Growing a Successful High Technology Region: Silicon Valley and the Role of Stanford University

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Outline: A 50 Year History

- Terman as Dean and Provost
  - a new vision for an engineering school
- The HP Story
  - Bill and Dave started it all
- The Second Golden Age: 1980-
  - Sun, Silicon Graphics, MIPS, Cisco
    - Technological drivers
- The Internet revolution of the 1990s
  - Yahoo, Granite, Vxtreme, and more to come
- Why at Stanford?
In the Beginning: Terman’s Vision

- Personal history:
  - Father was Stanford professor
  - UG @ Stanford; PhD @ MIT
  - Stanford EE faculty 1925–
  - Worked on radar in WW II
  - Returned to Stanford
    » Dean 1944–1958; Provost 1955–

- Some of his goals
  - faculty work with industry
  - build a west coast industry for our graduates
  - research as the key to develop new technologies
  - encourage entrepreneurship
  - industrial research park
The HP Story

- Terman brought Hewlett and Packard together
  - Encouraged them to work on the idea that became their first product

- Helping them get started
  - Hewlett back from an MS @ MIT
  - Packard took a leave from GE
  - $1,000 from Sperry Rand for materials and Packard’s salary

- 1939: Hewlett graduated and he and Packard gave it a shot

Audio oscillator used in Fantasia.
The Second Golden Age: 1980-85

- Period from 1980 to 1985 one of the most productive
- One research lab at Stanford produced
  - Sun
  - Silicon Graphics
  - MIPS
- In parallel: Cisco, Imagen, Teknowledge, Intellicorp
- Just a few stories from the period...
- The technology drivers in this period
Sun Microsystems

- Based on a research prototype (design by Andy Bechtolshiem)
- Goal: low-cost, graphics terminal
  - the first network computer!
  - motivated by need for graphics among researchers
- Initially totally bootstrapped
  - prototype parts from gift funds
- Initial HW and SW was completely home-brew
- Company founded by merging Stanford HW & Berkeley SW
  - both close to product
Silicon Graphics

- **Vision**: inexpensive, high performance 3-D graphics
  - Key: Geometry Engine
  - enabled significant breakthrough in price-performance

- **Founders**:  
  - Jim Clark (Stanford EE prof)  
  - a host of staff and students

- **One of the first to license the “Sun design”**

- **Protoype was graphics terminal**  
  - close to first product
MIPS

- One of the first RISC projects
  - Others: IBM and Berkeley

  - prototype microprocessor
  - design was conceptual basis for company
  - SW was prototype compiler

- Significant industrial disbelieve
  - vested interest, etc.

- Support from a few people

- History
  - Founding: 1984
  - IPO: 1989
  - Acquisition: 1992
  - Re-IPO: 1998
Stanford got into networking extensively early on
  – connect up all our computers
  – staff and students installed
Internal demand for networking products
  – first prototype = Sun design
  – incredible, ad hoc systems
Colleagues at other schools wanted these prototypes
Bosack and Lerner started Cisco to meet the demand.
Stanford prototype became first product
Driving Forces in the 1980s Period

- Faculty and research growth in experimental computer systems
  - Faculty hiring
    » EE played a key role in bringing in a number of experimentally-oriented, systems faculty
  - Research $
    » significant increase in research funding

- New technologies—the breakthroughs of 1979!
  - VLSI revolution
  - Microprocessors as computers
  - Xerox Alto as tool and inspiration (donated in 1979)
VLSI Revolution

- Mead and Conway textbook
- Idea: make integrated circuit technology available to a wider range of designers.
- Several experimental courses
  - one at Stanford
  - Xerox PARC played a key role
- Explosion of
  - research using new capability
  - explosion of interest in tools for this capability
Microprocessor Comes of Age

- First general-purpose microprocessor:
  - Intel 4004 (4-bit) (1971)
  - microprocessors don’t compete with “real” computers
- Motorola 68000 (1979)
  - first microprocessor that looks like a “real” computer
  - first 32-bit microprocessor
  - became basis for Apple Macintosh
  - Skip Stritter, Stanford PhD & MIPS cofounder, is an architect
- Visionaries: microprocessors will change computing!
The Xerox Alto

- The first personal computer
- Revolutionary machine
  - bit mapped graphics
  - integrated mouse
  - windows system
  - first Ethernet
  - first file server
  - first laser printer
- Inspiration for the Macintosh
- 15 machines donated to Stanford in 1979
1990s: The Internet Explosion

- Internet
  - key protocols designed by Cerf as faculty member at Stanford
  - heavy use by researchers
  - lots of local-area-networking
- Early information servers
  - ftp, gopher, etc.
- World Wide Web appears
- Mosaic–browser
  - Clark forms Netscape
- Internet use explodes
  - everyday users publish!
- Most researchers surprised!

Web traffic at Stanford
(1/2 from outside!)

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The Yahoo Story

- Two EE graduate students
  - avid web surfers
  - how to organize information?
  - working in a set of trailers!
- Developed Yahoo
  - Yet Another Hierarchically Organized Oracle
  - for their own use!
- Use of Yahoo on campus and off explodes
  - campus networking bill surges
  - move servers to Netscape
- Form independent company
Why Stanford?

- Federal research funding
- The role of graduate students
  - as inventors
  - as disseminators
  - as part of the workforce
- Industrial interaction
  - already covered this
- Encouraging entrepreneurship
- Fertile Ground
  - Valley is the ideal planting ground for new ideas
**Federal Funding of Research**

- Basic research programs
  - Funding often has
    - strategic focus
    - applied nature
  - But, research is still basic
    - not product-oriented
    - often not clear who will exploit results
  - Most interesting results often differ from
    - funder’s expectations
    - researcher’s expectations
  - Support and nurture a creative environment.

[Bar chart showing federal funding of research from 1979 to 1997, with millions of dollars on the y-axis and years on the x-axis.]
The Role of Students

- Students are the key to tech transfer
  - bring and develop new ideas
  - vehicle for technology transfer
    » transfer people with ideas not just ideas
  - students and research are interlocked:
    » largest fraction of PhD students/faculty member in US
  - graduate student support is largest budget item for Engineering
Educational Role

- Stanford is largest grantor of graduate engineering degrees in US
- Graduate population comes from all over the world
- Many of our graduates remain in the Valley

![Bar chart showing degrees granted by field and degree level.](chart.png)
Encouraging Entrepreneurship

- Licensing technology
- Faculty leaves to industry
- Entrepreneurship education
  - Stanford Technology Ventures Program
    » largest of its kind
    » includes a unique start-up focused co-op program
    » includes some business background
    » business plan contest
- Historical precedents
  - Terman and HP
  - Hennessy and MIPS
  - Yahoo
Benefits to the University

- Close to technology center
  - best place to be a high-tech faculty member
  - great opportunities for students, both summer and permanent
- Industrial collaboration
  - many interesting projects require industrial support
- Deeper understanding of industry by faculty
  - better researchers and better teachers
- Opportunity to be an entrepreneur and see your ideas to the market
  - best of both worlds
- Draws other good faculty and students
  - major recruiting advantage
Stanford: the Heart of Silicon Valley