

Education

and Tech Entrepreneurship

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Vivek Wadhwa
Richard Freeman
Ben Rissing

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The Foundation of Entrepreneurship

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Vivek Wadhwa

Executive in Residence/Adjunct Professor, Pratt School of Engineering, Duke University
Wertheim Fellow, Labor and Worklife Program, Harvard Law School
Fellow, Social Sciences Research Institute, Duke University

Richard Freeman

Herbert Asherman Chair in Economics, Harvard University
Director, Labor and Worklife Program, Harvard Law School
Director, Labor Studies Program, National Bureau of Economic Research

Ben Rissing

Wertheim Fellow, Labor and Worklife Program, Harvard Law School
Research Scholar, Pratt School of Engineering, Duke University

Student Research Team

Project Leaders:

Baris Guzel
Molly House

Researchers:

Poulomi Doshi
Mark Marex
Tim McLaughlin
Hope Lu
Varun Varghese
Deepak Vedanthan

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Introduction and Summary

The popular image of American tech entrepreneurs is that they come from elite universities: Some graduate and start companies in their garages; others drop out of college to start their business careers. The dot-com boom reinforced the image of technology CEOs being young and brash. But, even though Bill Gates and Steve Jobs founded two of the world's most successful companies, they are not representative of technology and engineering company founders. Indeed, a larger proportion of tech founders are middle-aged, well-educated in business or technical disciplines, with degrees from a wide assortment of schools. Twice as many U.S.-born tech entrepreneurs start ventures in their fifties as do those in their early twenties, as this paper will show.

Our earlier research on technology and engineering entrepreneurship revealed that skilled immigrants were a driving force in recent U.S. economic growth. From 1995 through 2005, skilled immigrant founders established 25.6 percent of all the startups nationwide, and 52.3 percent of those in Silicon Valley. This group tended to be highly educated in science-, technology-, and engineering-related disciplines. The majority came to the United States to study and decided to stay. These immigrant tech founders typically established a company thirteen years after coming to the United States and tended to gravitate to technology centers across the country.^{1,2}

What about U.S.-born tech entrepreneurs? Were they young college dropouts or well-educated? Were they graduates of elite schools or a diverse set of schools like the immigrant company founders? Where did they locate their companies?

To answer these questions, we surveyed 652 U.S.-born chief executive officers and heads of product development in 502 engineering and technology companies established from 1995 through 2005. These companies, identified from an existing dataset of corporate records in Dun & Bradstreet's Million Dollar Database, have more than \$1 million in sales, twenty or more employees, and company branches with fifty or more employees.

Our Findings

We observed that, like immigrant tech founders, U.S.-born engineering and technology company

founders tend to be well-educated. There are, however, significant differences in the types of degrees these entrepreneurs obtain and the time they take to start a company after they graduate. They also tend to be more mobile and are much older than is commonly believed.

- The average and median age of U.S.-born tech founders was thirty-nine when they started their companies. Twice as many were older than fifty as were younger than twenty-five.
- The vast majority (92 percent) of U.S.-born tech founders held bachelor's degrees. Additionally, 31 percent held master's degrees, and 10 percent had completed PhDs. Nearly half of all these degrees were in science-, technology-, engineering-, and mathematics- (STEM) related disciplines. One-third were in business, accounting, and finance.
- U.S.-born tech founders holding MBA degrees established companies more quickly (in thirteen years) than others. Those with PhDs typically waited twenty-one years to become tech entrepreneurs, and other master's degree holders took less time to start companies than did those with bachelor's degrees (14.7 years and 16.7 years respectively).
- U.S.-born tech founders holding computer science and information technology degrees founded companies sooner after graduating than engineering degree holders (14.3 years vs. 17.6 years). Applied science majors took the longest (twenty years) to create their startups.
- These tech founders graduate from a wide assortment of schools. The 628 U.S.-born tech founders providing information on their terminal (highest) degree, received their education from 287 unique universities. But degrees from top-ranked universities are over-represented in the ranks of U.S.-born tech founders. Ivy-League universities awarded 8 percent of the terminal degrees to U.S.-born tech founders in our sample.

...a larger proportion of tech founders are middle-aged, well-educated in business or technical disciplines, with degrees from a wide assortment of schools.

- The top ten universities from which U.S.-born tech founders received their highest degrees in our sample are Harvard, MIT, Pennsylvania State University, Stanford, University of California-Berkeley, University of Missouri, University of Pennsylvania, University of Southern California, University of Texas, and University of Virginia.
- U.S.-born tech founders with Ivy-League degrees tend to establish startups that produce higher revenue and employ more workers than the average. Startups founded by those with only high school education significantly underperform all others.
- Nearly half (45 percent) of the startups were established in the same state where U.S.-born tech founders received their education. Of the U.S.-born tech founders in our sample receiving degrees from California, 69 percent later created a startup in the state; Michigan, 58 percent; Texas, 53 percent; and Ohio, 52 percent. In contrast, Maryland retained only 15 percent; Indiana, 18 percent; and New York, 21 percent.

Methodology

In this study, we investigate the educational attainment of U.S.-born startup founders. The primary data source for this work is a subset of an existing dataset of corporate records included in Dun & Bradstreet's (D&B) Million Dollar Database. These listings contain U.S. companies with sales in excess of \$1 million, twenty or more employees, and company branches with fifty or more employees. To construct our dataset, we extracted records of all engineering and technology companies founded from 1995–2005 (representing the most current decade of data at the time of this initial search). This produced a listing of 28,766 companies. A portion (less than 10 percent) of these, which represented shell companies with zero U.S. employees or older companies with recent changes in control/corporate restructurings, were omitted from our dataset. Approximately 1,800 of the remaining companies were randomly contacted by our research team via phone or e-mail. During our interview requests, we sought to speak directly with a company founder(s) or a direct representative to determine if the founder or founders were U.S.-born. For this work, we defined "founders" as individuals

To construct our dataset, we extracted records of all engineering and technology companies founded from 1995–2005 (representing the most current decade of data at the time of this initial search).

holding the position of chief executive officer or chief technology officer at the time of startup incorporation.

Through these interviews, D&B data, and supplemental information from company Web sites, we gathered the following information for each U.S.-born tech founder in our dataset.

- U.S.-born tech founder(s) name
 - Terminal (highest) academic degree: level, field, school, state, graduating year
 - First academic degree: level, field, school, state, graduating year (if applicable)
 - Second academic degree: level, field, school, state, graduating year (if applicable)
 - Age of U.S.-born tech founder when company incorporated
 - Company address, city, state, zip code
 - Company primary U.S. Government Standard Industrial Classification (SIC) code
- We surveyed 652 U.S.-born tech founders of 502 engineering and technology companies. Our response rate was approximately 40 percent of those we attempted to contact.
- Highest academic degree: level, field, school, state, graduating year
 - First academic degree: level, field, school, state, graduating year
 - Second academic degree: level, field, school, state, graduating year
 - Age of founder when company incorporated
 - Company address, city, state, zip code
 - Company primary U.S. Government Standard Industrial Classification (SIC) code

Definitions

Engineering and Technology Startups

For the purposes of our study, the phrase “engineering and technology” indicates that the company’s main work focuses on design, manufacturing, or services. Our definition of engineering and technology firms includes the following industry groups, identified by three- and four-digit SIC codes:

- Semiconductors
- Computers
- Communications
- Biosciences
- Defense/Aerospace
- Environmental
- Software
- Innovation/Manufacturing-Related Services

Appendix A contains a full listing of the SIC codes associated with each industry. This list was adopted from an SIC code listing originally employed by a study authored by Dr. AnnaLee Saxenian, which explored the roles of immigrant startup founders in Silicon Valley.³

U.S.-Born Tech Founders

In most engineering or technology companies, the most critical startup roles are those of the president/chief executive officer and the head of development/chief technology officer. An individual can simultaneously perform both roles. This work focuses on the entrepreneurial contributions of these U.S.-born individuals. Other roles, such as finance and marketing, also can be very important in startups, but are not the focus of this research.

Educational Attainment of U.S.-Born Tech Founders

Terminal (Highest) Degree Completed

Technology and engineering company founders tend to be highly educated. The vast majority (92 percent) of U.S.-born tech founders hold at least a bachelor’s degree; 47 percent hold more advanced degrees (master’s, PhD, MD, or JD). Figure 1 details the breakdown of the terminal (highest) degrees they completed.

Fields of Education

U.S.-born tech company founders tend to have diverse educational backgrounds. The largest group (47 percent) of our sample held terminal degrees in science-, technology-, engineering-, and mathematics- (STEM) related fields. Thirty-four percent held degrees in business, finance, and accounting. Figure 2 provides details.

If all degrees held by these U.S.-born tech founders are considered (first, second, terminal), the percentage holding at least one degree in a STEM field increases to 55 percent. For instance, a U.S.-born tech founder may complete a terminal MBA degree after first obtaining a bachelor’s degree in engineering.

Figure 1:
Terminal Degree Completed
by U.S.-Born Tech Founders

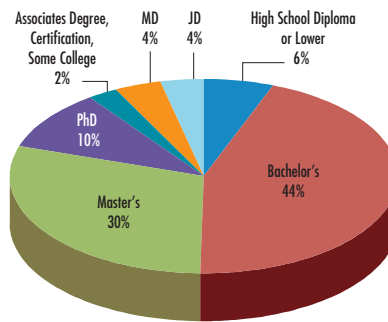
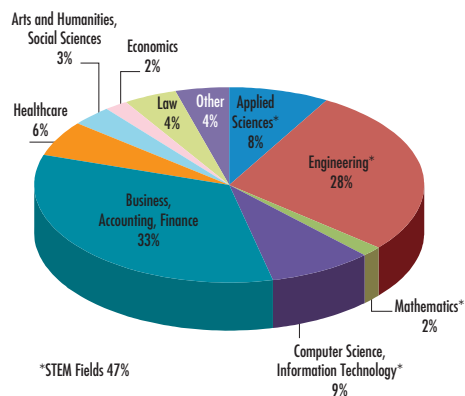


Figure 2:
Fields of Terminal Degrees Completed
by U.S.-Born Tech Founders



Age and Entrepreneurship

A common belief is that U.S.-born tech founders of technology companies tend to be young. We found that about 1 percent were teenagers when they started their firms. More than twice as many were older than age fifty than were younger than twenty-five. Many, in fact, were in their sixties when they founded their startups.

The vast majority of U.S.-born tech founders were older than twenty-five. The average and median age of key tech founders was thirty-nine. A breakdown of U.S. tech startup founders' ages at the time of company founding is shown in Figure 3.

We found a positive correlation between U.S.-born tech founders' terminal degree level (i.e., PhD, master's, bachelor's) and the period of time between graduation and startup formation. By collecting data on the specific year a tech founder graduated from his or her terminal degree program and the date he or she formed the startup, we were able to calculate the length of time between these events. On average, this was 16.4 years.

However, this length of time was noticeably shorter for individuals with specific degree types. MBA holders tended to found companies fastest, with an average lag time of 13.1 years. Together, all master's degree holders (14.7 years) founded companies faster than bachelor's degree holders (16.7 years); both founded companies faster than individuals who hold PhDs (20.9 years). These data are shown in Figure 4.

Additionally, we analyzed the field of the terminal degree completed by U.S.-born tech founders and the time to establishment of a startup. This intermediate period between startup creation and degree completion was shortest for computer science and information technology graduates (14.3-year average) and longest for applied sciences graduates (twenty-year average). A breakdown is found in Figure 5.

The vast majority of U.S.-born tech founders were older than twenty-five. The average and median age of key tech founders was thirty-nine.

Figure 3:
U.S.-Born Tech Founders' Age at Time of Company Founding

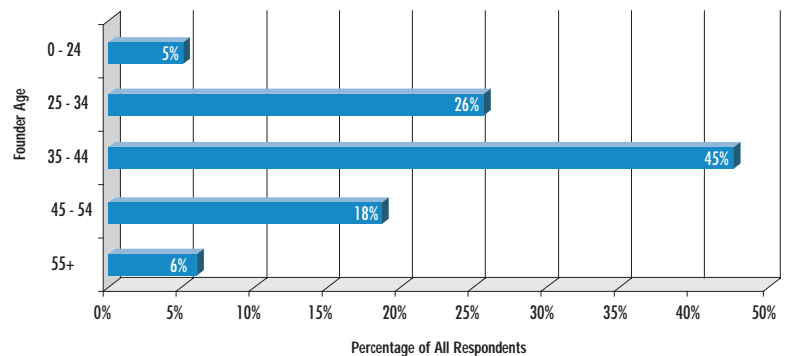
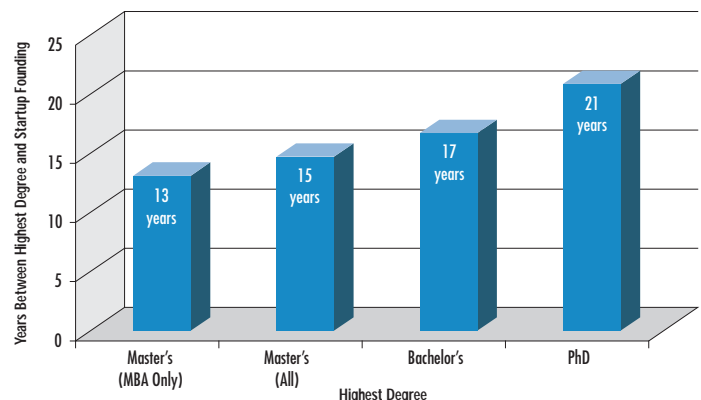


Figure 4:
Time Lag Between Completion of Terminal Education and Company Founding



The majority of U.S.-born tech founders holding bachelor's, master's, PhD, MD, and JD degrees fall within the thirty- to fifty-year-old age bracket.

When subdivided by a tech founder's age at the time of startup formation, our sample approaches a normal distribution. The majority of U.S.-born tech founders holding bachelor's, master's, PhD, MD, and JD degrees fall within the thirty- to fifty-year-old age bracket. It is interesting that the left tail of the distribution is dominated by high school degrees, while PhD, MD, and JD degrees constitute the majority of degrees held on the right tail. This information is presented in Figure 6.

Figure 5: Time Lag Between Completion of Terminal Degree and Company Founding by Field of Study

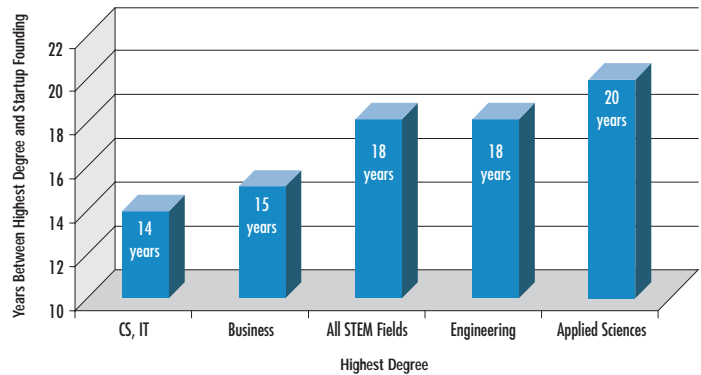
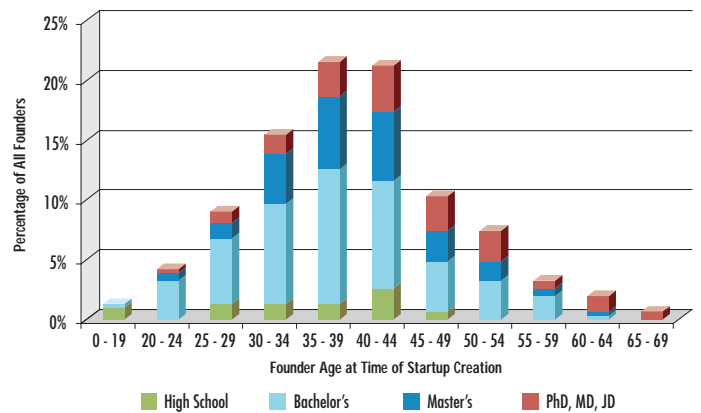


Figure 6: U.S. Tech Founder Age at the Time of Startup Establishment and Terminal Degree



Universities and Entrepreneurship

We found that U.S.-born tech founders of engineering and technology companies tend to graduate from a wide assortment of universities. While elite, highly ranked schools hold no monopoly on tech entrepreneurship, some elite schools are over-represented in the ranks of these tech founders, and companies formed by these schools' graduates outperform those established by others.

Top Ten Universities Graduating U.S.-Born Key Tech Founders

The 628 U.S.-born tech founders providing information on their terminal (highest) degree, received their education from 287 unique universities. Almost every major U.S. university was represented on this list. The top ten institutions in this group accounted for only 19 percent of the entire sample, as shown in Table 1.

Ivy-League Universities and Entrepreneurship

U.S.-born tech founders whose terminal degrees were awarded from Ivy-League schools (Brown, Columbia, Cornell, Dartmouth, Harvard, Princeton, University of Pennsylvania, and Yale) accounted for 8 percent of our sample. This group was led by Harvard University, which awarded terminal degrees to slightly more than 3 percent of our U.S.-born tech founder sample. Harvard was followed by the University of Pennsylvania with slightly more than a 2 percent contribution.

By contrast, in 2005, these Ivy-League schools graduated approximately thirty-three thousand bachelor’s, master’s, and PhD degrees, or 1.6 percent of all U.S. degrees awarded at these levels (see Table 2). As such, our results show a disproportionately high concentration of U.S.-born tech founders with terminal Ivy-League degrees engaging in entrepreneurial startup activities in the engineering

and technology industries. While the Ivy-League schools graduated a larger proportion of U.S. students twenty to thirty years ago, they did not come close to the proportions of terminal degrees represented among U.S.-born tech founders in our sample. We also note that the tech founders from our sample who graduated from Harvard University and the University of Pennsylvania held a disproportionately high number of MBAs—55 percent and 43 percent, respectively.

Table 1:
Schools Awarding U.S.-Born Tech Founders’ Terminal Degrees

Schools	Percentage
Top 10 Schools: Harvard University, Massachusetts Institute of Technology, Pennsylvania State University, Stanford University, University of California: Berkeley, University of Missouri, University of Pennsylvania, University of Southern California, University of Texas, University of Virginia	19%
Other Colleges and Universities	76%
High School	5%
Total	100%

Table 2:
Over-Representation by U.S.-Born Tech Founders with Terminal Degrees Awarded from Ivy-League Universities¹

Ivy School	Percentage of 1995–2005 U.S.-Born Tech Founders Receiving a BS, MS, or PhD Degree from This School	Percentage of All 2005 BS, MS, and PhD Degree Recipients
Ivy-League Schools: Brown University, Columbia University, Cornell University, Dartmouth College, Harvard University, Princeton University, University of Pennsylvania, Yale University,	8%	2%
Non-Ivy Schools	92%	98%
Total	100%	100%

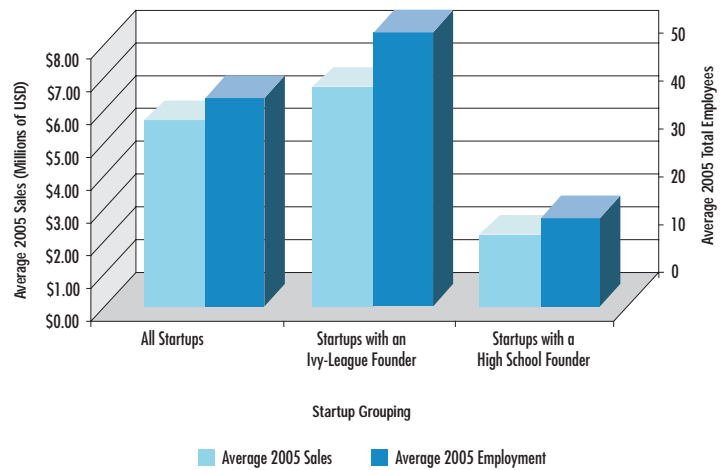
¹National 2005 bachelor’s, master’s, and PhD degree production data was obtained from the Institute for Education Sciences–National Center for Education Statistics. Individual schools’ 2005 graduation statistics were obtained from 2005 commencement announcements.

U.S.-Born Tech Founder Education and Startup Success

We found a correlation between a U.S.-born tech founder's terminal degree and company performance.

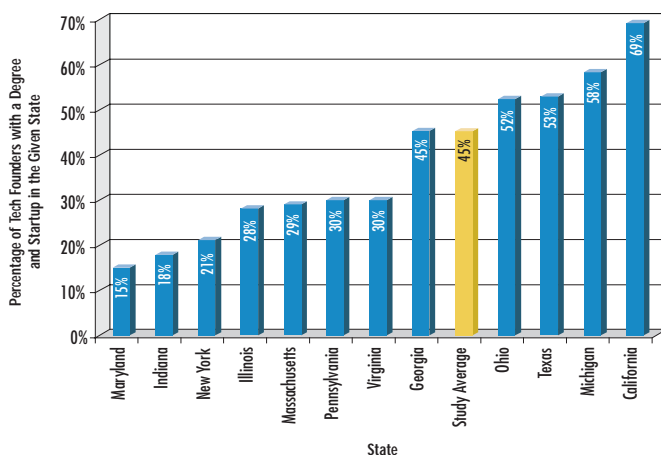
Figure 7 displays the average 2005 sales and total employment of the startups in our sample. In 2005, the average sales revenue of all startups in our sample was around \$5.7 million, and these companies employed an average of forty-two workers. Startups established by tech founders with terminal Ivy-League degrees had higher average sales and employment—\$6.7 million and fifty-five workers, respectively. The success of these two groups markedly contrasted with startups established by tech founders with high school terminal degrees, which had less than half the average revenues and number of employees—\$2.2 million and eighteen workers.

Figure 7:
Average 2005 Sales and Employee Count Comparison



University/Location of Startup

Figure 8:
Percentage of U.S. Tech Founders Who Established a Startup in the Same State in Which They Received a Degree



We also observed a correlation between the state in which U.S.-born tech founders received one or more of their academic degrees (terminal, first, or second) and the state in which they eventually established a startup. Nearly 45 percent of the tech founders in our sample established startups in the same state in which they were awarded one or more of their degrees. Our U.S.-born tech founder dataset included individuals who received degrees from academic institutions located in forty-seven of the fifty U.S. states. Figure 8 displays a breakout of retention rates in states where at least twenty tech founders both received degrees and established startups.

Summary of Findings and Conclusions

Our survey shows that education provides an advantage in tech entrepreneurship and that most U.S.-born tech founders of technology and engineering companies are middle-aged with sixteen years of work experience before they launch a startup. The twenty-year-old wunderkind is the exception, not the rule.

The education a tech founder receives is important in tech entrepreneurship. But, while elite, Ivy-League schools are over-represented in the ranks of U.S.-born tech entrepreneurs and achieve greater business success than others, 92 percent of the U.S.-born tech founders come from other colleges and universities. The biggest difference in business success is between tech founders with terminal bachelor's degrees and those with terminal high school diplomas.

Some states are more successful than others in retaining university graduates who go on to start

technology companies. California tops this list, but there also are large differences between Michigan, Texas, and Ohio, which rank above average, and Maryland, Indiana, and New York, which are at the bottom.

This research raises policy questions on how regions of the country and the country itself can foster greater tech entrepreneurship to boost economic growth. While we do not know how some of the tech founders would have fared had they not obtained higher degrees, the predominance of degree holders suggests that an advanced education has become critical, at least in the sectors covered in our sample. The majority of higher education and graduate degrees in our respondent body fell within tech founders of thirty-five to forty-four years of age. That a large number of U.S.-born tech founders have many years of experience in business also is important in understanding the supply of tech entrepreneurs.

Author Biographies

Richard Freeman

Richard Freeman holds the Herbert Ascherman Chair in Economics at Harvard University, and serves as faculty director of the Labor and Worklife Program at the Harvard Law School. He also is director of the labor studies program at the National Bureau of Economic Research, senior research fellow in Labour Markets at the London School of Economics' Centre for Economic Performance, and visiting professor at the London School of Economics. Freeman has published more than three hundred articles dealing with a wide range of research interests, and has written or edited more than thirty-five books, including: *America Works: The Exceptional Labor Market* (2007), *What Workers Want?* (2006, 1999), *Seeking a Premiere League Economy* (2004), and *Emerging Labor Market Institutions for the 21st Century* (2004).

Ben Rissing

Ben Rissing is a Wertheim Fellow in the Labor and Worklife Program at the Harvard Law School and the project manager of Duke's engineering outsourcing and immigration research. As a research scholar with

Duke University's Pratt School of Engineering, he investigated globalization, technology entrepreneurship, and the roles of multinational corporations. Rissing has a degree in mechanical engineering from the University of Virginia and a master's in engineering management from Duke University. He has been involved in projects ranging from engineering design and technology transfer to public policy in Washington, D.C. In his free time, Rissing enjoys competitive fencing and has competed in a number of national competitions.

Vivek Wadhwa

Vivek Wadhwa is a Wertheim Fellow with the Labor and Worklife Program at Harvard Law School and executive-in-residence/adjunct professor for the Pratt School of Engineering at Duke University. He also is an entrepreneur who has founded two successful technology companies, an active mentor and advisor to various startups, and a columnist for *BusinessWeek.com*. Wadhwa was named a "Leader of Tomorrow" by *Forbes.com*, and his company, Relativity Technologies, was named as one of the twenty-five "coolest" companies in the world by *Fortune* magazine. Wadhwa holds a bachelor's in computing studies from Canberra University in Australia and a master's from New York University.

Appendix A: Engineering and Technology SIC Codes

U.S. Government-Defined Standard Industrial Classification (SIC) Codes

Industry	SIC
Semiconductors	
Special industry machinery	3,559
Semiconductors and related devices	3,674
Instruments for measuring and testing electricity and electrical signals	3,825
Computers/Communications	
Electronic computers	3,571
Computer storage devices	3,572
Computer peripheral equipment, n.e.c.	3,577
Printed circuit boards	3,672
Electronic components, n.e.c.	3,679
Magnetic and optical recording media	3,695
Telephone and telegraph apparatus	3,661
Radio and television broadcasting and communications equipment	3,663
Communications equipment, n.e.c.	3,669
Bioscience	
Drugs	283
Surgical medical and dental instruments, and supplies	384
Medical laboratories	8,071
Laboratory apparatus and analytical, optical, measuring, and controlling instruments	382 (except 3,822, 3,825, and 3,826)
Defense/Aerospace	
Small arms ammunition	348
Electron tubes	3,671
Aircraft and parts	372
Guided missiles and space vehicles	376
Tanks and tank components	3,795
Search, detection, navigation, guidance, aeronautical, and nautical systems instruments and equipment	381
Environmental	
Industrial and commercial fans and blowers, and air purification equipment	3,564
Service industry machinery, n.e.c.	3,589
Sanitary services	495
Scrap and waste materials	5,093

Software

Computer programming services	7,371
Prepackaged software	7,372
Computer-integrated systems design	7,373
Computer processing, and data preparation and processing services	7,374
Information retrieval services	7,375

Innovation/Manufacturing-Related Services

Computers, and computer peripheral equipment and software (wholesale trade)	5,045
Electronics parts and equipment, n.e.c. (wholesale trade)	5,065
Computer facilities management services	7,376
Computer rental and leasing	7,377
Computer maintenance and repair	7,378
Computer-related services, n.e.c.	7,379
Engineering services	8,711
Research and testing services	873

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ⁱⁱⁱ Saxenian, A. Silicon Valley's New Immigrant Entrepreneurs. Public Policy Institute of California. 1999. Available online at http://www.ppic.org/content/pubs/report/R_699ASR.pdf.

^{iv} Institute for Education Sciences–National Center for Education Statistics (2006). Table 257. Bachelor's, master's, and doctoral degrees conferred by degree-granting institutions by field of study and year: Selected years, 1970–71 through 2004–05. 2006 *Digest of Education Statistics*. Available online at http://nces.ed.gov/programs/digest/d06/tables/dt06_257.asp.

KAUFFMAN
The Foundation of Entrepreneurship

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