

# MIT:

The  
*Impact*  
of  
*Innovation*



# MIT:

## *The Impact of Innovation*

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March 1997



Seven years ago, the Economics Department of BankBoston conducted the first study of its kind — an analysis of the financial and economic characteristics of the businesses established in a state by the alumni of a university. The state in this case was Massachusetts, the university was MIT. The study was an effort to more fully assess the significance of a great technological university to the economy of the Boston metropolitan area and the state of Massachusetts.

One of our key findings was a pattern that emerged on the relationship of innovation and business formation to economic growth and renewal. Our analysis showed how the creation and “growing up” of companies started by MIT founders has played a positive role in promoting rapid structural change in the Massachusetts economy.

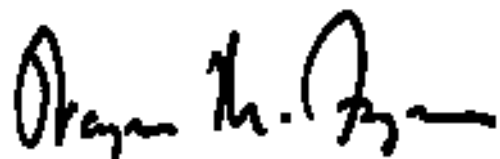
The current study — building on the work of our earlier analysis — is even more ambitious: it measures the national job creation of a single research university and provides new insight into why MIT alumni select their business sites and where they choose to expand nationally.

In a national economy that is increasingly emphasizing innovation, these findings extend our understanding of how MIT has been instrumental in generating new businesses nationwide. MIT is not the only university that has had a national impact of this kind, but because of its historical and continuing importance, it illustrates the contribution of research universities to the evolving national economy.

Our MIT studies are part of BankBoston’s ongoing efforts to monitor the condition of the New England, U.S. and global economies. In recent years, the globalization and increasing complexity of the world economy and the onset of new competitive pressures have made this task more challenging than ever before. These reports help to understand how economic and technological change will affect the fortunes of our region and nation.

Our latest report was a collaborative effort between Ed Moscovitch of Cape Ann Economics, and BankBoston’s Economics Department team: Richard DeKaser, Senior Economist, Paula Fitzgibbon, Senior Statistician, and Diane Fulman, Director of Global Programs, who directed the first MIT study.

We hope you will find this report useful. We welcome your comments and suggestions on the report and the ongoing work of the Economics Department at BankBoston.

A handwritten signature in black ink, appearing to read "Wayne M. Ayers". The signature is fluid and cursive, with a prominent initial "W" and a long, sweeping tail.

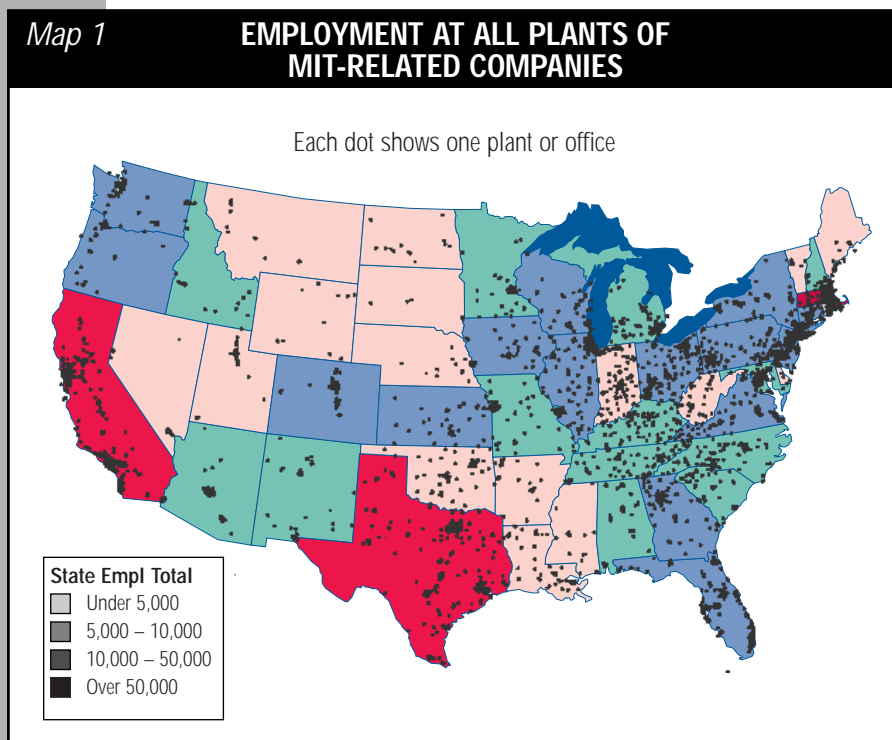
Wayne M. Ayers  
*Chief Economist*  
*BankBoston*

# Executive Summary

If the companies founded by MIT graduates and faculty formed an independent nation, the revenues produced by the companies would make that nation the 24th largest economy in the world.<sup>1</sup> The 4,000 MIT-related companies employ 1.1 million people and have annual world sales of \$232 billion.<sup>2</sup> That is roughly equal to a gross domestic product of \$116 billion, which is a little less than the GDP of South Africa and more than the GDP of Thailand.

This study is the first effort made to measure the national job creation impact of a single research university, and represents a case study of the significant effect that research universities have on the economies of the nation and its 50 states. Eighty percent of the jobs in the MIT-related firms are in manufacturing (compared to 16 percent nationally)

and a high percentage of products are exported. In determining the location of a new business, these entrepreneurs say the quality of life in their community, proximity to key markets, and access to skilled professionals were the critical factors, according to an MIT survey of 1,300 corporate founders which is incorporated into the study. Other significant factors in locating businesses were access to skilled labor, low



<sup>1</sup> For convenience, we use the term MIT “graduates.” In some cases, company founders are former students who left MIT before they graduated.

<sup>2</sup> MIT-related companies are companies whose founders include an MIT graduate, or a member of faculty or staff. Also included are companies which were spun-off from a major MIT lab or which were founded based on licensed MIT technologies. The MIT founder’s partners may not have been MIT-related. For example, Hewlett-Packard, the largest MIT-related company, had one founder with degrees from both MIT and Stanford (Hewlett) and one founder with two degrees from Stanford (Packard). It therefore would also be a Stanford-related company.

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business cost, and access to MIT and other universities. (Many of the MIT-related founders have degrees from other universities, and these entrepreneurs keep close ties with MIT and other research universities and colleges.) For these entrepreneurs, the traditional business location concerns of mature corporations regarding taxes and regulations played a lesser role in their location decision.

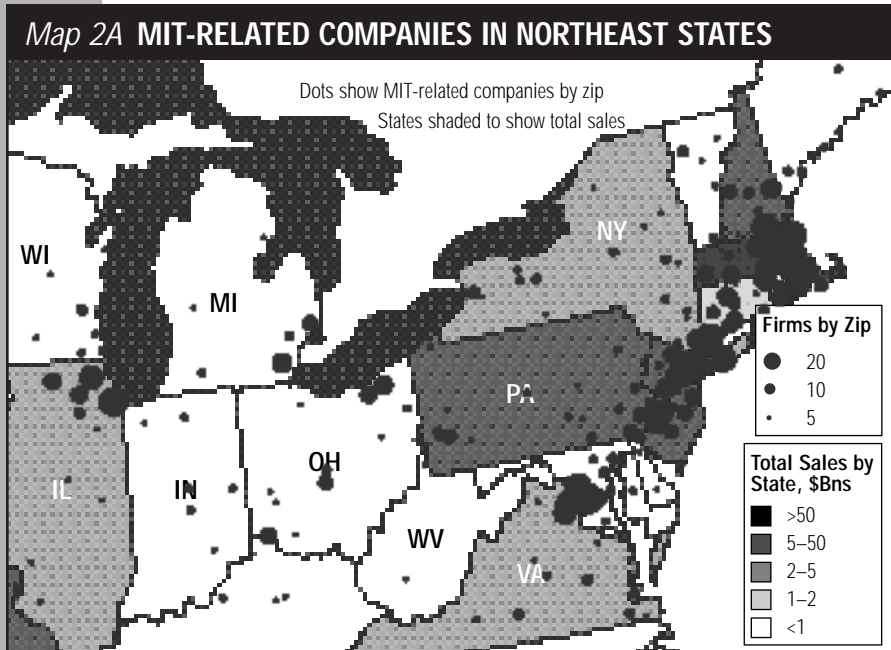
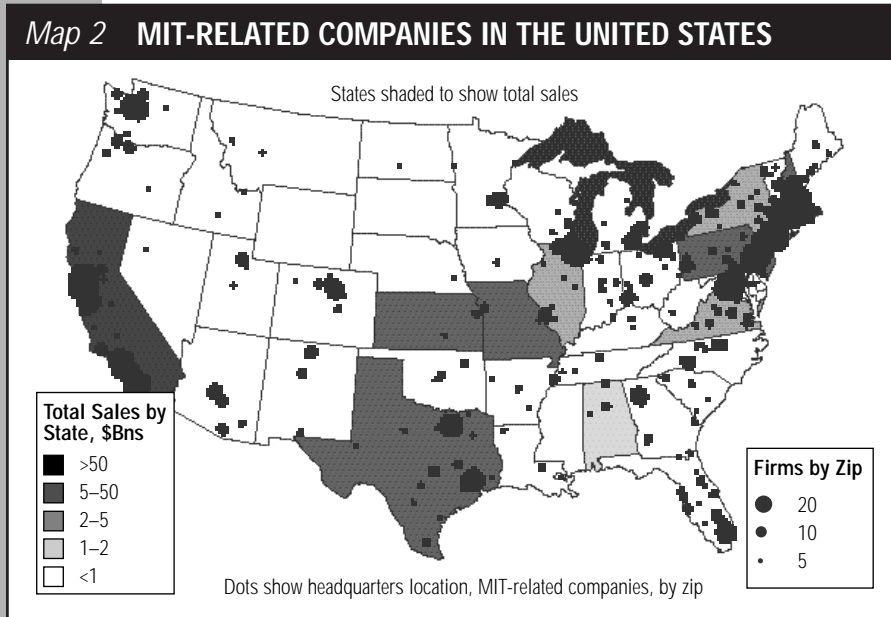
The findings of the study also reveal:

- ▶ The MIT-related companies have more than 8,500 plants and offices in the 50 states. The five states benefitting most from MIT-related jobs are California (162,000), Massachusetts (125,000), Texas (84,000), New Jersey (34,000) and Pennsylvania (21,000). Thirteen other states have more than 10,000 jobs each and only eight states have fewer than 1,000 jobs from these companies. As may be seen in Map 1, these jobs are distributed throughout the nation.
- ▶ Massachusetts is “importing” company founders as a result of MIT. The 1,065 MIT-related firms headquartered in Massachusetts employ 353,000 people worldwide and 125,000 people in the state. They generate worldwide sales of \$53 billion. These companies represent five percent of total state employment and 10 percent of the state’s economic base (those companies selling out-of-state). MIT-related firms account for about 25 percent of sales of all manufacturing firms in the state and 33 percent of all software sales. While only nine percent of MIT undergraduates are from Massachusetts, more than 42 percent of the software, biotech and electronics companies founded by MIT graduates are located in the state.

*Where MIT Produces Companies and Jobs*

The largest number of MIT-related companies are in Greater Boston, northern California and the Northeast, but significant numbers of companies can be found in the South, the Midwest, the Pacific Northwest, and in Europe. Jobs created by these

companies are in all 50 states. California, Massachusetts and Texas lead the nation in MIT-related jobs, but 15 other states — Washington, Oregon, Colorado, Kansas, Iowa, Wisconsin, Illinois, Ohio, Pennsylvania, New Jersey, New York, Connecticut, Virginia, Georgia and Florida — have more than 10,000 jobs each as a result of MIT-related companies. {Map 1 shows all jobs located in each state, regardless of where corporate headquarters are located. Map 2 shows the headquarters location of U.S. firms; the shading also shows total sales of MIT-related companies by state. Map 2A shows the Northeast portion of the U.S. in greater detail.}



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*The Types of Companies MIT Graduates Create*

MIT-related companies are not typical of the economy as a whole; they tend to be knowledge-based companies in software, manufacturing (electronics, biotech, instruments, machinery) or consulting (architects, business consultants, engineers). These companies have a disproportionate importance to their local economies because they usually sell to out-of-state and world markets and because they so often represent advanced technologies.

Firms in software, electronics (including instruments, semi-conductors, and computers), and biotech form a special subset of MIT-related companies. They are at the cutting edge of what we think of as high technology. They are more likely to be planning expansion than companies in other industries. They tend to export a higher percentage of their products, hold one or more patents and spend more of their revenues on research and development. (Machinery and advanced materials firms share many of these same characteristics, but are nowhere near so numerous as the electronics, software and biotech companies.)

These companies are highly dependent on a workforce of skilled professionals. They rank product quality and reliability, customer service and innovation as the most important ingredients to their success and devote substantial time and attention to studying how to build a corporate culture which stresses innovation, cooperation and individual attention.

Approximately 150 new MIT-related companies are founded each year. A relatively few large companies account for the bulk of total MIT-generated employment, with 106 companies of 1,000 or more employees representing nearly 90 percent of the jobs. Not surprisingly, most of the larger companies have been in existence for some time, but many younger entrepreneurs have built sizable companies in a short period of time. One in eight of the companies founded by a graduate out of school 15 years or less already has 100 or more employees.

## THE ROLE OF MIT-RELATED COMPANIES IN THE U.S. ECONOMY

Graduates of the Massachusetts Institute of Technology have founded some 4,000 currently active companies. Worldwide, these companies account for annual revenues of almost \$232 billion. On a value-added basis, that sum would be closer to \$116 billion, which is more than 50% of the gross state product of Massachusetts. Compared with foreign countries, these MIT-related companies would rank 24th largest in the world — just behind South Africa and ahead of Thailand. Their total employment exceeds 1.1 million jobs.<sup>3</sup>

Just over a quarter of these companies — 1,065 in all — have headquarters in Massachusetts and an additional 500 are located elsewhere in the Northeast. More than half the MIT-related companies are located outside the Northeast. MIT-related companies have a major presence in the San Francisco Bay Area (Silicon Valley), southern

California, the Washington-Baltimore-Philadelphia belt, the Pacific Northwest, the Chicago area, southern Florida, Dallas and Houston in Texas, and the industrial cities of Ohio, Michigan, and Pennsylvania. There's a good scattering of MIT-related companies throughout the Midwest, the South, and the Southwest.

### *Large Companies Account for Bulk of Employment*

A few large companies account for a substantial proportion of the total sales and employment of MIT-related companies. Table 1 below contains summary information for the 17 MIT-related companies with employment of 10,000 or more. These 17 companies employ 732,000 workers and have total sales of \$159 billion. The 106 largest MIT-related companies — those with employment of 1,000 or more — account for about 89% of total sales and employment. Employment information is available for 2,448 of the remaining companies; they average 53 employees each.<sup>4</sup>

**Table 1 MIT-RELATED COMPANIES WITH 10,000 EMPLOYEES OR MORE**

Company	City	State	Employment Thous.	Sales \$ Bns	Founder	MIT Class	Founded
Hewlett-Packard Co	Palo Alto	CA	102.3	31.5	William R. Hewlett	1936	1939
Rockwell International	Seal Beach	CA	82.7	13.0	Willard F. Rockwell	1908	1928
Raytheon Co	Lexington	MA	76.0	11.7	Vannevar Bush	1916	1922
McDonnell Douglas	St Louis	MO	63.2	14.3	James S. McDonnell Jr.	1925	1939
Digital Equipment Corp	Maynard	MA	61.1	7.6	Kenneth H. Olsen	1950	1957
Texas Instruments Inc	Dallas	TX	59.6	13.1	Cecil H. Green	1923	1930
Campbell Soup Co	Camden	NJ	43.8	7.3	John Dorrance	1895	1900
Intel Corp	Santa Clara	CA	40.0	16.2	Robert N. Noyce	1953	1968
Gillette Co	Boston	MA	32.8	6.8	William Emery Nickerson	1876	1901
Tyco International Ltd	Exeter	NH	32.0	5.1	Martin Weinstein	1961	1961
Tad Resources Intl	Cambridge	MA	30.0	0.5	David J. McGrath Jr.	1959	1956
AMP	Harrisburg	PA	28.7	4.0	Uncas A. Whitaker	1923	1941
National Semiconductor	Santa Clara	CA	20.3	2.6	Fred B. Bialek	1956	1967
Teledyne Inc	Los Angeles	CA	18.0	2.6	Henry E. Singleton	1940	1961
E G & G Inc	Wellesley	MA	15.0	1.4	Kenneth Germeshausen, Herbert E. Grier	1931 1933	1949
					Harold E. "Doc" Edgerton	1927	
Thermo Electron Corp	Waltham	MA	14.4	2.2	George N Hatsopoulos	1949	1956
Koch Industries Inc	Wichita	KS	12.6	19.0	Fred Koch	1922	1940
<b>Over 10,000 Jobs</b>	<b>Companies:</b>		<b>17</b>	<b>732.4</b>	<b>159.0</b>	<b>Average Employees:</b>	<b>43,084</b>
<b>1,000—10,000</b>			<b>89</b>	<b>257.9</b>	<b>46.9</b>		<b>2,898</b>
<b>Others (Employment Known)</b>			<b>2,448</b>	<b>128.9</b>	<b>25.0</b>		<b>53</b>
<b>Total</b>			<b>3,998</b>	<b>1,119.2</b>	<b>231.6</b>		

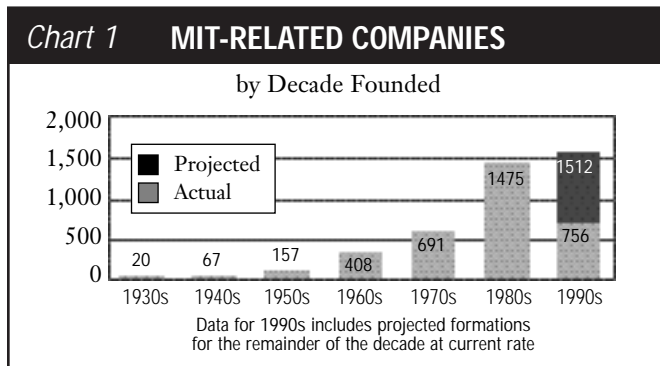
<sup>3</sup> Massachusetts gross state product in 1996 is forecast at \$208 billion by the New England Economic Project. Data on foreign economies comes from the CIA World Fact Book, 1995. South Africa's GDP was \$117 billion in 1993; Thailand's, \$110 billion. Data are based on official exchange rates and are from national statistical offices.

<sup>4</sup> Complete information on location, industry, employment, and sales is not known for all 4,000 companies. In each table, we report the number of companies for which relevant information is actually available. These totals will therefore vary from table to table.



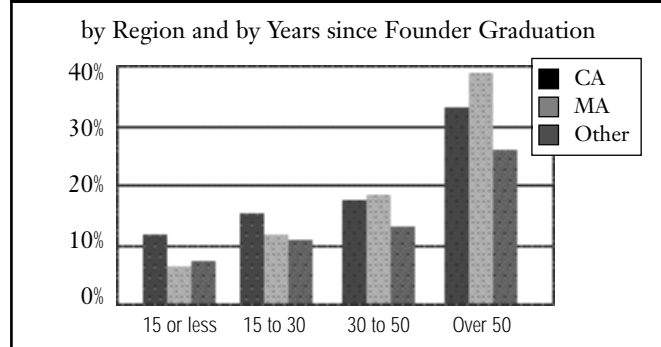
## MIT-Related Companies over the Decades

Although a few very large companies — all of which are at least 29 years old — account for the lion's share of total employment, the formation of new companies continues at an impressive pace, as shown in Chart 1. The rate of formation of new companies by MIT graduates appears to be accelerating. There are 1,475 currently active companies from the 1980s — more than twice the figure for the 1970s. Through mid-1995, some 756 companies had been founded during the 1990s; at this rate, the total for the decade should exceed 1,500.<sup>5</sup>



On average, the younger companies have fewer employees than older ones. Of the 17 largest firms (shown in Table 1), all but 5 were founded by students who left MIT more than 50 years ago and none were founded by those graduating in the last 30 years. Nonetheless, a few young graduates have managed to build companies of impressive size in a short period of time. Fifty-five companies with a founder who graduated in the last 30 years (and 25 with founders who graduated in the last 15 years) have 100 or more employees. Of these 55 younger and larger companies, 22 are in software, 8 in biotech and medical instruments, 8 are in electronics, and 5 are engineering consulting firms.

**Chart 2 PERCENT OF FIRMS WITH 100 OR MORE EMPLOYEES**



These 55 companies represent a significant proportion of MIT-related companies founded by more recent graduates, as shown in Chart 2. Of firms founded by an MIT graduate from the last 15 years, one in 12 (8%) already has 100 or more employees. This compares to 12% for founders out 15 to 30 years and 16% for founders out 30 to 50 years. California and Massachusetts firms are more likely to reach this size than those located elsewhere.

## Companies by Industry

The industry breakdown of MIT-related companies is not typical of the economy as a whole. Table 2 gives industry totals for number of companies, sales, and employment.<sup>6</sup>

**Table 2 MIT-RELATED COMPANIES BY INDUSTRY**

Industry	Companies		Employment Thous.	% of Total	Sales \$ Bns	% of Total
	Total	%				
<b>Total</b>	<b>2,884</b>	<b>100%</b>	<b>1,117</b>	<b>100%</b>	<b>231</b>	<b>100%</b>
Electronics Mfg	379	13.1%	635.0	56.9%	129.2	55.9%
Machinery Mfg	78	2.7%	39.1	3.5%	7.0	3.0%
Chemicals, Materials Mfg	64	2.2%	17.8	1.6%	3.8	1.6%
Aerospace Mfg	19	0.7%	89.8	8.0%	18.2	7.9%
Other Manufacturing	229	7.9%	112.3	10.1%	36.3	15.7%
<b>Mfg SubTotal</b>	<b>769</b>	<b>27%</b>	<b>894</b>	<b>80%</b>	<b>195</b>	<b>84%</b>
Software	365	12.7%	63.1	5.7%	9.6	4.2%
Drugs (Biotech), Medical	199	6.9%	23.9	2.1%	5.1	2.2%
Energy, Utilities	58	2.0%	7.2	0.6%	1.7	0.7%
Publishing, Schools	36	1.2%	6.1	0.5%	1.0	0.4%
Architecture	299	10.4%	16.8	1.5%	2.7	1.2%
Engineering Consulting	346	12.0%	23.5	2.1%	3.3	1.4%
Management Consulting	243	8.4%	12.2	1.1%	1.7	0.7%
Finance	195	6.8%	14.7	1.3%	7.2	3.1%
Law, Business Services	122	4.2%	39.3	3.5%	1.5	0.7%
Other	252	8.7%	16.0	1.4%	2.8	1.2%

<sup>5</sup> These figures undoubtedly understate formations in earlier years; the chart shows only active companies, and many businesses founded in these earlier years have undoubtedly gone out of business or been acquired by larger partners.

<sup>6</sup> There are a few companies for which MIT has employment data but no information on company product or industry. Such companies are necessarily excluded from Table 2, which explains the small discrepancy in totals between Tables 1 and 2.

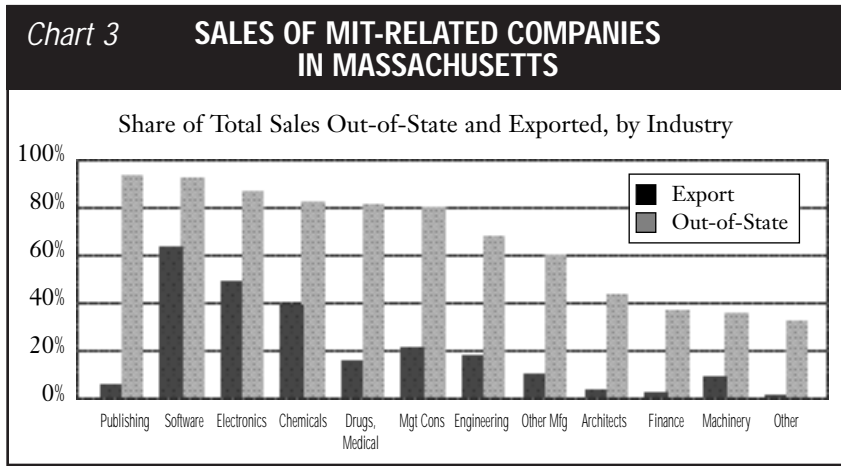
The MIT-related companies tend to cluster in a limited number of sectors. About 380 companies with employment of 635,000 are in electronics, which (as used here) includes computers, semi-conductors, instruments, telecommunications equipment, and electrical machinery and appliances. These electronics and instrument firms make up 13% of the MIT-related

companies but account for 57% of employment and 56% of sales. Other manufacturing firms (including machinery, aerospace, and advanced materials) account for an additional 24% of employment; all told, manufacturing firms make up 27% of the MIT-related companies, 80% of total employment and 84% of total sales.<sup>7</sup> Nationally, manufacturing accounts for less than 16% of total employment. (More detailed information on MIT-related companies is found in Appendix Table 3).

Company size varies substantially by industry. The average aerospace firm has 5,000 employees; the average electronics firm 2,100. The other manufacturing categories average 500 to 1,000 employees while the typical consulting, architecture, or finance firm has 50 to 100 employees. Software firms average 188 employees.

MIT-related companies have a disproportionate importance to their local economies because so many of them are manufacturing, biotech, and software firms (88% of the employment of MIT-related companies) which sell their products and services in national and world markets. In any regional economy, firms such as these, which sell out-of-region (the economic base) play the major role in driving

economic growth. As these firms grow, they create markets for utilities, service firms, retailers, and other local market businesses.



Figures from Massachusetts companies which participated in the 1995 founders' survey illustrate this point. Overall, 83% of company sales are to out-of-state markets; 35% of total output is sold abroad.

Chart 3 shows these percentages by industry.

Only architects, finance companies, machinery manufacturers, and law firms and other business service companies have in-state sales amounting to 50% or more of total revenue. For electronics, chemical, publishing, biotech, software, and management consulting firms, 80% of sales are out-of-state. Electronics and software firms export over half their total output.

## Sources of Our Information

### *Company Database*

Seven years ago the Economics Department of BankBoston collaborated with MIT on the first analysis of MIT-related companies. Since then, MIT has maintained a database of companies founded by its graduates. As of the summer of 1996, MIT was aware of 3,998 currently active companies founded by its graduates.<sup>8</sup> To provide more information about these companies and to lay the basis for maintaining current information on sales, employment, industry category, and location, the MIT database was matched against the records of American Business Information, which include employment, sales, and other information on some 10 million U.S. companies

<sup>7</sup> The definitions used here do not exactly parallel the standard definition of manufacturing. Some of the biotech firms are manufacturers; we've grouped them with biotech research firms and medical organizations. Similarly, publishing is considered manufacturing; we've linked it with private schools because both have a strong educational orientation. Thus, the figures cited here underestimate the total in manufacturing.

<sup>8</sup> Since the summer of 1996, MIT has learned of several alumni-founded or formed companies, ranging from Taiwan Semiconductor Manufacturing Company (employing 3,400) to Evergreen Solar Inc. (with 15 employees). These companies are not reflected in the report.

listed in the yellow pages. This report's findings with respect to total employment and sales, MIT course of company founders, industry and age of companies are derived from this database of MIT-related companies. A series of comprehensive tables summarizing the database is found in the Appendix to this report.<sup>9</sup>

### *Alumni Survey*

In its regular alumni surveys, MIT asks graduates if they have founded companies. In 1995, in-depth survey forms were mailed to some 4,000 founders of whom 1,334 (just over a third) responded. Since many of the founders of the largest MIT-related companies are no longer affiliated with their companies or have died, the companies represented in the survey are somewhat more recent and average fewer employees than the universe of MIT-related companies. All told, these surveyed firms employ 100,000 people. By industry and by region, however, they are reflective of the broader whole. The report's findings on why companies locate where they do, what gives them their competitive edge, how they received initial funding, where they sell their product, and how many patents they have are based on this 1995 survey. A comprehensive set of tables summarizing survey results appears in the Appendix.

## MIT and Entrepreneurship

Our study also draws on a series of telephone interviews with MIT founders. We asked these founders whether their stay at MIT had played a role in their decision to start their own companies and, if it had, how it had done so. All agreed MIT had encouraged them to become risk-takers. One founder sums it up this way:

*Let me try to give you my personal perspective about "risk-taking." I think it is a combination of several different factors. I knew I was not going to work for big companies when I was about to leave MIT. I would rather take the risk of failure than the risk of becoming nobody. There must be many alumni who felt the same way I did.*

<sup>9</sup> MIT has since learned of additional companies founded or formed by alumni. These companies range in size from Taiwan Semiconductor Manufacturing Company with 3,400 employees to Evergreen Solar Inc. with 15 employees. These companies recently identified are not included in this report.

## Portraits of MIT-related companies: *Thermo Electron, Waltham, MA*

George Hatsopoulos decided he'd like to start a company some day while he was still an elementary school student in his native Athens, Greece. As a college student at the Athens Polytechnic, he did library research to determine the best country to start his business; he chose the U.S. because of its entrepreneurial spirit and because it had been the home of inventors like Thomas Edison. In his junior year he was offered a scholarship to study in America. The best known American universities in Greece were Harvard, MIT, and Columbia. He chose MIT because he wanted to be an engineer.

As a candidate for a Ph.D. in mechanical engineering, he had a number of ideas for products to start his company. He selected the one most likely to attract venture capital — a device for the direct conversion of heat to electricity. He then went to his advisor and asked if he could do his thesis by developing this product. The professor agreed; when Hatsopoulos needed funding, the professor approached the MIT administration which gave Hatsopoulos a research grant in return for a half-interest in his product. (The university later gave Hatsopoulos its interest in the patent.) Today, Thermo Electron is a \$2 billion company, located in Boston entirely because of MIT.

Because he is in Boston and knows so many people at MIT, Hatsopoulos is able to recruit the very best talent from MIT — something he would not be able to do at a distance. (His San Diego operation has a similar relationship with Cal Tech.)

Thermo Electron was started in 1956 with the help of a \$50,000 loan from an "angel." A couple of years later, Hatsopoulos' bank (BankBoston) introduced him to Laurance Rockefeller, who invested a million dollars in the company. Hatsopoulos didn't want heavy bank debt and avoided large bank borrowing. In the early 1960s, he received substantial mezzanine funding (again from BankBoston).

In a later section, we report that few MIT founders relied on banks for startup funding. The Thermo Electron experience suggests that a question focused narrowly on startup funding alone may understate banks' roles in sustaining growth. Because of their familiarity with high-tech companies and the profits they made from successful high-tech companies in the 1960s, the Boston banks are more likely to lend to such ventures — giving Boston a further edge over other cities as a startup location.<sup>10</sup>

*MIT offers great mentors (professors) and more opportunities (professors' consulting/research activities) for students to test the water in establishing their own businesses. MIT exposes students to cutting edge technologies and new ideas. It probably is easier to explore business potential of these new ideas and technologies as entrepreneurs. It seems to be quite natural that MIT becomes a cradle of entrepreneurs.*

Another founder says that MIT instills the entrepreneurial spirit in its graduates. "You know that lots of people (students and professors) start their own companies." Many of his classmates started businesses while in school. This founder combined an electrical engineering degree with a management degree from the Sloan School, where he learned that high risk could lead to high return. After graduation, he passed up a safer job with a large company to take a senior position in a start-up.

Teradyne CEO Alex d'Arbeloff currently teaches a mechanical engineering course at MIT. Having the head of a billion dollar high-tech company as a course instructor must be a powerful role model for his students.

Several founders observed that enrollment at MIT was the first time they realized they were not the "smartest person in the world." One founder observed that this teaches a humility critical to CEOs who must learn to listen to customers and to respect the opinions of their employees. On the other hand, successful completion of an MIT education instills the confidence that bright people working together can solve problems. It's a "hands on" place; if there's a problem, students are encouraged to go down to the basement, build the appropriate equipment, and develop a solution. Finally, the founders point out, anyone who's at MIT for a few years knows what the state of the art is in his/her field.

Along the same lines, another founder said that because of the research and industrial ties of the faculty, MIT

students get to work on "real stuff." Students are "right in the middle of something big" — topics being argued about and worked on at that moment in the industrial world. Professors don't hesitate to work on real-world industrial problems. Other founders mentioned the importance of ties forged at MIT with fellow students who later become customers or cofounders.

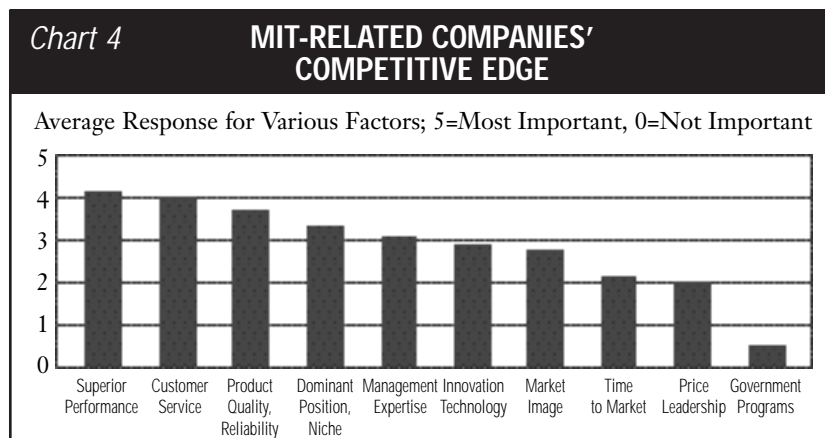
The MIT influence shows up in the fact that over half of all MIT-related companies are founded within 15 years of the time the founder graduated from MIT; one company in six is founded within 5 years of graduation.

## Insights on High-Tech Companies from the 1995 Survey

### *Competitive Edge, Obstacles to Success*

The 1995 survey of MIT graduates who have founded their own companies offers some fascinating insights into these knowledge-based companies and what makes them successful. Product quality and reliability, customer service, and innovation (in that order) are the most important factors in their success — ahead of price. Although price is not unimportant (it is hard for a company to compete if its price is "out of the ballpark"), it is more important to have a cutting edge product with outstanding performance and good customer service than it is to offer the lowest possible price.

The survey listed a number of competitive factors and asked respondents to rank each of them on a scale of 0 to 5, with 5 representing the highest importance. The results are summarized in Chart 4 below, which shows the average response to each factor across all industries.



Appendix Table 8 provides more detail, breaking down answers by industry, region, and company size. In the aerospace industry (where government is the major client), price



is the second most important factor (behind superior performance). In the aerospace industry — and only in this industry — price is more important than product quality and reliability, customer service, and innovation. Price is least important to finance and consulting firms. Time to market is particularly important in electronics and instruments, software, and aerospace and least important in management consulting and finance. Innovation, new technology, and time to market are particularly important to founders who graduated in the last 15 years. Government programs are important to success only for aerospace firms.

The two greatest obstacles to success in domestic markets are difficulty in obtaining funding and government regulations (Appendix Table 9). Somewhat surprisingly, there was relatively little variation by region in the ranking given to government regulation. This suggests that the kind of regulation bothering most firms is federal and not state (had state regulation been a problem, we'd presumably have seen regional differences in the response to this factor). To the extent that there is regional variation, Massachusetts firms actually rated government regulation as slightly less important than founders in other states.

This response suggests that Massachusetts was never as difficult a place to do business as its critics claim — at least for the kind of high-tech companies started by MIT graduates. Or perhaps the survey reflects the efforts of the governor and the legislature in recent years to improve the business climate.

Government regulation matters most to aerospace, biotech, and energy firms — reflecting, no doubt, the role of the government in defense procurement, drug approval, and utility regulation, as shown in Chart 5.

<sup>10</sup> The New Economic Reality, by Craig Moore and Edward Moscovitch. The School of Management, University of Massachusetts Amherst,

## Portraits of MIT-related companies: U.S. Generating Company, Bethesda, MD

Joseph P. Kearney graduated in 1973 with a Ph.D. in Nuclear Engineering. He also took courses from MIT's Sloan School of Management. In 1989 he founded U.S. Generating Company, which is an independent power producer, generating electricity and selling it to electric utilities. The company has 900 employees and sales of \$390 million. Headquarters are in Bethesda, Maryland; the company has 17 generating stations around the country. After graduation, Mr. Kearney took a position as assistant to the chief scientist at a nuclear company and later was a budget analyst for energy issues at the OMB under President Ford. He then started a company bringing project finance and technology into the oil fields. Later, he set up major new subsidiaries at Fluor and at a large natural gas company.

When two major companies wanted to get into the independent power business, they turned to Kearney and financed his new venture. These two partners put in \$1 billion of equity; the rest was borrowed from foreign banks (U.S. banks were effectively out of the market at the time because of the real estate crunch).

With electricity deregulation proceeding in many states, independent generators will no longer be guaranteed contracts with major utilities. As a result, there is tremendous competitive

pressure to reduce generating costs — and to do so without ignoring environmental controls. The company's strategy is to go beyond the minimum environmental requirements and to build a good relationship with the host community. In addition to speeding up the approval process, this extra environmental investment maintains staff loyalty and

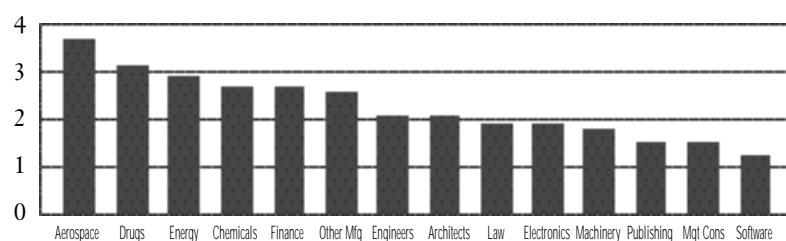
enthusiasm. A well-motivated staff, in turn, is essential to any effort to reduce generating costs. In the long run, the enthusiasm of the staff will do more to lower overall costs than the extra environmental investment will raise them.

The company pays above average wages because it wants above average performance from its staff. It is pushing decision-making responsibility down to all employees. Because the generating plants are computer controlled, computer literacy is a must for even the lowest-ranking staff members. There are strong financial incentives throughout the company salary schedule. "People can do incredible things when they feel good about their company." Kearney cites the example of an employee who flew across the country and back again on his own initiative to pick up a part and re-open a stalled plant in 24 hours — two days faster than would otherwise have been possible.

Chart 5

### GOVERNMENT REGULATION AS AN OBSTACLE TO SUCCESS

by Industry, 5=Most Important, 0=Not a Factor



Environmental regulation is undoubtedly a factor in the relatively high score given by chemical and other manufacturing firms. Government regulation made the least difference to software and publishing companies. Government regulation made much less difference to company founders who graduated in the last 15 years than to their older counterparts.

While intellectual property rights violations were not normally a major factor in domestic markets, they did matter to chemical, publishing, and software companies.

#### *Supportive Role of Government*

Government research funding has played a powerful, if indirect, role in the formation of the kind of high-tech companies described here. Hundreds of millions of dollars of defense research into semiconductors and electronics, much of it in New England, laid the foundation for the modern computer industry.

MIT has \$370 million of on-campus sponsored research, \$271 million of which is from federal agencies. There's another \$338 million of research at Lincoln Labs, which MIT runs for the Air Force (Ken Olsen worked on computer research there before starting Digital Equipment Corporation). The on-campus research accounts for about 30 percent of the Institute's budget. Because of these research funds, the faculty is much larger than would otherwise be the case. A large portion of research money — over \$70 million — goes to hire graduate students as research assistants. Some 2,100 graduate students (40% of all MIT grad students) currently receive research support averaging \$35,000 (including tuition as well as living expenses). The flow of federal dollars, then, brings thousands of the brightest young scientists in the U.S. to Boston, involves them in cutting edge research projects, and helps pay for their graduate education. As we've seen, many stay in the area and start companies.

#### *Firm Location*

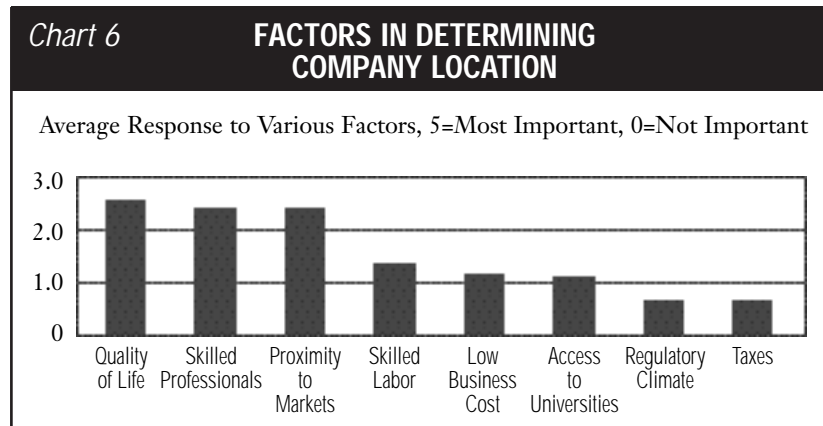
There is a lot to be learned about high tech companies from where they choose to locate — and the reasons for their choices. Of course, most firms are initially located where the founders are living at the time. But when company leaders make a conscious choice about location or expansion, the most important factors are quality

of life, proximity to markets, and access to skilled professionals — ahead of low taxes and regulatory environment. This is illustrated in Chart 6.

To build reliable, high-quality, innovative products, these companies are highly dependent on a workforce of skilled professionals. They locate where such professionals like to live. In this sense, the quality of life response is really a second vote for access to skilled professionals. These findings offer a new perspective on the debate over taxes and the business climate. As one founder explained to us, personal taxes are part of the quality of life for skilled professionals; personal income taxes on managers and engineers out of line with other states could make it hard for businesses to expand. On the other hand, if taxes are lowered at the expense of quality education, cultural facilities, open space, and good transportation, this also lowers the quality of life and would make it harder to recruit skilled people.

#### **High-Tech, High-Growth Industries**

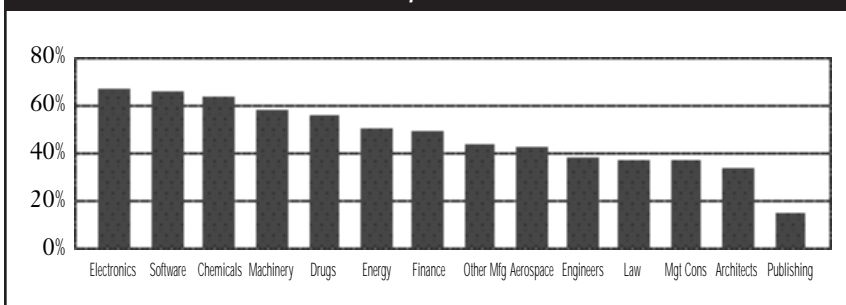
Firms in software, electronics (including instruments, semi-conductors, and computers), and biotech form a special subset of the MIT-related companies. They are at the cutting edge of what we think of as high technology. They are more likely to be planning expansion than MIT-related companies in other industries. They export a higher percentage of their product, are more likely to hold one or more patents, and spend more of their revenues on research and development. Together, firms in these



three industries account for two-thirds of the employment in all MIT-related companies; electronics and instrument firms alone account for 57%. These high-tech, high-growth firms are more likely to locate in California or Massachusetts than elsewhere in the country. As we'll see, MIT-related companies form a major part of these two premier high-tech complexes.

The expansion plans of firms in the 1995 survey form an interesting "leading indicator" pointing to growth prospects by industry. By this measure, the leading growth industries are electronics, software, and advanced materials (chemicals); over 60% of the firms in these industries are planning to expand (Chart 7). These are followed closely by machinery and biotech (drug) companies.

**Chart 7 PERCENT OF MIT-RELATED FIRMS PLANNING TO EXPAND, BY INDUSTRY**



Not coincidentally, these are also the industries with the highest R&D expenditures, the greatest likelihood of holding a patent, and the greatest share of export sales.

### *Patents; Research Expenditures*

Electronics, machinery, and chemical firms are most likely to hold patents; in all, about 75% of the survey firms in these industries held at least one patent (Chart 8). California and Massachusetts firms are more likely to hold patents than are their colleagues in the same industries in other states. This is certainly consistent with the reputation of these two states as the two premier technology locations in the country. All told, 41% of the Massachusetts firms responding to the survey and 45% of the California firms held at least one patent, as against 27% elsewhere.

## Portraits of MIT-related companies: Infoseek, Santa Clara, CA

As a high school student in Los Angeles in the early 1970s, Steve Kirsch was interested in computers. He earned an undergraduate degree in electrical engineering/computers at MIT in 1978 and completed a master's degree in 1980. The most interesting job offer he received that spring was from Rolm in Santa Clara, working on software system products.

He wanted to make a bigger impact on the world than he thought possible from a large company, so two years later (1982) he took \$40,000 of his own savings and founded Mouse Systems. The company is based on an idea he had while at MIT — an optical computer mouse which has no moving parts and which reads its position from an electronic mouse pad. (It has the look and feel of an ordinary mouse, but doesn't wear out or give jerky motions on the screen.) To start a company with so little capital, he arranged to have a contract shop actually manufacture the product and concentrated on marketing — at first as OEM equipment under other company's labels and later under his own company name.

After four years with Mouse Systems, he came across an idea for desktop publishing software. He combined with the author of the software, left Mouse Systems, invested more of his savings, and founded Frame Technology. Six years later, Kirsch was again looking for something new and different. Frame Technology was sold to Adobe and he founded Infoseek, the widely used Internet search engine.

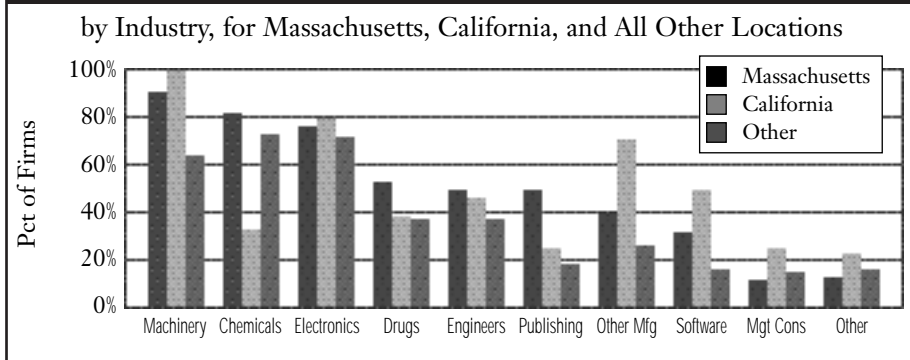
Kirsch is now on his third company — a pattern not uncommon among MIT-related entrepreneurs. He says with a laugh that "Only mediocre people start companies; the really smart ones know better." Why does he do it? The lure of something new and exciting, the challenge of a new problem to solve, and the conviction that you can do a better job than others.

Although Kirsch is a native Californian, he came to Silicon Valley because that was where his best job offer was. MIT-related companies are in California, he says, because MIT trains so many people in computer sciences and because so many of the companies that need such people are in Silicon Valley.

Kirsch believes that like the Boston area, Silicon Valley is a good place to start high-tech companies. He can visit 30 venture capitalists in one location; it's easy to find consultants, to buy equipment, and to arrange for contract manufacture. He reports that it's becoming harder to recruit in Silicon Valley as the area is getting crowded and the best prospects get many job offers.

To succeed in computer businesses, he says, you need dogged determination, a clear vision of where you want to go and how to get there, and the flexibility to adapt to the unexpected

**Chart 8 PERCENT OF SURVEY FIRMS HOLDING ONE OR MORE PATENTS**



The companies holding patents averaged 9.5 patents each, with another 2.7 patents pending and still another 9.2 patents held personally by the founder (Appendix Table 12). Larger companies are more likely to hold patents (55% of companies with 500 or more employees hold at least one patent as against only 31% of companies with fewer than 50 employees); the larger companies also hold more patents (45 per company for those with 500 or more employees versus only 6 for those with fewer than 50 workers).

Software, biotech (drugs), electronics, chemicals and advanced materials firms spend the most on R&D, as shown in Chart 9. Software companies spend 18% of total revenues on research; the average for all companies surveyed is 10%. Average spending on marketing is 11% of revenue.

*Exports*

Exports account for 26% of the sales revenues of the surveyed companies. Over half of the exports go to Europe, Australia, and Japan; almost a quarter go to Asia, and 10% go to Canada.

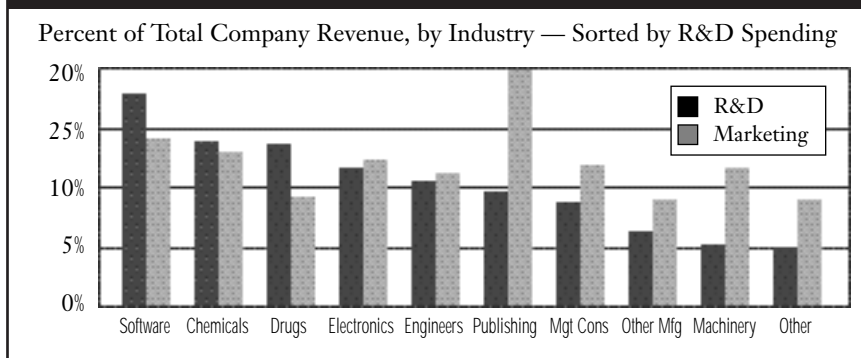
Exports are far more important to software and electronics firms (52% and 44%, respectively, of total revenues) than to companies in other industries

sell fully 65% of their output abroad; this compares with 28% for California software firms, 38% for firms in the rest of the Northeast, and 5% or less in other states. Across all industries, exports account for 35% of total sales for Massachusetts companies as against 24% in California and the Northeast, 16% in the Northwest, and only 4% elsewhere in the country.

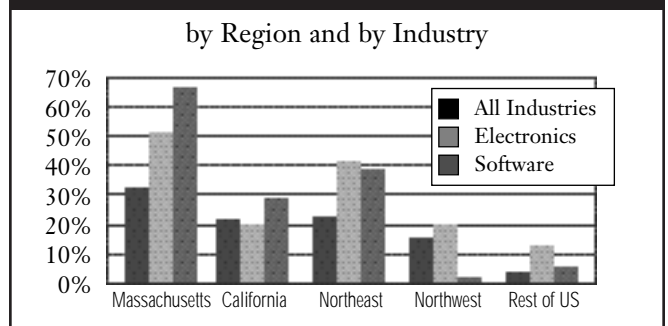
Cultural differences, government regulations, intellectual property rights violations, and difficulty in obtaining financing are the most important

obstacles to success in foreign markets (Chart 11). As we might expect for high-tech goods and services, tariffs are not the major obstacle to expanded trade.

**Chart 9 R&D & MARKETING, MIT-RELATED COMPANIES**



**Chart 10 EXPORT PERCENT OF SALES, MIT-RELATED COMPANIES**

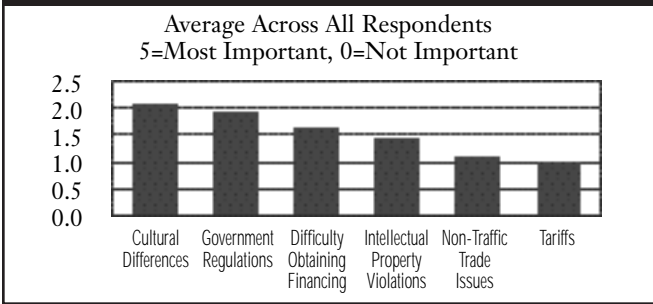


(none of which has an export share greater than 22%), as shown in Chart 10. These high-tech, high-growth industries clearly depend on foreign as well as domestic markets.

Massachusetts electronics and software firms are more heavily into export markets than their counterparts in other states. Massachusetts software companies responding to the survey



**Chart 11 OBSTACLES TO SUCCESS IN FOREIGN MARKETS**

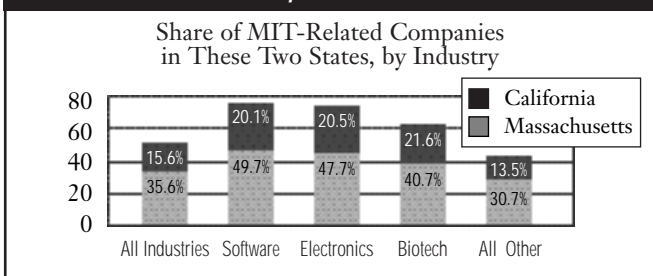


There are some very interesting differences between industries. Tariffs are a slightly more important obstacle for machinery manufacturers and energy generating companies; they are not a problem for consulting firms. We'd expect intellectual property rights violations to be a problem for software firms, and they are, but this difficulty was also given a fairly high rating by biotech companies, chemical and other manufacturers, and engineering and scientific consultants. Government regulations were a particularly important problem for energy and aerospace companies. The largest companies — those with 500 or more employees — were much less likely to report difficulties in obtaining financing than smaller firms.

### High Tech, High-Growth Firms in Massachusetts and California

MIT-related firms in the high-growth, high-tech industries (software, electronics, biotech) are particularly likely to locate in Massachusetts or in northern California. These two states account for 70% of all MIT-related electronics firms, 68% of software firms, and 63% of drug and medical firms (Chart 12). By contrast, they are host to only 44% of firms in all other industries.

**Chart 12 HIGH TECH COMPANIES IN CALIFORNIA, MASSACHUSETTS**



### Portraits of MIT-related companies: *Giannotti Corporation, Tacoma, WA*

Julio Giannotti graduated in 1971 with a graduate degree in naval architecture. He founded his company in 1976; today it has 240 employees and operates three shipbuilding and repair yards on the West Coast. Prior to attending graduate school at MIT, Giannotti had graduated from Annapolis and been a naval officer. After MIT, he returned to Annapolis to teach naval engineering. The company was started in 1976 as an engineering firm, but in 1994 he decided to go into the shipyard business and purchased yards in Tacoma, Washington and Alameda, California. This seemed a natural step as his engineering work had often involved on-site supervision at naval shipyards.

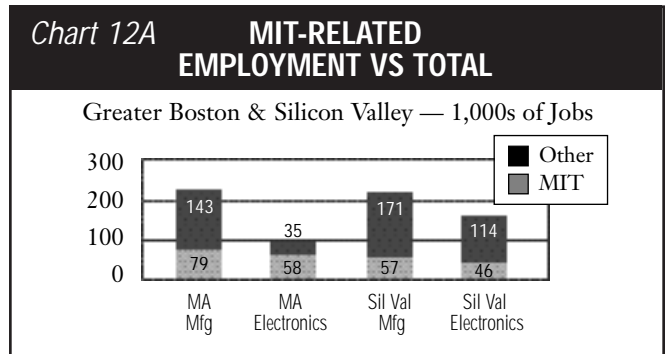
As the U.S. Navy cuts back from a 600 ship fleet to 300 and as competition increases from shipyards in Taiwan, China, and Korea, cost control and effective management are essential to maintain profit margins.

Giannotti's MIT classmates (many now naval officers) have become his customers. Also, MIT was an important recruiting source when he was in the naval engineering business. His MIT contacts played a key role in starting the company. As an MIT student, he was impressed by the fact that real companies with real problems turned to his professors for help.

### MIT in California

MIT has a substantial presence in both of the premier technology regions of the U.S. — Silicon Valley and greater Boston. Map 3 shows MIT-related companies and their employment in the San Francisco Bay area. As the map makes clear, the bulk of this employment is in the Silicon Valley area around San Jose at the southern end of the Bay. All told, there are 467 MIT-related firms with head offices in California which employ 348,000 people worldwide and have \$86 billion in sales. Of the 388 firms for which employment is known, 287 are in Northern California. They account for the greater part of the MIT presence in California — \$66 billion in world-wide sales and world-wide employment of 287,000. Total Silicon Valley employment of MIT-related companies (including California branches of companies located elsewhere and excluding non-California employment of companies with headquarters in the valley) is just over 73,000 — about half of total California employment of MIT-related companies. Of this, some 56,000 is in manufacturing and 46,000 in electronics. When these totals are measured against overall employment in the San Jose area, they amount to 25% of manufacturing employment in the area and 29% of electronics employment (Chart 12A).<sup>11</sup>

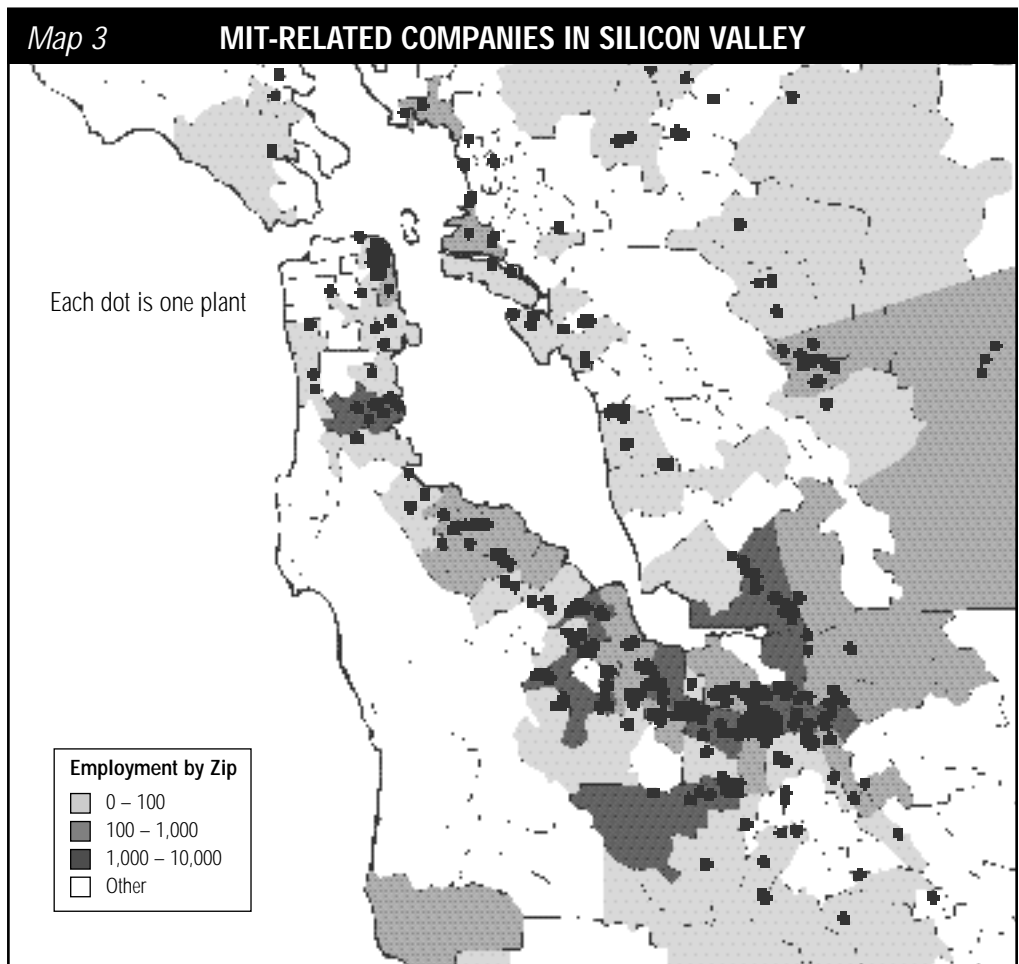
Well over half the sales and employment of MIT-related companies in California are in electronics and instruments, but there's a billion or more of sales in software and biotech as well. The



largest MIT-related firms in the region include Hewlett-Packard, Intel, National Semi-Conductor, 3Com, Tandem Computer, Raychem, Cirrus Logic, Lam Research, Genentech, and Symantec.

### MIT-Related Companies in Massachusetts

There are 1,065 MIT-related companies with headquarters in Massachusetts. The world-wide sales of these companies — \$53 billion — represent 7% of



<sup>11</sup> The comparison employment data in Chart 12A is for 1994 for the Greater Boston and Greater San Jose metro areas. It is taken from the Real Estate Consulting Alliance employment database.

<sup>12</sup> Based on totals from the American Business Information database of 209,000 Massachusetts companies.

the sales of all Massachusetts companies.<sup>12</sup> Two rough calculations suggest that MIT-related companies account for about 25% of the total sales of all Massachusetts manufacturing companies.<sup>13</sup> In software, sales of MIT-related companies in the state — \$4 billion — represent a third of the total.

Worldwide employment of these 1,065 companies is 353,000. This represents substantial growth from 1989 when we issued our first analysis of the economic impact of MIT-related companies. At that time we found 636 MIT-related companies in Massachusetts, with world-wide employment of 190,000.

A substantial share of the 353,000 jobs of companies with headquarters here are not actually in Massachusetts (Digital, Raytheon, Gillette, and other large MIT-related companies with headquarters here have employees across the U.S. and around the world.) There are 125,000 employees in Massachusetts of MIT-related companies. This figure includes the local employees of companies such as Hewlett Packard which have headquarters elsewhere but have branches or subsidiaries in Massachusetts. These 125,000 jobs represent about 5% of total state employment. Almost 80,000 of these jobs are in manufacturing and almost 60,000 of those are in electronics and instruments, as shown in Chart 12A. MIT-related companies account for over a third of manufacturing employment in the Boston area and over 60% of employment in electronics and instruments.

As discussed above, almost all this employment is in the state's economic base, which consists of the manufacturing, financial services, software, and other industries that sell mainly on national and world markets. Each job in the economic base supports a little more than one job in the state's domestic sector, so these MIT-related companies support indirect employment of an additional 125,000 employees. Counting direct and indirect employment, the companies account for roughly 10% of total state employment.<sup>14</sup>

<sup>12</sup> Based on totals from the American Business Information database of 209,000 Massachusetts companies.

<sup>13</sup> The Dun & Bradstreet database provides total sales by industrial category by state.

<sup>14</sup> Employment outside the economic base includes retailers, personal service firms, state and local government, and other enterprises that serve Massachusetts residents

## Portraits of MIT-related companies: *Technology Solutions Company, Chicago, IL*

Roderick S. Walker, class of 1970, has Bachelor and Masters degrees in electrical engineering and an SM from MIT's Sloan School of Management. He was one of the cofounders of Technology Solutions in 1988; it now has 750 employees and expects revenues of \$140 million. The company does multimillion dollar systems integration projects for large corporations.

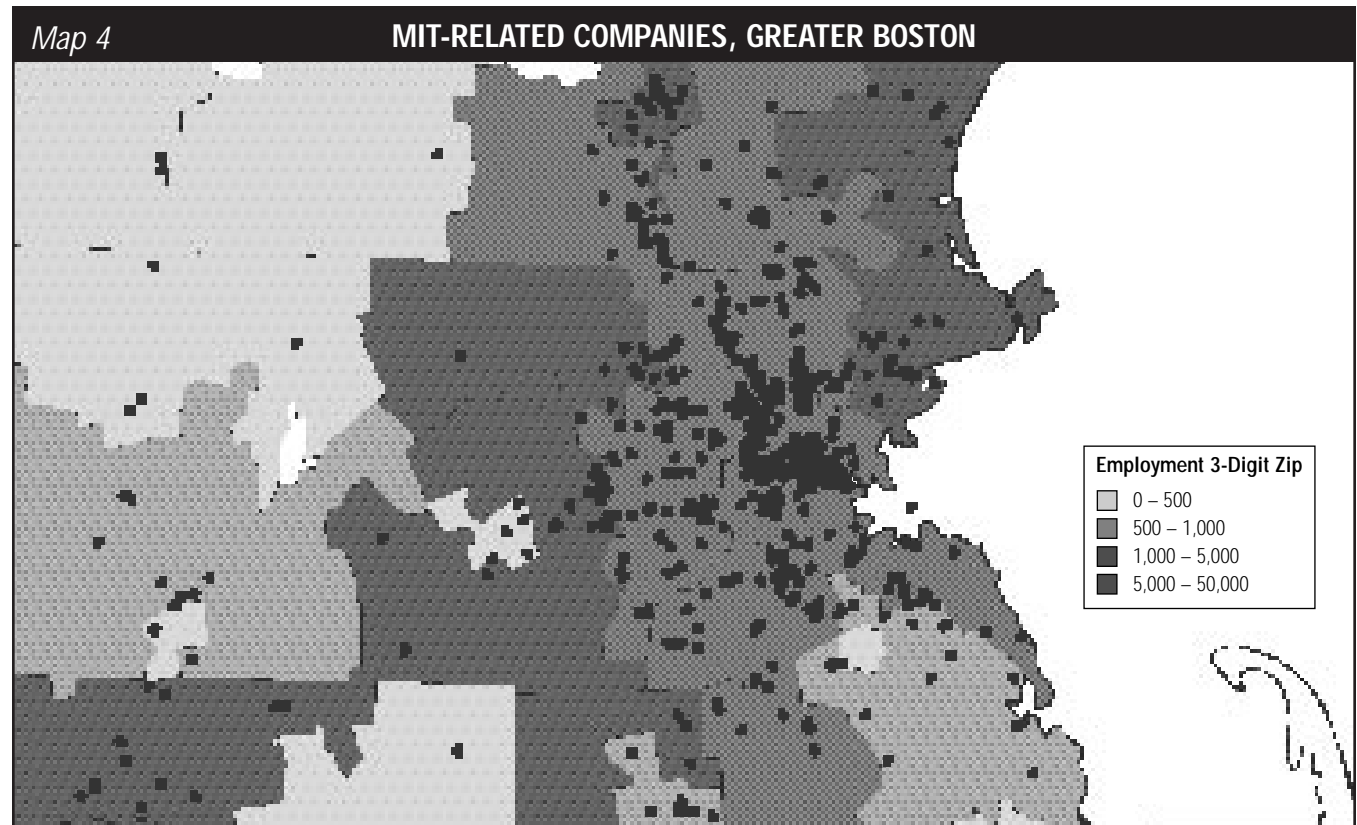
Walker's first job was at a one-year old start-up company; he followed the idea of "high-risk, high-return" he'd learned at the Sloan School. After 15 years, he left to become a partner at one of the Big 6 accounting firms in Chicago, where he and 7 colleagues ran a large systems integration practice. When the head of the group was fired, they all left to form their own company. Startup funding came from the family of one of the founders; they were cash-positive within five months and later turned to venture capitalists to finance additional expansion.

The company's strategy is to acquire a dominant market position in certain niches. One line of specialization, for example, is call centers (the places where your calls to 800-number marketing offices are answered). Technology Solutions has 200 people specializing in this area alone, designing and installing software systems for phone centers. More is involved than just software; the company helps its customers lay out their business vision, define what they hope the calling center will do for the customer, and determine how they will accomplish this objective and measure their performance.

Skilled professionals — particularly technology project managers — are critical to the company's success. Since anyone good in this field can easily find employment, Technology Solutions has to work hard to find and hold good people. One way to do this is to allow company staff to live wherever they like. Although headquarters are in Chicago, the company has employees living in 30 or more states around the country. The company strives to hold down turnover by having interesting work, an above-average compensation package, and a healthy corporate culture.

MIT-related companies are located throughout eastern Massachusetts, as shown in Map 4. Each dot on the map represents one company. The shading in the map shows the total number of MIT employees in each 3-digit zip code area (all companies with zips beginning 021, for example, are in one area).

One of the reasons MIT is so important to the Massachusetts economy is that most of the MIT-related companies never would have been located in Massachusetts absent MIT. Only 8.7% of MIT undergraduates grew up in the state, but some 36% of all MIT-related companies are located in



Raw numbers tend to understate the impact of MIT-related companies on Massachusetts. In one industry after another, these companies represent cutting edge technologies in their fields. Examples include Raytheon in missile and guidance systems, Thermo Electron in instruments and environmental technology, Lotus Development in software, Analog Devices and Analogic in integrated circuits and electronic devices, Cabot Corporation and American Superconductor in advanced materials, and Molten Metal in environmental technology, Teradyne in testing equipment for electronic components, M/A Com in microwave technology, BBN in electronics and networking, Genzyme, Biogen, and Alpha-Beta in biotechnology, Bose in speaker systems, and PictureTel in video conferencing.<sup>15</sup>

Massachusetts. Most of the MIT-related companies in Massachusetts were founded by people who came to the state to attend MIT, liked what they saw, settled down here, and eventually started their companies in Massachusetts. In the last 5 years, over 45% of the newly founded MIT-related companies in software, the internet, biotech, and electronics have been located in Massachusetts.

MIT attracts some of the brightest young people in the country (and the world); many of them like the Boston area and choose to stay here. As just one example, Alex d'Arbeloff came to MIT from his native Paris just after World War II and graduated in 1949. His first job was in New York, but he chose to come back to Boston 11 years later, where he and his partner Nick DeWolfe (also an MIT graduate)

<sup>15</sup> We've no doubt left out some very advanced companies. Another observer with different contacts and experience could undoubtedly put together an equally impressive list of other MIT-related companies with Massachusetts roots.

started an electronic testing equipment company in DeWolfe's home. When they outgrew the house, they chose to rent space in downtown Boston because they liked living on Beacon Hill and wanted to walk to work.

Today, Teradyne is a billion dollar company; it's still located in downtown Boston. Another MIT founder located his company north of Boston, so he could have easy access both to downtown and, on weekends, to the Maine coast and the New Hampshire mountains. These stories are worth retelling because they underscore the critical importance of the fact that scientifically oriented entrepreneurs like living in the Boston area. Absent the symphony, the parks, the ocean, the universities, the art museum, and the other cultural attractions that make Boston unique, the city would fail to hold these entrepreneurs and would grow more slowly.

Compared to Silicon Valley, Boston is actually the lower cost location for attracting top technical help. California taxes are more than comparable to those in Massachusetts, but there's far more vacant land for housing and industrial expansion in Massachusetts than in northern California.

The Boston area's appeal to MIT-related companies is reflected in the expansion plans of firms located here. Fully 57% of the surveyed firms located in Massachusetts are planning expansions — more than in any other region. The comparable figure for firms elsewhere in the East and the Midwest is only 40% (Chart 13).

## Portraits of MIT-related companies: Progress Software, Bedford, MA

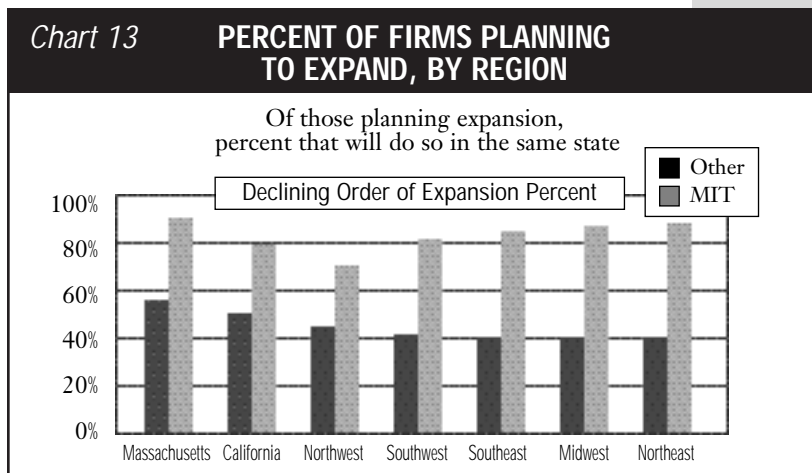
Joseph W. Alsop has an electrical engineering degree; he graduated in 1967. At the time, there was no separate course in computers; his EE program included significant software and computer training. After graduation, he began to take a master's course at the Sloan School, but left to start his first company (with other MIT cofounders) — a computer hardware firm. Annual sales rose to \$1 million and he sold the company, becoming a computer consultant in Texas. He tired of writing business software in COBOL and BASIC and decided to build a company around tools for developers of business software. He teamed up with other MIT graduates (people he had met after leaving the Institute) to form Progress Software. The company was located in Massachusetts because the others lived there.

Progress was founded in 1981 from the savings and sweat equity of its founders, who worked for two years in low-rent quarters without salary. Today, the firm has 1,000 employees and sales of \$140 million — over half of them overseas. His summary of what it takes to win in his business — good vision (foreseeing such developments as the shift from mainframes and minis to PCs and the shift from DOS to Windows and JAVA), timing, and product excellence.

Alsop has much to say about the difference between Silicon Valley and Massachusetts. Silicon Valley, he believes, is the center of the computer-software-semiconductor-electronics industry; most of the important recent developments (such as graphic user interface and the Intel microprocessor) are West Coast developments. Boston and Silicon Valley, especially the latter, are on a plane above all other technology centers. Nonetheless, he worries about the long-term viability of Massachusetts companies because people on the East Coast are not the risk takers found in Silicon Valley. This is of particular concern because the difficulty of doing multi-site software development rules out a major Silicon Valley development staff for Progress.

He believes there are risks as well as advantages to a Silicon Valley location; turnover there is high, with job changes every 18 months or so the norm. On the other hand, he says good Massachusetts programmers and managers can be recruited to California, while it is practically impossible to move West Coast programmers to greater Boston. After one winter, most who do come East want to go back.

Because risk-taking is essential to success in the software business, he feels there is no long-term threat in this area from Japanese or European competitors.





What's more, firms in Massachusetts were more likely to locate their new addition in-state than firms anywhere else in the country (91% for Massachusetts firms, as opposed to 79% in California, 71% in the Northwest, and 86% in the Northeast).

### MIT Contacts with MIT-Related Companies

One advantage of a Massachusetts location is the ease of ongoing access to MIT and other Boston area universities.

When asked the importance of various location factors, Massachusetts survey firms ranked access to MIT and to other universities ahead of low business cost; in every other region of the country, business cost was more important than contact with universities, as shown in Chart 14. (As indicated earlier, the most important location factors are quality of life and access to skilled professionals; these have average scores well above those shown in Chart 14 for business cost and university access).

Just under half of the Massachusetts firms represented in the survey reported regular contact with MIT; the major purpose of these contacts was consulting with faculty members, continuing professional education, and company recruiting (Appendix Table 11). About 1 in 5 firms outside Massachusetts remains in touch with MIT. Half of the firms in the study reported that they maintain regular contact with MIT or some other university.

There is relatively little variation in this percentage from one industry to the next. The companies of those who graduated more than 30 years ago are slightly less likely to maintain regular contacts than are the most recent graduates.

One example of ongoing contact with MIT comes from Analog Devices, a billion dollar manufacturer of precision electronic devices used for measurement and control.

Analog Devices participates in the Center for Quality Management, which was originally developed by MIT and now consists of 50 companies and 11 universities which work together to

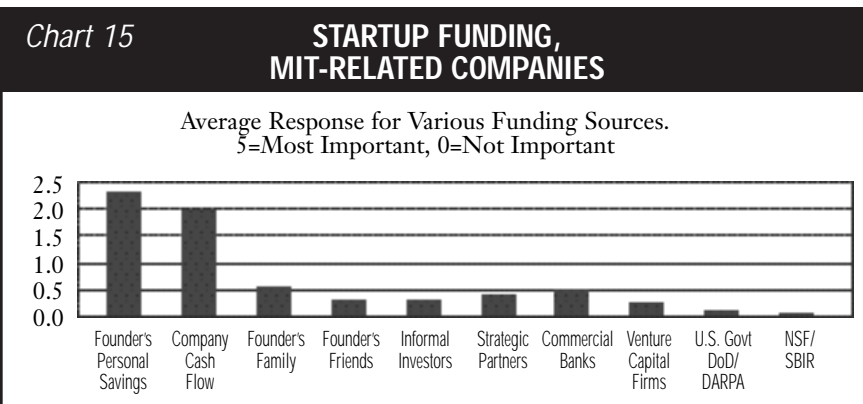
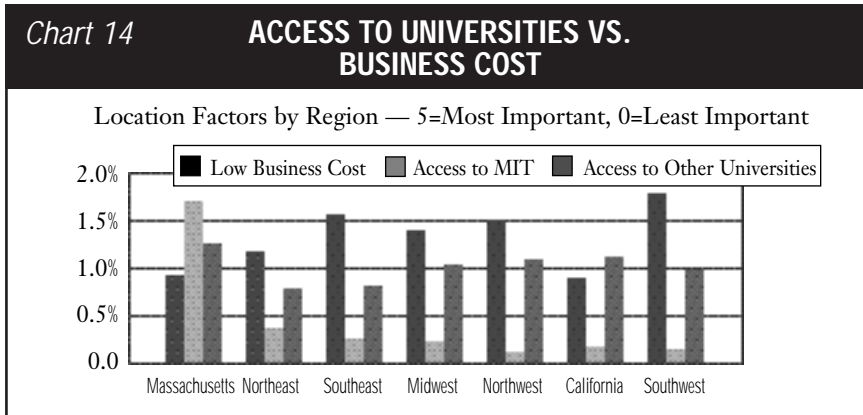
develop course materials and form a mutual learning network to promote problem solving and customer satisfaction.

### Company Funding

Most MIT-related companies are started with funds from the founder's personal savings or by re-investing cash flow, as shown in Chart 15 below.

There is generally little difference in the funding pattern across industries or regions of the country. There are, however, a few interesting exceptions

to this pattern. Informal investors — "angels" — play a significant role in starting up electronics, chemicals, and energy companies. Strategic partners are important to electronics, machinery, and



chemical firms. Venture capitalists are important to electronics and biotech firms, and DARPA (the Defense Advanced Research Projects Agency) was important to chemicals and materials firms. Commercial banks played a significant role with machinery, aerospace, other manufacturing, and finance companies. In none of these cases, however, were these alternate sources more important than cash flow and founder's savings.

Commercial banks were more important funding sources for older companies. For example, Analog Devices was started in 1965 with \$100,000 from the two founders and a promise from BankBoston to lend the new company \$1 for every \$1 of profit earned. Three years later, the company went public; it never needed venture capital.

With venture capital more readily available than it was a few years ago, firms started today are more likely to use venture capital and less likely to use commercial banks for initial funding. Also, there's a higher software and lower hardware content to startups today; this reduces the collateral against which banks can lend.

Cambridge Savings Bank played an interesting role in the start-up of Teradyne. While it did not provide start-up funds to the company itself, it went out of its way to provide mortgage loans and housing information to key staff the company brought to Boston.

Although venture capital was not a major source of funding for smaller firms, it was important for companies with 50 or more employees, and was even more significant for companies with 500 or more workers. This suggests that venture capitalists are good at picking winners or that venture capital is often a necessary tool for a company to become large (or both).

## Portraits of MIT-related companies: *Symbiosis Corporation, Miami, FL*

Thomas O. Bales, Jr. has a degree in mechanical engineering; he graduated in 1970. Symbiosis Corporation, which he cofounded in 1988, now has sales of \$60 million and 750 employees. It is a manufacturer of specialty medical devices and is located in Miami, Florida.

Bales had three cofounders, two of whom were friends from MIT days. The four were engineers working together for a medical instrument company supplying cardiologists. They thought they could run an instrument company better than business school grads; when an idea of theirs was rejected, they arranged an amicable split. Their former employer liked their product idea, put a down-payment on the initial shipment, and essentially financed their initial break-through.

Bales believes the secret to success in the medical instrument field is some sort of technological edge — some unique way of applying knowledge to a problem. Pacemakers (not his product, but a useful illustration) had been too heavy, so engineers with nuclear and rocketry experience familiar with strong, light-weight, corrosion-resistant materials such as tungsten and titanium were able to devise a light-weight substitute.

While engineers may be best at designing new products, he argues, they are not good at selling. His idea is to combine the engineering innovation of a small, scrappy company with the marketing muscle of larger instrument companies — hence the name Symbiosis.

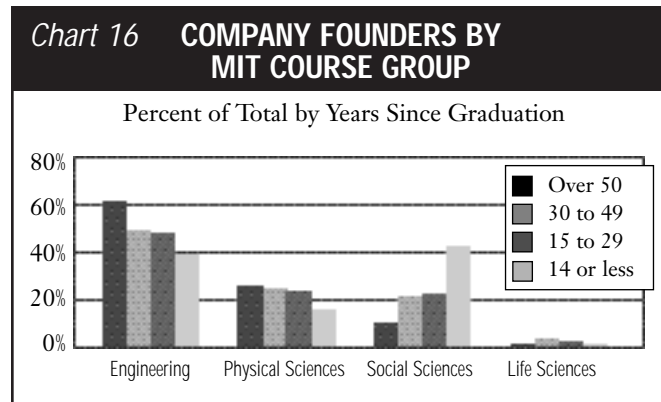
Symbiosis has recently been purchased by Boston Scientific, which will move some of its production to Miami (where production labor is \$5.50 an hour as opposed to \$15.50 in greater Boston). At the same time, many of the managerial and research portions of Symbiosis will be moved to Massachusetts, because it is so difficult to get technology managers, engineers, and other professionals to move to the Miami area.

With Symbiosis sold, Bales has gone on to start a new company providing rocket motors to the space program. He believes the importance of MIT is that anyone who's studied there knows what the state of the art is and has confidence that a group of bright people working together can solve practical problems

## MIT Founders and MIT Course Majors

The greatest number of MIT founders — some 13% of the total — come from the Institute’s electrical engineering and computer science program (the two are linked in the same department). Other programs heavily represented among the founders are management; mechanical, civil, and chemical engineering; physics; architecture; and aeronautics.

There’s been an interesting shift over the years in the course majors taken by company founders. More than 60% of the founders who graduated more than 50 years ago were engineering majors (Chart 16). Only 40% of company founders who graduated in the last 15 years are engineers, while 43% are from the social sciences/management.



There’s no predictable connection between the founder’s course and the type of company. For example, only 18% of biotech and medical companies are founded by life-science graduates; 40% are founded by engineers. Social science and management graduates account for 13% of electronics firms, 27% of other manufacturing firms, and 26% of software companies while engineering graduates account for 45% of the companies in finance and 33% of the management consulting firms.

## MIT Abroad

There are some 220 foreign firms started by MIT graduates, with total employment of 28,000. The largest number of these are in Europe and Latin America, as shown in Table 3.<sup>16</sup> The table divides these firms between those in manufacturing (including related areas like utilities, biotech, and software) and consulting (including finance and law).

There are 67 MIT-related businesses in Europe, most of which are in engineering and other consulting. The greatest number of these firms are in England, France, and Germany. Latin America has 52 firms, divided almost equally between consulting and manufacturing. The largest number of these are in Mexico, Brazil and Venezuela. East Asia includes the advanced countries on the Asian rim — Japan, Australia, Singapore, and Hong Kong. The Middle East includes Africa; “Asia” is the remainder of Asia.

Many of these are sizable businesses; those in Europe and East Asia average 215 employees and \$18 million in sales. Almost two thirds of these foreign businesses are started by alumni with MIT graduate degrees. This is in marked contrast to American founders, only one third of whom have advanced degrees from MIT.

**Table 3 MIT-RELATED COMPANIES ABROAD**

Number of Companies, by Industry and Region

	Total	Manufacturing	Consulting
<b>Europe</b>	<b>67</b>	<b>24</b>	<b>43</b>
England	12	8	20
France	8	3	11
Germany	4	3	7
Switzerland	2	3	5
Belgium	2	2	4
<b>Latin America</b>	<b>52</b>	<b>25</b>	<b>27</b>
Mexico	3	8	11
Brazil	8	2	10
Venezuela	3	4	7
Chile	2	2	4
Puerto Rico	3	1	4
<b>Asia</b>	<b>31</b>	<b>10</b>	<b>21</b>
Canada	20	3	17
East Asia	19	5	14
Middle East	12	5	7

<sup>16</sup> Table 3 is limited to the 201 foreign firms whose industry is known.



# Appendix –

*Detailed Data Tables*



## The Company Database

There are some 4,230 companies in the MIT database, of which 3,998 are currently active. Table A1 shows the extent to which these companies were included in our analysis. Some 1,845 companies were matched to the American Business Information (ABI) database and are still in business. These companies account for employment of 1.06 million and sales of \$225 billion — 95% or more of known employment and sales of MIT companies.

**Table A1 THE MIT COMPANY DATABASE**

	Companies		Employment 000's	Sales \$ Bns
	Total	Employment Known		
Matched to ABI	1,845	1,830	1,064	225
No ABI Data	1,933	557	27	4
Foreign	220	167	28	3
<b>Active Companies</b>	<b>3,998</b>	<b>2,554</b>	<b>1,119</b>	<b>232</b>
Out of Business				
Matched to ABI	36	32	2.0	0.2
Known by MIT	141	44	0.6	0.0
Duplicates	55	49	12.8	2.2
<b>Grand Total</b>	<b>4,230</b>	<b>2,679</b>	<b>1,135</b>	<b>234</b>

ABI keeps information only for U.S. companies; there are 220 foreign companies in the MIT database. For 167 of these, MIT itself has information on company employment — usually information supplied directly by the company founder in the survey of alumni-founded companies. Total employment of these foreign companies is 28,000. Finally, there are 1,993 domestic companies which did not match to the ABI database. Employment is known for 557 of these; they have 27,000 workers. These three groups of companies — 3,998 in all — are what might be called the “active company” database. These are the companies included in our analysis; they have 1.1 million employees and 232 billion dollars in world-wide sales.

Thirty-six companies were initially matched to the ABI database but in the last few months ABI reports that their phone numbers have been disconnected with no follow-up number. They have presumably gone out of business. Another 141 companies included in the MIT database are known to have ceased operation. In 55 cases, one company in the MIT family has since been acquired by another company in the family. Since our analysis includes total employment of large corporations, regardless of location, we have eliminated these 55 companies to avoid double counting employment and sales. These various categories account for all 4,230 companies known to MIT.

## Keeping Track of Company Changes

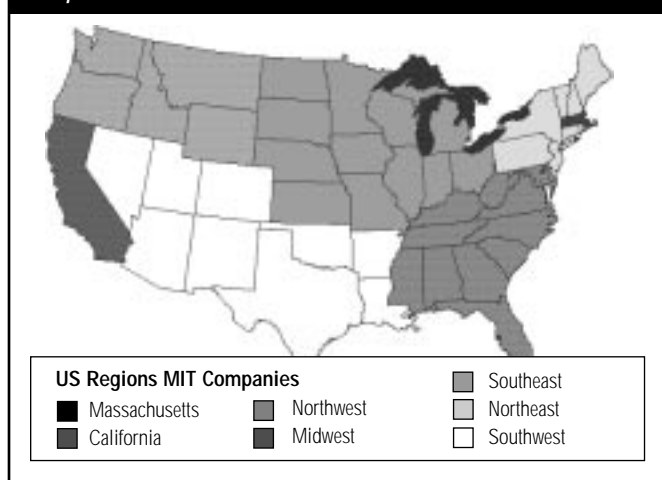
Following a group of companies over time is no easy task. Companies change addresses, phone numbers, and even company names. Companies are sold to other companies and may or may not retain their original name and corporate identity. We have done our best to sort out these various changes, and to be careful whether to count total corporate employment (when the MIT graduate founded the original company, as with Digital Equipment Corporation) or simply subsidiary employment (when an MIT-related company such as Lotus Development was sold to a non-MIT-related company such as IBM). Over the longer term, the tie-in with a source like ABI which actively checks on current employment and works to keep track of changes in corporate identity should help to keep current MIT information on the companies in its “family.”

Table A2 gives summary information on the 3,998 active firms in the MIT database. The data is shown in total and by region, industry, and years since the founder graduated, company size, and the general course area of the founder’s major at MIT.

## Definition of Industry, Geography, Course, and Size Codes

To simplify the presentation, companies are grouped by region and industry. The definitions are consistent between the company database and the founder survey and are presented here. The regions used to aggregate U.S. companies are shown in Map A1.

**Map A1 U.S. REGIONS FOR MIT COMPANIES**



Outside the U.S., the category for **Europe** includes Australia and Japan as well as the European countries. The **Middle East** category includes Africa

## Industries

**Electronics** includes computers, semi-conductors, instruments, and electric and electronic equipment.

**Machinery** includes industrial machinery and transportation equipment.

**Chemicals, Materials** includes chemicals other than drugs as well as high-tech materials and environmental firms.

**Aerospace** includes rockets and defense equipment.

**Other Manufacturing** is manufacturing other than the above categories and includes textiles, paper, plastics, and metal products.

**Energy, Utilities** contains public utilities and energy generating firms.

**Publishing, Schools** links private schools and publishing companies.

**Drugs, Medical** includes biotech companies, medical instruments, and medical practices.

**Software** is self-explanatory

**Architecture** includes architects and construction engineers

**Engineering Consulting** includes all consulting firms that deal in engineering and physical science issues, including environment, process engineering, and advanced materials.

**Management Consulting** includes all socioeconomic consulting, including management, marketing, and economics.

**Finance** includes venture capitalists, money managers, real estate developers, and banking houses.

**Law, Business Services** groups together lawyers, accountants, marketing, advertising, and other business services.

**Table A2 COMPANIES BY FOUNDER'S MAJOR**

Course	All MIT Companies		Last 15 Years	
	Total	Percent	Total	Percent
<b>All Companies</b>	<b>3,589</b>		<b>427</b>	
<b>Engineering</b>	<b>1,997</b>	<b>55.6%</b>	<b>196</b>	<b>45.9%</b>
Aeronautics	151	4.2%	14	3.3%
Civil Engineering	279	7.8%	17	4.0%
Chemical Engineering	267	7.4%	14	3.3%
Electrical Engineering	701	19.5%	74	17.3%
Materials Science	91	2.5%	9	2.1%
Mechanical Engineering	407	11.3%	47	11.0%
Nuclear Engineering	37	1.0%	8	1.9%
Ocean Engineering	64	1.8%	13	3.0%
<b>Life Sciences</b>	<b>88</b>	<b>2.5%</b>	<b>8</b>	<b>1.9%</b>
Biology	66	1.8%	3	0.7%
Nutrition	19	0.5%	2	0.5%
Psychology	3	0.1%	3	0.7%
<b>Physical Science</b>	<b>612</b>	<b>17.1%</b>	<b>39</b>	<b>9.1%</b>
Architecture	171	4.8%	23	5.4%
Chemistry	66	1.8%	1	0.2%
General Science	53	1.5%	0	0.0%
Earth Science	31	0.9%	2	0.5%
Mathematics	83	2.3%	3	0.7%
Meteorology	14	0.4%	0	0.0%
Physics	194	5.4%	10	2.3%
<b>Social Science/Management</b>	<b>892</b>	<b>24.9%</b>	<b>184</b>	<b>43.1%</b>
Urban Planning	89	2.5%	41	9.6%
Economics	48	1.3%	1	0.2%
Graduate Management	352	9.8%	85	19.9%
Humanities	44	1.2%	4	0.9%
Linguistics	1	0.0%	0	0.0%
Management	249	6.9%	11	2.6%
Philosophy	3	0.1%	0	0.0%
Political Science	35	1.0%	13	3.0%
Senior Executive	13	0.4%	6	1.4%
Sloan Fellow	57	1.6%	23	5.4%
Urban Executive	1	0.0%	0	0.0%

Table A2 shows the number of companies founded by graduates from each MIT course. It shows the percent of the total from each course, both for all companies in the database and for those founded since 1981. The total is slightly less than that the 3,998 because the course is not known in all cases. Table A2 also shows the major groupings used in the report — Engineering, Life Sciences, Physical Sciences, and Social Sciences/Management.

Table A3, displayed on the next page, gives basic data from the company database, showing the number of firms, total employment, average employment, sales, whether the founder had a graduate or undergraduate degree, and the course group. This information is shown for all firms by region, industry, company size, course group, and the years since the founder graduated.

Table A3

## SUMMARY DATA, FIRMS STARTED BY MIT GRADUATES

	Total Firms Surveyed	Pct of Firms in Category	Employees				Sales Revenue				Avg Yrs Founders		Percent of Founders in			
			Firms Reporting	Total Jobs 000's	% of all Jobs	Avg Size	Firms Reporting	Total Sales \$ Millions	% of all Sales	Avg Sales \$Mns	Since Grad	% Grad Degree	Engi- neering	Physical Science	Life Sci	Social Studies
<b>All Firms</b>	<b>3,998</b>	<b>100%</b>	<b>2,554</b>	<b>1,119.2</b>	<b>100%</b>	<b>438</b>	<b>2,452</b>	<b>231,578</b>	<b>100%</b>	<b>94.4</b>	<b>32.6</b>	<b>35%</b>	<b>49%</b>	<b>24%</b>	<b>2%</b>	<b>25%</b>
<b>By Region</b>																
Massachusetts	1,065	35.6%	827	353.0	31.7%	427.0	796	53,215	23.0%	66.9	32.4	30%	55%	23%	3%	20%
Northeast	505	16.9%	454	153.5	13.8%	338.0	436	27,681	12.0%	63.5	34.9	35%	46%	25%	2%	27%
Southeast	288	9.6%	258	38.9	3.5%	151.0	250	6,045	2.6%	24.2	31.6	39%	47%	26%	1%	25%
Midwest	200	6.7%	188	105.1	9.4%	559.0	185	37,916	16.4%	204.9	34.3	26%	41%	24%	5%	29%
Northwest	74	2.5%	64	8.8	0.8%	137.0	61	1,395	0.6%	22.9	29.0	33%	50%	29%	4%	16%
California	467	15.6%	388	347.9	31.2%	897.0	377	86,351	37.3%	229.0	30.5	28%	56%	24%	3%	17%
Southwest	172	5.8%	156	79.4	7.1%	509.0	151	16,319	7.1%	108.1	33.9	35%	51%	26%	3%	21%
Canada	23	0.8%	17	0.8	0.1%	44.9	16	101	0.0%	6.3	32.0	57%	33%	33%	0%	33%
Europe	94	3.1%	68	14.6	1.3%	215.0	68	1,228	0.5%	18.1	26.2	69%	43%	19%	0%	38%
Latin America	59	2.0%	46	5.1	0.5%	111.0	43	302	0.1%	7.0	27.0	59%	47%	9%	2%	42%
Asia	31	1.0%	25	3.5	0.3%	138.0	22	254	0.1%	11.6	25.3	65%	61%	19%	0%	19%
Middle East	13	0.4%	11	4.0	0.4%	359.0	8	634	0.3%	79.2	26.1	58%	40%	10%	0%	50%
<b>By Industry</b>																
Electronics	379	13.1%	302	635.0	56.9%	2,102.0	287	129,199	55.9%	450.2	35.4	33%	66%	20%	0%	13%
Machinery	78	2.7%	61	39.1	3.5%	640.0	62	7,014	3.0%	113.1	40.9	20%	71%	21%	0%	8%
Chemicals, Materials	64	2.2%	55	17.8	1.6%	324.0	51	3,774	1.6%	74.0	35.1	47%	67%	16%	0%	18%
Aerospace	19	0.7%	18	89.8	8.0%	4,988.0	16	8,212	7.9%	1,138.2	35.2	21%	42%	47%	0%	11%
Other Manufacturing	229	7.9%	200	112.3	10.1%	561.0	199	36,350	15.7%	182.7	37.5	29%	53%	19%	1%	27%
Energy, Utilities	58	2.0%	50	7.2	0.6%	145.0	50	1,727	0.7%	34.5	32.8	26%	55%	19%	0%	26%
Publishing, Schools	36	1.2%	30	6.1	0.5%	203.0	27	1,000	0.4%	37.0	33.0	31%	31%	17%	7%	45%
Drugs, Medical	199	6.9%	177	23.9	2.1%	135.0	167	5,136	2.2%	30.8	28.8	39%	40%	21%	18%	21%
Software	365	12.7%	336	63.1	5.7%	188.0	325	9,624	4.2%	29.6	25.3	28%	50%	23%	1%	26%
Architecture	299	10.4%	220	16.8	1.5%	76.4	217	2,728	1.2%	12.6	30.6	38%	45%	39%	1%	15%
Engineering Consulting	346	12.0%	290	23.5	2.1%	81.2	276	3,251	1.4%	11.8	33.2	46%	63%	26%	2%	8%
Management Consulting	243	8.4%	216	12.2	1.1%	56.5	210	1,692	0.7%	8.1	30.7	45%	33%	20%	2%	45%
Finance	195	6.8%	155	14.7	1.3%	94.6	145	7,175	3.1%	49.5	33.0	35%	45%	19%	0%	36%
Law, Business Service	122	4.2%	103	39.3	3.5%	381.0	101	1,544	0.7%	15.3	32.3	29%	43%	19%	4%	33%
Other	252	8.7%	229	16.0	1.4%	69.7	224	2,808	1.2%	12.5	33.7	24%	42%	23%	4%	31%
<b>All Firms</b>	<b>3,998</b>	<b>100%</b>	<b>2,554</b>	<b>1,119.2</b>	<b>100%</b>	<b>438.2</b>	<b>2,452</b>	<b>231,578</b>	<b>100%</b>	<b>94.4</b>	<b>32.6</b>	<b>35%</b>	<b>49%</b>	<b>24%</b>	<b>2%</b>	<b>25%</b>
<b>By Years Since Founder Graduation</b>																
75 or more	18	0.5%	8	172.4	17.6%	21,549.0	8	28,547	13.9%	3,568.4	98.7	6%	100%	0%	0%	0%
50—75	370	9.9%	224	306.2	31.2%	1,366.9	219	91,121	44.2%	416.1	57.7	16%	62%	26%	1%	10%
30—50	1,628	43.6%	1,030	398.6	40.7%	386.9	989	67,312	32.7%	68.1	39.7	28%	52%	26%	1%	21%
15—30	1,260	33.7%	864	80.4	8.2%	93.0	839	16,101	7.8%	19.2	23.3	41%	43%	24%	4%	28%
Less than 15	461	12.3%	318	22.2	2.3%	69.8	294	2,897	1.4%	9.9	10.4	61%	40%	15%	2%	43%
<b>By Company Size (Number of Employees)</b>																
5,000 or more	29	1.1%	29	816.0	72.9%	28,137.0	29	172,236	74.6%	5,939.2	47.5	19%	67%	24%	0%	10%
500—5,000	115	4.5%	115	201.4	18.0%	1,751.4	113	38,165	16.5%	337.7	41.2	33%	59%	21%	1%	19%
50—500	485	19.0%	485	79.8	7.1%	164.6	469	16,159	7.0%	34.5	35.9	34%	53%	19%	2%	25%
Less than 50	1,925	75.4%	1,925	22.0	2.0%	11.5	1,807	4,342	1.9%	2.4	30.3	35%	49%	24%	3%	24%
<b>By Founder's Major at MIT</b>																
Engineering	1,755	48.8%	1,190	521.6	64.9%	438.3	1,144	114,813	65.9%	100.4	34.2	28%	100%	0%	0%	0%
Physical Sciences	860	23.9%	538	196.4	24.4%	365.0	528	44,462	25.5%	84.2	33.8	33%	0%	100%	0%	0%
Life Sciences	88	2.4%	67	7.6	0.9%	113.0	64	1,277	0.7%	20.0	27.8	19%	0%	0%	100%	0%
Social Studies	892	24.8%	554	78.5	9.8%	141.6	535	13,768	7.9%	25.7	27.6	51%	0%	0%	0%	100%
<b>Founder Degree—Graduate/Undergraduate</b>																
Graduate	1,314	36.6%	845	284.9	35.4%	337.2	804	71,779	41.2%	89.3	27.3	100%	39%	23%	1%	37%
Undergrad	2,424	67.4%	1,600	727.7	90.5%	454.8	1,546	140,995	80.9%	91.2	35.5	0%	54%	25%	3%	18%

The tables which follow summarize information from the survey of company founders. Table A4 gives basic information about the companies of the participants — their industry, employment, sales, and location.

## Summary Tables — the Survey of Company Founders

Table A4

### SUMMARY INFORMATION, FOUNDERS PARTICIPATING IN THE SURVEY

	Total Firms Surveyed	Pct of Firms in Category	Firm Revenue		Employees		Average Years Since MIT Grad
			Firms Reporting	Avg Rev \$ Mns	Firms Reporting	Average Size	
<b>All Surveys</b>	<b>2,505</b>		<b>1,996</b>	<b>708.0</b>	<b>2,115</b>	<b>2,240</b>	<b>31</b>
<b>Only Surveys Submitted by Founders</b>							
All Founders	1,334	1,019	17.1	1,080	92	32	
<b>Founders by Region where Company Founded</b>							
Massachusetts	412	32%	328	26.8	350	152	31
Northeast	282	22%	221	19.5	235	80	34
Southeast	164	13%	131	9.3	130	63	32
Midwest	123	9%	99	5.9	110	40	34
Northwest	40	3%	31	13.1	33	88	27
California	160	12%	129	8.6	137	61	29
Southwest	98	8%	69	13.2	73	34	34
Canada	1	0%	0	0.0	1	5	29
Europe	6	0%	4	7.8	4	54	29
Latin America	6	0%	4	1.1	4	13	39
Asia	1	0%	1	110.0	1	60	26
Middle East	2	0%	1	0.3	2	78	30
<b>By Years Since Founder Left MIT</b>							
15 or less	179	13%	144	1.6	158	27	11
16 to 30	450	34%	373	47.8	396	189	23
More than 30	705	53%	502	22.7	526	133	44
<b>By Industry—All Regions</b>							
Electronics	157	12%	123	35.8	124	178	34
Machinery	33	2%	25	30.2	28	217	37
Chemicals, Materials	31	2%	23	19.1	25	90	40
Aerospace	8	1%	7	14.4	7	109	31
Other Manufacturing	96	7%	78	13.3	80	82	37
Energy, Utilities	21	2%	15	69.8	15	100	38
Publishing, Schools	26	2%	18	4.6	20	27	33
Drugs, Medical	83	6%	58	39.0	76	233	27
Software	186	14%	149	10.8	159	78	23
Architecture	96	7%	79	3.3	79	34	36
Engineering Consulting	200	15%	158	7.2	168	64	34
Management Consulting	125	9%	97	5.8	101	38	29
Finance	76	6%	54	53.6	63	127	34
Law, Business Services	74	6%	58	9.1	60	30	33
Other	122	9%	77	4.5	75	27	36

Table A4 gives a summary of the 1,334 company founders who responded to the MIT survey. (The survey was also sent to MIT graduates who are top executives in firms they did not start themselves; because the companies they work for are much larger and older than the MIT founded companies, we did not include these responses in this report.)

The survey asked respondents where their companies sold their product and where their employees were located, by the regions we've used to group firms in the

company database. Table A5 shows the percent of company sales going to each of these regions, by region where the company is located. For example, only 17% of the sales of MIT companies in Massachusetts go to Massachusetts markets. Using this same information, Table A5Ex shows exports as a percent of company sales, by region and industry. Finally, Table A6 shows the percentage of company employees located in each region. This is shown by region of company headquarters and, for Massachusetts, by industry.

Table A5

## REGION SHARE OF OVERALL COMPANY SALES, BY COMPANY LOCATION

	Firms Reporting	Total Revenue \$ Mns	Total Exports	Massachusetts	Other U.S. Northeast	U.S. Southeast	U.S. Midwest	U.S. Northwest	California	U.S. Southwest	Canada, Alaska, Hawaii	Europe, Australia	Latin America	Asia, India	Russia, Middle-East
<b>All Founders</b>	904	9,983	26%	10%	21%	12%	13%	3%	11%	5%	3%	14%	2%	6%	1%
<b>By Region Company Founded</b>															
Massachusetts	273	4,839	35%	17%	12%	8%	13%	2%	9%	4%	4%	20%	2%	8%	1%
Northeast	198	2,104	24%	3%	45%	9%	10%	0%	7%	2%	2%	13%	2%	6%	1%
Southeast	119	1,110	3%	3%	37%	45%	2%	1%	6%	3%	0%	1%	0%	1%	0%
Midwest	94	523	5%	5%	10%	11%	56%	6%	4%	3%	1%	4%	0%	1%	0%
Northwest	31	387	16%	0%	15%	3%	21%	18%	24%	3%	0%	0%	0%	16%	0%
California	118	642	24%	2%	11%	3%	8%	3%	45%	5%	2%	17%	0%	3%	2%
Southwest	62	232	3%	11%	8%	7%	8%	5%	4%	54%	0%	1%	1%	1%	0%
<b>By Industry — Massachusetts</b>															
Electronics	41	1,184	52%	11%	7%	7%	11%	3%	5%	3%	3%	31%	2%	15%	1%
Machinery	6	7	12%	63%	9%	4%	5%	1%	2%	2%	1%	3%	1%	6%	0%
Chemicals, Materials	8	115	39%	15%	15%	9%	7%	5%	9%	0%	0%	24%	0%	15%	0%
Other Manufacturing	16	214	9%	39%	16%	5%	22%	0%	7%	1%	1%	6%	1%	1%	0%
Publishing, Schools	4	12	5%	5%	29%	19%	7%	12%	15%	9%	5%	0%	0%	0%	0%
Drugs, Medical	12	782	16%	18%	15%	13%	15%	2%	15%	8%	1%	7%	2%	6%	0%
Software	52	963	65%	6%	9%	3%	7%	1%	6%	2%	14%	43%	2%	6%	1%
Architecture	16	42	3%	56%	22%	10%	5%	0%	0%	4%	1%	1%	0%	1%	0%
Engineering Consulting	39	164	18%	31%	13%	9%	20%	3%	4%	2%	1%	8%	0%	9%	0%
Management Consulting	29	229	23%	19%	13%	2%	37%	1%	4%	1%	2%	2%	6%	3%	9%
Finance	11	37	2%	61%	15%	5%	1%	9%	1%	6%	1%	1%	0%	0%	0%
Law, Business Services	14	21	12%	73%	7%	2%	1%	1%	3%	0%	0%	5%	0%	6%	0%
Other	25	69	0%	67%	21%	2%	8%	0%	1%	0%	0%	0%	0%	0%	0%

Table A5Ex

## EXPORT SHARE OF SALES, BY INDUSTRY AND BY REGION

	U.S. Total		Massachusetts		Northeast		Southeast		Midwest		Northwest		California		Southwest	
	Firms Reporting	Export Percent	Firms	Export Percent	Firms	Export Percent	Firms	Export Percent	Firms	Export Percent	Firms	Export Percent	Firms	Export Percent	Firms	Export Percent
Electronics	90	44%	41	52%	16	42%	7	9%	6	18%	3	20%	13	21%	4	1%
Machinery	21	19%	6	12%	4	20%	2	0%	6	9%	2	0%	1	0%		
Chemicals, Materials	18	23%	8	39%	2	0%	3	0%	2	8%	3	38%				
Aerospace	7	17%	1	100%	3	15%	1	25%	2	0%						
Other Manufacturing	62	22%	16	9%	10	37%	8	0%	12	1%	3	30%	7	26%	5	0%
Energy, Utilities	11	16%	5	0%	2	1%	1	0%	2	0%						
Publishing, Schools	13	4%	4	5%	2	2%	1	10%	3	3%	3	4%				
Drugs, Medical	55	17%	12	16%	11	25%	10	0%	7	5%	12	85%	3	0%		
Software	134	52%	52	65%	24	38%	10	15%	12	0%	6	3%	21	28%	7	0%
Architecture	75	3%	16	3%	25	0%	8	0%	7	0%	4	0%	11	5%	4	0%
Engineering Consulting	146	11%	39	18%	32	29%	25	5%	14	4%	7	1%	13	3%	14	7%
Management Consulting	94	22%	29	23%	21	58%	16	1%	10	8%	10	1%	7	65%		
Finance	55	2%	11	2%	15	9%	7	0%	8	0%	3	0%	8	1%	2	0%
Law, Business Services	54	2%	14	12%	17	0%	8	24%	1	0%	2	0%	9	36%	3	0%
Other	69	5%	25	0%	13	9%	13	1%	6	5%	2	0%	5	83%	4	0%

## Company Funding, Location, and Competitive Edge

Table A7 explores the sources of MIT company funding. For these questions, as for most of those presented, respondents were asked to rank the importance of an item, with 5 the most important and 0 indicating the item

wasn't important at all. To summarize these responses, we calculated the average response of all respondents in each category. If none of the questions in a particular series was answered, then blank items were not calculated. If some were answered and others not, the blanks were counted as zeros.

Table A6

## LOCATION OF FIRM EMPLOYEES, BY REGION OF FIRM HEADQUARTERS

	Employment			Other U.S. Massachusetts	U.S. North-east	U.S. South-east	U.S. Mid-West	U.S. North-west	U.S. California	U.S. South-west	Canada, Alaska, Hawaii	Europe, Australia	Latin America	Russia, Asia, India	Middle- East
	Firms Reporting	Total 000's	Ave- rage												
<b>All Founders</b>	897	69	77	26%	20%	13%	12%	4%	9%	4%	1%	7%	1%	2%	1%
<b>By Region Company Founded</b>															
Massachusetts	279	37.1	133	46%	16%	6%	10%	1%	5%	3%	1%	9%	1%	2%	1%
Northeast	196	11.2	57	7%	48%	10%	11%	0%	6%	1%	1%	11%	1%	4%	0%
Southeast	110	7.4	67	1%	23%	71%	1%	1%	1%	1%	0%	0%	0%	0%	0%
Midwest	92	3.9	43	5%	5%	4%	82%	3%	0%	0%	0%	1%	0%	0%	0%
Northwest	30	2.4	80	0%	4%	4%	0%	84%	2%	5%	0%	0%	0%	0%	0%
California	118	4.7	40	2%	12%	2%	4%	1%	66%	7%	2%	6%	0%	0%	0%
Southwest	61	2.1	34	7%	8%	3%	10%	11%	5%	56%	0%	0%	1%	0%	0%
<b>By Industry — Massachusetts</b>															
Electronics	48	8.0	166	60%	22%	2%	2%	1%	5%	1%	0%	3%	0%	3%	0%
Machinery	7	0.1	21	98%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chemicals, Materials	8	0.8	102	46%	2%	0%	9%	0%	9%	9%	0%	17%	0%	9%	0%
Other Manufacturing	17	1.6	92	40%	41%	0%	13%	0%	5%	0%	0%	0%	0%	0%	0%
Publishing, Schools	2	0.1	51	79%	4%	4%	4%	2%	5%	1%	1%	0%	0%	0%	0%
Drugs, Medical	15	12.0	802	18%	13%	15%	14%	3%	9%	8%	1%	18%	1%	1%	0%
Software	55	7.0	127	68%	6%	1%	4%	0%	3%	2%	0%	10%	1%	4%	1%
Architecture	13	0.4	32	92%	2%	1%	5%	0%	0%	0%	0%	0%	0%	0%	0%
Engineering Consulting	36	3.7	102	40%	34%	4%	12%	3%	2%	1%	1%	3%	0%	1%	0%
Management Consulting	28	1.7	60	33%	7%	1%	36%	0%	3%	0%	1%	1%	6%	3%	9%
Finance	13	0.5	38	90%	6%	4%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Law, Business Services	13	0.5	37	91%	8%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other	24	0.8	33	89%	10%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%

Table A7

## SOURCES OF COMPANY FINANCING

	Founder's Firms Reporting	Company Personal Savings	Cash Flow	Founder's Family	Founder's Friends	Informal Investors	Strategic Partners	Commercial Banks	Venture Capital Firms	U.S. Govt	
										DoD/ DARPA	NSF/ SBIR
<b>All Founders</b>	1,272	2.31	1.96	.53	.26	.31	.39	.51	.21	.14	.02
<b>By Region Company Founded</b>											
Massachusetts	408	2.00	1.84	.45	.29	.47	.43	.49	.44	.20	.01
Northeast	277	2.24	1.99	.62	.23	.25	.31	.44	.09	.07	.02
Southeast	159	2.26	1.88	.53	.21	.24	.43	.58	.03	.14	.03
Mid West	117	2.51	1.85	.63	.24	.18	.34	.67	.10	.03	.01
Northwest	39	3.31	2.41	.49	.21	.18	.46	.62	.13	.00	.04
California	159	2.65	2.11	.51	.25	.19	.53	.38	.25	.19	.03
Southwest	96	2.85	2.23	.55	.33	.41	.29	.69	.03	.13	.04
<b>By Industry</b>											
Electronics	84	3.54	2.94	1.33	.96	1.26	.94	1.01	1.10	.55	.09
Machinery	19	3.95	3.37	.89	.37	.95	1.42	1.58	.05	.21	.09
Chemicals, Materials	13	4.00	2.92	.85	.85	1.77	1.23	1.08	.62	2.15	.15
Aerospace	7	3.71	2.57	.00	.29	.57	.71	1.57	.00	.29	.00
Other Manufacturing	45	3.98	3.58	1.20	.67	.67	.53	1.82	.29	.02	.01
Energy, Utilities	11	3.18	1.91	1.00	1.36	1.09	.55	1.55	.00	.00	.00
Publishing, Schools	14	4.36	2.71	1.50	.93	.86	.71	.36	.00	.29	.00
Drugs, Medical	46	3.33	3.09	.96	.70	.63	.89	1.13	1.00	.15	.00
Software	134	3.92	3.58	.74	.31	.55	.80	.46	.57	.26	.02
Architecture	56	3.95	3.98	1.04	.20	.04	.52	1.02	.02	.09	.02
Engineering Consulting	111	4.18	3.42	.66	.29	.20	.32	.77	.14	.24	.06
Management Consulting	68	4.43	3.79	.50	.12	.19	.59	.26	.04	.19	.05
Finance	40	4.30	3.13	1.10	.50	.68	.78	1.53	.00	.00	.00
Law, Business Services	38	4.39	3.50	1.21	.34	.13	.45	.82	.05	.00	.00
Other	51	4.24	3.24	1.00	.39	.45	.69	.80	.25	.02	.03
<b>By Years Since Founder Left MIT</b>											
15 or less	127	3.92	3.18	.91	.48	.61	.74	.57	.43	.19	.06
16 to 30	297	3.96	3.56	.93	.44	.46	.78	.82	.47	.25	.04
More than 30	313	4.06	3.29	.90	.47	.59	.56	1.07	.24	.24	.02
<b>By Company Size (Employees)</b>											
500 or more	25	3.40	2.92	1.08	1.28	.96	.84	.56	1.40	.44	.01
50 to 500	114	3.42	3.53	.79	.37	.54	.78	1.79	.99	.34	.01
Less than 50	493	4.13	3.45	.91	.40	.47	.64	.71	.16	.20	.05

Table A8

## SOURCES OF COMPETITIVE EDGE

	Firms Reporting	Dominant Position, Niche Market	5 = Most Important, 0 = Not Important — Average for Companies in Category								Government Support Progs
			Superior Performance	Price Leadership	Market Image, Brand Recog	Product Quality, Reliability	Customer Service, Responsiveness	Time to Market	Innovation, New Tech	Management Expertise	
<b>All Founders</b>	1,216	3.42	4.23	2.04	2.76	3.71	3.97	2.20	2.92	3.10	.58
<b>By Region Company Founded</b>											
Massachusetts	383	3.59	4.25	2.11	3.11	3.92	4.08	2.40	3.23	3.15	.62
Northeast	262	3.30	4.29	2.02	2.73	3.63	3.90	2.06	2.84	3.07	.43
Southeast	157	3.49	4.21	2.01	2.59	3.68	4.05	2.06	2.54	2.99	.67
Midwest	116	3.03	4.17	1.98	2.69	3.75	3.97	2.23	2.99	3.25	.64
Northwest	38	3.68	4.58	2.24	2.63	3.97	4.13	2.61	3.05	3.11	.58
California	154	3.47	4.21	2.03	2.45	3.59	3.73	2.22	2.88	2.92	.61
Southwest	89	3.19	4.04	1.76	2.42	3.15	3.84	1.69	2.51	3.25	.39
<b>By Industry</b>											
Electronics	144	3.84	4.13	2.57	3.10	4.15	4.05	3.14	4.03	3.40	.86
Machinery	32	4.09	3.88	2.09	2.47	3.78	3.97	2.25	3.63	2.88	.19
Chemicals, Materials	29	3.55	3.97	2.24	2.28	3.83	3.69	2.59	3.45	3.38	.69
Aerospace	8	3.13	4.38	3.63	2.13	3.00	3.25	2.75	3.50	1.88	1.38
Other Manufacturing	88	3.32	4.03	2.31	2.80	4.10	4.00	2.15	2.67	3.23	.39
Energy, Utilities	20	3.15	3.85	1.95	2.20	2.95	3.75	1.80	2.40	3.85	.50
Publishing, Schools	23	3.57	3.87	1.96	2.91	3.74	3.26	2.13	2.70	2.91	.65
Drugs, Medical	75	3.79	4.47	1.77	2.89	3.84	3.48	2.01	2.92	2.87	.79
Software	179	3.82	4.18	2.13	2.96	3.96	3.93	3.00	3.57	3.22	.60
Architecture	92	3.11	4.49	2.00	2.52	3.41	4.15	1.86	2.30	2.68	.38
Engineering Consulting	179	3.33	4.41	1.78	2.74	3.44	4.08	1.89	3.21	2.77	.72
Management Consulting	120	3.13	4.48	1.56	2.92	3.58	4.17	1.46	2.05	2.97	.43
Finance	71	2.35	4.18	1.61	1.97	3.27	3.87	1.45	2.01	3.89	.65
Law, Business Services	67	3.06	4.18	1.88	2.70	3.48	3.91	1.85	2.21	2.85	.28
Other	89	3.54	3.97	2.44	2.88	3.79	4.10	2.03	2.21	3.20	.38
<b>By Years Since Founder Left MIT</b>											
15 or less	167	3.72	4.38	2.12	3.09	4.11	4.11	3.04	3.37	3.22	.88
16 to 30	437	3.70	4.35	2.14	3.02	3.81	4.03	2.28	2.86	3.04	.55
More than 30	612	3.15	4.10	1.94	2.49	3.54	3.88	1.91	2.83	3.10	.51
<b>By Company Size (Employees)</b>											
500 or more	42	3.76	4.50	1.93	2.98	3.69	3.69	2.60	3.83	3.74	.31
50 to 500	183	3.91	4.43	2.33	3.17	4.20	4.25	2.67	3.43	3.63	.77
Less than 50	849	3.36	4.21	2.02	2.72	3.66	3.98	2.10	2.78	2.98	.58



Table A9

## OBSTACLES TO SUCCESS IN NATIONAL MARKETS

5 = Most Important, 0 = Not Important — Average for Companies in Category

	Firms Reporting	Difficulty Obtaining Finance	Intellectual Property Rights Violations	Cultural Differences	Tariffs	Other Non-Tariff Trade Issues	Government Regulations	Other
<b>All Founders</b>	883	2.20	.76	.52	.20	.30	2.07	.83
<b>By Region Company Founded</b>								
Massachusetts	274	2.20	.86	.53	.23	.35	1.72	.73
Northeast	175	2.06	.59	.37	.17	.38	2.17	.75
Southeast	120	2.13	.82	.57	.17	.28	2.41	.94
Midwest	85	2.06	.87	.49	.16	.25	2.19	.96
Northwest	29	2.34	.79	.21	.03	.03	2.41	1.10
California	129	2.41	.71	.60	.26	.26	1.95	.79
Southwest	63	2.37	.51	.59	.21	.14	2.60	.98
<b>By Industry</b>								
Electronics	119	2.58	.88	.55	.39	.41	1.91	.51
Machinery	28	1.93	.82	.43	.36	.00	1.79	1.04
Chemicals, Materials	23	3.09	1.13	.57	.52	.43	2.70	.00
Aerospace	7	2.43	.86	.57	.00	.00	3.71	.71
Other Manufacturing	61	2.38	.49	.56	.36	.34	2.57	.84
Energy, Utilities	19	3.32	.26	.68	.53	.95	2.89	.53
Publishing, Schools	15	2.87	1.33	.47	.20	.13	1.53	.67
Drugs, Medical	56	2.20	.71	.46	.02	.36	3.09	.59
Software	136	2.25	1.15	.45	.16	.25	1.35	.89
Architecture	59	1.66	.47	.85	.10	.51	2.08	1.15
Engineering Consulting	135	1.78	.88	.45	.08	.22	2.09	1.01
Management Consulting	70	1.50	.56	.70	.04	.30	1.53	1.10
Finance	57	2.42	.70	.53	.05	.07	2.67	.51
Law, Business Services	35	2.26	.40	.49	.29	.14	1.91	1.00
Other	66	2.41	.29	.33	.33	.39	2.20	.98
<b>By Years Since Founder Left MIT</b>								
15 or less	135	2.61	1.02	.58	.26	.32	1.51	.79
16 to 30	316	2.26	0.79	.58	.14	.27	1.98	.79
More than 30	435	2.03	0.65	.47	.23	.32	2.30	.86
<b>By Company Size (Employees)</b>								
500 or more	32	1.41	.75	.75	.09	.16	2.03	.47
50 to 500	140	2.16	.76	.44	.29	.24	2.36	.70
Less than 50	601	2.24	.78	.49	.19	.31	1.97	.88

Table A10

## OBSTACLES TO SUCCESS IN FOREIGN MARKETS

5 = Most Important, 0 = Not Important — Average for Companies in Category

	Firms Reporting	Difficulty Obtaining Finance	Intellectual Property Rights Violations	Cultural Differences	Tariffs	Other Non-Tariff Trade Issues	Regulations	Other
<b>All Founders</b>	585	1.66	1.39	2.12	.99	1.13	1.92	.73
<b>By Region Company Founded</b>								
Massachusetts	203	1.48	1.47	2.15	1.03	1.08	1.83	.75
Northeast	112	1.42	1.27	2.08	.92	1.15	1.85	.71
Southeast	81	1.69	1.38	2.10	.70	1.10	2.02	.59
Midwest	47	1.34	.87	2.36	.87	1.28	1.81	.98
Northwest	17	1.76	1.94	1.76	.82	.94	1.65	.76
California	79	2.24	1.52	1.90	1.19	1.23	2.04	.56
Southwest	30	2.30	1.73	2.50	1.37	.93	2.67	.50
<b>By Industry</b>								
Electronics	109	1.79	1.23	2.08	1.23	1.44	2.09	.53
Machinery	15	0.67	1.13	2.13	1.67	.93	2.13	.67
Chemicals, Materials	18	2.39	1.61	1.83	1.17	.83	2.06	.28
Aerospace	6	2.17	.17	1.33	.83	1.33	2.83	1.00
Other Manufacturing	30	2.10	1.30	2.13	1.33	1.13	2.33	1.00
Energy, Utilities	8	2.38	1.38	2.13	2.25	1.88	3.75	1.25
Publishing, Schools	14	1.14	2.07	2.50	.86	1.00	1.07	.36
Drugs, Medical	29	2.21	1.97	1.59	1.07	1.14	2.31	.10
Software	101	1.74	2.10	2.33	1.14	1.22	1.73	.76
Architecture	27	1.22	1.19	2.11	.37	.48	.96	1.52
Engineering Consulting	84	1.54	1.52	2.30	.57	1.04	2.11	.82
Management Consulting	64	1.08	.72	2.47	.30	.55	1.44	.89
Finance	19	2.00	1.37	2.05	.74	1.05	2.32	.26
Law, Business Services	23	1.65	1.09	1.43	1.26	1.09	1.57	.61
Other	38	1.68	.74	1.71	1.50	1.74	2.11	.92
<b>By Years Since Founder Left MIT</b>								
15 or less	102	1.90	1.78	2.29	1.21	1.23	1.80	.91
16 to 30	220	1.73	1.50	2.25	.92	1.18	2.00	.76
More than 30	263	1.50	1.14	1.95	.96	1.05	1.91	.63
<b>By Company Size (Employees)</b>								
500 or more	23	.70	1.43	2.65	1.65	1.52	1.61	.39
50 to 500	111	1.67	1.32	2.14	1.17	1.09	2.05	.86
Less than 50	391	1.70	1.45	2.14	.92	1.13	1.89	.71

Table A11 gives information on respondents' contacts with MIT and other universities. Twenty-five percent of all founders reported some kind of ongoing contact with MIT; those that did so reported an average of 6.5 interactions each year.

*Table A11*

**CONTACTS WITH MIT AND OTHER UNIVERSITIES**

	MIT		Other Universities		MIT or Other Universities		Purpose of Contact 1 to 5, 5 = most important					
	Pct of All Firms	Annual Inter-Actions	Pct of All Firms	Annual Inter-Actions	Pct of All Firms	Annual Inter-Actions	Number of Firms	Faculty Consulting	Joint R&D	Tech-nology License	Continuing Prof Ed	Re-cruiting
<b>All Founders</b>	25%	6.5	40%	9.5	47%	12.8	571	3.1	1.7	1.0	2.6	2.5
<b>By Region Company Founded</b>												
Massachusetts	44%	8.3	39%	9.9	53%	15.4	200	3.3	1.7	1.0	2.3	2.7
Northeast	20%	3.3	35%	7.6	43%	9.1	108	3.1	1.8	1.0	2.4	2.3
Southeast	19%	5.2	45%	10.4	49%	12.7	76	3.0	1.8	0.8	2.5	2.4
Midwest	12%	2.6	43%	14.0	46%	15.5	48	3.4	2.1	1.0	3.0	2.4
Northwest	25%	5.1	58%	9.4	58%	14.3	19	2.9	2.2	1.7	3.5	2.8
California	18%	6.6	46%	8.8	53%	10.6	79	2.8	1.6	1.0	3.0	2.3
Southwest	11%	2.6	40%	7.1	42%	9.8	36	2.6	1.3	1.1	2.4	2.2
<b>By Industry</b>												
Electronics	30%	6.8	41%	6.6	54%	8.9	75	2.8	1.8	0.9	2.5	2.6
Machinery	30%	8.5	33%	16.0	48%	19.4	14	2.8	1.1	1.7	2.1	2.1
Chemicals, Materials	32%	10.2	45%	16.5	52%	27.1	17	3.8	2.2	0.9	1.4	1.8
Aerospace	0%	N/A	50%	4.0	50%	4.0	4	3.0	1.8	0.3	4.3	4.3
Other Manufacturing	14%	6.0	29%	6.8	33%	9.9	25	2.3	1.8	0.8	2.6	2.0
Energy, Utilities	24%	4.6	29%	24.8	33%	31.6	7	4.1	3.6	2.1	4.7	3.6
Publishing, Schools	27%	6.8	42%	21.5	46%	35.5	10	1.1	0.4	0.1	2.6	0.3
Drugs, Medical	17%	7.2	54%	13.0	58%	16.6	49	4.0	2.5	1.5	2.9	1.8
Software	26%	5.0	32%	8.8	40%	11.5	68	2.5	1.3	0.8	1.9	3.8
Architecture	30%	5.8	39%	6.8	52%	8.6	40	2.8	1.2	0.5	3.6	2.5
Engineering Consulting	31%	8.1	53%	8.9	60%	12.4	110	3.6	2.6	1.5	3.1	2.4
Management Consulting	35%	7.2	58%	10.9	64%	15.3	75	3.6	1.3	0.8	2.1	2.2
Finance	20%	3.7	30%	4.8	36%	6.1	23	2.9	1.4	0.9	2.1	2.3
Law, Business Services	19%	4.7	24%	8.7	34%	8.9	24	2.8	0.7	0.9	2.3	2.5
Other	16%	4.1	24%	8.8	29%	11.0	30	2.1	1.2	0.6	2.6	2.8
<b>By Years Since Founder Left MIT</b>												
15 or less	34%	7.9	44%	9.7	55%	13.8	86	2.8	2.0	1.4	2.4	3.3
16 to 30	28%	6.3	44%	8.4	53%	11.1	217	3.1	1.8	1.0	2.6	2.8
More than 30	21%	6.0	36%	10.4	42%	13.8	268	3.2	1.6	0.9	2.6	2.0
<b>By Company Size (Employees)</b>												
500 or more	32%	6.1	45%	9.7	52%	12.1	24	3.6	1.8	1.0	3.1	3.0
50 to 500	37%	8.0	46%	10.8	57%	16.1	97	3.3	1.9	1.1	2.5	3.2
Less than 50	25%	5.9	42%	9.1	49%	11.7	401	3.0	1.7	1.0	2.6	2.4

Table A12

## PATENTS HELD, INVESTMENT IN R&amp;D &amp; MARKETING

	R&D, Marketing			Founders Reporting Patents					
	Firms Reporting	Percent of Revenue Invested in		Firms Reporting	Percent of Founders	Number of Patents			
		R&D	Marketing			Firm		Personal	
					Patents	Pending	Patents	Pending	
<b>All Founders</b>	900	10.2%	11.4%	458	34%	9.5	2.7	9.2	0.8
<b>By Region Company Founded</b>									
Massachusetts	282	11.9%	12.0%	170	41%	15.7	2.9	7.3	0.9
Northeast	192	9.1%	10.5%	89	32%	10.2	2.6	22.7	0.8
Southeast	113	9.9%	12.2%	44	27%	5.9	7.2	7.1	0.6
Midwest	87	7.9%	9.7%	35	28%	3.3	2.1	4.1	0.8
Northwest	30	10.7%	10.8%	12	30%	1.1	0.5	1.8	0.3
California	120	10.9%	11.6%	72	45%	3.7	0.9	5.2	1.0
Southwest	62	8.3%	12.8%	32	33%	2.3	0.6	2.7	0.7
<b>By Industry</b>									
Electronics	120	12.2%	12.8%	118	75%	8.9	3.6	8.8	0.7
Machinery	24	5.5%	11.9%	25	76%	24.8	0.8	6.2	1.1
Chemicals, Materials	26	13.7%	12.9%	23	74%	32.9	6.1	6.9	0.7
Aerospace	6	2.9%	5.8%	3	38%	6.7	2.0	1.3	0.3
Other Manufacturing	67	6.5%	8.9%	32	33%	3.6	0.8	7.7	0.5
Energy, Utilities	12	4.2%	8.9%	4	19%	2.3	1.3	2.5	0.0
Publishing, Schools	15	9.7%	20.1%	7	27%	0.7	0.4	7.4	0.6
Drugs, Medical	53	13.6%	9.3%	35	42%	23.5	12.1	51.7	2.5
Software	132	17.9%	14.1%	53	28%	0.5	0.7	1.8	0.9
Architecture	76	7.5%	6.9%	12	13%	1.6	0.2	3.6	0.3
Engineering Consulting	126	11.2%	11.5%	82	41%	3.1	0.9	4.9	0.8
Management Consulting	94	8.9%	12.2%	19	15%	27.3	0.2	1.4	0.4
Finance	51	4.4%	10.9%	12	16%	0.1	0.1	3.9	0.2
Law, Business Services	35	4.4%	11.0%	10	14%	3.7	3.2	2.5	0.7
Other	63	3.6%	10.8%	23	19%	4.8	0.4	4.8	0.3
<b>By Years Since Founder Left MIT</b>									
15 or less	124	13.6%	11.8%	127	28%	2.6	3.3	4.0	1.3
16 to 30	345	10.8%	10.8%	275	39%	3.9	2.4	13.3	0.5
More than 30	431	8.7%	11.8%	56	31%	13.6	2.5	1.3	1.3
<b>By Company Size (Employees)</b>									
500 or more	32	9.4%	10.9%	24	55%	45.2	9.0	18.8	0.3
50 to 500	157	9.3%	11.5%	99	52%	7.5	5.2	20.0	0.6
Less than 50	636	10.3%	10.8%	275	31%	6.3	1.4	5.6	1.0

In calculating the average number of patents held, we capped the number held by any one company at 500 to minimize the extent to which one company could skew the averages for an entire category.

Table A13

## DETERMINANTS OF COMPANY LOCATION

5 = Most Important, 0 = Not Important — Average for Companies in Category

	Firms Reporting	Access to Skilled		Proximity to Principal Markets	Favorable Environment		Low Business Cost	Quality of Life	Access to		
		Labor	Professionals		Regulatory	Tax			MIT	Other Universities	Other Factors
<b>All Founders</b>	1,210	1.35	2.45	2.44	.61	.61	1.20	2.75	.71	1.06	1.38
<b>By Region Company Founded</b>											
Massachusetts	391	1.69	2.96	1.99	.46	.44	.95	2.73	1.69	1.29	1.34
Northeast	257	1.19	2.28	2.76	.49	.54	1.18	2.44	.39	.82	1.41
Southeast	150	1.03	1.99	2.86	.92	1.03	1.58	2.71	.26	.84	1.63
Midwest	111	1.24	2.29	2.81	.83	.78	1.41	2.39	.20	1.05	1.46
Northwest	39	0.69	1.97	2.23	.79	.77	1.49	3.77	.10	1.10	1.26
California	156	1.35	2.52	2.39	.53	.46	.87	3.33	.14	1.16	1.28
Southwest	89	1.33	1.98	2.39	.80	.74	1.72	3.00	.11	.98	1.17
<b>By Industry</b>											
Electronics	147	2.27	3.34	1.59	.52	.64	1.31	2.97	1.16	1.24	1.35
Machinery	29	2.17	2.03	2.31	.83	.62	1.31	2.17	.66	.34	1.55
Chemicals, Materials	30	1.97	2.97	1.20	.33	.17	1.27	2.73	1.17	1.10	1.87
Aerospace	8	1.63	2.38	2.75	.50	.38	1.38	2.25	.13	1.38	2.38
Other Manufacturing	86	1.72	1.65	2.95	1.00	.94	1.74	2.55	.15	.49	1.45
Energy, Utilities	19	1.68	2.21	2.89	1.53	1.74	1.79	2.37	.58	1.00	2.11
Publishing, Schools	21	1.48	1.81	1.86	.57	.48	1.43	2.14	.48	.76	2.05
Drugs, Medical	78	1.50	3.00	2.26	.94	.81	1.05	2.90	.69	1.59	1.41
Software	177	1.24	2.84	2.02	.53	.58	.96	2.68	.82	1.05	1.69
Architecture	90	1.14	2.21	3.59	.57	.49	1.24	3.58	.52	1.09	.61
Engineering Consulting	191	1.07	2.49	2.30	.60	.58	1.18	2.67	.81	1.42	1.24
Management Consulting	118	0.95	2.55	2.52	.36	.42	1.01	2.74	.87	1.25	1.33
Finance	72	0.76	1.78	3.21	.67	.64	1.19	2.35	.44	.47	1.08
Law, Business Services	63	0.89	1.94	3.27	.43	.41	.86	2.92	.41	.84	1.29
Other	81	1.01	1.49	2.68	.62	.68	1.35	2.64	.41	.62	1.62
<b>By Years Since Founder Left MIT</b>											
15 or less	174	1.44	2.67	2.53	.67	.72	1.18	2.81	.84	1.26	1.59
16 to 30	422	1.31	2.59	2.53	.69	.67	1.19	2.95	.69	1.08	1.41
More than 30	614	1.34	2.29	2.36	.54	.54	1.21	2.60	.68	.99	1.31
<b>By Company Size (Employees)</b>											
500 or more	190	1.48	2.69	2.22	.61	.64	1.16	2.52	.87	1.06	.98
50 to 500	181	1.98	2.96	2.25	.76	.80	1.28	2.78	.95	1.05	1.47
Less than 50	839	1.18	2.28	2.53	.58	.57	1.19	2.80	.62	1.06	1.46

Table A14

## FACTORS AFFECTING FIRM EXPANSION

	Firms Reporting	Pct of Firms Planning Expansion	Pct Expand Same Location	Firms Reporting	Skilled Labor	Access to Low-cost Labor	Factors Determining Location 5 = Most Important, 0 = Not Important					Present Home of Company	Low Overall Business Costs
							Skilled Professionals	Proximity to Principal Markets	Favorable Environment	Regulatory	Tax		
<b>All Founders</b>	1,150	48%	87%	781	1.7	1.0	2.8	2.7	1.3	1.3	3.6	1.7	
<b>By Region Company Founded</b>													
Massachusetts	359	57%	91%	268	2.1	1.1	3.3	2.4	1.2	1.2	3.7	1.6	
Northeast	254	41%	86%	155	1.5	0.9	2.3	2.7	1.2	1.2	3.5	1.7	
Southeast	146	42%	88%	90	1.2	0.8	2.5	3.1	1.5	1.2	3.4	2.0	
Midwest	109	41%	89%	76	1.6	1.0	2.7	2.6	1.4	1.4	3.8	1.7	
Northwest	36	50%	71%	22	1.2	0.8	2.5	3.0	1.2	1.8	3.6	1.7	
California	147	52%	79%	101	1.5	1.0	3.0	3.0	1.7	1.6	3.5	1.8	
Southwest	86	45%	82%	58	1.5	0.9	2.3	3.0	1.3	1.4	3.1	1.9	
<b>By Industry</b>													
Electronics	131	65%	88%	104	2.7	1.8	3.2	1.9	1.4	1.7	3.7	2.0	
Machinery	29	59%	94%	24	2.5	1.8	2.6	2.5	1.6	1.4	3.9	2.0	
Chemicals, Materials	24	63%	93%	22	2.4	1.3	2.8	2.2	2.0	1.5	3.7	2.2	
Aerospace	7	43%	50%	5	0.8	0.8	2.6	1.2	2.0	1.4	3.2	2.2	
Other Manufacturing	74	47%	72%	51	1.6	1.7	1.7	2.9	2.2	1.7	3.4	2.2	
Energy, Utilities	18	50%	88%	14	1.1	1.1	1.9	3.7	1.6	1.6	2.8	1.6	
Publishing, Schools	21	14%	50%	11	1.9	1.3	2.5	3.3	1.2	1.8	2.9	2.0	
Drugs, Medical	74	55%	95%	55	1.5	0.9	2.9	2.6	1.6	1.3	2.8	1.7	
Software	169	63%	95%	135	1.6	0.6	3.3	2.6	0.9	1.1	4.0	1.6	
Architecture	87	34%	82%	50	1.3	0.4	2.2	3.2	1.1	1.1	3.4	1.4	
Engineering Consulting	180	42%	84%	109	1.6	0.9	3.1	2.9	1.5	1.4	3.6	1.8	
Management Consulting	119	37%	78%	70	1.1	0.5	3.4	3.1	0.6	0.7	3.4	1.0	
Finance	70	49%	91%	51	1.2	0.7	2.2	3.3	1.7	1.6	3.1	1.6	
Law, Business Services	63	38%	83%	32	1.9	0.7	2.5	2.9	0.6	0.7	3.6	1.8	
Other	84	35%	85%	48	1.5	1.1	2.0	2.3	1.3	1.5	4.1	1.7	
<b>By Years Since Founder Left MIT</b>													
15 or less	171	67%	93%	135	1.9	0.9	3.5	3.0	1.2	1.4	4.0	1.9	
16 to 30	426	54%	85%	303	1.8	1.0	2.8	2.8	1.3	1.3	3.5	1.6	
More than 30	553	37%	85%	343	1.6	0.9	2.5	2.5	1.4	1.3	3.5	1.7	
<b>By Company Size (Employees)</b>													
500 or more	33	64%	80%	31	2.1	1.2	3.3	2.3	0.9	1.0	3.0	1.1	
50 to 500	167	66%	83%	145	2.1	1.3	2.8	2.9	1.5	1.5	3.6	1.9	
Less than 50	845	45%	89%	545	1.6	0.9	2.8	2.7	1.3	1.3	3.6	1.7	

**Table A15 MIT-RELATED COMPANIES—JOBS AND SALES, BY STATE**

State	Jobs, MIT-Related	Sales, MIT-Related Plants & Offices (in millions)
Alabama	9,300	\$1,154
Alaska	360	\$56
Arizona	7,600	\$1,163
Arkansas	2,500	\$493
California	162,000	\$19,216
Colorado	15,600	\$3,164
Connecticut	10,300	\$890
District of Columbia	770	\$88
Delaware	2,100	\$306
Florida	15,500	\$2,521
Georgia	14,800	\$2,852
Hawaii	400	\$79
Idaho	5,300	\$1,133
Illinois	12,100	\$1,899
Indiana	4,700	\$489
Iowa	13,300	\$960
Kansas	13,900	\$526
Kentucky	5,600	\$772
Louisiana	2,100	\$562
Maine	2,100	\$410
Maryland	6,800	\$958
Massachusetts	125,000	\$16,669
Michigan	7,600	\$1,073
Minnesota	5,500	\$2,445
Mississippi	1,030	\$158
Missouri	9,200	\$1,143
Montana	160	\$18
North Carolina	8,100	\$1,680
North Dakota	110	\$64
Nebraska	1,900	\$1,048
Nevada	1,300	\$36
New Hampshire	8,800	\$1,574
New Jersey	33,700	\$1,834
New Mexico	5,300	\$1,035
New York	15,100	\$3,092
Ohio	18,300	\$3,327
Oklahoma	4,800	\$843
Oregon	10,200	\$2,891
Pennsylvania	21,000	\$2,360
Rhode Island	3,900	\$308
South Carolina	9,200	\$1,101
South Dakota	380	\$56
Tennessee	6,600	\$890
Texas	84,200	\$13,001
Utah	4,200	\$524
Vermont	650	\$47
Virginia	15,300	\$1,626
West Virginia	1,260	\$128
Washington	10,300	\$1,327
Wisconsin	12,000	\$1,373
Wyoming	130	\$19

BankBoston (NYSE:BKB), with assets of \$62.3 billion as of December 31, 1996, was founded in 1784 and is the 15th largest bank holding company in the United States. BankBoston is engaged primarily in commercial and consumer banking in southern New England, providing financing and capital markets services to selected corporations nationally and internationally, and full-service banking in key Latin American markets. The Corporation and its subsidiaries operate through a network of 650 offices in the United States and through more than 100 offices in 24 countries in Latin America, Europe and Asia, the third-largest overseas network of any U.S. bank. The Corporation's common and preferred stocks are listed on the New York and Boston stock exchanges.





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