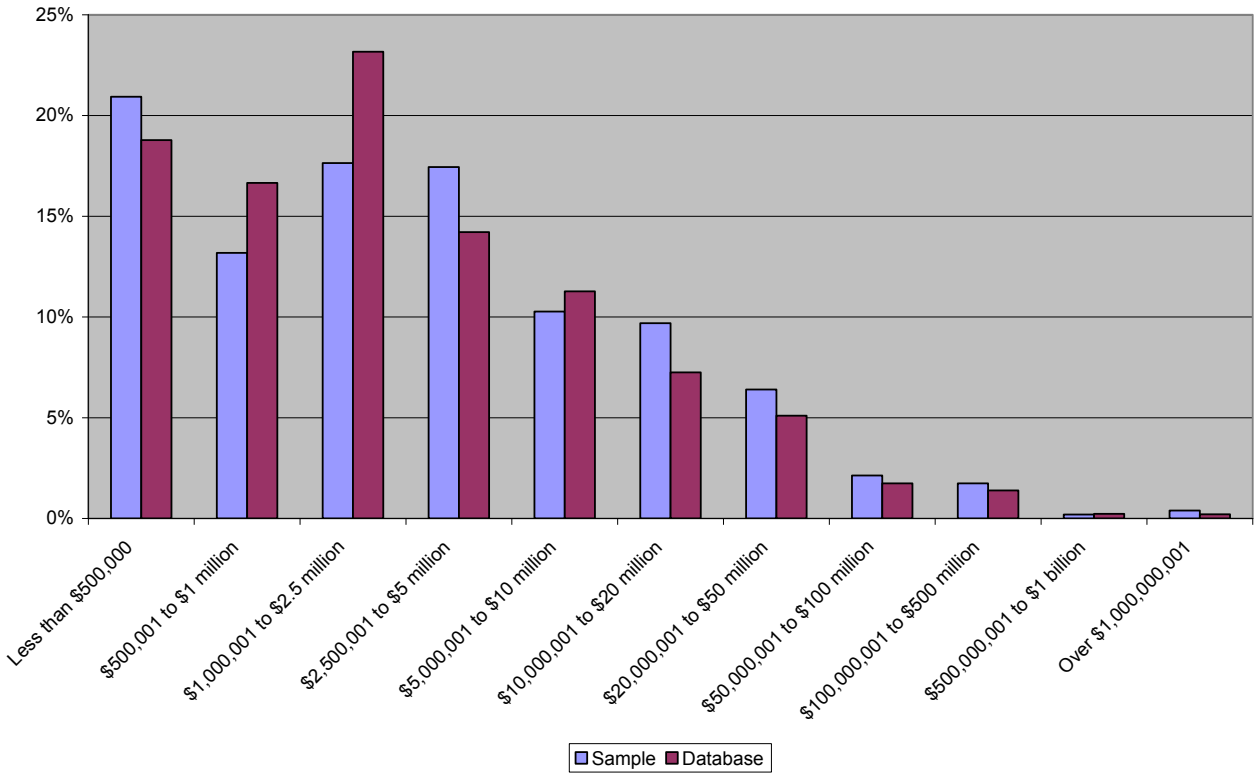
The one exception relates to very small companies, those with fewer than five employees. As one can discern in the figure, there are many more companies with one to four employees in the overall manufacturing establishment population in Massachusetts than in our sample. This size group represents more than 35 percent of the total number

of manufacturing establishments in the state according to the *InfoUSA.com* data base. Approximately 16 percent of our sample is made up of establishments with 1 to 4 employees. Our sample tends to slightly over-represent establishments with 20-49 employees as well as those with 50-99 and 100-249.

Representativeness by Sales Volume

The volume of sales found in the sample establishments is almost identical to that of the overall population of establishments in Massachusetts (see **Figure 2.3**). Only one sales category (annual sales between $1 million and $2.5 million) shows a large variance from the *InfoUSA.com* data base. Despite this under-sampling, the entire distribution demonstrates that our sample tracks rather well with the population in terms of annual sales.

Figure 2.3 Sales Volume: InfoUSA Database vs. Survey Sample



Representativeness by Geography

Table 2.1 provides the geographical distribution of the establishments listed for the survey respondents compared to the data base. We divided the regions according to the economic regions commonly used by the state and delineated by UMass Lowell's *Massachusetts Economic Assessment and Analysis Project*. 27 percent of our respondents operated within the Greater Boston area, a figure slightly smaller than the 35 percent in the full establishment population of the state. The percentage of sample firms in Southeastern Massachusetts matches almost exactly the population proportion. The same is true in Northeastern region. That leaves small oversamples in Central and Western Massachusetts. Considering the evidence shown here, the sample appears to be reasonably representative of the geographic dispersion of manufacturing establishments in the state.

Table 2.1 Geographic Distribution of Massachusetts Manufacturers

	InfoUSA Data Base	CURP Survey Sample
Western Mass.	13.0%	20.3%
Central Mass.	13.7%	17.0%
Northeastern Mass.	18.0%	16.3%
Greater Boston	34.9%	26.7%
Southeastern Mass.	20.4%	19.7%

The final sample of 706 establishments appears to be well representative of the full manufacturing sector in the Commonwealth. This provides us with a good deal of confidence that we can be fairly confident in the inferences we make about the manufacturing sector as a whole based on the data from the sample we have derived.

Interviews with Manufacturers

Surveys are useful for gathering a large amount of representative data, but they are not quite as useful for obtaining an in-depth understanding of the key issues of concern to Massachusetts manufacturers. In-depth interviews helped us complete the story of manufacturing in the Commonwealth and helped confirm or question the information we received in the mailed survey.

With the help of the state's leading economic development organizations, the CURP research team began collecting names of key contacts in the manufacturing community with the intent of engaging in one-on-one interviews. The goal of these

interviews was to add a narrative to the survey statistics and to allow manufacturing firms to articulate their own individual interests.

By utilizing our contacts from our partner organizations, as well as "cold-calling" and e-mailing manufacturing firms from information collected in our data base, we were able to conduct 104 interviews over the course of three months. The interviews were conducted by CURP research associates recruited specifically because of their extensive business experience and ties to manufacturing in Massachusetts. The interviews were primarily held in the offices of those being interviewed. Some interviews were tape-recorded with permission, and all interviewers kept notes of each interview.

Our goal, as in the survey, was to obtain a reasonably representative distribution of firms on the basis of geography, industry, employment, and plans for expansion or relocation. In the interviews, we spoke mainly with CEOs, owner-operators, vice presidents for manufacturing operations, human resources personnel, and public relations associates. The questions posed in the interviews were similar to those asked in the original survey, but the face-to-face setting allowed for elaboration at the respondent's discretion. In several instances, the answers recorded in the mailed survey were modified and expanded upon to provide a more nuanced explanation than one could discern from the survey responses alone.

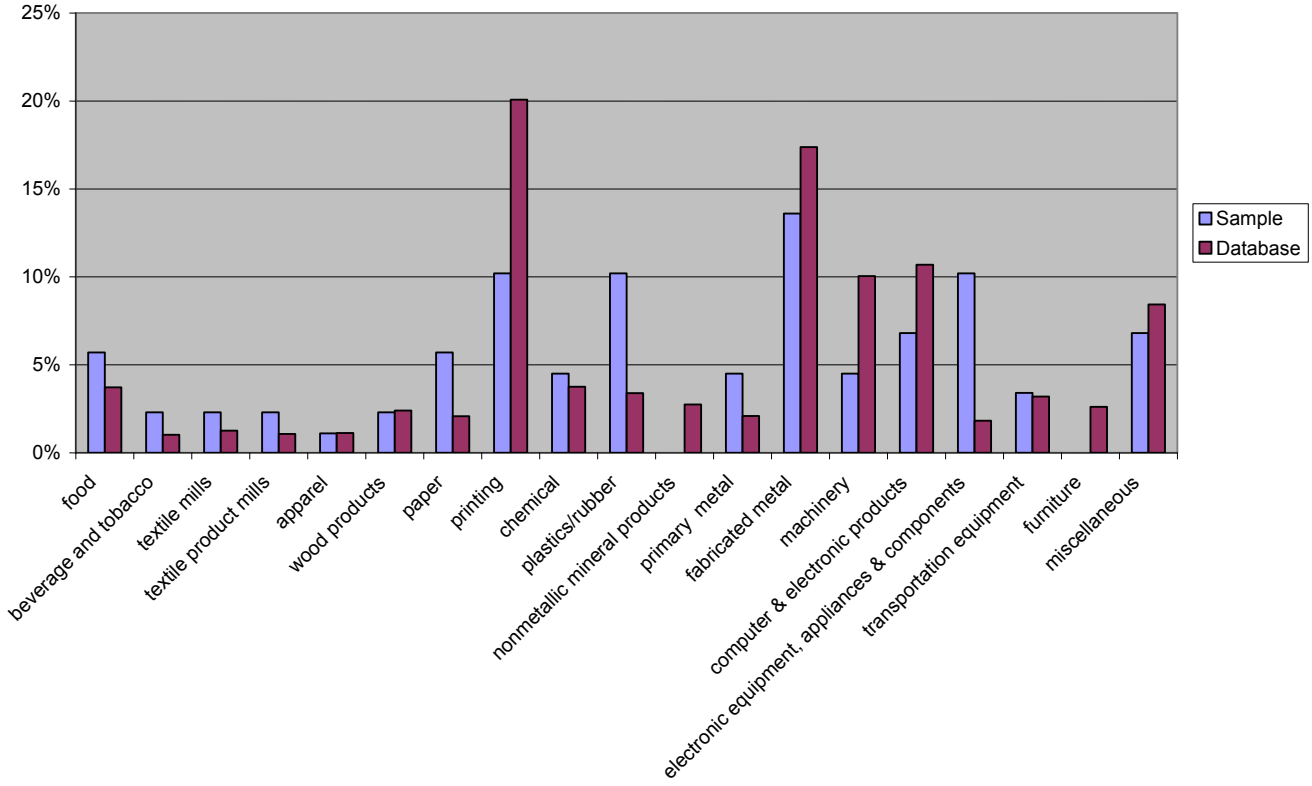
Representativeness of the Interview Sample

As one might imagine, it was a challenge to obtain 104 interviews from corporate leaders in the Massachusetts manufacturing sector.[24] Most businesses contacted were simply too busy to agree to the requested time. We expended great effort through repeated contacts to achieve as representative and balanced an interview panel as possible. As a result, the distribution of the interviews falls closely in line with the data base distribution for both industry and geography breakdowns.

Manufacturing Industries

Figure 2.4 reveals that our interview sample is fairly representative of the overall distribution of manufacturing industries in Massachusetts. Similar to the survey data, the major industry category where we found a discrepancy between the proportion of establishments in our interview sample and in the *InfoUSA.com* data base was in the printing industry. About 10 percent of our interviews were with executives in the printing industry, which represents, as noted above, about 21 percent of all manufacturing establishments in the state. Again, the predominance of small print shop franchises that do not consider themselves manufacturers may explain some of this discrepancy.

Figure 2.4 Industry Distribution: InfoUSA Database vs. Interview Sample



The other major industries where the number of interviews under-represent the full population of manufacturing establishments are machinery manufacturing, and computers and electronic products manufacturing. While we would have preferred to have a few more interviews in each of these categories, we believe that the particular companies interviewed were fairly representative of their industry sectors. In return, we over-sampled establishments in paper manufacturing, in plastics, and in electronic equipment manufacturing.

Still, with more than one hundred interviews conducted, we are confident that the themes and patterns evoked in the interviews give us a realistic picture of manufacturing in Massachusetts.

Geography

Also similar to the survey data, the geographic dispersion of the manufacturers interviewed closely matches that of the population (see **Table 2.2**). Some 31 percent of the interviews took place with firms located in Greater Boston, houses about 35 percent of all firms in the state. We have small oversamples of firms in Western and Central Massachusetts, but in general the interviews broadly reflect the geographic distribution of manufacturing establishments in the data base.

Table 2.2 Geographic Distribution: InfoUSA Database vs. Interview Sample

	InfoUSA Data Base	CURP Interview Sample
Western Mass.	13.0%	22.6%
Central Mass.	13.7%	17.5%
Northeastern Mass.	18.0%	14.4%
Greater Boston	34.9%	30.9%
Southeastern Mass	20.4%	14.4%

Summary

While the survey sample and the interviews did not precisely match the distributions of establishments in the data base, it appears from these comparisons that both were reasonably representative. Most of the discrepancies between the sample and the population from which it was derived can be explained by two observations. First, the fact that many companies in at least one large industry (printing) do not view themselves as in the manufacturing sector and therefore may have decided not to complete the survey questionnaire. Second, the discrepancies for two industries

(computer and electronic products, and electronic equipment, appliances, and components) nearly cancel each other out and the sample discrepancies may be due to the fact it is hard to distinguish firms from each other as belonging to one or the other industry.

Overall then, we have a high degree of confidence that our sample results mirror the population of manufacturers in the Commonwealth with a fair degree of accuracy.

Chapter 3

What Massachusetts Manufacturers Tell Us about their Companies

As we saw in Chapter 1, the current state and future prospects of manufacturing in Massachusetts are not anywhere near as grim as historical industry statistics and some media reports might have us believe. We have today, despite a looming national recession, a relatively healthy manufacturing sector in Massachusetts employing nearly 300,000 workers, putting the Commonwealth in the middle of the pack among U.S. states in terms of manufacturing employment concentration. We have lost more than a half a million jobs in manufacturing since the peak of 801,000 in 1943, and more than 100,000 of these since 2000, but forecasts out to 2016 suggest that the worst of the decline may be over.

In this and succeeding chapters, we rely on the survey results and interviews we carried out with manufacturing firms in the Commonwealth to assess whether there is any corroborating evidence for the relatively rosy forecast we made at the end of Chapter 1.

Toward a Better Understanding of the State's Manufacturing Sector

Understanding the Commonwealth's manufacturing economy begins by taking another look at the key industries in the Commonwealth and the products they make. **Table 3.1** summarizes the employment levels in the broad manufacturing industries that make up the state's durable and non-durable manufacturing sectors. As of 2004, computer and electronic products accounted for the most manufacturing jobs in the state with 71,000, followed by fabricated metal products, with about 36,000. Other areas of production that make up large sections of our manufacturing base include printing, paper,

chemicals, plastic products, prepared foods, and miscellaneous manufacturing (which can cover a range of products from surgical and medical instruments to children's toys.)

Table 3.1 Manufacturing Jobs by Product Type and Sector (2004)

Massachusetts - Total Employment		3,199,900
Massachusetts - Manufacturing Employment	**Technology Intensity**	311,850
Durable Goods Manufacturing		204,034
Computer and electronic product	High Tech	71,640
Fabricated metal product manufacturing	Medium-Low Tech	36,292
Miscellaneous manufacturing	Medium-Low Tech	26,029
Machinery manufacturing	Medium-High Tech	20,810
Other transportation equipment	Medium-High Tech	12,890
Electrical equipment and appliance	High Tech	11,840
Nonmetallic mineral product manufacturing	Medium-Low Tech	7,126
Furniture and related product manufacturing	Low Tech	6,174
Primary metal manufacturing	Medium-Low Tech	5,136
Wood product manufacturing	Low Tech	4,387
Motor vehicles, bodies and trailers, and parts manufacturing	Medium-High Tech	1,806
Nondurable Goods Manufacturing		107,816
Food manufacturing	Low Tech	23,805
Chemical manufacturing	Medium-High Tech	17,645
Printing and related support activities	Low Tech	17,234
Plastics and rubber products manufacturing	Medium-Low Tech	15,986
Paper manufacturing	Low Tech	12,354
Textile mills	Low Tech	6,471
Apparel manufacturing	Low Tech	4,419
Leather and allied product manufacturing	Low Tech	3,183
Textile product mills	Low Tech	2,775
Beverage and tobacco product manufacturing	Low Tech	2,709
Petroleum and coal products manufacturing	Medium-Low Tech	1,235

Source: U.S. Bureau of Labor Statistics, U.S. Census of Manufacturers

Over time Massachusetts has been moving towards higher-technology manufacturing and away from low-technology products, such as textiles, apparel, and simple metal fabrication that were the bread and butter during the state's peak manufacturing era. As we saw in Chapter 1, Massachusetts lost manufacturing jobs across the board from 1969 to 2000, but these losses were disproportionately concentrated in the low-tech sector.

Among the thousands of manufacturers in the Commonwealth, only a very small number are of the scale to be major national producers. **Appendix 3A** provides a list of the establishments in Massachusetts with $100 million or more in annual sales compiled from the *Massachusetts Manufacturers Register for 2007* database. According to this source, there are 17 companies that produce more than $1 billion in annual output in their Massachusetts establishments. Most of these are companies with famous names, such as Analog Devices, Biogen Idec, Boston Scientific, EMC, the GE Aircraft Engine Group, Gillette, PerkinElmer, and Thermo Electron.

In addition, there are another 18 companies that produce between $500 million and $1 billion in annual output in the Commonwealth. The most famous of these are Acushnet, Coca-Cola Bottling, Hewlett-Packard, Millipore, Stride Rite, Texas Instruments, and Welch Foods. Adding firms with $100 to $500 million in annual sales yields a list of about 160 "large" manufacturers in the state out of a total of more than 8,700 producers.

What We Make in Massachusetts

Despite the loss of manufacturing firms, the Commonwealth still produces a prodigious array of products. **Appendix 3B** provides a list of manufactured components and completed products made by the nearly 700 firms in our survey that provided such information to us. The list is divided into the four OECD technology sectors that we introduced in the first chapter and includes more than 1,100 different products. A small sample of the products provides a glimpse of just how broad-based manufacturing in Massachusetts remains.

Chief among the *high-technology* products are aerospace components, aircraft controls, printed circuit boards, bio-surgery products, fiber-optic components, infrared sensors, optical safety lens, semiconductor equipment, acoustic loudspeakers, radar equipment, and wireless data transmission equipment.

Among the *medium-high-technology* products are ceramic components, machine tools, electrical and electronic switches, high voltage cable assemblies, specialty chemicals, electrical marine supplies, oil-water separators, and robotic systems for welding.

Among the *medium-low-technology* products are bearings, construction castings, fabricated metal parts, HVAC duct work, decorative glass, band saw blades, floor tiles, lighting fixtures, plastic food wrap, sailboats, and snow shovels.

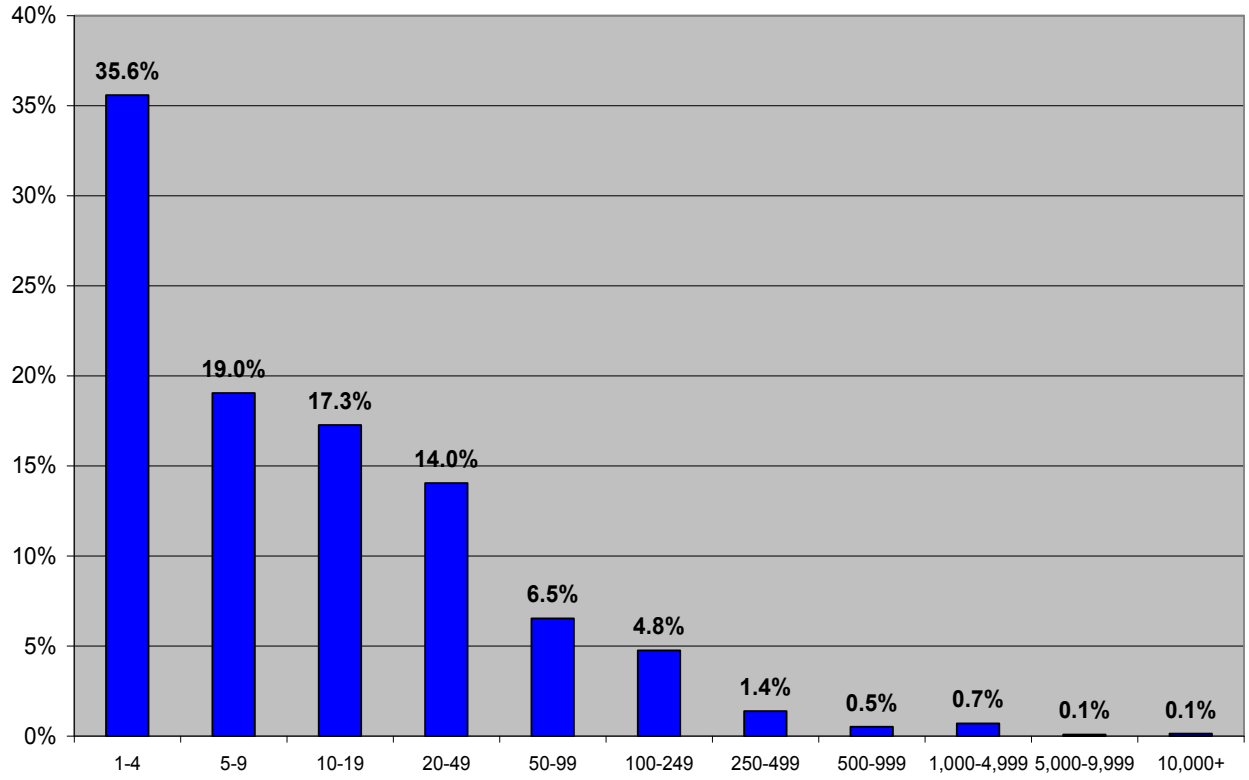
And among the *low-technology* products still being manufactured in Massachusetts are stacked heels for shoes and boots, offset printing, gaskets and gears, cannoli shells, beer, frozen seafood, frozen desserts, and dried cranberries. It is quite an array.

Manufacturing Firm Size by Employment

Of the entire population of 8,760 Massachusetts manufacturing firms that we identified from the *Info USA* database as still in business in Massachusetts in 2007, a little more than one third (36%) are very small, employing four or fewer employees and another 36 percent employ between 5 and 19 workers (see **Figure 3.1**). Hence, nearly three quarters of all manufacturing concerns in the Commonwealth employ no more than a mid-sized grocery store or real estate office. Larger firms with 20 to 99 workers represent another 21 percent of all manufacturers in the state while 6.2 percent of all firms employ between 100 and 499 workers. That leaves just 1.4 percent of the state's manufacturers — about 120 firms — with 500 employees or more, mirroring to a great extent the roughly 1.8 percent of firms with $100 million or more in annual sales.

If we look to where the majority of the state's manufacturing employees are working, the distribution looks, of course, quite different. The smallest manufacturers with just 1-4 workers employ just 2 percent of the total manufacturing workforce in the state, despite representing 36 percent of all establishments. As **Table 3.2** reveals, the small number of firms with 500 or more workers employ more than a third of the Massachusetts manufacturing workforce with firms of 100-499 workers employing another third. Thus, about 700 firms — about eight percent of the total number of manufacturers in Massachusetts — are responsible for employing two-thirds of all manufacturing workers in the state.

Figure 3.1 Manufacturing Firm Size by Employment Level (Database)



Source: *Info USA* database

Table 3.2 Estimated Share of Total Manufacturing Employment In Massachusetts by Size of Firm

Size of Firm (Employees)	Share of Manufacturing Firms	Share of Total Manufacturing Workforce
1-4	35%	1.9%
5-19	36%	8.7%
20-99	21%	21.1%
100-499	7%	32.9%
500+	1%	35.4%

Source: Estimates based on 8,760 firms with valid addresses in the *Info USA* database

These larger employers provide a substantial number of manufacturing jobs in the Commonwealth directly. Our personal interviews with CEOs, owners, and firm managers also revealed that these large firms are crucial to the continued operations of many of the literally thousands of firms employing fewer than 100 employees. A Worcester primary metal manufacturer that employs 85 workers, for example, has re-focused its operations to respond to the "just in time" demands of their large medical device sector customers. The owner/manager says that his business success is now contingent on his "ability to respond quickly and extremely reliably" to several large manufacturing companies. The fact that these larger manufacturers are relying on smaller suppliers to produce specific components they consider outside their core competencies means that many of the smaller companies owe their existence to being part of the supply chains of larger companies operating in the state.

The vice president/general manager of an Agawam company that employs just under 100 workers reinforces this point. His company is a contract manufacturer dedicated to the bio-tech industry. The firm provides components to several large Greater Boston companies. Because this small company can meet the needs of its larger customers quickly and consistently, it has had a steady supply of orders that have kept the firm fully employed.

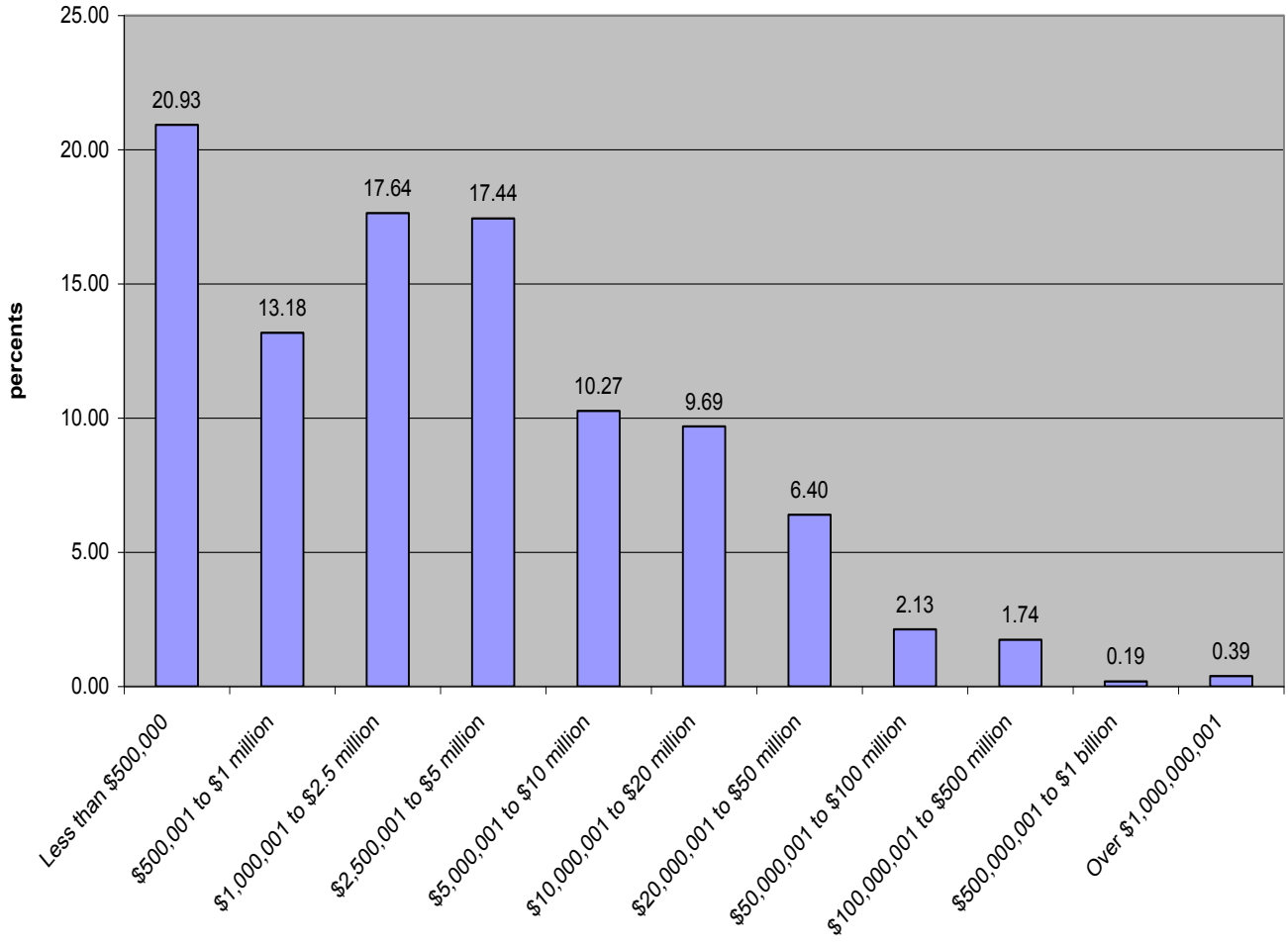
The relationship between small and large manufacturers is also beneficial to the larger firms. A government affairs executive for a very large electronics equipment manufacturer located in Greater Boston indicated that his company's manufacturing is focused on the R&D/design functions while they contract with smaller companies for the multiple components that they need for final assembly. For this company, a

Massachusetts-based supplier network is a critical element in its successful business plan. Effectively, this firm is as dependent on its smaller suppliers as the suppliers are on it. Such a symbiotic relationship between larger and smaller firms is common throughout many manufacturing industries in the Commonwealth.

Manufacturing Firm Size by Sales

Our survey reveals that about 70 percent of manufacturers in Massachusetts generate less than $5 million in annual sales, while only 2 percent of firms report revenues over $100 million (see **Figure 3.2**). This skewed distribution of sales volume suggests that the largest 2 percent of firms — those with $100 million plus in annual sales — actually generate about two-thirds (64%) of total sales volume, while the bottom half of all manufacturing firms is responsible for only about 2.3 percent (see **Table 3.3**). Maintaining these large firms in the state is critical to the future of the state's economy.

Figure 3.2 Sales Revenue of Study Firms



Source: CURP Survey, 2007

Table 3.3 Share of Total Massachusetts Manufacturing Sales Volume by Firm Size Category

Firm Size by Annual Sales Volume	Percent of Total Massachusetts Manufacturing Sales Volume
Under $2.5 million	**2.3%**
$2.501-$20 million	**14.6%**
$20,001-$100 million	**19.5%**
$100 million +	**63.5%**

Source: CURP Survey, 2007

The Geographic Dispersion of Manufacturers in Massachusetts

One of the striking features of the manufacturing sector in Massachusetts is its geographic diversity. Forming the fourth largest sector in the Commonwealth's economy, manufacturing jobs can be found just about everywhere. The 706 manufacturers we surveyed - about 9 percent of the state total – operate in 230 cities and towns throughout Massachusetts. The 33 communities with the highest concentrations of these firms were home for about half of the establishments in our sample. The other half are spread out across the state.

Of the 706 manufacturing establishments in our sample, 655 are headquartered in Massachusetts, dispersed across 197 cities and towns throughout the state. We found that 95 percent of respondents' companies were originally founded in the Commonwealth and that six out of seven operate exclusively within the state. These data reflect the fact that manufacturing jobs in Massachusetts are still largely home-grown, distributed widely within the state, and not imported from out-of-state.

An interview with the CEO of a Chelmsford computer and electronic products manufacturer that employs more than 600 workers emphasized the importance of "home-grown." His company was started in Cambridge, expanded to Burlington, and then expanded again in Chelmsford. The key concern was keeping the company's Massachusetts workforce.

Links to Primary Suppliers

Manufacturers in Massachusetts depend on each other and are closely linked locally in many ways. This is consistent with the conventional wisdom that

manufacturing supplies are often bulky or complex and so suppliers are located close to their customers to save time and reduce transportation costs. Overall, survey respondents indicated that their firms are supplied primarily from within the U.S. (92%), with a heavy concentration of in-state primary suppliers (43%). Only 8 percent reported that their primary suppliers are located in foreign countries (see **Table 3.4**).

As expected, the geographic spread of the supply chain varies by size of firm. Almost 95 percent of small firms (0-19 employees) purchase their primary supplies from U.S. sources while 17 percent of the largest firms (101+ employees) report that their primary suppliers are located in foreign countries. Half of the smaller firms report that their primary suppliers are Massachusetts-based while only about one-quarter of the largest firms say they rely on primary suppliers located in the state.

Table 3.4 Location of primary suppliers

Region	All Firms	0-19 Employees	20-100 Employees	101+ Employees
Massachusetts	**43%**	**49%**	**39%**	**26%**
Other U.S. States	**49%**	**45%**	**51%**	**57%**
Foreign Country	**9%**	**6%**	**10%**	**17%**
	100%	**100%**	**100%**	**100%**

Source: CURP Survey, 2007

Links to Customers

Who exactly are Massachusetts manufacturers selling to? In our survey research we found that 43 percent of our respondents reported their primary customers were other manufacturers. The majority, however, sell to non-manufacturing businesses (37%) or directly

to customers (20%) (see **Table 3.5**). The latter are mostly print shops and retail manufacturers such as bakeries. There was almost no difference in this pattern by size of firm.

Table 3.5 Type of Primary Customer

	Other Manufacturers	Non-Manufacturing Businesses	End Users/ Consumers
All Firms	**43%**	**37%**	**20%**
0-19 Employees	**42%**	**36%**	**22%**
20-100 Employees	**45%**	**37%**	**18%**
101+ Employees	**42%**	**33%**	**25%**

Source: CURP Manufacturing Survey, 2007

A large number of non-manufacturing businesses in Massachusetts are dependent on the state's manufacturers to provide them with the goods they need to operate. Presumably many of these businesses could switch to imports for the manufactured products they require, but having the manufacturer close by provides service benefits and just-in-time delivery that might not otherwise exist. The tight link between local manufacturers and their business customers suggests the health of local manufacturing affects a lot more than the manufacturing sector per se. Buttressing this contention, our survey reveals that nearly a third (32%) of respondents report that their primary customers are located in the same region within the state (see **Table 3.6**).

Overall, nearly half (45%) of the primary customers of Massachusetts manufacturers are located in the Commonwealth, and more than 60 percent are located in New England. Only about 10 percent of the current primary customers of in-state manufacturers are based in foreign countries.

Table 3.6 Location of Primary Customers of Massachusetts Manufacturers by Number of Employees

Region	All Firms	0-19 Employees	20-100 Employees	101+ Employees
Same region in Massachusetts	**32%**	**44%**	**22%**	**8%**
Massachusetts	**13%**	**14%**	**13%**	**6%**
New England or New York	**16%**	**14%**	**19%**	**13%**
Other U.S. States	**29%**	**22%**	**34%**	**52%**
Foreign Country	**11%**	**7%**	**13%**	**21%**
	100%	**100%**	**100%**	

Source: CURP Survey, 2007

The location of primary customers varies dramatically by size of firm. Almost 60 percent of small firms report that their primary customers are located in the Commonwealth, but this is true for only about 15 percent of the largest firms. Indeed, more than half of the largest companies report that their primary customers are elsewhere in the United States, and one in five of these companies indicate that their primary customers are foreign purchasers. Hence, small companies overwhelmingly supply local customers, while the largest supply a national and global market.

Interviews with executives from two very large Greater Boston companies revealed that they have actually established branch manufacturing operations in foreign countries to meet the demands of their foreign customers. These companies are truly global in their business and are fully involved in foreign markets. They rely on their Massachusetts headquarters for R&D, product design and testing, and production for their U. S. sales.

When we inquired as to why their customers purchased products from them rather than other suppliers, our sample of firms cited quality and service as the two most

attractive features of buying from them (see **Table 3.7**). There was virtually no difference in these responses based on size of firm with the exception that the smallest firms were twice as likely to report that location was one of the key reasons their customers bought from them.

Table 3.7 Reasons Customers Buy from Massachusetts Manufacturers

	All Firms	0-19 Employees	20-100 Employees	101+ Employees
Quality of Product	**41%**	**40%**	**40%**	**44%**
Customer Service	**32%**	**33%**	**32%**	**24%**
Price	**28%**	**29%**	**25%**	**25%**
Location	**8%**	**10%**	**5%**	**4%**
Other	**8%**	**7%**	**8%**	**11%**

Source: CURP Survey, 2007
Totals can add to more than 100% because respondents could report more than one reason

Customers apparently opt to buy goods from Massachusetts manufacturers rather than from other domestic suppliers because of the superiority of the goods produced in-state and the service they receive. Price still matters for many producers, as more than a quarter (28%) of our sample listed price as a key reason for the purchase of their products. If the cost of production could be reduced in Massachusetts, this could potentially mean a stronger customer base both inside and outside of the Commonwealth for these firms.

Primary Competitors

According to our survey, Massachusetts manufacturers compete almost exclusively with other U.S. firms. In fact, nearly three out of 10 (29%) company executives we surveyed noted that their main competitors come from the same region in Massachusetts where their own firms operate (see **Table 3.8**). In total, more than half of our respondents reported that their primary competition is coming from somewhere in New England. Only 15 percent of our sample identified foreign manufacturers as their major competitor.

Not unexpectedly, this varies by size of firm. The larger the enterprise, the more likely its primary competitors are located outside the region and indeed outside the state. Three quarters of the largest firms report that their primary competitors are located outside of New England or New York, and more than a quarter of these large firms identify a foreign company as their major competitor.

Table 3.8 Location of Primary Competitors

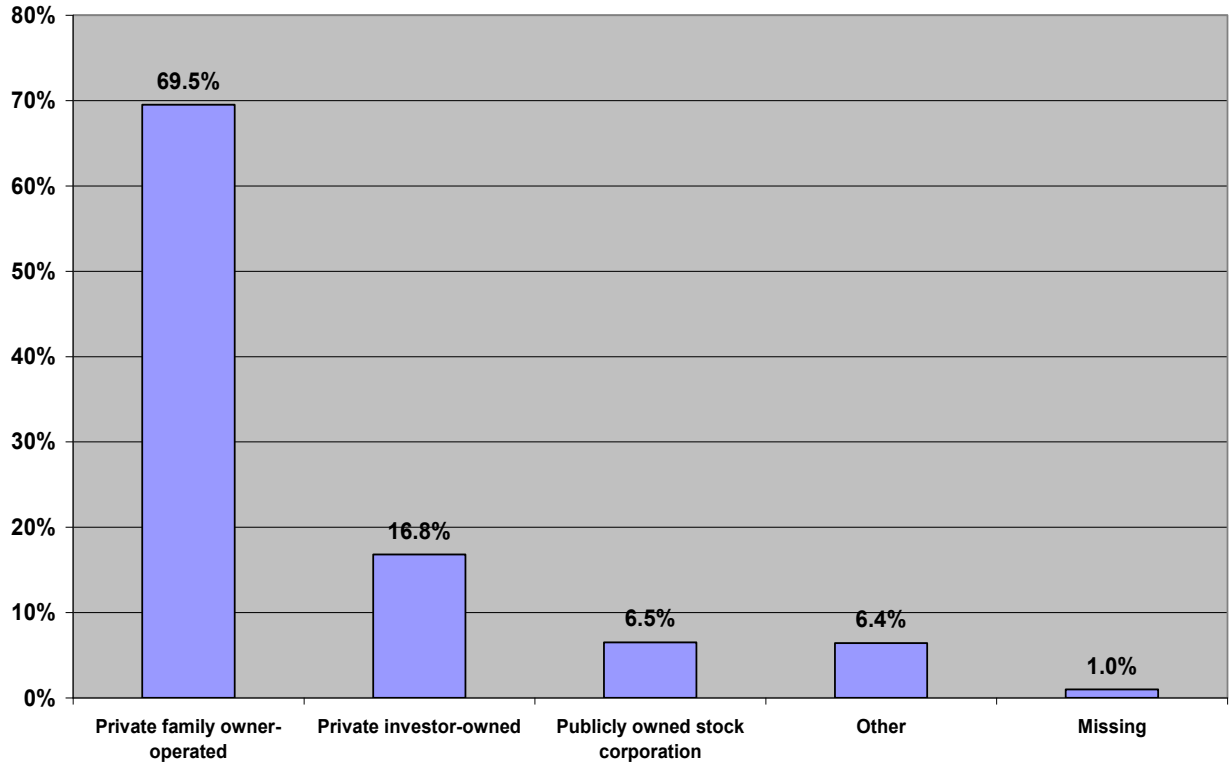
Region	All Firms	0-19 Employees	20-100 Employees	101+ Employees
Same region in Massachusetts	**29%**	**38%**	**21%**	**10%**
Massachusetts	**10%**	**12%**	**10%**	**5%**
New England or New York	**13%**	**13%**	**15%**	**8%**
Other U.S. States	**30%**	**22%**	**34%**	**48%**
Foreign Country	**15%**	**14%**	**19%**	**27%**
Total	**100%**	**100%**	**100%**	**100%**

Source: CURP Survey, 2007

Manufacturing Firms by Ownership Structure

The vast majority (86%) of manufacturing concerns in the state are privately owned (see **Figure 3.3**). Nearly 70 percent are family owned and operated, while 17 percent are owned by private investors. Only 7 percent are publicly owned stock corporations, consistent with the large number of small manufacturers in the state. The high proportion of non-publicly traded family-owned firms suggests that the bulk of the manufacturing sector is not susceptible to the kind of stockowner pressure for quarterly profits often seen in larger, investor-owned firms.

Figure 3.3 Ownership Structure of Massachusetts Manufacturers



Source: CURP Survey, 2007

Of course, the form of ownership varies substantially by the size of the firm. **Table 3.9** reveals that nearly 80 percent of the smallest firms are family-owned along with 69 percent of firms with 20-100 employees. On the other hand, more than half of the largest firms are either owned by private investors or by stockholders.

Table 3.9 Ownership Structure by Size of Firm

	All Firms	0-19 Employees	20-100 Employees	101+ Employees
Private family-owned	**70%**	**79%**	**69%**	**38%**
Private investor-owned	**17%**	**13%**	**21%**	**20%**
Publicly-owned stock corporation	**7%**	**1%**	**5%**	**35%**
Other	**7%**	**8%**	**5%**	**7%**

Source: CURP Survey

Manufacturing Technology and Improved Productivity

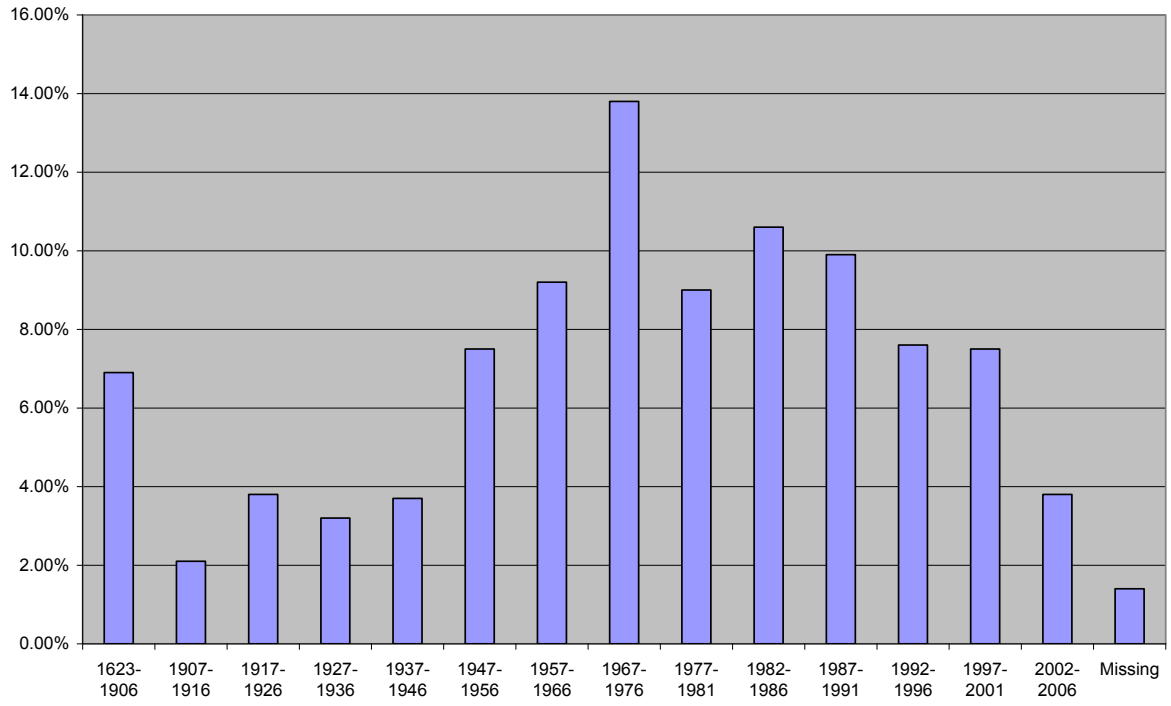
Our survey reveals that in addition to making more high-tech goods than before, manufacturers also employ a great deal of new technology in their production processes. While 49 percent of all respondents say that they have experienced a substantial increase in the use of new technology, the difference between large and small companies is noteworthy. Nearly two-thirds (66%) of large companies have substantially increased their use of new technology versus 46 percent of small companies.

With greater advances in technology and machinery, productivity has risen in most of these firms. Nonetheless, fewer than 18 percent of the firms in our sample report that productivity improvements have been responsible for large scale reductions in employment. Fewer than 8 percent report substituting less-skilled labor for higher-skill workers, and only 5 percent use fully automated machinery for assembly and fabrication. In short, new high-tech production methods do not appear to be a major source of lost manufacturing jobs. Downsizing has presumably been more the result of firms going out of business, losing customers, or moving to other locations for production.

Manufacturing Enterprise: Old and New

Many manufacturers in the Commonwealth have been here for quite some time. Indeed, one out of five manufacturing firms has been in business at least sixty years, going back to the World War II era or earlier (see **Figure 3.4**). More than half of the firms in our sample were founded in the years between 1957 and 1991. At the other end of the age spectrum, nearly 30 percent of our surveyed firms have been in business in the Commonwealth for twenty years or less and one-third of these young firms (more than one in 10 of *all* firms) have been in business for no more than a decade. As we saw in Chapter 1, this suggests that while the state has lost a great number of manufacturing firms, new ones continue to be formed and many of these appear to be prospering.

Figure 3.4 Year Company Founded



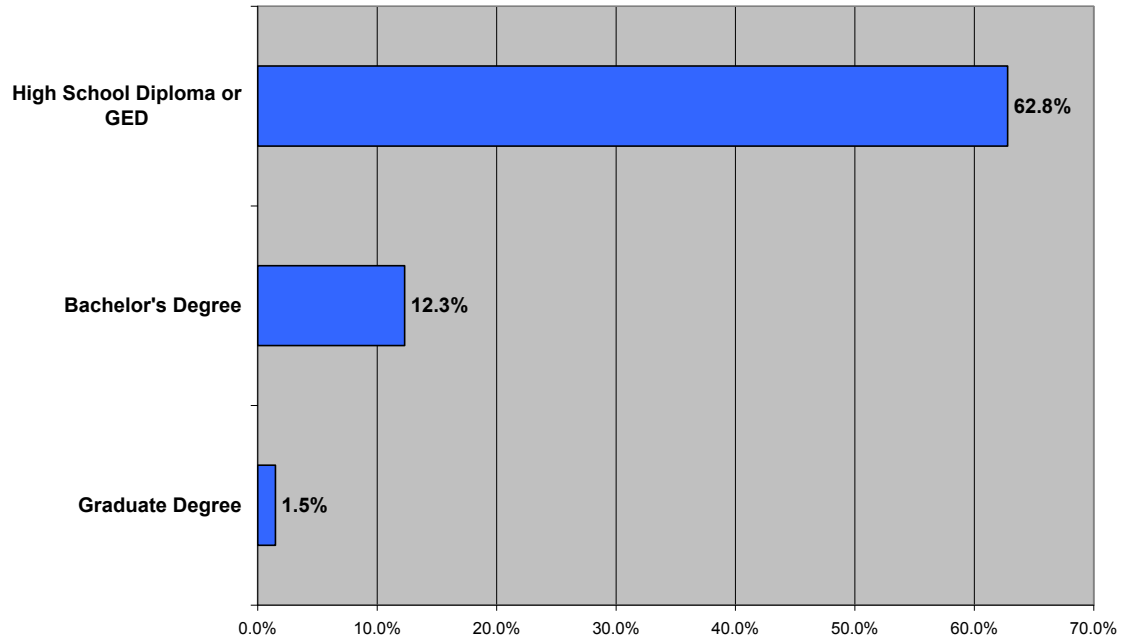
Source: CURP Survey, 2007

Education of the Manufacturing Workforce

Education, and higher education in particular, is often viewed as the key to securing a well-paying job and a good career. For manufacturing employment in Massachusetts our data tell a more nuanced story. In fact, more than 60 percent of our survey respondents report that a majority of the jobs in their facilities require no more than a high school education or a GED and a third of all firms (32.7%) report that at least three-quarters of their jobs require no more than this amount of schooling. By contrast, only one-eighth (12.3%) of the firms indicate that a majority of jobs require a Bachelor's degree and only 1.5 percent report that a majority of their jobs require a graduate education (see **Figure 3.5**). Hence, manufacturing remains a sector where workers with limited schooling have the opportunity to obtain good jobs at reasonably high pay, often with an array of job benefits.

Many non-manufacturing industries require that a majority of their workers have a college degree or more to secure entry-level positions or to advance to higher positions of responsibility. However, many manufacturing employers rely on workers with sound vocational skills rather than bachelor's or master's degrees. These vocational skills prove important in this sector. Nearly 44 percent of survey respondents report that a majority of their jobs require advanced technical skills even when they do not require a college degree.

Figure 3.5 Percentage of Firms Reporting That a Majority or More of Their Jobs Require Stated Amount of Formal Education



Source: CURP Survey, 2007

This, too, depends to some extent on the size of the firm. Larger firms are more likely to require a larger proportion of their employees to have advanced education while smaller firms are more likely to require a larger share of their workforce to have specialized technical skills (see **Table 3.10**). The larger firms often have in-house professional services provided by workers with advanced education while smaller firms usually purchase these services from outside vendors.

Table 3.10 Education Requirements by Size of Firm

	0-19 Employees	20-100 Employees	101+ Employees
Percentage of Jobs Requiring B.A.	**22%**	**23%**	**41%**
Percentage of Jobs Requiring Specialized/Technical Skills	**55%**	**37%**	**18%**

Source: CURP Survey

The Massachusetts workforce is clearly a major advantage for the state. One of the most consistent comments that we received from the manufacturers we personally interviewed was the importance of the skills possessed by their workers. Many of these are skills learned on the job or in vocational education programs rather than in a college or a university. Regardless of industry, size of firm, or location within the state, manufacturing executives were nearly unanimous in their claim that the quality of their workforce was vital to the success of their firms.

A small, 20-employee fabricated metal industry company in Hanover is representative of Massachusetts' smaller manufacturers in this respect. The owner/operator believes strongly that he is well positioned for growth and has begun to export. He recognizes that his sales prospects could be even greater if he were to relocate his operations to a lower cost area. He admits, however, that because 100 percent of his production is dependent on highly skilled workers operating machinery designed specifically for his business, he cannot relocate without losing an almost irreplaceable workforce.

On a very different scale, a large pharmaceutical company in Waltham that employs almost 500 workers is also dependent on its workforce but has a greater supply of potential workers. The company's General Manager says that "the availability of

world class researchers, access to fabulous hospital and academic resources, and the great R&D talent pool in Greater Boston are essential to our success."

Hourly Wages in Massachusetts Manufacturing

Manufacturing is generally known for paying better than average wages to its hourly workers, given the education distribution in this sector. Despite the fact that almost two-thirds of the firms in our survey report that a majority of their employees need no more than a high school diploma or GED to qualify for a job, the average (mean) hourly wage of unskilled production workers is $12.81, substantially more than double the federal statutory minimum wage of $5.85 an hour and more than sixty percent higher than the current Massachusetts minimum wage of $8.00. As **Table 3.11** reveals, 27 percent of the firms we surveyed reported paying an average wage of more than $14.00 an hour to their unskilled workers and nearly half of these firms reported paying an average that exceeds $16.00. We found a slight variation by size of firm, with larger firms generally paying more than smaller ones for their unskilled workers. The average wage among firms employing fewer than twenty employees was $12.36, compared with $13.11 for firms of 20 to 100 employees and $13.63 an hour for firms that employ more than 100 workers.

Skilled production workers are, of course, better paid despite the fact that many have no more formal education than their unskilled counterparts (see **Table 3.12**). Across all the firms in our survey, the average hourly wage for skilled workers was $20.48. We found little variation in average wages by size of firm. Only 13 percent of our survey firms reported paying less than $14.00 an hour for their skilled workers. At the other end of the wage spectrum, we found that 5 percent of the companies pay at least

$30.00 an hour for such workers. On a full-year, full-time basis, these well-remunerated production workers are earning in excess of $60,000 per year.

Table 3.11 Average Hourly Wages for Unskilled Production Workers in Massachusetts Manufacturing

Average Hourly Wage	Percent of Firms
$8.00-$10.00	**30%**
$10.01-$12.00	**27%**
$12.01-$14.00	**17%**
$14.01-$16.00	**14%**
$16.01+	**13%**
Mean	**$12.81**
Median	**$12.00**

Source: CURP Survey

Table 3.12 Average Hourly Wages for Skilled Production Workers in Massachusetts Manufacturing

Average Hourly Wage	Percent of Firms
$8.00-$14.00	**13%**
$14.01-$18.00	**29%**
$18.01-$22.00	**31%**
$22.01-$30.00	**22%**
$30.01+	**5%**
Mean	**$20.48**
Median	**$20.00**

Source: CURP Survey

Summary

In sum, Massachusetts manufacturers make a remarkably diverse array of finished products and components. As our survey results demonstrate, the state remains a major producer in such high-tech industries as aerospace, fiber-optics, and semiconductors. But it produces so much more. Although we expect high-tech to continue to outpace low- and middle-tech production, traditional manufactured products such as chemicals, lighting fixtures, fabricated metal parts, and frozen foods still make up a sizable portion of the Commonwealth's manufacturing sector.

There is no one city or region that is responsible for the bulk of this production. Manufacturing companies are spread throughout the Commonwealth and bring jobs to cities and towns, large and small.

Because so many of the state's manufacturing establishments are family-owned, they are not subject to shareholder pressure to improve short-term profits. This allows companies more latitude to provide high quality goods without sending jobs out of the state or abroad in search of lower production costs. This, in turn, prevents disruptions of local and regional supply chains, which provides an additional benefit to Massachusetts.

Employing new technology, as our research shows, has apparently not led to sharp job losses. In fact, of the companies we surveyed, new technology has had very little impact on employment levels, despite much higher productivity. Very few firms reported moving to fully automated production processes, suggesting that even amidst a shift toward higher-tech products and components, assembly of these items still requires a significant amount of hand labor.

Increased pressure in other industries for a more educated workforce does not seem to be the case in manufacturing. Our respondents indicated that they employ a large proportion of high school graduates who more likely require vocational skills than those obtained from a college or university education.

Overall, our survey paints a picture of a highly interlinked manufacturing sector in Massachusetts which combines a growing segment of high technology firms that sell in national and global markets with a bevy of traditional manufacturers who remain in business because of the quality and service they can deliver to local customers.

What keeps these firms in Massachusetts as the world economy becomes increasingly globalized and, in Thomas Friedman's term, "flat," may not be obvious. Chapter 4 will address the key factors that have kept our remaining manufacturing firms operating in Massachusetts.

Appendix 3A Massachusetts Manufacturing Establishments with $100 million + in Annual Sales Revenue (2006)

Name	Industry	NAICS4	Sales Volume
Analog Devices Inc	Electronic Equipment & Supplies	3344	$1 billion +
Biogen Idec Inc	Biological Products	3254	$1 billion +
Boston Scientific Corp	Surgical Instruments	3391	$1 billion +
Cabot Corp	Carbon Black	3251	$1 billion +
Connell LP	Fabricated Plate Work-Boiler Shops	3334	$1 billion +
EMC Corp	Electronic Storage Devices	3341	$1 billion +
GE Aircraft Engine Group	Aircraft Engines & Engine Parts	3364	$1 billion +
Gillette Co.	Perfumes Cosmetics/Toilet Preparations	3256	$1 billion +
Lucent Technologies	Telephone & Telegraph Apparatus	3344	$1 billion +
M/A-Com Inc	Semiconductors & Related Devices	3344	$1 billion +
New Balance Athletic Shoe Inc	Footwear	3162	$1 billion +
Ocean Spray Cranberries Inc	Cranberries (Canners)	3114	$1 billion +
Perkin Elmer Inc	Laboratory Analytical Instruments	3345	$1 billion +
Raytheon Co.	Aerospace/Radar/Navigation Systems	3345	$1 billion +
Thermo Electron Corp	Measuring/Controlling Devices	3345	$1 billion +
Waters Corp	Laboratory Analytical Instruments	3345	$1 billion +
Wyeth Pharmaceuticals Inc	Drug Millers	3254	$1 billion +
Acushnet Co.	Golf Equipment	3399	$500 m. to $1. b.
Axcelis Technologies Inc	Semiconductor Devices	3344	$500 m. to $1. b.
Boston Turning Works	Wood-Turning	3372	$500 m. to $1. b.
Coca-Cola Bottling Co.	Bottlers	3121	$500 m. to $1. b.
Connleaf's Inc	Tobacco Products	3122	$500 m. to $1. b.
Creo Americas Inc	Printing Equipment	3332	$500 m. to $1. b.
First Petroleum	Petroleum Products	3241	$500 m. to $1. b.
Hewlett-Packard	Computers-Electronic Equipment	3341	$500 m. to $1. b.
Millipore Corp	Laboratory Analytical Instruments	3345	$500 m. to $1. b.
MKS Instruments Inc	Industrial Measuring/Control Instruments	3345	$500 m. to $1. b.
New England Business Svc Inc	Printers	3231	$500 m. to $1. b.
Northern Graphics	Printers	3231	$500 m. to $1. b.
Stride Rite Corp	Rubber & Plastics-Footwear	3162	$500 m. to $1. b.
Texas Instruments Sensors	Electronic Equipment & Supplies	3344	$500 m. to $1. b.
Varian Semiconductor Equipment	Semiconductor Devices	3344	$500 m. to $1. b.

Watts Water Technologies Inc	Valves	3329	$500 m. to $1. b.
Welch Foods Inc	Canning	3114	$500 m. to $1. b.
Wyman Gordon Co.	Forgings	3321	$500 m. to $1. b.
3M Touch Systems	Physicians & Surgeons Equipment	3329	$100 to 500 m.
A H Notini & Sons Inc	Tobacco Products	3122	$100 to 500 m.
A W Chesterton Co .	Gaskets-Packing & Sealing Devices	3399	$100 to 500 m.
ADE Corp	Semiconductor Devices	3344	$100 to 500 m.
Aearo Corp	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Agri-Mark Inc	Cheese Processors	3115	$100 to 500 m.
Air Liquide America Corp	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Allegro Micro Systems Inc	Electronic Equipment & Supplies	3344	$100 to 500 m.
American Biltrite Inc	Tapes-Pressure Sensitive	3222	$100 to 500 m.
American Insulated Wire Corp	Drawing/Insulating-Nonferrous Wire	3313	$100 to 500 m.
Ames Color File	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Analogic Corp	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Applied Biosystems	Scientific Apparatus & Instruments	3272	$100 to 500 m.
Astra Zeneca	Medicinal Chemicals/Botanical Products	3254	$100 to 500 m.
Atlas Copco Compressors Inc	Air & Gas Compressors	3339	$100 to 500 m.
Avery Dennison Corp	Stationery-Tablets/Related Prods	3222	$100 to 500 m.
Babcock Borsig Power Inc	Heating Equipment	3334	$100 to 500 m.
Battenfeld Gloucester Engineering	Special Industry Machinery	3333	$100 to 500 m.
Bay State Milling CO.	Milling	3112	$100 to 500 m.
Bayer Diagnostics	Surgical/Med Instruments/Apparatus	3329	$100 to 500 m.
Bayer Health care Diagnostics	Laboratory Analytical Instruments	3345	$100 to 500 m.
Bemis CO. Inc	Plastics-Raw Materials/Powders/Resins	3252	$100 to 500 m.
Boston Beer CO. Inc	Brewers	3121	$100 to 500 m.
Braun Inc	Physicians & Surgeons Equipment	3329	$100 to 500 m.
Brooks Automation Inc	Automation Systems & Equipment	3339	$100 to 500 m.
Bruker Bio Sciences Corp	Laboratory Analytical Instruments	3345	$100 to 500 m.
Bruker Daltonics Inc	Laboratory Analytical Instruments	3345	$100 to 500 m.
Cabot Corp-Inkjet Colorants	Colors & Pigments	3251	$100 to 500 m.
Candela Corp	Lasers-Medical	3345	$100 to 500 m.
Candy Cupboard	Candy & Confectionery	3113	$100 to 500 m.
Capstan Atlantic	Metal-Powder Fabricators	3259	$100 to 500 m.
Carando Foods	Sausages/Other Prepared Meat Products	3116	$100 to 500 m.
Cargocaire Engineering Corp	Ventilating Systems	3399	$100 to 500 m.

Chomerics Inc	Electronic Equipment & Supplies	3344	$100 to 500 m.
CirCor International Inc	Valves	3329	$100 to 500 m.
Clariant Corp	Plastics-Raw Materials/Powders/Resins	3252	$100 to 500 m.
Coca-Cola Bottling Co.	Bottlers	3121	$100 to 500 m.
Cognex Corp	Machinery-Specially Designed & Built	3363	$100 to 500 m.
Commonwealth Maintenance System	Janitors Equipment & Supplies	3333	$100 to 500 m.
Covalence Adhesives	Physicians & Surgeons Equipment	3391	$100 to 500 m.
CPF Inc	Bottlers	3121	$100 to 500 m.
Crown Cork & Seal Co.	Can	3324	$100 to 500 m.
Cytyc Corp	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Decas Cranberry Products Inc	Cranberry Products	3114	$100 to 500 m.
Duro Industries Inc	Finishers of Textiles	3133	$100 to 500 m.
Dutch Maid Bakery Inc	Wholesale Bakers	3121	$100 to 500 m.
Eastern Acoustic Works Inc	Sound Systems & Equipment	3343	$100 to 500 m.
ECM Plastics Inc	Plastics-Raw Materials/Powders/Resins	3252	$100 to 500 m.
Entegris Inc	Chemicals	3255	$100 to 500 m.
Enterasys Networks Inc	Radio/TV Broadcasting Equipment	3342	$100 to 500 m.
First Years Inc	Infants Equipment & Supplies	3369	$100 to 500 m.
Fleetline Petroleum Products	Petroleum Products	3241	$100 to 500 m.
FlexCon Corp	Paper Coating	3222	$100 to 500 m.
Franklin Sports Industries Inc	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Ge Water & Process Tech	Water Purification/Filtration Equipment	3333	$100 to 500 m.
General Dynamics C4 Systems	Communications Equipment	3342	$100 to 500 m.
Gentex Optics Inc	Ophthalmic Goods	3391	$100 to 500 m.
Genzyme Corp	Physicians & Surgeons Equipment	3329	$100 to 500 m.
H C Starck Inc	Primary Smelting/Refining-Nonferrous Metals	3314	$100 to 500 m.
H P Hood LLC	Fluid Milk	3115	$100 to 500 m.
Haartz Corp	Coated Fabrics	3133	$100 to 500 m.
Hall Corp	Resistors	3344	$100 to 500 m.
Hallmark Sweet Inc	Jewelry	3399	$100 to 500 m.
Harvey Industries Inc	Metal Doors Sash Frames & Trim	3323	$100 to 500 m.
Hasbro Games	Games Toys & Children's Vehicles	3369	$100 to 500 m.
Hollingsworth & Vose Co.	Paper	3221	$100 to 500 m.
Hologic Inc	X-Ray Apparatus & Supplies	3345	$100 to 500 m.
I Robot Corp	Robots	3339	$100 to 500 m.
Instron Corp	Testing Apparatus	3345	$100 to 500 m.
J J Wild Inc	Computers-Electronic	3341	$100 to 500 m.

Jostens	Jewelry	3399	$100 to 500 m.
Kadant Inc	Paper Mill Machinery	3332	$100 to 500 m.
Kanzaki Specialty Papers Inc	Paper Converters	3221	$100 to 500 m.
Kronos Inc	Time Recorders & Systems	3345	$100 to 500 m.
L S Starrett Co.	Tools-Precision	3335	$100 to 500 m.
Leach & Garner Co.	Jewelers Findings/Materials/Lapidary	3345	$100 to 500 m.
LTX Corp	Semiconductors & Related Devices	3344	$100 to 500 m.
Lucent Technologies	Electronic Equipment & Supplies	3344	$100 to 500 m.
Mack Technologies Inc	Computer Peripherals	3344	$100 to 500 m.
Malden Mills Industries Inc	Textile Fibers	3132	$100 to 500 m.
Medtronic Interventional	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Mercury Computer Systems Inc	Semiconductor Devices	3344	$100 to 500 m.
Mestek Inc	Heating Equipment	3334	$100 to 500 m.
Microsemi Corp	Semiconductor Devices	3344	$100 to 500 m.
Microvasive Endoscopy Division	Physicians & Surgeons Equipment	3329	$100 to 500 m.
Morgan Construction Co.	Steel Works/Blast Furnaces/Rolling Mills	3241	$100 to 500 m.
National Nonwovens	Felt Products	3132	$100 to 500 m.
Nestle Waters North America	Bottlers	3121	$100 to 500 m.
New England Business Services	Printers-Business Forms	3231	$100 to 500 m.
New England Confectionery Co.	Candy & Confectionery	3113	$100 to 500 m.
NFA Corp	Narrow Fabrics & Other Smallwares	3132	$100 to 500 m.
NMS Communications Corp	Telephone & Telegraph Apparatus	3344	$100 to 500 m.
Nova Biomedical	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Nutcracker Brands Inc	Salted & Roasted Nuts & Seeds	3119	$100 to 500 m.
Nutra Max Products Inc	Physicians & Surgeons Equipment	3391	$100 to 500 m.
Old Colony Envelope Co.	Envelopes	3222	$100 to 500 m.
Parlex Corp	Semiconductors & Related Devices	3344	$100 to 500 m.
Pharmasol Inc	Perfumes Cosmetics	3256	$100 to 500 m.
Polar Beverages Inc	Bottlers	3121	$100 to 500 m.
Polaroid Corp	Photographic Equip & Supplies Manufacturer	3333	$100 to 500 m.
Procter & Gamble Co.	Soaps & Detergents	3256	$100 to 500 m.
Quaker Fabric Corp	Fabrics	3132	$100 to 500 m.
Reed Business Information	Converted Paper/Paperboard	3222	$100 to 500 m.
Rogers Foam Corp	Plastics-Fabrics Film	3261	$100 to 500 m.
Rule Industries Inc	Plastics-Raw Materials/Powders/Resins	3252	$100 to 500 m.
Saint-Gobain Containers	Glass Containers	3272	$100 to 500 m.
Saucony Inc	Sporting & Athletic Goods	3399	$100 to 500 m.

Schneider Automation Inc	Electronic Controls	3353	$100 to 500 m.
Sea Change Intl Inc	Television-Cable	3342	$100 to 500 m.
Slesar Brothers Brewing Co.	Brewers	3121	$100 to 500 m.
Smith & Nephew Dyonics Inc	Physicians & Surgeons Equipment	3329	$100 to 500 m.
Smith & Wesson Holding Co.	Firearms	3329	$100 to 500 m.
Southwick Clothing LLC	Men's Clothing	3152	$100 to 500 m.
Spalding Sports Worldwide	Sporting & Athletic Goods	3399	$100 to 500 m.
Springfield Wire Inc	Heating Equipment	3334	$100 to 500 m.
Steinway Musical Instruments	Musical Instruments	3399	$100 to 500 m.
Sullivan Paper Co. Inc	Paper Converters	3221	$100 to 500 m.
Syratech Corp	Cutlery	3322	$100 to 500 m.
United Electric Controls Co.	Physicians & Surgeons Equipment	3329	$100 to 500 m.
Vertex Pharmaceuticals Inc	Pharmaceutical Preparation	3254	$100 to 500 m.
ViCor Corp	Electronic Equipment & Supplies	3344	$100 to 500 m.
Volex Inc	Wire & Cable Machinery	3335	$100 to 500 m.
Watts Regulator Co.	Plumbing Fixture Fittings & Trim	3329	$100 to 500 m.
Weetabix Co. Inc	Cereals	3112	$100 to 500 m.
Xcel Machining Technology Inc	Machine Shops	3363	$100 to 500 m.
Zoll Medical Corp	Physicians & Surgeons Equipment	3391	$100 to 500 m.

Source: Manufacturing News, Inc. (MNI), 2007 Massachusetts Manufacturers Register

Appendix 3B What Manufacturers Make in Massachusetts

This appendix provides a list of the products manufactured by the 706 manufacturing establishments that completed the manufacturing survey in 2007. The products are divided by OECD technology category.

OECD Manufacturing industries classified according their global technological intensity (ISIC Revision 2)

High-technology
1. Aerospace
2. Computers, office machinery
3. Electronics-communications
4. Pharmaceuticals

Medium-high-technology
5. Scientific instruments
6. Motor vehicles
7. Electrical machinery
8. Chemicals
9. Other transport equipment
10. Non-electrical machinery

Medium-low-technology
11. Rubber and plastic products
12. Shipbuilding
13. Other manufacturing
14. Non-ferrous metals
15. Non-metallic mineral products
16. Fabricated metal products
17. Petroleum refining
18. Ferrous metals

Low-technology
19. Paper printing
20. Textile and clothing
21. Food, beverages, and tobacco
22. Wood and furniture

First Product Mentioned by Each Firm (N=698 Firms)
Overall Number of Products Listed by 698 Firms = 1,148

High Technology

Components

- Aerospace components
- Aerospace adhesively bonded structures
- Aerospace products for commercial and military jet engines
- Aircraft Acquisition Systems
- Aircraft component manufacturing
- Aircraft Controls
- Aircraft Engine Components
- Aqueous Inkjet Pigmented Dispersions
- Assembly of printed circuit boards
- Biologicals for human T/B cell research
- Biomaterial - Calcium Phosphate
- Bio-Pharmacuetical products for rare genetic diseases.
- Bio-surgery products.
- Biotech and pharma process equipment
- Components for launch vehicles and rockets, land based gas turbines, nuclear submarines, marine vessels
- Circuit Board Assemblies
- Cleaning blades for copiers and printers
- Control, navigation & communications
- Custom fabricated parts for paper, water, high tech industries
- Custom machined parts for computers/microwaves
- Custom rigid thermoplastic profiles
- Custom sheet metal fabrication (enclosures, brackets, etc.) - for electronics, telecommunications
- Defense Electronics
- Electroplating of electronic parts for the medical, aerospace, automotive, telecommunications industries
- Fiber-optic components
- Infrared sensors
- Large aluminum castings for medical semi-conductor and precision instruments
- Machined components for medical and communications industry
- Machined metal parts, vacuum chambered used in semiconductor and flat panel industry
- Machined parts for antennae and microwaves
- Machined parts used in elevators, semiconductor equipment, and commercial heat film
- Manufacture aircraft engine components

Complete Products

- Armored vehicles
- Automation Control Systems
- Batter control systems for the batter and breading food industry
- Broadcast Equipment
- Chemical & Mineral Processing Machinery
- Electronic data storage and hardware
- High-shear fluid processing systems
- Infrared Imaging Systems
- Loudspeakers
- Manufacture of medical products
- Medical and flash memory storage
- Medical and industrial fiber optic imaging systems
- Medical devices
- Medical implants
- Optical inspection systems for mfg printed circuit boards
- Pharmaceutical products
- Professional dental devices
- Radar equipment
- Retainers and other various orthodontic appliances
- UHF High and low power television
- Underwater Acoustic Products primarily for use by the US Navy and allied Navies.
- Video Surveillance systems - hardware and software
- Weapon systems for military/defense applications
- Wireless Data Transmission Equipment

High Technology (continued)

Components

Manufacture components for medical devices
Medical Device Components
Medical equipment manufacturer
Medical Job Shop Coating
Medical molded plastic components
Medical, Aerospace, Military, Semiconductor, commercial high precision components and assemblies
Microwave military electronics
O-Rings & custom elastomeric seals for automotive & aerospace applications
Optical Components & subsystems
Optical housing, robotics
Optical Safety Lenses and Scanner Windows
Physiological Assays for Medical Research
Plastic coating applicator for medical devices
Power distribution Panel for NAVY Ships
Precision contract machining for the Aerospace, Military, Medical and Commercial markets
Precision machined parts (aerospace, medical, commercial)
Precision machining for commercial and aerospace industries
Precision manufactured components for aircraft, aerospace, commercial companies
Precision optical components
Process equipment for advanced semiconductor packaging applications
Proteins and immuno-assay kits for med research
RF and microwave electronic devices and components
Semiconductor equipment
Semiconductor Integrated Circuits
Semiconductor lasers
Semiconductor Test probes
Specialty metal products for medical markets
Specialty tools for aircraft
Spectral imaging and spectrometer products for Industrial process controls, Defense, Life Sciences and Telecom
Structural forgings for military and commercial aircraft
Titanium Aerospace Parts

Medium High Technology

Components

Ceramic Components
ceramic glazes
Composites used in apparel and auto industry
Custom die-cut parts specializing in electrical insulation, thermal transfer materials,
Diamond Machine Tools
Die cut materials for electronics industry
Direct fit catalytic converters for the automotive aftermarket
Electric Hinges
Electrical and electronic switches
Electrical contacts and contact assemblies
Electrical Cords & Assemblies
Electromechanical components
Electronic components
Electronic controls
Generator Sets
Glass tubing
High voltage cable assemblies
Imaging Chemicals
Impregnated Filter media
Industrial vacuum pumps and instrumentation
Liquids, aerosols, pastes, etc.
Manufacturer of plastic compounds, color and additive concentrates, and specialty filled resins on a custom or
Measuring instruments - dial indicators, micrometers, comparators
Parts for power generating industry
Photomasks
Plastic composite parts for electronics
precision machined component parts
Precision machined components for the electronic, semi-conductor, construction, hydraulic & pneumatic
Precision Metal Fabrications for the electromechanical industry
Sheet metal for the electronic Ind.
Specialty chemicals and materials used in fabrication of printed circuit boards
Spun Metal parts for lighting industry
Swiss Screw machine products for electronics
Voltage regulators for small gas engines
Wire and cable used in the audio industry
Wire and cables for electronics

Complete Products

Agricultural Fertilizer
Can Sealing Equipment
Cardiac Assist Medical Device
Chillers
Commercial lighting fixtures
Dental Health products
Dental/Medical devices
Electric control panels
Electric Signs
Electrical marine supplies
Electronic Equipment
Electronic Meter Calibrators
Electrophoresis units
Environmental test chambers
Facilities maintenance chemicals and floor coatings
Fare Collection Equipment for Public Transit and Parking Garages
Hydraulic Power Units
magnetic work holding and lifting equipment
Manufactured environmental controls
Meg-Thermal Coated Papers
Metal forming, metal cutting and metal cleaning machines
Metal forming, metal cutting and metal cleaning machines
Oil Water separators
Packaging Machinery
Paper mill machinery
Plastic Extrusion Machinery
Plastic packaging machinery
Precision measuring tools
Research chemicals
Robot systems for welding and material handling
Robotic Automation and Lab Automation Equipment
Scraped Surface Heat Exchangers, Tubular heat exchangers. Serving primarily the Food and beverage industry.
Solid Carbine Endmills and drills
Specialty chemicals
Stainless Steel Commercial Kitchen Equipment
Static control products

Medium High Technology (continued)

Complete Products
Steam Turbines
Strain gauge sensors
Strain gages
Test Equip. for Electro Static Discharge
Test Probes
Underwater and moisture instrumentation
Vacuum, gas and pressure measurement instruments
Values and instruments

Medium Low Technology

Components

- Anodizing and related aluminum surface finishes
- Bearings
- Blanchard grinding services
- Blind Rivets
- Castings and Machined Castings
- CNC Machining (6)
- Cold Forming and thread rolling
- Construction Castings for Roadway Applications
- Contract machining (2)
- Custom deep drawn metal stampings
- Custom injected molded plastics parts or industry use
- Custom machine parts (5)
- Custom Metal fabrication for industries and homeowners
- Custom mix rubber
- Custom rotational moulding
- Custom thermoforming of plastic sheet end products
- Die cutting and related services in support of textile, plastics, metal, computers, electronic manufacturing
- Electroplating (2)
- Engraved print cylinders
- Fabricated metal machine parts
- Fabricated Reinforced Steel
- Fabricated structural steel
- Fabricated Wire Products
- Galvanizing
- General Machine Shop
- General machining products
- HVAC CFC recovery system connectors
- HVAC duct work
- High temp & corrosion resistant fabricators
- Injection molded plastic products
- Injection molding of plastic fasteners
- Jig grinding services
- Job Shop - machine shop
- Job shop - to customer specifications
- Job shop, misc metals
- Laser cutting
- Machine parts
- Machine shop products
- Machined and milled connectors
- Machined components
- Manufacture of plastic parts

Complete Products

- Anatomical Models for Surgical Training
- ASME Section VIII Div I pressure vessels and heat exchangers
- Band saw blades
- Brass church altar ware
- Cable and wire harness
- Cast polymer products
- Cat Toys
- Cemetery memorials
- Concrete masonry units
- Conveyor belts
- Custom architectural metal work
- Custom award and recognition jewelry
- Custom manufacture rubber products
- Custom metal wire display racks
- Cutting tools
- Cylinder Brushes
- Decorative Glass
- Expanded polystyrene packaging
- Fire Alarm Devices
- Fitness Equipment
- Fiberglass Boats
- Flagpoles
- Floor Tiles
- Food service smallware
- Fuel for power plants
- Fuel repair kits
- Gas Turbine packaging
- Generators
- Hand Guns
- Heating radiators
- Hunting firearms
- HVAC Products and Services
- Injection molded home plastics
- Injection molded rigid plastic boxes
- Insulation Products
- Lamps
- Lighting
- Lighting fixtures for commercial and institutional buildings
- Looseleaf Binders
- Manufacture new and rebuilt grinding machine tools
- Manufacture of Roller Chain Tools
- Metal Enclosures/cabinets
- Mfg. high temperature insulated wire and cable
- Musical instruments
- Nameplates
- Non-metallic washers and gaskets
- Paint products

Medium Low Technology (continued)

Components

Mechanical, machine shop services
Metal Components
Metal Cutting - Broaching Tools and Accessories
Metal Fabrication
Metal Finishing (8)
Metal Machine parts
Metal Stamping (6)
Metallic or wood laminates
Manufacture of precision machined parts for valves and control systems
Miscellaneous Plastic Products re: analog systems
Panel processing, thermo-laminating, hot roll laminating of PVC and HPL
Products to substrate wood panels
Parts for new machinery and machines and machining services to repair machinery
Plastic color concentrate
Plastic injection molds and various tooling
Plastic parts and components
Plastic resin
Pneumatic switches
Powder metal parts
Precision & General machining
Precision machined parts
Precision Machined Parts for metal industry
Precision machined parts from metals and plastics
Precision machines and/or welded component parts made to customer prints/specifications
Precision machining and welding of metals and composite materials specific to customer prints/requirements
Precision Machining Services
Precision metal fabrication
Precision Metal Part Production
Precision metallic stampings
Precision molds for plastic industry
Precision parts to customer blueprints
Precision sheet metal
Precision sheet metal components
Precision sheet metal mfg for OBM users
Production Parts
Protective nylon coating for metal fabricated parts
Prototype and production machining to customer supplied drawings
PVC trim boards

Complete Products

Percussion instruments
Pipe assemblies
Pipe organs
Plastic bottles for centrifuge industry
Plastic Food wrap
Plastic level doorknob adapter for ADA
Plastic packaging containers
Plastic packaging materials
Plastic Products
Plastic Products for industrial and consumer markets
Plumbing
Pneumatic hand tools and supporting jaws
Polyurethane film and sheet
Precious Metal Jewelry
Precision machined hardware
Precision tools and dies
Product design & development
Prototypes
Radiators
Residential baseboard radiators
Rockwell hardness test blocks
Roller chain
Sailboats
Sheet Metal Products
Shower faucets
Silver gift products
Small hand tools
Small Machine Products
Snow shovels
Stainless Steel screws, nuts and bolts
Task lights
Thermoplastic insulated electronic cable
Tools
Torque Hand Tools
Vacuums for professional woodworkers
Vinyl Fences
Well water expansion tanks
Wire Cable Blocks
Wire Cable Blocks

Medium Low Technology (continued)

Components

Refine Precious metals from industry
Replacement machine parts
Replacement plastic lenses for fluorescent lights
Screw Machine Products and CNC machining
Semi-finished alum. castings
sheet metal components
Sheet Metal fabrication
small P/Os and T/Us for the wire and cable industry.
Special Machinery Manufacturing and machine tool parts
Specialty Plastics Compounds
Springs
Stamping, heat treating, honing and burnishing, nickel and gold plating.
Steel Rule Dies
Structural Steel
Structural steel fabrication
Sub contract machining
Thermoplastic extruded tubing
Welding
Weldments

Low Technology

Components

Architectural millwork,
Architectural Millwork, Moldings, Custom Wood Doors
Architectural woodwork
Binding and finishing services
Bookbinding
Books/research/rubber/chemicals
Coated fabrics
Contract Braiding
Converts cover material for books and packaging
Custom Draping and accessories
Finishing work for printing industry
Flock-coated products
Gaskets
Gears
Hand bookbinding
Manufacturer of plastic film used to make laminated safety glass for use in vehicles and buildings
Patterns and samples and gradings and mannens for clothing done on a CAD system
Stacked heels for shoes and boots
Webbing and webbing straps
Wood tooling for green sand foundries
Wool Processing

Complete Products

Adult disposable incontinent diapers
Antique Auto Interiors & Tops
Antique reproduction furniture
Auto seat covers
Bath and body products, home fragrances, gifts
Bedding Manufacturing
Beer
Bell's Seasoning and Stuffing mixes
Blueberry Wine
Bread
Brochures
Business cards
Candy Product
Cannoli shells - pastry
Casebound books
Compost
Confectionary Products
Contract Furniture
Copying
Corrugated Boxes
Covered Elastic Thread
Curtains and Draperies
Custom cut meats
Custom Interior Millwork
Custom manufacturing moldings, trim and cabinetry
Custom wood cabinets
Customized benefit statement printing
Dairy Products
Decals
Decorative Papers
Doors
Dried Cranberries
Dunkin' Donuts products
Emblematic and award items - pins, etc.
Embroidered and screen-printed apparel
Enclosures
Engraving and nameplate manufacturing
Engraving services
Fabricate insulated window units, doors and other products from purchased flat glass
Fabrics/textiles
Fasteners
Finished lumber
Fresh sausage and beef products
Ffrozen desserts
Frozen Seafood
Fudge

Low Technology (continued)

Complete Products
Furniture
General commercial printing
Granite Countertops
Granite curbing (roads), Architectural/building
Granite landscape (residential)
Granite quarry Bloc
Granite manufacturer
Greeting cards and high-end invitations
Handmade/sewn items
Hardwood Lumber for high end uses
Ice cream
Ice Rescue and Safety Products
Illuminated signs
Inspection, Packaging, and Distribution of Medical Devices
Items and apparel with custom printed embroidered logos for schools and business
Labels & Decals
Lumber
Luxury pre-fab post and beam homes
Mailing fulfillment
Marking devices and signs
Marshmellow Fluff
Mattresses and box springs
Meat products
Medical device packaging
Metal and foam bed products
Microbrewery - Beer
Millwork for hospitals
Miso, a seasoning
Molding paneling
Museum exhibit cases
Non-woven fabrics
Nonelectric signage
Notebooks
Novelty trimming - laces, ribbon, braid
Offset printing
Packaged dry mix concrete
Packaging
Packaging of hardware
Pallets
Paper manufacturing for the food industry
Paper tablets
Paper tubes
Paper tubes and cans
Peanut Butter
Portuguese Sausage: Linguica, Chourico, Morcellas, Patties, Franks, Ground

Low Technology (continued)

Complete Products
Precast Concrete Products
Premium business papers and specialty papers
Prepared fresh refrigerated soups, stews, chowders, gravies and sauces
Presentation Folders
Preserves
Pressure-sensitive labels
Pressure treat lumber/plywood
Pressure Treated Lumber
Print Paper bags
Printed Materials
Printed decorative papers for laminate industry
Printed forms
Printed textile goods
Printing
Printing and mailing
Processed Meat Products
Quarry cut granite building stone
Ready Mix Concrete
Real estate signs
Recognition Folders & Frames
Residential furniture
Sail boat cushions
Sailcloth
Sails
Screen printing
Set-up paper boxes primarily for jewelry, confection and stationary and ancillary products
Shelf stable foods
Shipping containers
Shoe soles
Signs (12)
Silk screens and screen printing
Slaughterhouse fresh meats
Smoked Seafood
Snack tables
Soy Foods (tofu and tempeh)
Specialized Printing
Specialty coated paper for imaging and electronic industries
Specialty direct mail format
Sport drinks
Tables
Tailored Men's Clothing
Textile Roll Goods
Textile Screen printing
Tree Injection Systems

Low Technology (continued)

Complete Products
Twine
Upholstery fabric and specialty yarns
Vacation Guides, Newspapers, Websites,
Window, Table and Bed Coverings
Wine
Women's Clothing
Wood Fencing
Wood Product
Wood Products: architectural woodwork
Wood Windows and Doors
Woolen woven felt - endless
Wrapping Tissue
Yarn

Chapter 4

Why Have Manufacturers Stayed in Massachusetts?

As the data and projections in the first chapter demonstrate, the process of birth and death among manufacturing firms is a dynamic one. While the second half of the twentieth century was, on balance, unfavorable to the manufacturing sector, the elimination of manufacturing jobs has begun to slow, and it is likely to proceed at a similar slow pace over the next decade even as the current weakness in the national economy takes its toll. Considering these recent trends, it is important to understand the experiences of the manufacturers themselves — how they have weathered the storm of deindustrialization, how national and global industrial developments have affected their business practices, and where they see their own companies and the statewide manufacturing sector headed in the near future. The responses we received to our survey and the interviews we carried out with CEOs and managers provide us with insights on all of these questions.

What Has Changed for Massachusetts Manufacturers in the Past Decade?

In the survey, we probed the extent to which, over the past 10 years, Massachusetts manufacturers have experienced changes in the way they do business and changes in the business environment within which they operate. Survey respondents ranked each question using a scale of 1 (did not experience this change at all) to 5 (experienced this change a great deal). The questions covered possible changes in

customer demands for lower prices, better service, or improved product quality; the use of new technology in their production processes; shifts in their customer markets; the use of outsourcing; and changes in the skills they require in their employees.

Customer Demands for Lower Prices, Better Service, and Improved Product Quality

The increasingly stringent demands of customers emerged as the standout transformation in the manufacturing environment, greatly exceeding all others. As **Table 4.1** demonstrates, more than half of all firms reported that the increased demands for lower prices, for improved service delivery, and for better product quality, had changed the way they do business.[25] The relative importance of these customer demands is made even clearer by the fact that *no other* development was reported to have been experienced so profoundly by more than half of the sample firms.

These three items — price, quality, and service — reflect separate phenomena that have affected manufacturers in Massachusetts over the past decade. The correlation between the items, however, is striking. Firms that claimed to have experienced an increase in one of these customer demands were likely to have experienced the others, as well. This observation is particularly strong for the correlation between increased demands for service delivery and for product quality. The correlation between each of these two and the demand for lower prices, while still robust, is weaker. Many customers appear to recognize to some extent that improvements in delivery and quality come with an added cost. Still, for a large proportion of our sample, customers have demanded all three simultaneously, putting extreme strain on the capabilities of manufacturers. As buyers expect firms to reduce prices while simultaneously improving product quality, firms must somehow find a way to cut costs and increase efficiency (e.g., by

implementing “lean” business practices), lest dissatisfied customers search for new suppliers that can meet their rigorous expectations, either in Massachusetts or, increasingly, in other states and countries.

One example of a Massachusetts manufacturer successfully responding to aggressive customer demands was interviewed in New Bedford. The president and CEO of a 400 employee rubber products manufacturer described the major changes his company went through in 2000 to meet higher auto industry demands. They restructured their product lines, introduced more technology and automation into their processes, cut back their workforce, and increased their workers’ skill levels. They also implemented pervasive lean manufacturing and “Just-In-Time” procedures that are now required by their customers. Based on these changes, the CEO is now forecasting continued growth in revenues and expects to see employment levels increase as sales improve.

In a less encouraging interview, the owner/CEO of a Gardner-based plastics manufacturing firm described his 100 employee company’s efforts to meet the demands of customers. He has completely automated his manufacturing processes and established a rigorous continuous improvement program in an effort to remain as competitive as he can. His primary problem is that he competes directly with Chinese manufacturers who have a major cost advantage due to differences in regulation, wages, and benefit levels. He is very concerned that increases to his cost of doing business could price him out of business. His utilization of technology and lean processing are keeping him competitive at the present time, but rising costs are a major threat.

Table 4.1 Changes in the Business Environment Experienced by Massachusetts Manufacturing Firms in the Past Decade

Type of Change	Number of Firms	Percent of Firms
Increased Customer Demands for *Lower Prices*	440	62%
Increased Customer Demands for *Improved Service Delivery*	425	60%
Increased Customer Demands for *Better Product Quality*	386	55%
Substantial Increase in Use of New Technology	334	49%
Substantial Increase in Productivity due to Improved Technology	293	42%
Shift from Local Markets to National Markets	207	29%
Shift from National Markets to Global Markets	189	27%
Reduction in Employment due to Improved Technology	120	17%
Increased Outsourcing of Previous Internal Operations to Firms in Other States and Other Countries	80	11%
Increased Offshoring of Previous Internal Operations	73	11%
Increased Outsourcing of Previous Internal Operations to Other Massachusetts Firms	71	10%
Substitution of Skilled Labor for Less Skilled Labor	66	10%
Substitution of Less Skilled Labor for Skilled Labor	49	7%

Source: CURP Survey

Using New Technology to Boost Productivity

Apart from customer demands, the most prevalent change reported by the manufacturers we surveyed and interviewed was the implementation of new technologies. In part, this change reflects the composition of the Massachusetts manufacturing sector, with its high proportion of companies engaged in computer and software development, biotechnology, medical devices, and other advanced products. As customers have put heavier pressure on manufacturers to lower prices and increase quality, the state's manufacturers have responded by incorporating new technologies into their production processes in order to boost productivity so as to drive down costs or produce a product with more consistent quality. Indeed, of the 675 firms responding to this set of survey questions, 334 (49.5%) of them told us that they had experienced major increases in their use of new technology (see **Table 4.2**).

In an interview with the vice president of operations for a 200-employee Middleborough manufacturer of "state of the art" devices for measuring flow rates for various types of liquids, we learned that the company was introducing robotics into their operations. Because its products are in high demand throughout the world, with 70 percent of their customers located outside the United States, the firm's sales growth is offsetting any need to reduce its workforce despite the increase in automation.

The use of more technology, however, does not always translate into higher productivity. There are many cases where the immediate result of new technology is actually a decline in productivity because the new technology is inappropriate, has "bugs" that need to be corrected, or because it takes time for the workforce to learn how to use the technology effectively.[26] Still, of the 334 firms reporting that new technology

was an important part of their competitive strategy, there were only a few that reported no change in productivity or little improvement. Nearly four-fifths (79%) of the firms using new technology found that its introduction paid off in "strong improvement" or "very strong improvement" in productivity.

Table 4.2 Increase in Productivity by Increase in Technology

	Increase in Productivity Due to Improved Technology					
Change in New Technology	1 No Change	2 Little Improvement	3 Moderate Improvement	4 Much Improvement	5 Great Improvement	Total
1 No Increase	51	6	0	0	0	57
2 Little Increase	11	77	22	4	1	115
3 Moderate Increase	5	29	110	22	3	169
4 Much Increase	0	8	47	114	12	181
5 Great Increase	1	3	12	40	97	153
Total	68	123	191	180	113	675

Source: CURP Survey

Little Change in Skills Required

While altering the technology used to manufacturer their products, these companies have not significantly changed the skill level of their workforces. The two lowest-scoring changes listed by these companies were the substitution of skilled labor for less-skilled labor and the reverse, the substitution of less-skilled labor for more highly-skilled labor. Fewer than 10 percent of respondents attributed major significance

to either employment trend. Thus, even as the technologies used in manufacturing in Massachusetts have been overhauled to meet the new realities of the business environment, the skill level of the workers using these new production technologies does not seem to have changed substantially.

Differences by Size of Firm

Large firms have had to adapt to much more rapid changes than small firms. While the rank order of the importance of changes over the past decade does not differ substantially by firm size, the proportion of firms citing each change in the business environment does vary by size, with *large firms more likely than smaller ones to have experienced nearly all of the changes* probed in the survey. **Table 4.3** breaks down the responses found in Table 4.1 by the number of workers employed at the firm using the same categories as in Chapter 3: small firms (fewer than 20 employees), medium-sized firms (20-100 employees), and large firms (more than 100 employees).

Regardless of firm size, the most important change listed by respondents is increased customer demand for lower prices. But while only a little more than half (54.8%) of the smallest firms listed this factor as one that has greatly affected their operations, two-thirds of middle-sized firms (68.3%) and four-fifths (79.8%) of the largest firms report this as a major change encountered over the past decade.

This same ranking holds true for increased customer demands for improved service delivery and better product quality. More than 70 percent of large firms reported that these phenomena have affected their operations to a large extent over the last 10 years.

Table 4.3 Changes in the Business Environment Experienced by Massachusetts Manufacturing Firms by Size of Firm

Type of Change	1-19 Employees	20-100 Employees	101+ Employees
Increased Customer Demands for Lower Prices	54.8%	68.3%	79.8%
Increased Customer Demands for Improved Service Delivery	52.5%	66.7%	76.2%
Increased Customer Demands for Better Product Quality	46.3%	62.6%	72.6%
Substantial Increase in Use of New Technology	44.0%	47.6%	64.3%
Substantial Increase in Productivity due to Improved Technology	36.1%	43.9%	56.0%
Shift from Local Markets to National Markets	23.5%	35.0%	40.5%
Shift from National Markets to Global Markets	17.9%	32.1%	47.6%
Reduction in Employment due to Improved Technology	16.4%	15.9%	25.0%
Increased Outsourcing of Previous Internal Operations to other Massachusetts Firms	12.0%	7.5%	7.1%
Increased Outsourcing of Previous Internal Operations to Firms in other States or Countries	10.6%	11.8%	13.1%
Increased Offshoring of Previous Operations	9.1%	11.8%	17.1%
Substitution of Skilled Labor for Less Skilled Labor	8.3%	10.2%	14.3%
Substitution of Less Skilled Labor for Skilled Labor	6.7%	5.7%	12.4%

Source: CURP Survey

This pattern continues down the list of perceived changes, failing to hold only for the least-frequently listed developments. Larger firms are much more likely to report important changes in their use of technology and in improved productivity due to its use. They are about twice as likely to report that they are shifting their focus from local markets to national markets. They are almost three times as likely as small firms to have looked to global markets as destinations for their products.

What might be surprising, however, is that larger firms are only slightly more likely to have outsourced some of their operations to firms in other states and countries and *less* likely to have outsourced to other Massachusetts firms. This potentially counterintuitive finding may be due to the fact that larger firms have been outsourcing for many years while smaller firms have only resorted to this strategy more recently. Thus, the smaller firms are more likely to report they have experienced a *recent* increase in this practice.

As for their workforces, regardless of size, firms are just a little more likely to have substituted skilled labor for less skilled labor as the reverse. As noted above, most firms report little or no change in the skills they require from their workers.

Why Have Firms Decided to Continue Operations in Massachusetts?

When policy makers and analysts discuss the relative advantages and disadvantages Massachusetts has in attracting business investment and encouraging economic development, they often cite the region's reputation as a hub of learning, innovation, and technology, and its strategic location in the dense Northeast corridor, right on the Atlantic ocean. However, when we asked manufacturers what has kept them in the Commonwealth during a period when so many of their peers have left, we heard a

very different story. Geographic location and proximity to the plethora of technological and educational resources of which the Commonwealth is so proud seems to play a relatively minor role in the location decisions of these firms. Rather, what really seems to stand out as keeping firms in the Commonwealth is the strong work ethic of the Massachusetts workforce, the inertia that comes from having roots in the state, proximity to customers, the availability of an appropriated skilled workforce, and the quality of life in the region.

Table 4.4 provides this information. We asked in our survey "How important is each of the following factors to your decision to continue to operate manufacturing facilities in Massachusetts?" Respondents had the opportunity to reply on a 1 to 5 scale where 1 was "not important at all" and 5 was "extremely important."

Over half (52.0%) of all respondents listed "a strong work ethic in the workforce" as an "important" or "extremely important" reason for continuing operations in Massachusetts. Right behind this answer at 51.7 percent was "inertia" — the difficulty of picking up and moving to another location.

We interviewed the Vice President of Finance for a 200 employee precision machining company in Westfield. He raved about the quality of his workforce. More than 90 percent of his employees possess advanced technical skills, a critical factor for such a job shop for the aerospace and semi-conductor industries. The shop's high-quality products are highly engineered to the specifications of the customer in small batches. The company official made it clear in the interview that his firm would be out of business without its current employees and that western Massachusetts enjoys a strong reputation for skilled workers.

Table 4.4 Reasons for Staying in Massachusetts: Percent of Firms Reporting Reason as "Extremely Important" or "Very Important"

Reason	*Number of Firms*	*Percent of Firms*
Strong work ethic in workforce	347	52.0
Inertia (too hard to relocate)	345	51.7
Proximity to customers	260	38.7
Availability of appropriate skilled labor	258	38.5
Availability of reasonably priced labor	258	38.5
Quality of life (e.g. public schools, recreation, and cultural institutions)	249	37.3
Monetary or in-kind incentives from state, local governments or quasi-publics	221	33.7
Availability of reasonably priced land for expansion	219	33.3
Accessibility to transportation for shipping and commuting (e.g. highways, airports, rail, seaport)	216	32.1
Proximity to key suppliers	148	22.1
Proximity to professional or research support services	74	11.1
Proximity to universities and colleges	71	10.6
Critical mass of similar firms in region	66	10.0
Proximity to European markets	37	5.5

Source: CURP Survey

The quality of the workforce was emphasized over and over again in our interviews. The general manager and the controller of a defense contractor located in Fitchburg emphasized the importance of the company's workforce. The firm makes highly sophisticated marine propulsion devices that must be state-of-the-art to satisfy its customers. Roughly 50 percent of their 100 employees are either engineers or possessors of advanced technical skills. The company's officials asserted that the direct costs of doing business are not their greatest concern. Instead, maintaining and growing their technical workforce is critical to success. Both company officials we interviewed stressed that they are very satisfied with their location and could not imagine a relocation that would risk losing, or reducing, the competitive advantage they gain from the quality of their workforce. They believe they will triple their production in the next five years.

Regardless of firm size, the enormous amount of effort and resources that a company would have to invest to move its facilities to another location and either relocate its workforce or recruit a new one often outweighs the cost savings that firms could enjoy by leaving the region. Inertia plays a substantial part in helping the Bay State hang on to much of its remaining manufacturing base. This inertia likely affects both firms and individuals. At the firm level, the sizeable investment in capital and land and the existing pool of skilled employees renders relocation, if not impossible, at least difficult. At the individual level, all employees (including executives, managers, and laborers) must either uproot themselves and move their families at great expense to a new site, or find new jobs. It is important to bear in mind, however, that this inertial process likely operates in other regions, as well, and may be a significant hindrance to the state's solicitation of new investment in manufacturing.

Not all interviewees were pleased with their Massachusetts location. We interviewed the CEO of a 70 employee plastics manufacturer near Worcester. He enumerated a long list of complaints with regard to running his business in Massachusetts. Still, he acknowledged that it would not make sense to relocate. Although he was very "frustrated" and said "improvements are needed on every front," he expects significant growth in sales and employment. He is simply too well established to seriously consider moving.

Seven additional factors were clustered with between 32 and 39 percent of respondents considering these as very important to their decision to remain in Massachusetts: proximity to customers, availability of appropriate skilled labor; availability of reasonably price labor, the quality of life in the region (including public schools, recreation, and cultural institutions), the availability of monetary or in-kind state, local, and quasi-public incentives, and the availability of highways, airports, rail, and seaport services for transportation. Firms have become extremely customer-oriented, and as they have seen rapidly increasing customer demands for increased quality, improved service delivery, and lower prices on their products, these firms have found that proximity to their customers is indispensable for their continued success. Further down n the list at 22.1 percent was the importance of being close to key suppliers

In contrast, only about 10 percent of survey respondents believe proximity to professional or research support services or proximity to universities and colleges is extremely important or very important to their decision maintain manufacturing operations in Massachusetts. Even fewer noted the need for a critical mass of similar firms in the region and proximity to European markets.

Where Size Makes a Difference

As it turns out, the most important reasons for staying in Massachusetts do not seem to differ very much with the size of establishment. Small firms rank "a strong work ethic in the workforce," and "inertia" as the top two reasons for continuing their operations in the Commonwealth just as much as middle and large-sized enterprises. Half or more of all those who responded to the survey in each employee size category mentioned these two as important (see **Table 4.5**).

Similarly, there was little difference in the secondary importance assigned to the "availability of appropriately skilled labor;" the "availability of reasonably priced labor;" the "quality of life;" the importance of "monetary or in-kind incentives from state or local governments or quasi-publics;" and "transportation accessibility." Few firms of any size expressed a need for a "critical mass of similar firms in the region" to keep them from leaving.

Table 4.5 Reasons for Staying in Massachusetts by Size of Firm: "Extremely Important" or "Very Important"

Reason	***1-19 Employees***	***20-100 Employees***	***101+ Employees***
Strong work ethic in workforce	50.8	53.6	55.4
Inertia (too hard to relocate)	53.3	49.8	51.8
Proximity to customers	45.5	45.1	**19.3**
Availability of appropriate skilled labor	36.2	43.6	43.3
Availability of reasonably priced labor	37.5	38.2	42.7
Quality of life (e.g. public schools, recreation, and cultural institutions)	37.1	38.8	37.8
Monetary or in-kind incentives from state, local governments or quasi-publics	35.2	33.0	31.7
Availability of reasonably priced land for expansion	40.4	25.7	28.0
Accessibility to transportation for shipping and commuting (e.g. highways, airports, rail, seaport)	32.1	30.5	34.1
Proximity to key suppliers	27.2	20.2	10.8
Proximity to professional or research support services	11.2	7.6	18.1
Proximity to universities and colleges	9.3	10.6	18.2
Critical mass of similar firms in region	10.6	8.9	11.0
Proximity to European markets	3.7	4.9	11.0

Source: CURP Survey

Where firms did differ, there appear to be good reasons for the differences. While 45 percent of small and middle-sized firms ranked "proximity to customers" as important to their continued operations in Massachusetts, fewer than one in five (19%) large firms expressed the same need. Most of these firms operate in regional, national, and global markets and therefore being close to customers does not necessarily convey much benefit.

Small firms, on the other hand, are significantly more likely to consider the availability of reasonably priced land as a reason to stay put in Massachusetts. Land may account for a much larger cost factor for smaller firms and therefore having reasonable land prices (particularly outside of Greater Boston) may have contributed to their remaining in state. Proximity to key suppliers is also more important for smaller firms. Indeed, the larger the firm, the less important it appears to be as a factor in determining location.

Three additional factors do seem to be somewhat more important for large firms than for smaller firms, although none of these appear to be particularly powerful reasons for remaining in Massachusetts. Larger firms are twice as likely as small firms to list "proximity to universities and colleges" as important to their location decision. They are three times more likely to list "proximity to European markets" and significantly more likely to list "proximity to professional or research support services." In none of these cases, however, did more than one out of five large firms list these factors as important to their location plans. We would certainly see much different responses if we queried firms in the biotech sector or other high technology industries which often point to the

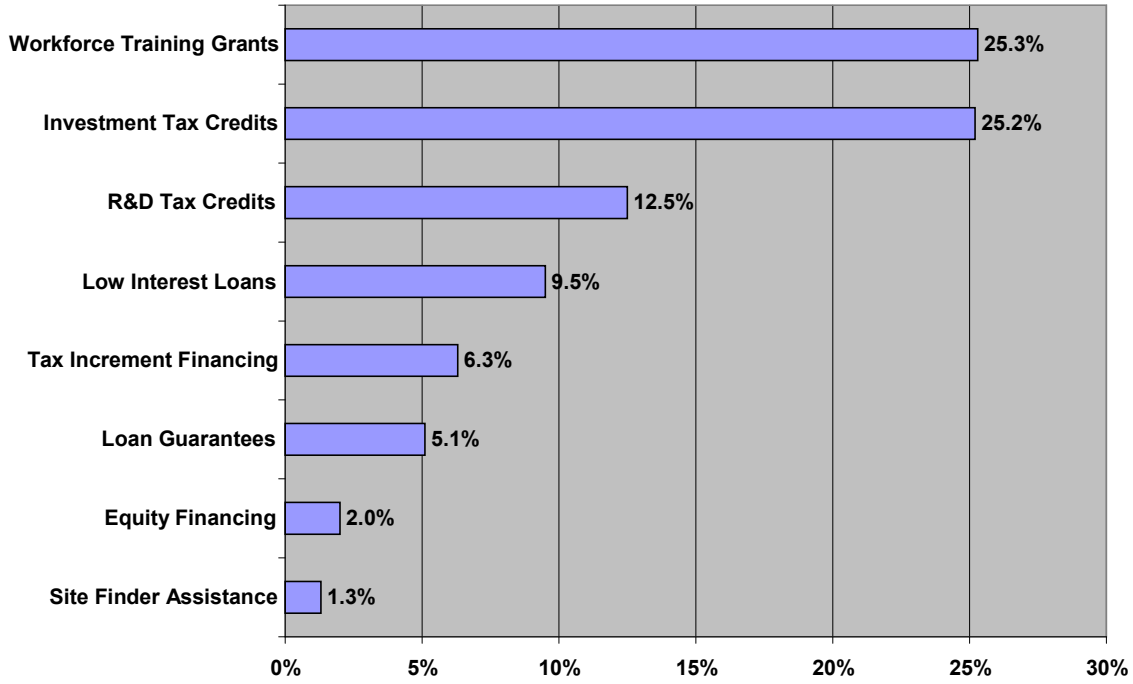
plethora of universities and research talent as one of the most important reasons for settling in Massachusetts.

In fact, proximity to such centers of knowledge does matter a great deal for manufacturers whose work uses complex technology. One example is an international medical device manufacturer that employs more than 500 workers in the Neponset Valley. It has recently expanded in Massachusetts and is considering an additional expansion to accommodate a consolidation of its North American manufacturing operations. Central to the decision of this high technology company is the state's combination of an extremely strong medical device sector and the region's rich array of academic institutions and hospitals.

Incentives Used by Massachusetts Manufacturers

In order to understand better how state and local governments may have helped firms to remain in the Commonwealth, we asked respondents whether they have availed themselves of existing government incentives. As **Figure 4.1** reveals, by and large, most firms have *not* made use of any of the existing programs meant to assist local firms. Where they have, the most commonly utilized incentives are workforce training grants and investment tax credits, each received by just over one quarter of the firms in our survey. Tax credits for research and development are used by just one in eight companies, while low interest loans, tax increment financing, loan guarantees, equity financing, and site finder assistance have been used by fewer than one in 10.

Figure 4.1 Percent of Massachusetts Manufacturing Firms Using State or Local Incentive Programs



Source: CURP Survey

Indeed, these survey results suggest that many firms are either unaware of incentive programs they could use, have found access to them too cumbersome, have failed to qualify for the incentives, or have found them to have little value.

These results, however, belie substantial differences in incentive utilization among firms of different sizes. **Table 4.6** reveals that larger firms have been much more aggressive in seeking out and obtaining these incentives, while smaller companies seldom take advantage of these opportunities. Nearly half (47%) of all manufacturing firms with 100 or more employees report that they have taken advantage of state investment tax credits, compared with only 30 percent of middle-sized firms, and just 17 percent of the smallest. Similarly large disparities in utilization were found for each of the incentives

about which we queried the manufacturers. More than a third (35%) of the largest firms have availed themselves of state R&D tax credits while less than one in twenty (4.7%) small firms have done so. Nearly two-thirds (65%) of the largest firms use workforce training grants; less than one-tenth (9.7%) of the smallest firms report such use. The largest firms were more than 10 times as likely to rely on tax increment financing and nearly twice as likely to obtain low-interest loans as the smallest firms. Most of the state and local incentive programs are not used by smaller firms at all.

Whether more information about these programs would see a greater take-up rate among smaller firms was not considered in our survey, but it is worth further research. Smaller firms may not have the expertise or staff to complete the application procedures for many of these state incentives.

Table 4.6 Use of State Incentives by Massachusetts Manufacturing Firms by Size of Firm

	1-19 Employees	20-100 Employees	101+ Employees
Workforce Training Grant	**9.7%**	**35.0%**	**65.0%**
Investment Tax Credit	**17.1%**	**29.3%**	**47.0%**
R&D Tax Credit	**4.7%**	**15.5%**	**35.0%**
Low Interest Loans	**6.8%**	**12.2%**	**12.0%**
Tax Increment Financing	**2.4%**	**6.5%**	**24.1%**
Loan Guarantees	**2.7%**	**8.9%**	**4.8%**
Equity Financing	**1.5%**	**2.4%**	**3.6%**
Site Finder Assistance	**0.9%**	**1.2%**	**0.0%**

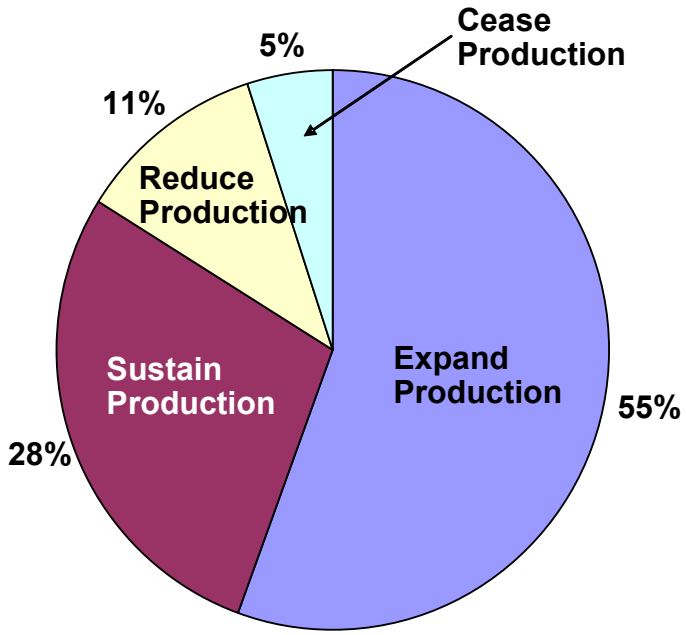
Source: CURP Survey

Expectations about Future Production of Massachusetts Manufacturers

What about the future? Is the relative optimism of Chapter 1 corroborated by evidence from the CURP survey? Indeed, it is. In spite of the challenges facing manufacturers in Massachusetts, the majority of the firms surveyed reported that they expected to remain in the state and to continue growing here, foreseeing increases both in production and in employment. More than half (55.3%) of all respondents predicted increasing production levels in the next five years, and another 28 percent foresaw sustained production levels at current rates. By comparison, only one in nine firms predicted reduced production levels, and fewer than 5 percent expected to cease production in Massachusetts altogether (see **Figure 4.2**).

A major factor driving these positive production expectations is the widespread optimism about new product development. More than 70 percent of the survey respondents stated that they anticipate introducing new products over the next five years. While high expectations are the norm for all Massachusetts manufacturers, large companies are exceptionally optimistic. A full 90 percent of firms with more than 100 employees expect to produce new products.

Figure 4.2 **Expected Production Levels of Massachusetts Manufacturing Firms Over Next Five Years**



Source: CURP Survey

Small firms reported the least likelihood of expanding production and the highest likelihood of closing up shop. Less than half (47%) of the small firms we surveyed expect to see increased production over the next five years while 7 percent indicated that ceasing production was likely (see **Table 4.7**).

The production plans of middle-sized firms differ only slightly from the largest. In both cases nearly two-thirds expect to boost production levels in the near future. While 3 percent of the middle-sized firms believe that they may go out of business over the next five years, none of the largest enterprises we surveyed suggested that ceasing operations in Massachusetts would occur during this period.

Obviously, if these plans bear out, Massachusetts's manufacturing sector will remain strong.

Table 4.7 Expected Production Levels of Massachusetts Manufacturing Firms over the Next Five Years by Size of Firm

	All Firms	1-19 Employees	20-100 Employees	101+ Employees
Expand Production	**55%**	**47%**	**67%**	**65%**
Sustain Production	**28%**	**33%**	**22%**	**20%**
Reduce Production	**11%**	**13%**	**8%**	**15%**
Cease Production	**5%**	**7%**	**3%**	**0%**

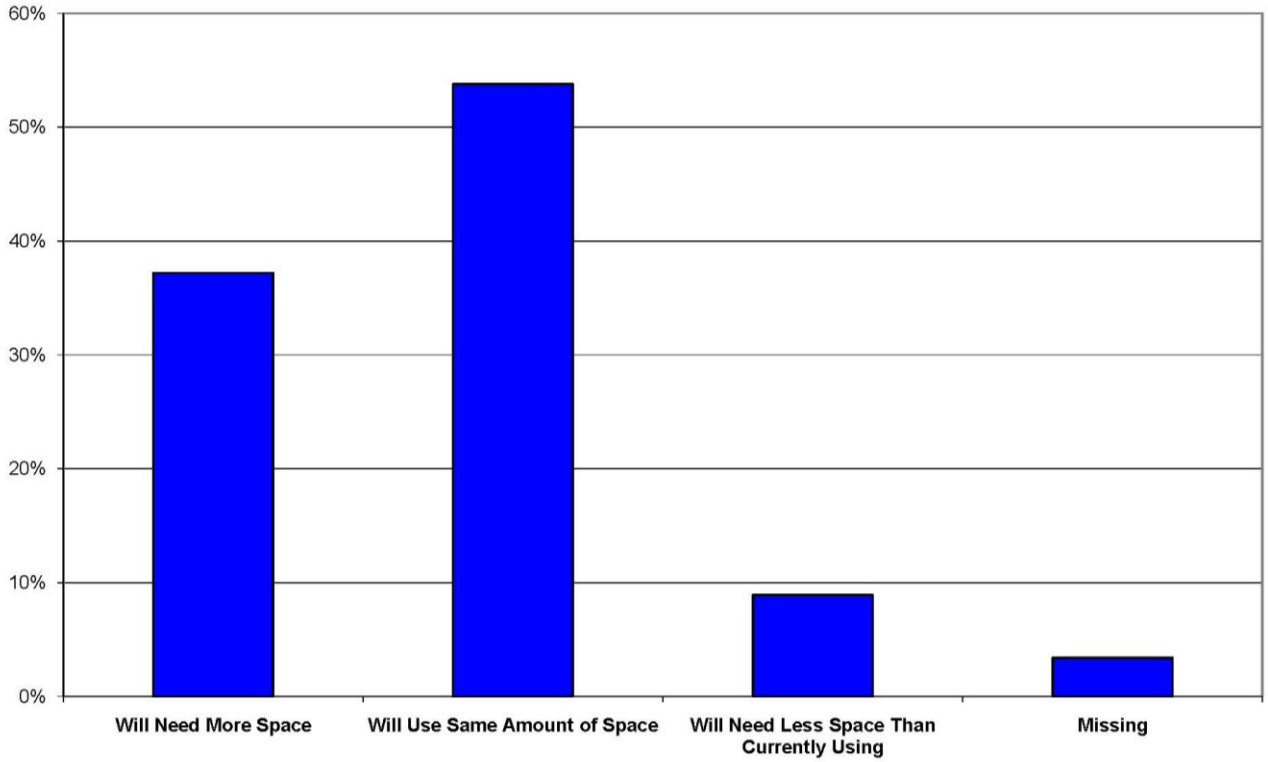
Source: CURP Survey

Real Estate Needs of Massachusetts Manufacturers

When respondents were asked about the anticipation of their real estate needs over the next five years, nearly 36 percent anticipate needing more space while 52 percent anticipate they will need the same amount of space they are currently using (see **Figure 4.3**). Future space requirements varied somewhat by size of establishment with larger firms more likely to report they will need additional plant space. About a third (33%) of the smallest firms reported a need for more space, in contrast to 45 percent of the largest firms. On the other hand, about 9 percent of the smallest firms think they will need less space, while 12 percent of the largest firms believe they will be able to cut back on the real estate they occupy in Massachusetts. (see **Table 4.8**).

What appears to be true is that a large number of existing firms will be able to expand production without necessarily increasing the amount of plant space they need to do so. This could reflect that many of these firms have excess capacity at the present time and that larger orders could be supplied by current plant and equipment.

Figure 4.3 Anticipation of Real Estate Needs Over the Next Five Years



Source: CURP Survey, 2007

Table 4.8 Projected Real Estate Needs of Massachusetts Manufacturing Firms by Size of Firm

	All Firms	1-19 Employees	20-100 Employees	101+ Employees
Will need more space	**36%**	**33%**	**41%**	**45%**
Will need same space	**52%**	**58%**	**52%**	**43%**
Will need less space	**9%**	**9%**	**7%**	**12%**

Source: CURP Survey

One of the factors contributing to the modest real estate expectations is the widespread introduction of continuous improvement/lean/just-in-time production methods that place emphasis on aggressive space utilization through realignments on the shop floor. More than 84 percent of all respondents stated they have introduced these

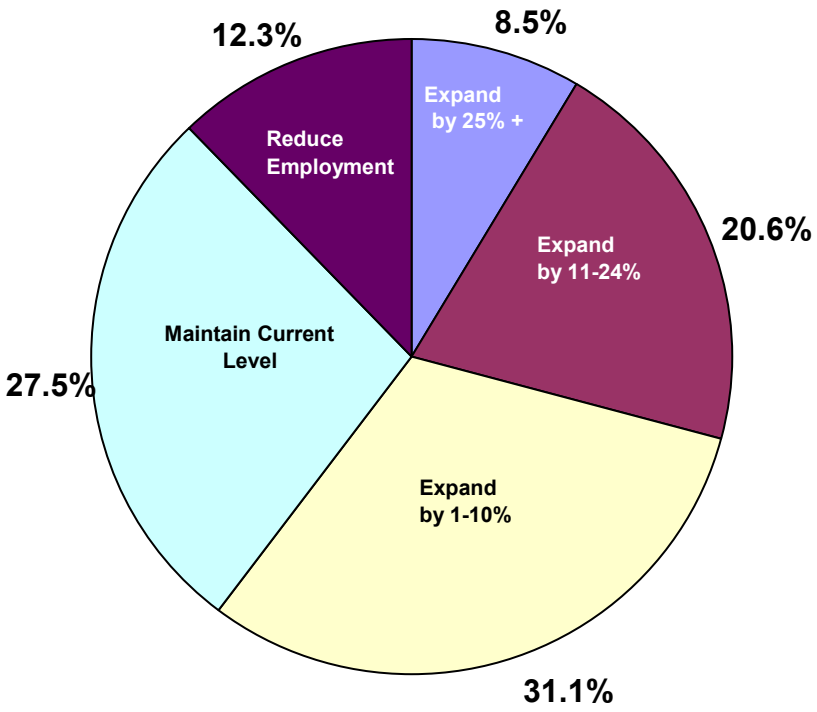
methods, including a full 94 percent of the large manufacturers we surveyed. Manufacturers are growing into space that they have made available through the introduction of new production processes.

Employment Needs of Massachusetts Manufacturers

What does this portend for employment? In line with the reasonably optimistic conclusion we came to at the end of Chapter 1, nearly nine out of 10 firms (87%) we surveyed expect their employment levels to grow or at least stay constant over the next five years (see **Figure 4.4**). More than one out of twelve firms (8.5%) actually expect to increase employment by at least 25 percent and another one in five (20.6%) are planning on increasing the number of their employees by 11 to 24 percent. Only 12.3 percent — about one in eight — of the survey respondents expect their firms to reduce employment over the next five years.

All of this points to optimism, even among business owners who face the pressures of meeting high customer expectations in a state that reputedly has a history of a high cost of doing business.

Figure 4.4 5 Year Employment Projections of Massachusetts Manufacturing Firms



Source: CURP Survey, 2007

There are slight variations by size of firm in the employment expansion plans of Massachusetts manufacturers. As **Table 4.9** reveals, small firms are most likely to report that they expect to maintain their current employment levels. Thirty-eight percent of firms with 1-19 employees reported an expected stable employment base, while only 19 percent of larger firms did so. Middle-sized firms were more likely to report that they expect to increase employment. Indeed, 70 percent of such firms believe they will be adding employees over the next five years. Almost two-thirds (64%) of the largest firms expect to increase employment, but these firms were also the most likely to expect a reduction in their employment levels (17% vs. 11% for the smallest firms and 12% for the middle-sized establishments.)

Over all, though, if the 706 manufacturing firms in our survey are representative of the more than 8,700 in the Commonwealth, these employment forecasts suggest a healthy employment outlook for the industry — or at least one certainly in contrast with the sharp employment reductions experienced over the past decade.

Table 4.9 Employment Projections of Massachusetts Manufacturing Firms by Size of Firm

	All Firms	1-19 Employees	20-100 Employees	101+ Employees
Expand by more than 25%	**9%**	**8%**	**10%**	**4%**
Expand by 11-25%	**21%**	**15%**	**26%**	**29%**
Expand by 1-10%	**31%**	**27%**	**34%**	**31%**
Maintain current level	**28%**	**38%**	**18%**	**19%**
Reduce employment	**12%**	**11%**	**12%**	**17%**

Source: CURP Survey

The personal interviews with 104 companies substantiate the survey findings. If anything, the interviews paint an even more optimistic picture. Of all interviews, a full 78 percent indicated that they expect growth. The reasons vary across businesses, but there appears to be a general consensus that Massachusetts manufacturers have been preparing themselves to succeed in an increasingly competitive environment. This preparation has included focusing on their core competencies and out-sourcing most functions that they can purchase for less than they can produce in-house; introducing ever higher standards of lean production and continuous improvement; and intensifying the application of new technology. Today, the remaining Massachusetts manufacturers

believe they excel in quality and service. Many firms forced to compete purely on price have already closed down or left the state.

It was common to hear small manufacturers link their future to the availability of skilled workers. Several mentioned that they could hire more skilled workers today and accelerate their growth if the desired workforce were available. For example, an owner/manager of a machine shop in Agawam that employs 60 workers stated that he has enough business from a national aeronautical company to immediately hire additional machinists: "I could hire four to six machinists to work today if they were available."

The general manager of a manufacturer of precision imaging technologies for the Defense Department is planning to add more than 25 percent to its current 300 employee workforce in Greater Boston. He credits the region's talent pool for driving this growth. The CEO of a large plastics products manufacturer in central Massachusetts is expecting major growth in supplying the state's growing medical device and bio-tech sectors and anticipates expanding his current 1,000 person workforce between 11 and 25 percent. A Boston area bio-tech firm employing thousands of scientists, technicians and production workers is also looking forward to expanding by nearly the same amount. Key to this company's success, says the company's CEO, is the exceptional R&D resources of the region. Regardless of their size, location and products, these companies are bullish on their futures in Massachusetts.

Summary

The 706 manufacturing companies that completed our survey and the more than 100 personal interviews with manufacturers provide abundant evidence corroborating our earlier projection that the worst of this sector's decline is over and that the firms

remaining in Massachusetts appear, for the most part, to be quite viable. Firms that have managed to keep their operations running thus far have had to meet increasing demands from their customers for higher quality, better service, and lower prices. Although competitive companies address all three, many respondents said that their customers are willing to ease their demand for lower prices to get better quality and service.

Another way that Massachusetts manufacturing establishments have stayed afloat or, better yet, prospered, is by employing new technology. The resulting boost in productivity has helped firms remain competitive. What is more, because of increased sales, the new efficiency measures apparently have not meant large layoffs. We saw only slight replacements of unskilled labor with skilled labor despite the heavy use of new technology.

When it comes to business conditions in Massachusetts, we found that the strong work ethic of the state's workforce and simple inertia were mentioned most often by firms when asked about what factors keep them from moving away from the Commonwealth. Other factors were the availability of appropriately skilled labor and proximity to customers. One advantage that Massachusetts is better known for — its extensive array of universities and colleges — seem much less important to manufacturers, especially small family-owned firms, than these other factors.

The data presented in this chapter support our claim that there are many forces keeping these jobs in the state. With only 5 percent of manufacturers expecting to cease their operations here and most reporting much more optimistic projections for growth in productivity and employment over the next five years, there is reason to believe we are indeed entering a new era, as the first chapter of this report proposes.

But to succeed in this sector in an age of global markets requires constant attention to maintaining a good business climate. How the state can help in this matter is the subject of the next chapter.

Chapter 5

The Challenges Facing Massachusetts Manufacturers

As we have found in this study, manufacturers in Massachusetts are poised to provide a substantial level of employment for the foreseeable future, maintaining an industrial base that provides good jobs at good pay for hundreds of thousands of Massachusetts workers. We found from our survey and our interviews that there are some good reasons why manufacturing has remained in the state. But manufacturers in Massachusetts continue to face challenges that need to be addressed to assure the bright future we believe is possible for this sector of the state's economy.

Across the board, as the current chapter will demonstrate, our research found that the high costs of labor, energy, taxes, workers' compensation, and most noticeably, health care, were all challenging issues for manufacturing firms in Massachusetts. Additionally, and most importantly, we found that the pool of skilled production workers needs to be expanded to meet the future labor force needs of manufacturers who will see a large number of their current employees retire or leave their firms over the next five to 10 years. With the manufacturing workforce aging, there is a need to find new recruits for this sector who have the skills and inclination to fill the jobs that will become vacant. There are some differences in the ranking of challenges depending on firm size, location, and industry, but the overwhelming majority of Massachusetts manufacturers are in general agreement about the challenges they face.

The Key Challenges

In conducting our survey, we asked each of the survey respondents to rank a long list of possible challenges face on a scale that ranged from 1 = "not a challenge at all" to 5 = "poses a great deal of challenge." This scale therefore permitted respondents to convey just how serious they believe each challenge to be.

Massachusetts made headlines in 2006 when it passed legislation that requires all residents to obtain health insurance coverage. However, in the spring of 2007 when our survey was conducted, the cost of employer-paid health insurance was reported as the biggest challenge manufacturing firms face in expanding or maintaining their operations in Massachusetts, regardless of industry type, firm size, or location. Some 410, or 62 percent of the 665 firms that answered the question, reported that health care costs "pose a great challenge" to their ability to sustain or expand in the Commonwealth. An additional 150 firms (23%) ranked this challenge a 4 in our 1 to 5 ranking system. By comparison, only 4 percent (27 firms) reported that it was not a challenge at all. Thus, nearly nine out of 10 firms (85%) rated health insurance costs as a critical cost factor that could ultimately compromise their ability to maintain operations in the Commonwealth. The average score on this question, out of a possible 5.0, was 4.35 (see **Table 5.1**).

A vice president of a Sutton manufacturer of plastic food wraps that employs 60 workers, most with only a high school education, indicated that the increasingly high cost of health care insurance coupled with difficulties in finding entry level workers was driving them to more active consideration of labor-saving robotics in their production process. This company anticipates a strong increase in demand for its products over the next five years and is exploring it options for how this demand can be met.

Other factors that stood out as clear challenges for Massachusetts manufacturing firms were also associated with direct costs. The high cost of workers' compensation was reported to be a significant challenge almost as frequently as health care. Of the 657 firms responding to this question, 312 firms (47%) reported that the high cost of workers' compensation presented a challenge to doing business "a great deal" (=5) while another 179 (27%) answered "4" on the challenge scale. The mean response was 4.09.

Table 5.1 Challenges Facing Massachusetts Manufacturers

Rank	Issue	Mean Response
1	High Cost of Health Insurance	4.35
2	High Cost of Workers' Compensation	4.09
3	High Taxes	3.97
4	High Energy Costs	3.94
6	High Labor Costs	3.88
7	High Cost of Housing	3.38
8	Cost of Supplies, Services, or Parts	3.25
9	Environmental Regulations	3.18
10	Zoning and Building Code Regulations	3.16
11	Inadequate Supply of Appropriately Skilled Labor	3.15
12	Cost of Construction	2.96
13	Customers are Moving to other locations	2.46
14	MA Weather and Climate	2.23
15	Suppliers are Moving to other locations	2.22
16	Aggressive Trade Unions	2.04
17	Inadequate Transportation/Infrastructure	1.91
18	Inferior Quality of MA supplies, services, or parts	1.90
19	Increased Merger and Acquisition Activities	1.88
20	Ability to Import Skilled Foreign Labor (HB1)	1.68

Scale: 1 = no challenge; 5 = poses a great challenge

Source: CURP Survey

It is perhaps noteworthy that such a large number of manufacturers are concerned about the high cost of workers' compensation even after the state has done much to reign in the costs of this program. According to a study by the Department of Consumer and Business Services in the State of Oregon, Massachusetts ranked seventh *lowest* among the 50 states (plus the District of Columbia) in terms of the workers' compensation premium rate in 2004 and this was an improvement over its 15th place ranking in 2002.[27] The continuing concern over workers' compensation may be a holdover from a time when the premiums were substantially higher.

After health care insurance and workers' compensation costs, the most significant challenges reported by our sample were high taxes and high energy costs. When we asked firms about the challenges they face going forward, 43 percent reported that high taxes affected them "a great deal" with another 28 percent suggesting that high taxes posed an important challenge to them. On our scale of concern from 1 to 5, the average score for high taxes came in at nearly 4, just below the 4.09 for workers' compensation and the 4.35 for health insurance costs.

The cost of electricity is often a significant concern for production facilities because of the greater use of machinery than other types of commercial business. The response to the question on high energy costs almost mirrors the response to the question on taxes. Seventy percent of the 658 respondents assigned a "4" or "5" to high energy costs as a major challenge, contributing to an average score of 3.94, just a small fraction below taxes and slightly above labor costs at 3.88. This is all the more significant because our survey was carried out in mid-2007, *before* the latest sharp spike in energy costs. One would expect this factor is even a greater challenge today.

Typical of Massachusetts companies that continue to make products that consume a great deal of energy in their manufacturing process is a Merrimack Valley fabric manufacturer. This employer of 50 workers, 75 percent of whom are low-skilled machine operators, has enough of a competitive advantage due to its location to anticipate stability and modest growth. It has moved almost completely from labor-intensive production to automation. It fully subscribes to continuous improvement practices but is frustrated that a factor beyond its control, the price of energy, is a major threat to its competitive position.

When interviewed, the president of a large Western Massachusetts paper products manufacturer discussed his company's response to rising energy costs. Operating in over 800,000 square feet of space and employing 700 employees on a 24/7 schedule, this company has installed a wood-fired boiler to generate heat and is trying to develop other alternative energy sources. The president wants to keep the company in Massachusetts and expressed his loyalty to his workforce. While he expects a 10 percent increase in production over the next five years, he says he has to address his energy problems if he is to be able to make the case to stay in the Commonwealth.

Although it is not terribly surprising that some of the main challenges to doing business in Massachusetts are the ones associated with direct costs, it is noteworthy that other factors such as environmental regulations, zoning and building code regulations, access to skilled labor, and the cost of construction are not considered as critical a challenge and that factors such as aggressive unions and the state's transportation infrastructure do not rank as serious challenges at all. A good indication of this pattern is demonstrated in **Table 5.2**, where we have listed the five challenges with the largest

percentage of 5's ("poses a great deal of challenge") and the five with the highest percentage of 1's ("not a challenge at all"). All five of the greatest challenges are related to the direct cost of doing business in the state. In contrast, two-thirds (67%) of the firms we surveyed do not currently see restrictions on the import of foreign labor as posing a challenge to continued operations in the Commonwealth. Nearly two-thirds (63%) do not worry about the possibility of being the target of merger and acquisition activity. A clear majority (56.5%) is not concerned about dealing with aggressive trade unions and has not had trouble with the quality of the supplies, services, or parts they purchase from other Massachusetts firms. Nearly half report no concern whatsoever that the transportation infrastructure in the state could be a barrier to their continued operations here.

Table 5.2 Top 5 Challenge vs. Top 5 "No Challenge" Issues Facing Massachusetts Manufacturers

Top Challenges	Percent of Survey Respondents reporting "a great deal of challenge"	No Challenge	Percent of Survey Respondents reporting "not at all a challenge"
High Cost of Health Insurance	62%	Ability to Import Foreign Labor	67%
High Cost of Workers' Compensation	48%	Increased Merger & Acquisition Activity	63%
High Energy Costs	43%	Aggressive Trade Unions	57%
High Taxes	43%	Inferior Quality of Massachusetts Supplies, Services, and Parts	53%
High Labor Costs	39%	Inadequate Transportation Infrastructure	47%

Source: CURP Survey

The Recruitment Challenge

One factor that does show up as a critical challenge, if not quite as serious as the set of direct costs Massachusetts manufacturers face, is finding an adequate supply of appropriately skilled labor. More than two out of five (42%) survey respondents checked off a "4" or "5" when it came to judging how serious a challenge this is to them. Only 16 percent reported no problem in this area. In one interview, the president of a Westfield manufacturer of aircraft engine components explained that he was actually turning down contract offers because of a lack of workers capable of operating sophisticated production machinery. He seeks high school graduates with intelligence and mechanical aptitude to be trained on his company's equipment. He is not finding them.

To obtain a better reading of how serious this is, we asked a series of additional questions about the difficulty of recruiting various kinds of labor to their firms. **Table 5.3** provides these results. Respondents ranked this question from 1= "not difficult" to 4= "Difficult" and 5= "extremely difficult."

Table 5.3 The Difficulty in Recruiting Labor for Massachusetts Manufacturers

Type of Employee	Percent reporting "Extremely Difficult"	Percent reporting "Difficult"	Percent reporting "Difficult" or "Extremely Difficult
Executive Management	15%	24%	39%
Middle Management	8%	20%	28%
Scientific/R&D	25%	28%	53%
Skilled Craftsmen	35%	32%	67%
Entry Level	7%	20%	27%

Source: CURP Survey

As the table demonstrates, two-thirds (67%) of Massachusetts firms report that they face difficulty or extreme difficulty when trying to recruit skilled craftsmen. For most manufacturers these are their most critical employees, for they are responsible for setting up and operating sophisticated machine tools, often working to close tolerances. Without these workers, most manufacturers would be out of business in quick fashion. In general, our respondents revealed that finding good craftsmen is more difficult than finding workers who are better "educated" in terms of their scientific prowess or R&D capabilities. Indeed, firms complain of extreme difficulty in recruiting craftsmen more than twice as often as is the case in recruiting executive managers and four times as often compared to recruiting middle managers. About one in four firms (27%) report some difficulty recruiting even entry level workers into their manufacturing establishments. This may reflect the fact that manufacturing is no longer considered by many young workers as the type of employment they would prefer.

We interviewed the son of the founder of a precision machining shop in Woburn. He is now its general manager. This business employs 100 workers of whom 60 were characterized as "world class machinists." According to the general manager, business is currently "great." The company has a broad customer base, primarily located in Massachusetts, that includes manufacturers in the aerospace, medical devices, and other technology sectors. The firm's competitive advantage is its ability to perform very complex and precise work in a "flexible, creative, responsive, and speedy manner." It is not unusual for this firm to complete more than 10,000 individual jobs in a year. The general manager believes his company provides a critical service to the state's high technology manufacturers and, as a result, has the potential for a healthy future in the

Commonwealth. The major concern, however, is maintaining and replenishing the firm's key employees – its machinists. Like other firms we interviewed, the managers do not see a sufficient pool of potential new workers with the skills they need and their absence is considered the company's Achilles heel.

A Cape Cod electronic components manufacturer reported an extreme version of this commonly-held concern: an aging production workforce, particularly among highly skilled workers. The director of human resources for this 140-person company said that shop floor workers were mostly between 40 and 65 years old. Even though she expects the company could expand its workforce by 11 to 25 percent over the next five years, she is very worried about her firm's ability to maintain operations if they do not replenish their workforce. She specifically cited the high cost of housing on the Cape and the lack of interest among young people in manufacturing as the key problems her company faces.

From our interviews, it became clear that this problem is extremely wide-spread. The owner/president of a 40-employee precision machining operation in Avon was emphatic about his workforce concerns. His company responds to very precise customer specifications for its designed components. He hires primarily (75-100%) high school graduates and believes he could expand his workforce by 25 percent if he could find properly skilled workers. He trains in-house but has been frustrated with the limited pool of young people willing to be trained as skilled workers.

The treasurer of another medium-sized firm based in Leominster laments that "there are no young people coming into the industry." His company employs 48 workers and they do custom injection molding (plastics) for larger Massachusetts manufacturers. His average wage for skilled workers is $26/hour and his company provides the needed

training for his employees, but he is frustrated by the fact that it is difficult to find enough potential employees with an aptitude for and an interest in manufacturing.

Large manufacturers express a variation on this theme. The public affairs manager of a Merrimack Valley subsidiary of a very large international firm cited recruitment as his company's top issue. This company's workforce is predominately composed of highly skilled electrical engineers and designers. The company has a persistent problem in recruiting experienced engineers from a national pool due to the high cost of housing in Eastern Massachusetts.

Hence, the lack of an adequate pool of replacement workers at home plus the difficulty of recruiting a pool of workers from states where living costs are lower presents a "double whammy" to manufacturers trying to replenish the present cohort of workers who are reaching retirement age.

Key Challenges by Firm Size

As we have seen in previous chapters, Massachusetts is home to many very small manufacturing firms as well as some very large manufacturers that employ thousands of employees in plants around the state. Such large differences in firm size might result in different needs and unique challenges. **Table 5.4** provides information on this issue.

Typically, smaller firms feel they face greater challenges to sustainability than either middle-sized or larger firms. Not surprisingly, meeting the high cost of health care insurance for their employees appears to be a most critical challenge to smaller firms. Of firms that employ fewer than 20 people, more than two-thirds (69%) listed the high cost of health care as a great challenge (response of "5"). Larger firms also saw health care insurance costs as the greatest challenge they face, but fewer than half (48%) of the

survey respondents from firms with at least 100 employees rated it as posing a great deal of challenge to sustained operations. Mid-sized firms fell in-between.

The high cost of workers' compensation followed a similar pattern. Smaller firms reported more frequently than mid-sized and large firms that meeting this cost was a significant challenge to expanding or sustaining business. Fifty-four percent of small firms revealed that the cost of workers' compensation is a great challenge. Only 31 percent of large firms and 46 percent of medium-sized firms responded the same way.

Table 5.4 Key Challenges by Size of Firm

Percent of Firms Rating Issue as a Serious Challenge to Sustaining or Expanding Operations in Massachusetts

(Percent responding with "5" on Rating Scale)

	Small Firms 1-19 Employees	Medium Sized Firms 20-100 Employees	Large Firms 101+ Employees
High Cost of Health care	69%	55%	48%
High Cost of Worker's Compensation	54%	46%	31%
High Energy Costs	46%	42%	36%
High Taxes	50%	38%	26%
High Labor Costs	43%	34%	36%
Inadequate Supply of Appropriately Skilled Labor Force	26%	19%	13%
Environmental Regulations	27%	23%	17%
Zoning and Building Code Regulations	29%	20%	14%
Cost of Supplies, Services, or Parts	29%	14%	12%
High Cost of Housing	30%	16%	19%
Cost of Construction	21%	14%	11%
Customers are Moving to other locations	16%	15%	11%
MA Weather and Climate	6%	3%	6%
Succession Plan for Ownership Operations	12%	5%	3%
Inadequate Transportation/Infrastructure	3%	3%	6%
Suppliers are Moving to other locations	9%	3%	5%
Inferior Quality of MA supplies, services, or parts	8%	5%	2%
Aggressive Trade Unions	10%	7%	7%
Increased Merger and Acquisition Activities	2%	3%	2%
Ability to Import Skilled Foreign Labor (HB1)	3%	6%	6%

Source: CURP Survey

This pattern is followed by the responses to the question when the challenging factor is high taxes. Half of the owner/managers of small firms in our sample stated that high taxes are a great challenge to sustaining their operations, compared to 38 percent of the managers of medium-sized firms and only 26 percent of the respondents from large firms. Hence, small firms are nearly twice as likely as large firms to list high taxes as a serious barrier to sustaining their operations in the Commonwealth. Smaller firms are also twice as likely (26% vs. 13%) as large firms to report that they find it a great challenge to find appropriately skilled workers. Similarly, they are twice as likely (29% vs. 14%) to worry about zoning restrictions and building codes; more than twice as likely (29% vs. 12%) to be concerned about the cost of supplies, services, and parts in the state; and four times (12% vs. 3%) as likely to see succession planning as a great challenge. Succession planning is a challenge not typically faced by large firms and public corporations, but it is a concern for smaller firms. Indeed, nearly one in four small firms (23%) that answered the question about succession planning rated this challenge as a "4" or "5" on the five point scale. If these firms do not have a family member who wishes to take over the business when members of the older generation retire, it may be difficult for the firm to find someone who is willing and able to buy the firm and operate it.

Recruiting new workers is also a more serious problem for smaller companies, especially when it comes to skilled craftsmen (see **Table 5.5**). Firms with fewer than 20 employees apparently have no more difficulty recruiting executive managers than do middle-sized or large firms. They fare about as well as large firms when it comes to attracting scientific/R&D personnel. But when it comes to hiring skilled craftsmen, they are about one-third more likely to report difficulty or extreme difficulty than large firms;

forty percent more likely to do so with respect to middle managers, and more than twice as likely to report difficulty when they are recruiting entry level employees.

We can discern from this pattern that smaller manufacturers in Massachusetts are most vulnerable to the issues that challenge all manufacturers. Because there are so many small manufacturers in Massachusetts, and because our survey data revealed that Massachusetts manufacturing firms produce goods for and buy goods from many other manufacturing firms in the state and region, the health of the larger firms is, at least partly, intertwined with the bevy of smaller ones. Therefore, paying careful attention to anything that can relieve some of the high cost of doing business for these small manufacturers or assisting with workforce development and succession planning will be beneficial to all.

Table 5.5 Difficulty in Recruiting Labor by Size of Firm Percent Reporting "Difficulty" or "Extreme Difficulty"

Type of Employee	Small Firms 0-19 Employees	Medium Sized Firms 20-100 Employees	Large Firms 100+ Employees
Executive Management	38%	39%	39%
Middle Management	30%	25%	21%
Scientific/R&D	52%	50%	54%
Skilled Craftsmen	71%	65%	53%
Entry Level	28%	17%	13%

Source: CURP Survey

Key Challenges by Location

To explore differences by region in Massachusetts, we have broken the state up into five separate regions, as defined by the *Massachusetts Economic Assessment &*

Analysis Project of the University of Massachusetts Center for Economic and Civic Opinion and the John W. McCormack Graduate School of Policy Studies. The regions are Greater Boston, and the Northeastern, Southeastern, Central, and Western regions of the Commonwealth. Our survey reveals that the majority of challenges to expanding or maintaining manufacturing operations in Massachusetts do not differ across the state, but there are a few challenges that are somewhat location specific.

The same top five challenges manufacturers as a whole face in Massachusetts — health care costs, high taxes, labor costs, the cost of workers' compensation, and the cost of energy — remain the top five regardless of region, although the ranking of these five challenges does differ slightly by region. This suggests that statewide initiatives to address these challenges would safely benefit Massachusetts manufacturers no matter where they are located. What we do find is that in Northeastern and Central Massachusetts, as well as in Western region of the state, the inadequacy of an appropriately skilled labor force is slightly more challenging to manufacturers than in the Greater Boston area. This may be due to the fact that these regions differ noticeably in terms of industry specialization, though these regions all have high percentages of establishments in the printing and metal industries. Zoning and building code regulation appear to be less of a problem in Northeastern Massachusetts than anywhere else in the commonwealth. Not surprisingly, housing costs are reported as less of a concern in Central and Western Massachusetts compared to the rest of the state.

The mean answer reported for challenges faced by manufacturing establishments in the five regions of the state are found in **Table 5.6**. The averages are based on answers that range from 1, "not a challenge," to 5, "a great challenge."

Table 5.6 Key Challenges by Region Within Massachusetts

	Greater Boston	North-eastern MA	South-eastern MA	Central MA	Western MA
High Cost of Health care	4.17	4.33	4.52	4.40	4.40
High Cost of Worker's Compensation	3.86	4.03	4.22	4.16	4.24
High Energy Costs	3.64	3.89	4.02	4.16	4.07
High Taxes	3.87	3.99	4.02	4.12	3.93
High Labor Costs	3.86	4.06	3.90	3.96	3.68
Inadequate Supply of Appropriately Skilled Labor	2.98	3.21	2.98	3.21	3.47
Environmental Regulations	3.14	3.18	3.08	3.27	3.24
Zoning and Building Code Regulations	3.30	2.91	3.18	3.14	3.21
Cost of Supplies, Services, or Parts	3.22	3.16	3.45	3.31	3.19
High Cost of Housing	3.47	3.50	3.61	3.28	3.01
Cost of Construction	3.07	2.74	3.11	2.95	2.91
Customers are Moving to other locations	2.18	2.51	2.58	2.62	2.62
MA Weather and Climate	2.25	2.09	2.16	2.26	2.39
Succession Plan for Ownership Operations	2.19	2.40	2.15	2.26	2.17
Inadequate Transportation/Infrastructure	1.92	1.89	1.79	1.86	2.02
Suppliers are Moving to other locations	1.99	2.03	2.08	2.13	1.99
Inferior Quality of MA supplies, services, or parts	1.90	1.89	1.86	1.80	1.96
Aggressive Trade Unions	1.97	1.82	1.91	1.95	1.90
Increased Merger and Acquisition Activities	1.69	1.74	1.56	1.69	1.75
Ability to Import Skilled Foreign Labor (HB1)	1.67	1.67	1.45	1.68	1.61

Source: CURP Survey

Key Challenges by Industry Type

The specific industries that manufacturers are in create unique challenges to doing business in Massachusetts. Across industry types there is a noticeable variation in how strongly manufacturers rate the challenges to maintaining or expanding operations in Massachusetts.

As **Table 5.7** reveals, one of the noticeable differences across industries is in the ranking of high labor costs. In the food industry, for example, labor costs are comparatively less challenging than they are in the primary and fabricated metal

industries. The same is true for acquiring appropriately skilled labor in the Commonwealth. The food industry in Massachusetts perceives acquiring labor as much less of a challenge than the metal working industries. This may reflect the fact that food industry workers typically need lower skills than those that work with metal.

High taxes pose a challenge to nearly all manufacturers, but especially to primary metal firms and wood product companies. Environmental regulations appear to be a greater burden to wood product companies and printing establishments. High energy costs were noted especially by plastics and rubber product manufacturers, primary metal firms, fabricated metal product producers, and food processors. Each of these must cope with special circumstances that may need special treatment.

Table 5.7 Challenges Facing Massachusetts Manufactures by Specific Industry

MEAN RESPONSES BY NAICS CODE

	311-Food Mfg	321 – Wood Products Mfg	323 - Printing	326 – Plastics and Rubber Plastics Mfg	331 – Primary Metal Mfg	332 – Fabricated Metal Mfg	333 – Machinery Mfg	339 – Miscellaneous Mfg	334/335 – Computer and Electronic/ Electronic Equipment, Appliance and Component Mfg
High Labor Costs	3.25	3.91	3.71	3.84	4.13	4.11	3.79	3.84	3.95
Aggressive Trade Unions	1.78	1.73	1.93	1.88	2.30	2.02	1.93	1.93	1.59
Cost of Construction	3.26	3.33	2.69	2.90	3.32	3.06	2.79	2.87	2.55
Cost of Supplies, Services, or Parts	3.03	3.45	3.25	3.15	3.53	3.45	3.04	3.24	2.97
Inferior Quality of MA supplies, services, or parts	1.52	1.73	2.05	2.02	2.02	1.89	1.85	1.89	1.63
Customers are Moving to other locations	1.81	1.70	2.63	2.98	2.73	2.83	2.52	2.36	2.08
Suppliers are Moving to other locations	1.81	1.46	2.16	2.23	2.13	2.09	1.98	1.98	1.92
High Taxes	3.84	3.79	3.95	4.08	4.24	4.21	3.85	3.97	3.75
Zoning and Building Code Regulations	3.35	3.45	3.11	3.23	3.42	3.23	3.07	3.19	2.73
Environmental Regulations	2.90	3.37	3.26	3.13	3.21	3.14	3.02	3.13	2.72
Inadequate Supply of Appropriately Skilled Labor Force	2.03	3.07	2.89	3.20	3.75	3.55	3.51	3.11	2.98
High Energy Costs	4.06	3.81	3.99	4.14	4.16	4.13	3.86	3.79	3.43
MA Weather and Climate	2.19	2.30	2.31	2.36	2.06	2.29	2.19	2.19	2.12
Inadequate Transportation/Infrastructure	1.65	1.93	2.00	2.12	1.83	1.72	1.64	1.91	1.77
Ability to Import Skilled Foreign Labor (HB1)	1.42	1.37	1.40	1.90	1.58	1.52	1.43	1.67	1.72
Increased Merger and Acquisition Activities	1.52	1.33	1.79	1.90	1.67	1.48	1.33	1.70	1.82
Succession Plan for Ownership Operations (Private Business)	2.03	1.73	2.23	2.34	2.06	2.12	2.23	2.54	1.93
High Cost of Housing	3.40	3.43	3.56	3.21	3.42	3.42	3.07	3.36	3.38
High Cost of Health care	3.97	4.47	4.35	4.41	4.63	4.54	4.23	4.32	4.17
High Cost of Worker's Compensation	3.60	4.23	4.08	4.10	4.43	4.29	4.04	4.07	3.76

Source: CURP Survey

Summary

When asked about the greatest challenges to maintaining their operations, manufacturers were unambiguous in their response. Massachusetts' high cost of energy, labor, worker's compensation, taxes and health care — especially given the new universal coverage mandate — create a formidable challenge for companies in remaining financially viable. Although we have given each issue separate consideration, it should be acknowledged that relief in one area (such as health care costs) may contribute to relief in another (e.g. workers' compensation premiums).

This chapter illustrates where manufacturing is vulnerable and where it is not. Our data show that the five greatest challenges all involve the direct cost of doing business in Massachusetts. Conversely, most manufacturers are not concerned with imported foreign labor driving down the costs of their competitors, nor are they worried about being bought out by bigger firms. Similarly, the influence of trade unions does not appear to present major obstacles to their business in the state.

One critical area that poses significant challenges not directly related to production costs is the ability to recruit skilled labor. This could indicate a need for more appropriately targeted education initiatives, or perhaps as suggested above, might relate to employers' inability to offer high enough wages in light of the high cost of living in the state.

Smaller companies appear the most vulnerable to all of these factors. Because the state's manufacturing industry is so dependent on regional supply chains and is generally quite interdependent, the loss of small firms can be felt throughout much of the manufacturing sector, including the larger firms. This report, therefore, recognizes the

need to keep all of our manufacturers viable, not just those that account for the bulk of revenues and employment. Reducing the cost of doing business in Massachusetts and assuring an adequate supply of replacement labor are the first steps toward stabilizing the industry and encouraging future growth.

Chapter 6

What Manufacturers Want from Government

Two things should be clear from what we have learned in the previous two chapters. The first is that the manufacturing sector in Massachusetts, after a long-term massive shakeout of lower-productivity producers and thus a sharp reduction in employment, has reached the point where further reductions in employment may be quite modest. What is left is a sector that could provide 260,000 well-paying jobs or more well into the future. Second, this optimistic forecast for manufacturing comes with warnings from producers that they, in cooperation with state and local governments, must address a number of fundamental challenges if they are to remain in the state and prosper.

Much of what is needed for this scenario to unfold will depend on manufacturers themselves continuing their skillful efforts at remaining competitive in Massachusetts by introducing new technology, maintaining their strong supplier chains and consumer links, and finding new ways to use their capabilities to supply products to newly evolving industries.

But the feedback from both our survey and the personal interviews clearly reveal a number of important roles for government, both at the state and local levels. These can be divided into three primary areas:

- Changing government's attitude toward manufacturing and manufacturers
- Reducing some of the direct costs of doing business in the Commonwealth
- Improving and expanding workforce training

Massachusetts Manufacturing Needs Respect

One of the most important factors we uncovered, particularly in the personal interviews, was something quite intangible, but so prevalent that it bears mentioning at the very beginning of this chapter. It is what one might call the "Rodney Dangerfield" syndrome. Manufacturers feel that they have been largely ignored by state and local government and given very little respect despite the size of this sector and the important contributions it makes to the Commonwealth's prosperity. Too often, they feel, state and local officials act as though the era of manufacturing is over in the Commonwealth and therefore this sector can be the recipient of "benign neglect" rather than affirmative action. So much attention is given to the "new" sectors of the state's economy — the life sciences, biotech, nanotech, and financial services — that seldom does anyone stop for a second to consider just how many workers traditional "old" manufacturing still employs and how much the sector adds to gross state product (GSP).

While intangible, this lack of respect ends up having a tangible impact. Other sectors, including the film industry and the life sciences are treated to large state subsidies. Manufacturing produces more jobs and adds much more to total state output than any of these industries, but seldom does the state come forward with such highly publicized incentives for this traditional set of industries.

Even more critical is the impact of the state's benign neglect on the ability of manufacturers to attract a workforce to take the place of the one that is rapidly reaching retirement age. Because so little attention is showered on manufacturing, many young prospective workers have the impression that manufacturing is a failing sector and therefore one that should be avoided, rather than a vibrant sector that one might want to

prepare to enter. Why train for a sector that is roundly considered to be old-fashioned, or worse yet, dying?

The general manager of a fabricated metal product manufacturer in Greater Boston with 25 employees summed up a widespread frustration that we found frequently. Manufacturing, he said, is treated as though it is made up only of "old smokestack companies." He thought that if the state simply shared the truth about modern manufacturing in the Commonwealth, it would help him and others attract younger workers to take the place of the sector's aging workforce.

Linked to this workforce problem is the attention that the state is giving to the importance of getting a university or college education. If all the new jobs are going to require an advanced degree, then it would be clear that the state should focus its resources on building up higher education, not investing in vocational educational institutions, workforce training programs, and community colleges. Indeed, this does appear to be the tone of the rhetoric coming from government and from the media, and it further dissuades young people from considering training that would lead them to good, well-paying, relatively stable jobs in manufacturing.

Manufacturers want the government to recognize the contributions this sector is making to the state's prosperity and use the power of the bully pulpit to change public attitudes about manufacturing and its prospects. This would, they believe, go a long way toward helping them solve some of the challenges they continue to face in Massachusetts.

Specific State Initiatives to Help the Manufacturing Sector

Beyond the simple issue of respect, our survey revealed a clear distinction in terms of what government action could be of greatest assistance to manufacturing firms in the state. In our survey, we presented to our respondents a series of state and local initiatives that, if implemented, could affect businesses in Massachusetts. We then asked our respondents to what extent each of the initiatives might help their companies sustain or expand their operations in the state. Respondents could select from a scale of 1 ("not at all") to 5 ("a great deal").

Reducing the Direct Cost of Doing Business

According to our survey and interview responses, manufacturers are united in their desire for government to help lower their costs of doing business. There is simply no getting around the fact that Massachusetts manufacturers experience the Commonwealth as a high-cost location for production. This is not to say that government-imposed costs alone are exceptionally high. Rather, it is the *combination* of costs — health insurance, energy, the high cost of living that requires the paying of higher wages, taxes, and programs such as workers' compensation and unemployment insurance — that so concerns manufacturing firms in the state.

Indeed, according to **Figure 6.1**, of all twenty-five possible government actions that we listed in our survey, the four that respondents selected as potentially providing the most help to sustaining or expanding their operations in Massachusetts were all related to the direct costs of doing business in the state. Number one, by far, was any action the state could take to reduce the cost of health insurance. More than nine out of 10 (92.3%) survey respondents checked a "4" or "5" on this question, and nearly 75% checked off a

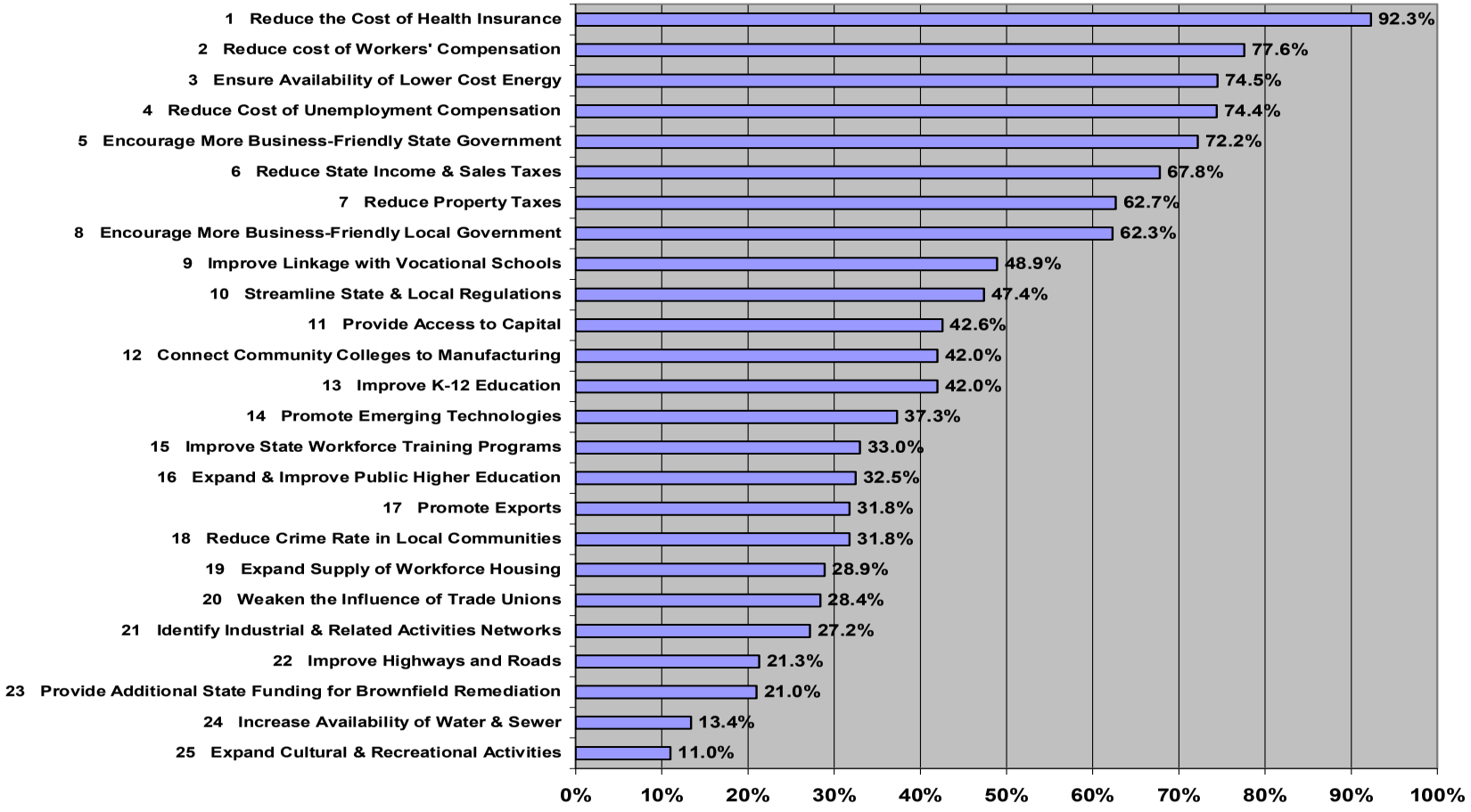
"5," denoting that such action would provide "a great deal of help". The executive vice-president of an Agawam printing company employing 140 workers summed up the sentiments of most manufacturers when he told us that the toll of rising health care costs on his firm's viability was "huge!"

The other three actions rounding out the top four were (2) reducing the cost of workers' compensation, (3) ensuring the availability of lower cost energy, and (4) reducing the cost of unemployment insurance. In each case, between 72 and 78 percent of our respondents reported that dealing with these direct costs of doing business would be quite helpful to the success of their firms.

Our personal interviews with CEOs and owner/managers turned up similar results, except here the respondents apparently recognized that workers' compensation costs have declined. While 80 percent would like the state to do something about health insurance premiums, only 48 percent mentioned reducing the cost of workers' compensation as critical to them. Reducing state income and sales taxes, ensuring the availability of lower cost energy, reducing local property taxes, and the cost of unemployment compensation are all seen as taking precedence over doing something about workers' comp (see **Table 6.1**).

Again, what really irks managers is not any one single cost, but the fact that Massachusetts seems to be such an expensive place to do business because the cost of so many things seems exorbitant. Managers stressed in the interviews that the Commonwealth has so many high cost factors that in the aggregate the cost of doing business seems to be out of line with most other states and regions. One owner/operator of a small machine shop in Gloucester made it clear to us that he was shutting down

Figure 6.1 Actions State and Local Government Can Take to Help Manufacturers Sustain or Expand Their Operations in Massachusetts – Percent reporting action would be important to sustaining or expanding their Massachusetts operations



Source: CURP Survey

his 12-worker company *because* the combination of costs was just too much. His business provides sophisticated grinding operations for small components. These components are easily shipped to him and returned to his customers through commercial delivery services. As a result, proximity to customers is not a factor, but costs are. He finds his Massachusetts location poses such a major competitive disadvantage that he is looking for a lower cost location for his business.

Table 6.1 Key State and Local Initiatives Identified in the 104 Personal Interviews

Initiative	Interviewee Citation
Reduce the costs of health insurance	80%
Reduce state income and sales tax	64
Ensure the availability of lower cost energy	63
Reduce local property taxes	56
Reduce the cost of unemployment compensation	55
Reduce cost of worker's compensation	48

Source: CURP Interviews

Improving Workforce Training

Returning to our survey results, we found an array of factors on which manufacturers would like to see state or local action. A good number of these relate to preparing the workforce of the future.

- *Linkage to Vocational Schools* - Almost half of the survey respondents (48.9%) stressed the need for improving the linkage between vocational schools and their own operations. Many would like to see vocational education more closely mirror the realities of today's manufacturing sector, teaching skills now required for the sector's increasingly sophisticated machinery and production

processes. There was more than a hint in some of the interviews that vocational education has not kept up with the changing needs of manufacturing industry.

- *Connection to Community Colleges* - Almost as many of our survey respondents (42%) would like to see the state's community colleges connected more closely to the manufacturing sector. As manufacturing evolves, they believe that community colleges could offer more programs geared toward this sector, presumably including associate degrees in manufacturing technologies.
- *Improvement of K-12 Schools* - The same percentage (42%) noted that improvements in K-12 education would be helpful to them.
- *Improvement of State Workforce Training Programs* – Beyond the vocational schools, community colleges, and K-12 schools, one-third (33%) of our survey respondents mentioned the need for improving state workforce training programs that are offered outside of the traditional school setting.

The chief operating officer of an Agawam plastics manufacturer employing 160 workers summed up the feelings of many of those we interviewed when he stressed that that the *single most important* effort the state could undertake to expand efforts to develop a skilled workforce. He was referring to the need for more resources in vocational education and direct workforce training. As might be expected from the challenges noted in the last chapter, expanding and improving higher education scored lower in our survey than any of these other approaches to assuring an adequately prepared workforce for the future.

In our personal interviews, several of the largest employers expressed concern over K-12 education. Their comments generally were targeted to two specific areas. The first reflected the need for more scientific and technical preparation. STEM programs (Science, Technology, Engineering, and Math education) were referenced as being critical to providing future workers with the skills manufacturers will need as they continually increase the use of sophisticated technology in their production processes. The marketing manager of a 1,400-employee high-tech manufacturer in the Merrimack Valley typified this view. His company's workforce is highly educated and his firm needs additional entry level engineers. He fears that Massachusetts's schools are not encouraging the "best and brightest" of students to consider careers in science and engineering and are therefore making his job of recruiting such talent that much more difficult. A vice president for the same manufacturing company emphasized that even before STEM could be successful, it was important to make sure that all students were receiving "basic readiness education."

Promoting Massachusetts Manufacturing

A third area where manufacturers would like to see state or local action revolves around promoting the industry, streamlining the state and local regulatory environment, and helping to provide access to capital for the renovation and expansion of their businesses.

- *Streamlining State and Local Regulations* – Nearly half (47.4%) of the survey respondents noted that they would like to see both the state government and local municipalities find ways to reduce bureaucratic "red tape" and reduce the time needed to obtain zoning variances and building inspections. Adding transparency and reducing uncertainty in these processes would be moves in the right direction.

- *Promoting Emerging Technologies* – More than a third (37.3%) of the survey respondents mentioned that the promotion of emerging technologies would be important to sustaining or expanding their Massachusetts operations. As more of the Massachusetts manufacturing base is linked to such industries as the life sciences, biotechnology, and nanotechnology, manufacturers see promotion of these industries as helpful to them.

- *Promoting Exports* – A third (31.8%) of our survey respondents checked off the promotion of exports as a government initiative that could benefit their operations. Presumably, state-sponsored trade missions that emphasized the manufacturing prowess of the Commonwealth could help drum up additional business for home-based producers. With the U.S. dollar so weak, this strategy could reap significant benefits for local manufacturers of final products and components.

- *Providing Access to Capital* – More than two-fifths (42.6%) of the survey responses mentioned providing greater access to capital funds as important to their businesses. This was particularly true for the small and middle-sized firms, which often do not have the same access to private capital markets as larger well-established firms. Connecting smaller firms to private venture capital funds and making more capital available at reasonable interest rates would help some manufacturers improve or expand their operations.

Improving the Local Community

Rounding out the list of actions is a hodge-podge of activities that a minority of manufacturers would like to see the state or local officials consider. These include actions that would reduce neighborhood crime, presumably in the vicinity of their establishments (31.8%), and expand the supply of workforce housing to combat the high cost of housing, which discourages workers from locating in the state (28.9%). Many of our interviewees discussed the importance of the quality of life in the Commonwealth. Often, corporate decision-makers, particularly the owner/operators of small and medium-sized companies, wish to remain in Massachusetts because of the perceived quality of life here. Many said that as long as the quality of life remains high, they will stay here and absorb the higher cost of doing business, at least as long

as those costs do not make them non-competitive with firms in other states and regions. One owner of a printing company on Cape Cod suggested that the state specifically market the Cape and the Berkshires to owner/operators because of the quality of life available there.

As for other factors, only a relatively small number of respondents feel that improving highways and roads (21.3%), providing additional aid for brownfield remediation (21.0%), and increasing the availability of water and sewer hookups (13.4%) would be of much help to sustaining or expanding their operations in the Commonwealth. And despite the high marks given the Commonwealth's quality of life, only 11 percent of survey respondents feel the state could help them by putting more resources into cultural and recreational activities. Apparently, they believe the state already has a sufficient array of such activities to make Massachusetts a great place to live. The CEO of a MetroWest biotech manufacturing company that employs more than 150 workers believes that other states paint a poorer picture of Massachusetts when competing for business. He recommended that the state be more aggressive in promoting the advantages of Massachusetts which, from his perspective, are significant.

In sum, survey respondents maintain that the state government should be focusing on lowering the direct costs of doing business in the state, improving the supply of appropriately trained workers, and promoting manufacturing at home and abroad. In the opinion of the state's manufacturers themselves, nothing could be more helpful for keeping a vibrant manufacturing sector in Massachusetts.

State and Local Action by Size of Firm

As might be expected, there are some major differences by size of firm in what CEOs and owner/managers see as appropriate state and local actions that could help their companies prosper. **Table 6.2** provides information from the CURP survey for firms with 0-19 employees, 20-99 employees, and larger firms with 100 employees or more.

Regardless of size, reducing the cost of health insurance comes out number one and reducing the cost of workers' compensation number two when it comes to the actions that manufacturers believe will be most useful for assuring the staying power of this sector. In almost all cases, however, the owners of small and middle-size firms consider the need for state and local assistance much more pressing than do larger establishments. This is particularly true when it comes to tax relief. Small firms are more than twice as likely as the largest firms to urge reductions in state income and sales taxes (47.5% vs. 20.7%) and in local property taxes (47.4% vs 23.5%). While access to capital is a much lower priority overall, nearly one in four small companies think that if the state were to assist in this way it would be of great help in sustaining or expanding their Massachusetts operations. By contrast, fewer than 8 percent of large firms listed this as very important. Smaller firms are also more than twice as likely to see the need for improving the linkage with vocational schools (30.7% vs. 13.4%). This may reflect a greater ability of large firms to carry on in-house training, while smaller firms must rely on a supply of already-trained workers.

Table 6.2 Actions State and Local Government Can Take to Help Manufacturers Sustain or Expand their Operations in Massachusetts: Percent Reporting Action Would be Very Important

		Number of Employees		
		1-19	20-100	101+
1	Reduce the Cost of Health Insurance	77.6%	71.8%	61.0%
2	Reduce cost of Workers' Compensation	55.6%	50.4%	42.7%
3	Ensure Availability of Lower Cost Energy	45.6%	45.9%	42.7%
4	Reduce Cost of Unemployment Compensation	50.5%	45.6%	34.2%
5	Encourage More Business-Friendly State Government	46.4%	45.8%	34.6%
6	Reduce State Income & Sales Taxes	47.5%	39.4%	20.7%
7	Reduce Property Taxes	47.4%	36.4%	23.5%
8	Encourage More Business-Friendly Local Government	45.4%	45.8%	34.6%
9	Improve Linkage with Vocational Schools	30.7%	23.9%	13.4%
10	Streamline State & Local Regulations	27.4%	27.5%	18.5%
11	Provide Access to Capital	23.7%	20.0%	7.3%
12	Connect Community Colleges to Manufacturing	22.0%	19.4%	16.1%
13	Improve K-12 Education	24.7%	19.8%	20.0%
14	Promote Emerging Technologies	19.8%	22.4%	16.0%
15	Improve State Workforce Training Programs	17.3%	14.6%	12.2%
16	Expand & Improve Public Higher Education	15.2%	14.6%	11.1%
17	Promote Exports	19.9%	15.9%	12.2%
18	Reduce Crime Rate in Local Communities	16.8%	13.8%	12.5%
19	Expand Supply of Workforce Housing	12.7%	11.7%	11.0%
20	Weaken the Influence of Trade Unions	19.8%	15.1%	15.9%
21	Identify Industrial & Related Activities Networks	15.3%	11.5%	7.3%
22	Improve Highways and Roads	9.4%	7.5%	11.0%
23	Provide Additional State Funding for Brownfield Remediation	8.5%	9.3%	8.5%
24	Increase Availability of Water & Sewer	6.6%	7.1%	9.8%
25	Expand Cultural & Recreational Activities	7.0%	3.4%	4.9%

Source: CURP Survey

While it is rare that large firms see more need for state or local action than smaller firms, this does seem to be the case when it comes to improvements in roads and highways and in increased availability of water and sewer facilities. Small firms may rely on these services less than larger firms, thus explaining this particular finding. For example, a very large computer and electronic product manufacturer in the MetroWest region expressed his frustrations with the transportation infrastructure. Because this company has been adding significant numbers of new employees to its workforce, the company's expansion is affecting congestion on local highways. The

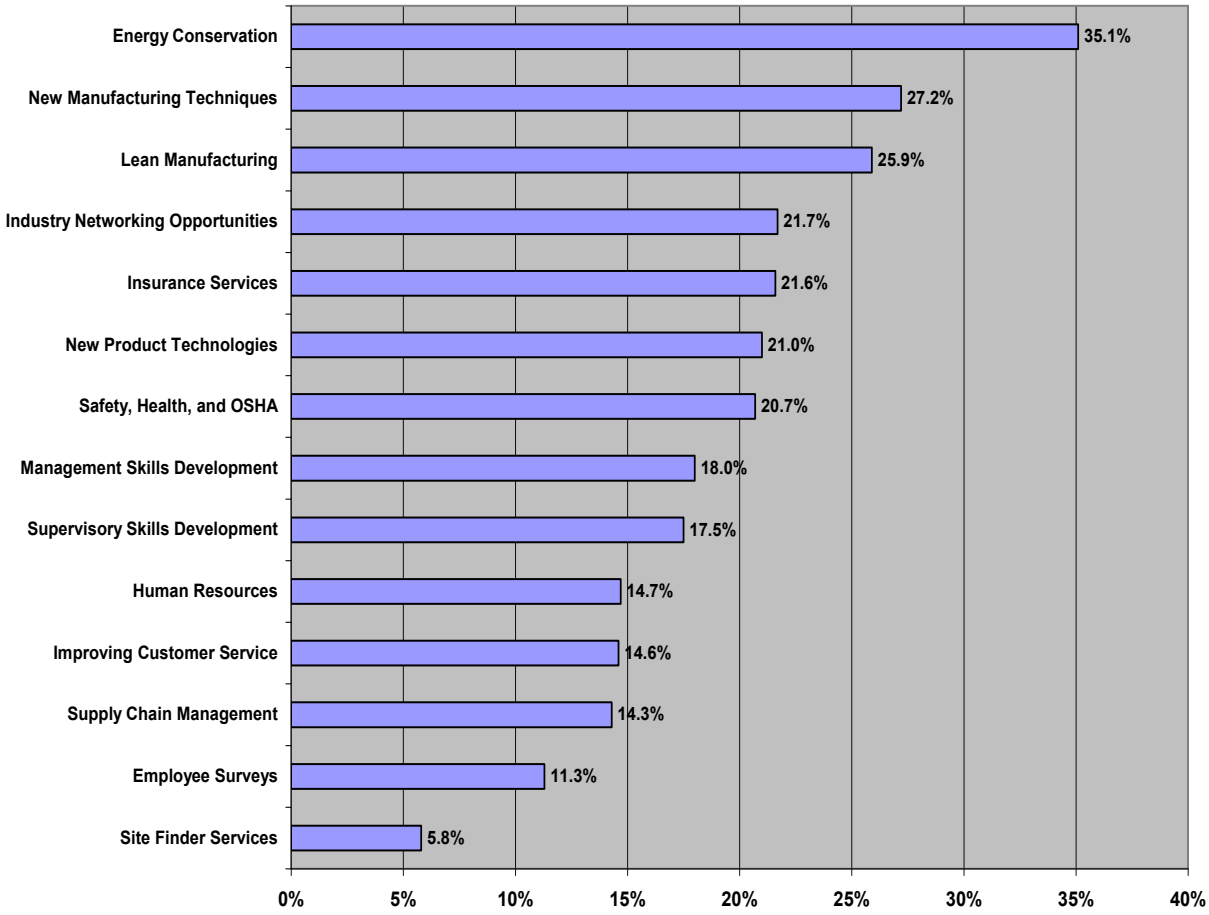
treasurer of another large manufacturer, employing 750 workers in Massachusetts, cited the limited parking available in the older industrial city in which the plant is located, as a potential limitation to growth, and a possible threat to staying, at its existing location. He is working with city officials to find a solution to this problem and he argues that if his company's growth continues, they will need city assistance to make parking available. While we did not find many companies with such a specific need for municipal assistance, the number of jobs involved is significant.

Information/Training Services for Massachusetts Manufacturers

As part of our CURP survey, we asked our respondents whether they would like to have information or training provided to them on a range of business practices. **Figure 6.2** provides information on their answers.

In general, most respondents were not particularly interested in receiving additional information on business practices. They feel they have sufficient information to continue to make progress in their industries. Still, more than a third (35.1%) of those we surveyed would appreciate more information on energy conservation and more than a quarter could use information or training in new manufacturing techniques and lean manufacturing. About one in five firms would like information about industry networking opportunities, insurance services, new product technologies, and safety and health (OSHA) best practices.

Figure 6.2 Information/Training Requested by Survey Respondents



Source: CURP Survey

We did discover significant differences by size of establishment, but the results were generally unexpected. We expected to find that smaller firms would be the most interested in receiving information or training in advanced business practices. But, in general, we found just the opposite. As **Table 6.3** reveals, the larger the firm the more likely they were to answer in the affirmative when we inquired as to whether their company would like to receive such information. This was somewhat surprising, since we thought that larger firms would have greater access to information and therefore not request additional information if it were made available. Our only

explanation for this finding is that small and middle-sized firms do not have the internal administrative structure to digest additional information and therefore feel that more information or training would not be particularly helpful.

Table 6.3 Information/Training Requested by Firm Size

	Number of Employees		
	1-19	20-100	101+
Energy Conservation	30.0%	38.9%	50.6%
New Manufacturing Techniques	23.6%	29.8%	36.1%
Lean Manufacturing	15.7%	31.8%	51.8%
Industry Networking Opportunities	20.9%	23.3%	22.9%
Insurance Services	27.2%	16.7%	15.7%
New Product Technologies	20.4%	21.7%	25.3%
Safety, Health, and OSHA	17.7%	22.9%	32.5%
Management Skills Development	13.6%	18.0%	39.8%
Supervisory Skills Development	10.0%	22.0%	38.6%
Human Resources	10.6%	18.8%	24.7%
Improving Customer Service	11.2%	16.3%	27.7%
Supply Chain Management	11.2%	14.3%	28.9%
Employee Surveys	7.4%	13.9%	22.9%
Site Finder Services	7.1%	5.7%	2.4%

Source: CURP Survey

More than half (50.6%) of the large firms we surveyed would like to receive more information about energy conservation. This was significantly higher than the 30 percent of small firms and 39 percent of mid-sized establishments. Large firms were more than three times as likely to request information on lean manufacturing, on management skills development, on supervisory skills development, and information on carrying out employee surveys. They were nearly twice as likely to want information or training when it came to safety and health, human resource management, improving customer service, and supply-side management. The only

information that few firms of any size requested had to do with site finder services, presumably because few of these firms are considering relocation.

There were, however, several interviews that suggested the state and/or local government should prepare land and development sites for industries that were ready to expand or relocate. This would be particularly helpful for manufacturers that needed to move very quickly into full scale production. The senior vice president of operations for a large Greater Boston biotech manufacturing company specifically cited Ireland as a country that uses this approach very successfully

Summary

Our analysis thus far has indicated that the manufacturing sector in Massachusetts will likely stabilize and continue to be a major contributor to the state's economy. To ensure that these projections materialize, this chapter has highlighted the areas where manufacturers believe the government can be of most assistance to them in ensuring a business environment conducive to economic growth and sustained employment.

The results from this portion of our survey were quite clear. Manufacturing firms across the board want the government to recognize the critical role this sector continues to play in the Commonwealth and they are looking to government for relief with regard to the cost of doing business. Health insurance tops the list of costs that present obstacles to sustaining or expanding operations in the Commonwealth. A resounding 92.3% of respondents expressed a strong desire for relief in this area. Having the government try to do something about energy prices, workers'

compensation premiums, and unemployment insurance costs ranked very high as well. These sentiments were echoed in personal interviews with manufacturers around the state, confirming the results we found in our large survey.

In addition to the direct cost of doing business in Massachusetts, the respondents we surveyed and even more emphatically the executives we interviewed stressed the need for the state to improve vocational education through vocational high schools, community colleges, and workforce training programs. Streamlining the regulatory process and providing greater access to capital also ranked fairly high on this list, again relating directly to actions that the government can take to promote manufacturing.

As we have found in previous chapters, responses tend to differ by firm size. In this case, the differences were slight, but desire for the government's help in the areas described above is uniformly higher among small and medium sized companies

It is clear from our findings that manufacturers are looking to state and local government to partner with them to ensure that the next stage in the evolution of the state's manufacturing sector is one of enhanced growth and sustained employment opportunity. Paying more attention to manufacturing itself and paying particular attention to these concerns could serve the Commonwealth well.

Chapter 7

Conclusion

Massachusetts manufacturing industries suffered some severe losses in the second half of the twentieth century with employment losses so large that the impression left was one of a sector becoming increasingly moribund. The truth, however, is that despite the loss of more than 100,000 jobs over the last decade alone, the sector's productivity gains were so prodigious that manufacturing now is actually responsible for a larger share of total state product than 10 years ago. Moreover, given the repositioning of this sector away from lower productivity producers into higher ones, manufacturing is unlikely to experience in the future employment losses anywhere near as severe as in the past. Today, the Commonwealth enjoys a robust and highly efficient manufacturing sector that is leading the nation in technological advances and that stands to hold a critical position in the state's economy throughout the 21st century. The typical manufacturing company in Massachusetts today has few dead-end jobs on assembly lines slick with leaking lubricating oils and overseen by a clipboard-toting drill sergeant of a supervisor. These images are as antiquated as the two-ply tire, the side vent window, and the transistor radio. Manufacturing is now for the most part a "high tech" sector and nearly every company for which the old image rang true is out of business.

Yet the continued health of Massachusetts manufacturing sector is not guaranteed, even given the transformation in its products and processes. There is much that government can do, at both the state and municipal levels, to encourage current manufacturers to continue operations here and to attract new manufacturers by

promoting Massachusetts as a dynamic and inviting place to locate production facilities.

Through the collection of new data on the state of manufacturing and on the concerns of manufacturers, CURP has striven to bring up to date our understanding of this vital sector. With the very real and very frequent news of layoffs at manufacturing plants in the recent past and with the thrilling potential of the incipient biotech and nanotech industries, many in state government and in the general public have stopped paying attention to traditional manufacturing. We do so because so many of the jobs in this sector disappeared over the past twenty years and based on this history it was easy to project that with global competition the rest of the state's manufacturing sector would soon follow. But as this report has shown, with deference to Mark Twain, the report of the death of Massachusetts manufacturing "has been grossly exaggerated." Indeed, just the opposite may be true. With much of the low-productivity, standard commodity production gone from the state, what is left is both substantial in terms of gross state product and employment and potentially quite vital. Manufacturing is poised to have something of a renaissance in Massachusetts, with highly sophisticated producers set to continue and expand operations in-state and to employ more than a quarter of a million workers well into the future.

A Bright Future for Manufacturing in the Commonwealth

In Chapter 1 we reviewed the past 70 years of manufacturing activity in the Commonwealth, noting the rapid rise in employment during World War II, the slow and punctuated decline of textile production and durable goods manufacturing that

took place through the middle of the century, and the steady drop in employment that has occurred since the early 1980s, interrupted only by a plateau from the mid-1960s through the mid-1980s fueled by high-tech mini-computer producers. While we know that Massachusetts will never see as many manufacturing jobs as during the war years of the early 1940s, or even during the mini-computer boom, projections from the Bureau of Labor Statistics (BLS) make us optimistic that, given the range of industries still located here, the worst of the employment decline has passed. Over the next decade we can expect more manufacturing jobs to leave the state, but not at the precipitous pace that characterized the declines in the early part of this decade. While Massachusetts lost 112,000 manufacturing jobs between 1996 and 2006, we project a loss of no more than an additional 30,000 jobs by 2016. At the same time, given robust gains in productivity, this sector will continue to provide at least one-eighth of the state's total gross state product and if past trends continue this share of total output will actually increase.

What We Learned from the New Manufacturing Survey and Interviews

After detailing in Chapter 2 the methods used to investigate the state of manufacturing in Massachusetts, we began in Chapter 3 to reveal the results of CURP's survey of manufacturing firms. We looked into specific characteristics of our sample of more than 700 firms, including what they produce, whom they employ, where they are located, how they are organized, and how they are integrated into the larger economy of the state, the nation, and the world. Massachusetts is the home of a diverse range of manufacturers, including several firms that employ thousands of

workers, hundreds that employ between 20 and 1,000, and thousands of small companies that have fewer than five employees. Many of the largest firms make up the celebrated high-technology industries that produce aerospace products, computer components and software, and complex machine tools. Medium- and low-technology industries are also well-represented, with many food producers, chemical manufacturers, producers of paper and printed materials, and still there are several textile companies and apparel companies that continue to succeed by implementing state-of-the-art technology or by producing for specialized niche markets.

Because of the difficult situation facing manufacturing across the United States given the rise of global competition, and because of the reputation that Massachusetts is an expensive state in which to do business, it is somewhat remarkable that the state still sustains a manufacturing base that employs nearly 300,000 people. Our survey therefore was aimed at ascertaining what has kept so many manufacturers here, even as many of their competitors have relocated or shut down. We investigated this question in Chapter 4 by looking into what changes firms have experienced over the past decade, which factors have influenced their decision to remain in Massachusetts, and what they expect to happen in the near future.

More than anything else, companies have maintained operations in the Commonwealth because of their satisfaction with the workforce and because logistical challenges make the idea of relocation too cumbersome. Especially for smaller manufacturers, this high degree of inertia is the deciding factor. These are small operations that have, in many cases, remained in the hands of the same family for generations. The owners of these firms have deep roots in their local communities,

and their employees have strong ties to their families and their neighbors. Along with the sheer cost of relocating (even to more cost-friendly regions or countries), these social considerations go a long way toward sustaining the manufacturing sector in Massachusetts.

Overall, we found that a majority (55%) of the firms we surveyed expect to increase their production over the next five years with another 28 percent expecting to sustain their current production levels in Massachusetts. Only one out of six firms see reducing production here or ceasing production altogether.

There were similarly optimistic reports regarding employment projections. Three out of five firms in the Commonwealth expect to increase the size of their Massachusetts workforce over the next five years with another 28 percent maintaining employment at current levels. Only one out of eight firms expects to reduce employment. We take this survey evidence as corroborating evidence of the strong employment projections we made in Chapter 1.

In Chapter 5 we turned the analysis of the previous chapter on its head by looking at the challenges that Massachusetts manufacturers face when they consider their future. Chief among their concerns is the high cost of living and doing business in Massachusetts. While their local roots and the burdensome prospect of relocation serve to keep these firms here, the cost of health insurance, workers' compensation, taxes, energy, labor, and housing all combine to make the Commonwealth one of the most expensive places to do business. Furthermore, these costs weigh most heavily upon the state's smallest enterprises, which are least capable of paying the high premiums of a Massachusetts address. Whereas the largest employers' economies of

scale permit them to carry these high costs, small firms, which make up the majority of manufacturing enterprises in the state, see these costs as real threats to their continued viability. These expenses are difficult to bear both for the firms themselves and for the individuals that they employ. As research from CURP has shown,[28] the astronomical cost of living in Massachusetts (in particular, prohibitive housing prices) puts the Commonwealth at a relative disadvantage when it comes to keeping employees here and attracting new workers to move in.

But the cost of doing business in the Commonwealth was only one of the three factors that manufacturers stressed as challenges to sustaining or expanding their operations in the state. In the interviews we carried out with more than one hundred CEOs, owner/operators, and senior executives of manufacturing firms to supplement our large survey, we encountered over and over again a frustration with the state's apparent policy of "benign neglect" of this important economic sector. Newly evolving industries in the life sciences, biotech, and nanotech receive much more attention from state officials and certainly from the mass media. Financial services companies obtain subsidies to keep them in the state. The film industry enjoys huge tax credits. Manufacturing may not be as attractive or "sexy" as these industries, but manufacturers still want to be shown the respect they believe they deserve.

This question of respect is not simply a matter of pride. The manufacturing workforce is aging rapidly and firms are going to need to find a large number of replacement workers as the current workforce retires. Because of its past history of large scale layoffs and the false expectation that this trend will continue, many young people refuse to consider manufacturing in their future. The lack of attention to

manufacturing by government officials — and the spectacular touting of "post-industrial" industries in the state — only seems to reinforce this expectation. As a result, not enough young workers are learning manufacturing skills or taking advantage of vocational education to prepare them for what could be well-paying, reasonably secure careers in these industries.

How Government Can Help

Extending this consideration of manufacturers' concerns about the future, we assessed in Chapter 6 their suggestions for policies that could help them thrive over the next decade. When it comes to reducing the cost of doing business in the state, respondents to the CURP survey first and foremost suggested they want government to find ways to reduce the cost of employee health insurance. A common health care plan for small manufacturers to buy into may be one way to ease some of the burden born by these firms. Manufacturers would also like to see the government consider ways to further reduce workers' compensation and unemployment insurance costs, lower energy bills, and lower state and local taxes.

As Massachusetts becomes a leader in "green" building and energy technology, we should not forget the state's manufacturers. Subsidies, in the form of grants or tax-credits, that encourage the greening of manufacturing facilities to reduce emissions and capture more renewable energy in the form of solar and geothermal systems should have a substantial impact on the ability of manufacturers to lower costs and stay in business.

As for paying more respect to manufacturing, those manufacturing executives we interviewed would like to see state government promote this sector by creating an accurate perception of the manufacturing industry in Massachusetts today. Using the bully pulpit, state leaders can counter inaccurate perceptions that may dampen the ability of in-state manufacturers to attract new business and recruit new employees.

This question of assuring an adequate, well-trained workforce for the future came up over and over again in our survey and in the subsequent interviews we carried out. Manufacturers indicated that, although satisfied with the workforce in general, they have trouble recruiting entry level workers and especially skilled labor. With nearly half the current workforce aged 45 or older, finding and training a replacement workforce is critical to the future of this sector. Manufacturers would like to see the state put much more emphasis and many more resources into vocational education, workforce training programs, and community colleges. They feel that all the state seems to talk about is making sure our universities and colleges remain the best in the world, while the workers they need are usually trained in other kinds of institutions.

A likely place to start a new campaign to recruit replacement workers for the state's manufacturing sector would be a serious and sophisticated statewide awareness and education campaign targeting parents, school teachers, and young people aimed at encouraging the next generation of craftsmen and craftswomen to consider pursuing the industrial arts. Our survey indicates that little formal education beyond a high school diploma, but a great deal of vocational training, is necessary to be a viable job candidate in manufacturing. Creating more of a relationship between manufacturing firms and vocational high schools would allow the curriculum to be sculpted to reflect

the needs of firms and create awareness among youth that well-paying jobs in manufacturing will be available to them should they pursue it as a career option.

Other resources could be utilized to train adults who lack vocational schooling to compete for jobs in manufacturing. Community colleges and adult education centers could offer training and certificate programs in manufacturing technologies that match the needs of regionally-located firms. There are policies we could pursue starting now that would create opportunities for newly arrived immigrants and for incumbent workers at risk of losing a job in manufacturing due to a lack of skills. Moreover, there are some successful programs training at-risk youth, ex-offenders, and other segments of the population that often have difficulty finding, taking, and holding steady jobs. These programs have a high success rate in placing these newly trained workers in good jobs with local manufacturers. They should be applauded, encouraged, and expanded.

The good news is that we do not have to invent our work force strategy from scratch. Exemplary models, such as the new manufacturing concentration at Berkshire Community College, the very successful E-Team Machinist Job Training Program at Lynn Vocational Technical Institute, or the training facilities at Worcester Technical High School, are already in existence. These three programs grew out of local conditions and met local needs, but at the same time these programs are not linked into a strategic network of education and training pathways for new and incumbent workers to pursue modern skills and high-wage job opportunities. Nor are these programs part of a larger strategic partnership between government and industry intended to promote the modern industrial workplace.

This report was not intended as a blueprint for workforce development. However, without being able to go into great depth, here are some actions that the Commonwealth and its municipalities might pursue to fill the workforce needs of the state's manufacturing sector:

Raising Awareness and Interest

- Engage in sustained efforts to publicize the successes of manufacturing firms in Massachusetts.
- Increase the opportunities for young people in grade schools and middle schools to participate in STEM projects relating math and science to manufacturing.
- Create and promote a "Green Technology" curriculum for middle school and high school students.
- Recognize that vocational and technical schools in this state suffer from a cultural stigma that must be overcome.
- Create an outreach campaign specifically targeted to recent immigrants and urban youth.

Education and Training Infrastructure

- Work with manufacturers in newly emerging green technology industries to create specific curriculum modules for the Academies for Advanced Industrial Arts.
- Designate some resources in youth employment programs specifically for part-time jobs and/or internships with manufacturers prepared to provide both employment opportunities and an educational experience.
- Increase opportunities for workplace-based training programs, including computer training and English for Speakers of Other Languages (ESOL) classes, for incumbent workers in need of additional skills.
- Promote and expand the state's apprenticeship training system.

This all feeds into some larger issues. Our research found that successorship was an issue for many firms, primarily smaller firms. Without someone to take over smaller firms when their current owners and principals retire, many companies which otherwise would be able to compete and remain in business close their doors. Some type of "dating" service that matches the needs of aging firms to capable future owner/managers would be a good way to ensure that viable businesses will not die out simply because there is no one available to operate them.

Maintaining these smaller and mid-sized businesses is important not only for the jobs they themselves currently provide. Many of these firms produce components and parts for larger firms in the region. If they were to go out of business, these important supply chains could be broken, eliminating one of the key reasons larger firms themselves remain in Massachusetts.

In sum, manufacturing has a bright future in Massachusetts, especially if the state can partner with manufacturers to provide them the respect they need and deserve, disseminate accurate information about the strengths of this sector, help manufacturers to reduce their direct costs of doing business, and assure that training programs are in place to produce the next generation of well-paid, high-productivity workers for this important sector of the Commonwealth's economy. It is time to end the implicit policy of benign neglect and to begin active and affirmative investment in this powerful sector.

Endnotes

[1] Daniel Bell, *The Coming of Post-Industrial Society* (New York: Harper Colophon Books, 1974).

[2] Barry Bluestone and Bennett Harrison, *The Deindustrialization of America: Plant Closings, Community Abandonment, and the Dismantling of Basic Industry* (New York, Basic Books, 1982).

[3] Bluestone and Harrison, p. 9.

[4] Joseph Schumpeter, *Capitalism, Socialism, and Democracy* (New York: Harper & Row, 1942).

[5] Thomas Friedman, *The World is Flat: A Brief History of the Twenty-First Century* (New York: Farrar, Straus, and Giroux, 2005).

[6] The term "arsenal of democracy" was actually coined by Jean Monnet, a French businessman who worked as economic liaison to the United States for the French government in exile. Henry Hopkins, a close adviser to Roosevelt suggested the term to the president. This particular fireside chat was broadcast on December 29, 1940, at a time when Nazi Germany had already conquered much of Europe and was threatening Britain. See Richard Barnett, *The Alliance: America, Europe, Japan, Makers of the Postwar World* (New York: Simon & Schuster, 1983).

[7] See Shipyards and Suppliers for U. S. Maritime Commission During World War II (http://www.usmm.net/shipbuild.html). Also see www.necco.com/AboutUs/History.ppt; http://www.massmoca.org/history.php; http://www.charlestownbusiness.com/history.html; http://www.guyotbrothers.com/aboutus.htm; http://www.giftwrapcompany.com/gwc_company_history.html; http://www.referenceforbusiness.com/history2/24/Cabot-Corporation.html; http://www.scott-duff.com/WhoHowManyWhen.htm.

[8] The employment statistics we rely on in this section of the report are adjusted to take into account a change in the U.S. industrial classification system implemented in 2002. From 1939 until 2001, the U.S. Bureau of Labor Statistics (BLS) and the U.S. Census used the *Standard Industrial Classification* (SIC) system to categorize individual industries. Beginning in 2002, the BLS shifted to the substantially more detailed *North American Industry Classification System* (NAICS) and re-estimated industry employment back to 1990. As a result of this shift in classification, some sectors originally classified as manufacturing were now classified as non-manufacturing. The NAICS system yields a total manufacturing count of 40,000 fewer than SIC for 1990. To make the *pre*-NAICS based data consistent with the NAICS data, we subtracted 40,000 jobs from the SIC data for the years 1939-1989. The official SIC figure for 1943 was 841,700 jobs, higher than reported here. However, the absolute difference in employment levels between years remains unchanged. For information on NAICS, see U.S. Office of Management and Budget (OMB), National Technical Information Service (NTIS), *North American Industry Classification System* (Washington, D.C. U.S. Government Printing Office, 2006).

[9] According to the Massachusetts Biotechnology Council, the biotechnology "sector" is comprised of a diverse set of individual 4- and 5-digit NAICS code industries including:

NAICS Code	Industry	% of NAICS Code Employment
3254	Pharmaceutical Manufacturing	100%
54171	R&D in Physical, Engineering & Life Sciences	48
334516	Analytical Laboratory Instrument Manufacturing	25
54138	Testing Laboratories	33
62221	Hospitals	4.5
42421	Drug and Druggist Sundries Wholesalers	35
61131	Colleges and Universities	1.9

In 2005, these industries combined employed a total of 75,074 workers. See Andrew Sum, et. al., *Mass Jobs: Meeting the Challenges of a Shifting Economy* (Boston, MA.: Mass Inc. and the Center for Labor Market Studies, Northeastern University), November 2007, p. 13.

[10] See net change in Initial Year Establishments in 1996 and 1997, Table 1.2.

[11] US Census Bureau, *Statistics of U.S. Businesses, 2008*. http://www.census.gov/csd/susb/susbdyn.htm

[12] Births and deaths were originally reported based on incomplete data and did not always sum to the following years' "Initial Year Establishment" levels. This discrepancy was corrected by distributing the difference of net change in proportion to the originally reported ratio of births to deaths. These discrepancies amounted to 3.9% of all births and deaths. Therefore the adjusted levels should be considered more accurate than those originally reported but not 100% precise.

[13] The data for this section are from U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings, States and Areas 1939-75* (Washington, D.C.: Government Printing Office, 1991), Bulletin No. 1370-12.

[14] Table 1.4 provides data at the 4-digit NAICS code level of detail. The North American Industry Classification System (NAICS) has been in use since 2002 and is the official Census Bureau system for classifying industries. The larger the number of digits in the code, the more detailed the industry. The data are from the U.S. Census of Manufacturers, 2002 (Washington, D.C.: Government Printing Office).

[15] The OECD methodology is detailed in Thomas Hatzichronoglou, "Revision of the High-Technology Sector and Product Classification," STI Working Papers 1997/2 (Paris: Organization for Economic Cooperation and Development, 1997).

[16] These data are from the U.S. Bureau of Labor Statistics, *Quarterly Census of Employment and Wages*, as reported in Navjeet Singh, Jonathan Latner, and Rebekah Lashman, *Massachusetts Manufacturing Chartbook* (Chelsea, MA.: Commonwealth Corporation, Fall 2007).

[17] Murray Gendell and Jacob S. Siegel, "Trends in Retirement Age by Sex, 1950-2005," *Monthly Labor Review* (July 1992), pp. 22-29. The estimates provided in Table 1.11 are subject to error for several reasons. First, Gendell's and Siegel's retirement rates are themselves projections made during the 1990s, and it is not known whether they were borne out in reality. Second, the rates employed in our analysis are for the periods 1995-2000 and 2000-2005, the most recent dates projected by Gendell and Siegel. However, the retirement rates by age seem not to vary dramatically, so it is likely that the rates used here more or less accurately reflect the contemporary retirement rate for each sex and age group. Finally, the estimates by Gendell and Siegel apply to all American workers, not just those in manufacturing. To the extent that manufacturing workers retire early (due, in many cases, to the

excessive bodily wear that accompanies many routine production jobs), our retirement projections may actually *underestimate* the number of jobs that we can expect to open up in the next decade.

[18] U.S. Bureau of Labor Statistics turnover data as reported in http://www.nobscot.com/survey/index.cfm.

[19] A few municipalities either had no manufacturing presence in 2002, or too few manufacturing establishments to allow disclosure of the employment data. These municipalities included Acushnet, Palmer, Sudbury, and Wilbraham.

[20] Projections for Massachusetts are based on a "shift-share" analysis which relies on projections for U.S. manufacturing industries as they appear in Eric B. Figueroa and Rose A. Wood, "Industry Output and Employment Projections to 2016," Monthly Labor Review, November 2007, 53-85.

[21] The recent decline in the dollar follows a pattern that began in 2002. Since March of 2002, the dollar has been devalued by 43% against the euro, 30% against the British pound, 22% against the yen, and 14% against the "fixed" rate Chinese yuan. Ultimately, such sharp declines in the value of the dollar force the price of imports to rise even as foreign firms do everything they can to reduce their costs. Auto companies like Toyota, Honda, and BMW has built assembly plants in the U.S. in order to reduce their exposure to the declining dollar. Essentially, the U.S. has become the "low cost" region for production.

[22] See David Soule, Joan Fitzgerald, and Barry Bluestone, "The Rebirth of Older Industrial Cities: Exciting Opportunities for Private Sector Investment," Center for Urban and Regional Policy, Northeastern University, April 2004.

[23] *InfoUSA.com* is a commercial company that provides mailing lists for sales leads. The company claims to have over 4 million customers. According to InfoUSA.com, business information is procured by splitting apart and cataloguing 5,200 phone books, annual reports and other business directories in order to find information on "nearly every business in the nation." The company hand-keys each record and calls every business in order to assure reliable information. It then adds public record data from county courthouse filings, SEC and 10K filings, and Secretary of State data. *InfoUSA.com* claims they add 50,000 new businesses each week from sources such as new business registrations and utility hook-ups. Every month, the company cleans the data with the USPS National Change of Address (NCOA) Zip+4 and Delivery Sequence File to standardize and keep the addresses as current as possible. For more information on InfoUSA.com, see http:www.infousa.com/cgi-bin/abicgi/abicgi.pl. In some cases, we checked the InfoUSA.com data against a second data base, the *2007 Massachusetts Manufacturers Register* published by Manufacturers' News, Inc., 1633 Central Street, Evanston, Illinois 60201.

[24] In the end, we interviewed at 100 manufacturing firms and four additional non-manufacturing firms that have moved to Massachusetts or expanded here.

[25] In this series of questions, respondents were asked to rate the extent to which they had experienced each change on a scale ranging from 1 ("not at all") to 5 ("a great deal"). The percentages shown here refer to the proportion of firms that gave responses of 4 or 5 for each relevant factor.

[26] For a discussion of the link between the introduction of new technology, technology "lags," "learning curves," and productivity, see Barry Bluestone and Bennett Harrison, *Growing Prosperity: The Battle for Growth with Equity in the 21st Century* (Boston: Houghton Mifflin, 2000).

[27] See Derek Reinke and Mike Manley, "2004 Oregon Workers Compensation Premium Rate Ranking Summary," Department of Consumer and Business Services, Information Management Division, State of Oregon, December 2004.

[28] See Bonnie Heudorfer and Barry Bluestone, with Chase Billingham and Lauren Nicoll, *The Greater Boston Housing Report Card 2006-2007: An Assessment of Progress on Housing in the Greater Boston Area* (Boston, MA: The Boston Foundation, 2007).