

Entrepreneurial Impact: The Role of MIT

Edward B. Roberts and Charles Eesley
MIT Sloan School of Management

February 2009



Executive Summary



KAUFFMAN

The Foundation of Entrepreneurship

Executive Summary

Entrepreneurial Impact: The Role of MIT

Edward B. Roberts and Charles Eesley

Edward Roberts is the David Sarnoff Professor of Management of Technology, MIT Sloan School of Management, and Founder/Chair of the MIT Entrepreneurship Center, which is sponsored in part by the Ewing Marion Kauffman Foundation. Charles Eesley is a doctoral candidate in the Technological Innovation & Entrepreneurship Group at the MIT Sloan School of Management and the recipient of a Kauffman Dissertation Fellowship. We thank MIT, the MIT Entrepreneurship Center, the Kauffman Foundation, and Gideon Gartner for their generous support of our research.

The views expressed herein are those of the authors and do not necessarily reflect the views of the Ewing Marion Kauffman Foundation or MIT.

Executive Summary

Research- and technology-intensive universities, especially via their entrepreneurial spinoffs, have a dramatic impact on the economies of the United States and its fifty states. A new report on just one such university, the Massachusetts Institute of Technology, indicates conservatively that, if the active companies founded by MIT graduates formed an independent nation, their revenues would make that nation at least the seventeenth-largest economy in the world. A less-conservative direct extrapolation of the underlying survey data boosts the numbers to 25,800 currently active companies founded by MIT alumni that employ about 3.3 million people and generate annual world sales of \$2 trillion, producing the equivalent of the eleventh-largest economy in the world.

These findings result from an analysis of MIT alumni-founded companies and the entrepreneurial environment that fosters this new-company creation. Conducted by Edward B. Roberts and Charles Eesley of the MIT Sloan School of Management,¹ the report is based on a 2003 survey of all living MIT alumni, with additional detailed analyses, including verification and updating of revenue and employment figures to 2006 from records of Compustat (public companies) and Dun & Bradstreet (private companies).

The ultimate value of this study is to help us understand the entrepreneurial impact that universities can have. We know that universities play an important role in many economies, creating economic impact through their core education, research and development, and many other spillovers, but universities also can create a culture and

The 25,800 currently active companies founded by MIT alumni employ about 3.3 million people and generate annual world sales of \$2 trillion, producing the equivalent of the eleventh-largest economy in the world.

programs that make entrepreneurship common. While MIT’s leadership in developing successful entrepreneurs has been evident anecdotally, this study—one of the largest surveys of entrepreneur alumni ever conducted—quantifies the impact of MIT’s entrepreneurship success. And, while MIT is more unique in the programs it offers and in its historical culture of entrepreneurship, it also provides a benchmark by which other institutions can gauge the economic impact of their alumni entrepreneurs. The report also provides numerous examples of programs and practices that might be adopted, intact or modified as needed, by other universities that seek enhanced entrepreneurial development.

Just 796 of the largest MIT alumni companies (about 2 percent of the total companies)—those with employment of 1,000 or more—account for more than 80 percent of total sales and 70 percent of total employees of all the MIT alumni-founded firms (see Table 1).

Using the direct extrapolation technique, the study’s authors conclude that an estimated 6,900 MIT alumni companies with worldwide sales of approximately \$164 billion are located in Massachusetts alone and represent 26 percent of the sales of all Massachusetts companies. Notable also are the 4,100 alumni-founded firms based in California, which generate an estimated \$134 billion in worldwide sales.

Nearly 60 percent of the MIT alumni companies are located outside the Northeast. In addition to

Table 1. Estimated Employment and Sales Data for All Active MIT Alumni Companies

Jobs	Percent of Companies	Median Employees	Median Sales (Millions)	Estimated Total Employees	Estimated Total Sales (Millions)
More than 10,000	0.3%	15,000	1,523	1,339,361	1,389,075
1,000–10,000	1.8%	1,927	308	1,043,932	235,532
Others (Employment known)	97.9%	39	11	900,001	226,671
Total	100.0%	155	3	3,283,294	1,851,278

1. The full report, “Entrepreneurial Impact: The Role of MIT,” can be downloaded free from: www.kauffman.org/mit

States Benefiting Most from Jobs Created by MIT Alumni Companies

Massachusetts	<1 million jobs
California	526,000 jobs
New York	231,000 jobs
Texas	184,000 jobs
Virginia	136,000 jobs

these companies' major presence in the San Francisco Bay Area (Silicon Valley) and southern California, they also are notable in 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. A good scattering of MIT-related companies are located throughout the Midwest, the South, and the Southwest.

The states currently benefiting most from jobs created by MIT alumni companies are Massachusetts (for which just under one million jobs worldwide are estimated for the entire population of more than 6,900 active MIT alumni-founded, Massachusetts-headquartered companies), California (estimated at 526,000 jobs from its current approximately 4,100 MIT alumni-founded firms), New York (estimated at 231,000 jobs), Texas (estimated at 184,000) and Virginia (estimated at 136,000). Fifteen other states are likely to have more than 10,000 jobs each and only eleven states seem to have fewer than 1,000 jobs from MIT alumni-founded companies.

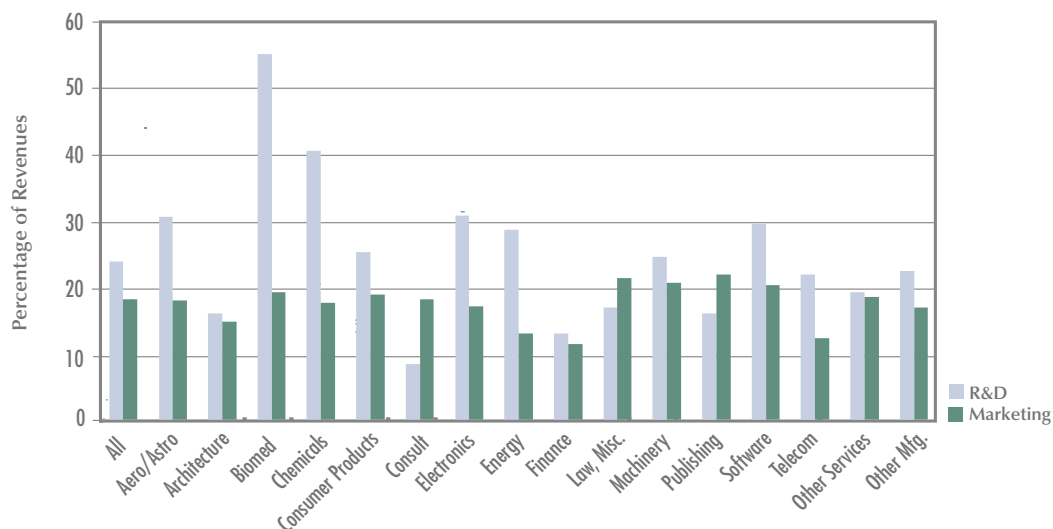
Further, new-company formation by MIT graduates appears to be accelerating. Among active companies, 2,900 came from the 1980s and 5,900 were founded during the 1990s. Some 9,950 companies in total are estimated to have been founded during the 1990s, and more than 5,800 companies between 2000 and 2006.²

Economic Impact

In any regional economy, firms that sell to out-of-state and world markets play the major role in driving economic growth because the growth of these firms in total revenues also drives their growth in local employment. They primarily are knowledge-based companies that employ more higher-skilled as well as higher-paid employees. These companies create growing markets for utilities, service firms, retailers, and other local-market businesses.

MIT alumni-founded companies have a disproportionate importance to their local economies because so many of them are manufacturing (instruments, machinery, and electronics, including semiconductors and computers), biotech, software (48 percent of the employment of MIT alumni companies), or consulting firms (architects, business consultants, engineers) that sell to national and world

Spending on R&D and Marketing in MIT Alumni Companies



2. The notable growth among women entrepreneurs appears to mirror the growth in the number of women graduating from all levels at MIT, rising from just over ten female graduates per year (1 percent) in the 1930s to 43 percent of undergraduates and 30 percent of the graduate student population in 2006. Women founders start appearing in the 1950s and grow to about 10 percent of the report sample by the 1990s.

Percentage of High-Growth, High-Tech MIT Alumni Firms located in California and Massachusetts

Electronics firms	66%
Software firms.....	62%
Drug and medical firms.....	62%
All other industries	36%

markets. Overall, 54 percent of their company sales are to out-of-state markets; 13 percent of their total sales come from goods or services sold abroad by U.S.-headquartered MIT alumni firms.

The MIT alumni high-technology firms in software, electronics, and biotech form a special subset of companies that spend more of their revenues on research and development, are more likely to hold one or more patents, and tend to export a higher percentage of their products. They are more likely than companies in other industries to be planning expansion. Together, firms in these three industries account for one-third of the employment in all MIT alumni companies.

The companies' expansion plans form an interesting "leading indicator" that points to growth prospects by industry. More than 30 percent of the firms in chemicals, aerospace, and biotech are planning to expand. They are followed closely by telecommunications and consumer products companies. Not coincidentally, these are also the industries with the greatest likelihood of holding a patent, the highest R&D expenditures, and the greatest share of export sales.

Regional Impact

Almost all founders (89 percent) of MIT alumni companies started their companies in the general location in which they were living at the time. The largest fraction of these founders (65 percent) indicated that they were living there because this was

where they had been employed, and 15 percent indicated that they were living there because that location was where they attended university. When asked what factors influenced the location of their companies, the most common responses (in order) were: (1) where the founders lived, (2) network of contacts, (3) quality of life, (4) proximity to major markets, and (5) access to skilled professional workers (engineers, technicians, and managers). Taxes and the regulatory environment were rated as less important factors for most industries.

High-tech startups depend heavily on the availability of skilled professionals to build reliable, high-quality, innovative products. The startup companies locate where these professionals like to live. These findings offer a new perspective on the factors listed above in the location decisions of MIT alumni founders for their companies. Quality-of-life issues include access to a strong educational system, cultural facilities, open space, and good transportation.

MIT alumni firms in the high-growth, high-tech industries (software, electronics, biotech) are particularly likely to locate in California or Massachusetts, especially in the premier technology regions of Silicon Valley and Greater Boston. These two states account for 66 percent of all MIT alumni electronics firms, 62 percent of software firms, and 62 percent of drug and medical firms. By contrast, they are host to only 36 percent of firms in all other industries.

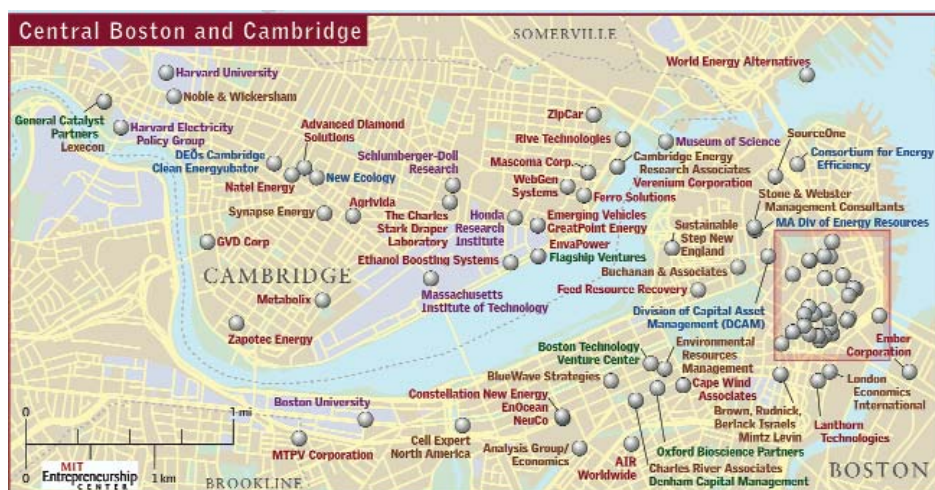
Survey results indicate that California has the head offices of approximately 4,100 MIT alumni firms, which employ 526,000 people worldwide and have \$134 billion in sales. The 2,675 MIT alumni firms in northern California alone account for the greater part of the MIT presence in California—\$78 billion in worldwide sales and worldwide employment of 322,100. Total Silicon Valley employment of MIT alumni companies is estimated at just over 260,000—about half of total California employment of MIT

MIT alumni-founded companies are disproportionately important to their local economies because so many of them are manufacturing, biotech, software, or consulting firms that sell to national and world markets.

The Creation of an Industry Cluster:

In 2008, approximately ninety-five biotech companies were documented as located within the Kendall Square area, a neighborhood adjacent to MIT and centered on the intersection of Main Street, Broadway, Wadsworth Street, and Third Street in Cambridge. This biotech presence is compared to fifty-five such companies that were documented in this MIT neighborhood three years earlier.

In ongoing research on the MIT-related life sciences complex in Cambridge, Professor Fiona Murray of MIT Sloan now finds that sixty-six of the 493 MIT “life scientists” (including those associated with the Broad and the Whitehead Institutes) have founded or served on the boards of directors of at least one venture-funded company, totaling 134 companies in all. Eighteen of these faculty or staff have founded or been board members of at least three companies each, with one MIT faculty member having twenty such relationships. Fifty additional MIT “life science” people serve as science advisory board members of an additional 108 companies, bringing a total of at least 242 life science companies into strong ties with the MIT



community. These ties are both cause and result of the interconnections between MIT and the entrepreneurial and industrial community. A map of the Kendall Square Biotech Cluster can be found at <http://entrepreneurship.mit.edu/biotech/invite/map2006.pdf>.

alumni companies. Of this, some 135,200 are in manufacturing and 75,500 in electronics.

An estimated 6,900 MIT alumni companies are headquartered in Massachusetts. The estimated sales of these companies—\$164 billion—represent 26 percent of the sales of all Massachusetts companies. Worldwide employment of these 6,900 companies is one million, with a substantial share of these jobs across the United States and around the world. MIT alumni companies in Massachusetts are located primarily throughout its eastern region.

However, these numbers understate the impact of MIT alumni companies on Massachusetts. In one industry after another, these companies generally represent cutting-edge technologies in their fields. Historical examples include Raytheon in missile and guidance systems; ThermoElectron in instruments and environmental technology; Lotus Development (now part of IBM, so not included in the impact estimates), Medical Information Technology, and Progress Software, all in software; Analog Devices and Analogics in integrated circuits and electronics devices; A123 Systems and American Superconductor

in advanced materials; 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 acoustic systems; and AVID in video conferencing.

One reason MIT is so important to the Massachusetts economy is that, without MIT, most of these companies never would have been located in Massachusetts. Most of the MIT alumni companies in Massachusetts were founded by former students who came to the state to attend MIT, liked what they saw, settled down and eventually started their companies in Massachusetts. Less than 10 percent of MIT undergraduates grew up in the state, but approximately 31 percent of all MIT alumni companies are located in Massachusetts. In the last five years, more than 37 percent of the newly founded MIT alumni companies in software, the

Internet, biotech, and electronics have located in Massachusetts.

One advantage of locating in Massachusetts is the proximity to MIT and other Boston-Cambridge-area universities. When asked the importance of various location factors, Massachusetts firms ranked access to MIT and other universities ahead of low business cost; in every other region of the country, business cost was more important than contact with universities. (As indicated earlier, the most important location factors are quality of life and access to skilled professions; these have average scores well above those for business cost and university access.)

Approximately 32 percent of the MIT alumni entrepreneurs report having, or anticipate having, an ongoing connection with MIT. Most frequently, this ongoing connection has taken the form of recruiting new employees, doing joint research, and/or having faculty advisors or directors.

Case Study: A123 Systems

No doubt at least one interesting story can be told for each startup the Technology Licensing Office licenses. A most recent one³ illustrates primarily the formal role of the TLO in helping to create new companies and bring MIT technology to market. It also illustrates the power and workings of the overall MIT entrepreneurial ecosystem.

In spring 2001, Ric Fulop '06, a serial entrepreneur who had been involved in five startups by the time he was twenty-five years old, was looking for his next opportunity. Howard Anderson, also a serial entrepreneur who teaches the "New Enterprises" subject and several other MIT entrepreneurship classes, and was founder of the YankeeTek VC firm, had participated in investments in two previous Fulop ventures that had lost \$10 million. But Anderson had deep admiration for Fulop and gave him space in his office to help him

think through his next undertaking. After a few months of research into the energy business, and then narrowing to battery technology, Fulop scanned the country in search of technological alternatives, including reviewing MIT TLO's database on MIT technologies. As a result, Fulop approached Professor Yet-Ming Chiang '80 with his idea of using carbon nanotubes as a basis for setting up a new battery company. Chiang quickly convinced Fulop that Chiang's lab had more interesting battery R&D underway and the two

The Entrepreneurial Environment at MIT

In addition to surveying alumni, the analysis provides an in-depth look at the MIT environment that fosters entrepreneurship leading to company formation and notable job creation among MIT's alumni. Rather than any single or narrow set of influences, the overall MIT entrepreneurial ecosystem, consisting of multiple education, research, and social network institutions and phenomena, contributes to this outstanding and growing entrepreneurial output. This ecosystem rests upon a long MIT history since its 1861 founding and its evolved culture of "Mens et Manus," or "mind and hand." The tradition of valuing useful work resulted in the development of strong ties with industry, including encouraging faculty consulting and even faculty entrepreneurship since before the beginning of the twentieth century. Over the years, the increasingly evident MIT entrepreneurial environment has attracted entrepreneurship-inclined students, staff, and faculty, fostering an environment of ever-increasing

entrepreneurial efforts. The entrepreneurship emphasis at MIT now includes a series of interconnected institutional elements, summarized below, that operate in an innovation ecosystem.

Alumni initiatives in the 1970s appear to be the first direct institutional moves to encourage entrepreneurship, leading to the establishment of the now-worldwide **MIT Enterprise Forum**. The Forum builds connections between technology entrepreneurs and the communities in which they reside, and produces extensive educational programs about entrepreneurship through a network of twenty-four chapters. Since its beginning, the Cambridge, Mass., chapter alone has helped nurture about 700 young companies, with equivalent numbers across the rest of the country. Since beginning in 1990, the **MIT Entrepreneurship Center** has crystallized these efforts by launching nearly thirty new entrepreneurship courses available across MIT, and by assisting in the formation and growth of a large number of related

began serious discussions. As they looked for a third partner to run engineering, Chiang introduced Fulop to Bart Riley, who incidentally had been an early employee of American Superconductor, an earlier MIT spinoff that Chiang had co-founded in 1987. By September 2001, Fulop, Chiang, and Riley had decided to form a new battery company, A123 Systems, and began to negotiate with the TLO (leaving Chiang out of the discussions to avoid conflict of interest) for exclusive rights to Chiang's MIT battery developments. All went smoothly with MIT and, by December 2002, the company had completed its first round of venture capital funding from Sequoia Capital, Northbridge, YankeeTek, and Desh Deshpande (see later discussion of the Deshpande Center), who also became chairman of the A123 Board. The A123 story since then has been magical, with more than \$250 million in

venture funding by December 2008, six manufacturing plants in China and Korea, more than 1,800 employees, and more. A123 is moving rapidly forward with multiple products in its three target markets, including cordless tool batteries (its first product application was the launch of a new line of professional tools by the DeWalt division of Black & Decker), multi-megawatt batteries for renewable integration into the electric grid, and batteries for transportation (with more than nineteen models of hybrid and plug-in vehicles with major American and European automakers under development). A123 already has become one of the world's leading suppliers of high-power lithium ion batteries.

3. *The A123 Story: How a Battery Company Jumpstarted its Business*, www.xconomy.com/2008/01/24/the-a123-story-how-a-battery-company-jumpstarted-its-business/.

student entrepreneurship clubs. The resulting increase in networking among students, and between students and the surrounding entrepreneurship and venture capital community appears in survey results to be the primary MIT-related factor influencing the growth of new company formation by MIT alumni.

Classes taught at MIT by discipline-based academics and experienced successful entrepreneurs and venture capitalists have generated an effective blend for learning both theory and practice. Mixed-team project classes, consisting of both management students and engineers and scientists, have had great impact in MIT students' understanding of the entrepreneurial process, and have influenced the subsequent founding of many new companies. Student-run activities such as the **MIT \$100K Business Plan Competition** have moved numerous students, often with faculty as team members, to develop their

ideas to the point of public scrutiny. At least 120 companies have been started by participants in these student-run prize competitions.

The MIT Technology Licensing Office has consistently led the nation's universities in licensing technology to startup firms, licensing 224 new companies in just the past ten years. The TLO also has brought its experience and knowledge into active engagement with MIT students, faculty, and alumni. The TLO has helped pioneer a strategy of leveraging intellectual property from MIT to form companies based on the long-term roles and contributions of those companies in their given sectors, as opposed to simply their short-term licensing revenue potential.

In recent years, creation of formal MIT institutions focused on encouraging entrepreneurship has accelerated. In 2000, the **Venture Mentoring**

“Importing” Company Founders

As a result of MIT's presence, Massachusetts is “importing” company founders. More than 38 percent of the software, biotech, and electronics companies founded by MIT graduates are located in Massachusetts, while less than 10 percent of arriving MIT freshmen are from the state.

Not only do MIT alumni, drawn from all over the world, remain heavily in Massachusetts, but their entrepreneurial offshoots benefit the state and country significantly. Greater Boston, in particular, as well as northern California and the Northeast, broadly, are homes to the largest number of MIT alumni companies, but significant numbers of companies are also in the South, the Midwest, the Pacific Northwest, and in Europe. About 30 percent of MIT's foreign students form companies, of which at least half are located in the United States. Those estimated 2,340 current firms located in the United States but formed by MIT foreign-student alumni employ 101,500 people. In other words, talented foreign-born students attending MIT play an increasingly important role in creating U.S. companies, making MIT a magnet for worldwide talent that significantly benefits the U.S. economy.

Estimated Number of Companies Founded by “Foreign” MIT Alumni

Location	Total
United States	2,340
Europe	790
Latin America	495
Asia	342

Brontes

The Brontes single-lens 3D imaging technology, derived from MIT Deshpande Center research funding to Professor Douglas Hart '85, was licensed by the MIT Technology Licensing Office to Brontes at its formal company startup stage in 2003. Professor Hart was a reluctant entrepreneur who had thought the principal market application would be facial recognition for security.

"I came from an era where your job was to be a faculty member and teacher, not to spin out companies," he said. But, encouraged by the Deshpande Center's executive director, he attended a 2002 MIT \$50K networking event and met the two graduate students who eventually became his company co-founders. They presented their preliminary ideas to the Cambridge Enterprise Forum Concept Clinic to discuss the variety of commercialization alternatives they were evaluating for the 3D technology. That helped them formulate their business plan for the \$50K competition, where

they were selected as the runner-up. As the team developed a prototype system, they explored the market opportunities and discovered a large need in dental imaging. After forming the actual spinout company, they returned to present at the Enterprise Forum Startup Clinic, and then received two rounds of seed capital, followed by venture capital funding in 2004. Brontes was scheduled a case presentation to the regular Enterprise Forum when it was purchased by 3M in 2006 for \$93 million.

Service was created to help any MIT-related individual—student, staff, faculty, alumnus/a—who was contemplating a startup. Eighty-eight companies already have been formed by those VMS has counseled.

The **Deshpande Center for Technological Innovation** was initiated in 2002 to provide small research grants to faculty whose ideas seemed especially likely to be commercialized and to help them make the leap between research and innovation. In its first five years, the Deshpande Center has funded eighty faculty research projects. Fifteen spinout companies already have been formed from these projects.

In 2006, the MIT Sloan School of Management created a new **Entrepreneurship & Innovation track** within its MBA program to provide intensive opportunities for those students who seem dedicated to an entrepreneurial life. It is too soon to know what outcomes this focused approach will produce, but

about 25 percent of incoming MIT Sloan MBA candidates now are enrolling in E&I. Initial students already have engaged in numerous company-building activities and have won important university business plan competitions.

Beyond the MIT influences on firm formation, 85 percent of the alumni entrepreneurs reported in the survey data that association with MIT had significantly helped their credibility with suppliers and customers. Fifty-one percent of the entrepreneurs also felt that their association with MIT helped in acquiring funding.

All of these forces—from initial orientation and culture to all-encompassing clubs and activities to now-concentrated educational opportunities—contribute to building and sustaining the MIT entrepreneurial ecosystem. That system has been uniquely productive in helping to create new firms that are having an impressive economic impact.

KAUFFMAN
The Foundation of Entrepreneurship

4801 ROCKHILL ROAD
KANSAS CITY, MISSOURI 64110
816-932-1000
www.kauffman.org