Abstract

Founded in 1891, Stanford University is a private research and teaching university modeled after Cambridge and Oxford but with a strong element of basic and applied research.

The success of Silicon Valley arose out of the culture created by Hewlett Packard more than 60 years ago. Today, the Silicon Valley economic model has been adapted and is going global. The Stanford – Silicon Valley interactions have evolved over the past 20 years. This talk explores the guidelines developed two decades ago at Stanford to manage conflicts at the interface.
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The Future
From Berkeley to Silicon Valley
to Stanford

Completed studies in physics at the University of California, Berkeley - 1964
Took position at Start-up Company in Mountain View, CA

Spectra Physics - employee at first Laser company  1964
Stanford University - PhD in Applied Physics  1969

Chromatix  Start-Up company  1969
Assistant Professor at Stanford

Quanta-Ray Inc  Co-founder  1974
Lightwave Electronics  Co-founder  1984
Dean of Research Stanford  1987
Return to teaching and research  1992
Mobius Photonics  2005

Contribute to Professional Societies and to Science and Technology
Policy in California - Chair, *California Council on Science and Technology*

An academic career can be combined with outside entrepreneurial
and service activities if conflict of commitment and interest issues
are properly managed.
The Spirit of Stanford University

Founded in 1891, at first Stanford emphasized a “practical education” to assist industry to build the economy of the West. Stanford was open to both men and women.

"Of all the young men come to me with letters of recommendation, the most helpless are college young men." Senator Leland Stanford.

Later, Stanford modified his stance on a “practical” education and observed that

“a man will never construct anything that he cannot conceive.”

and extended the curriculum to include liberal arts.

Stanford - a Private Research University
The University was viewed as an organization of “Technical Scholars” by Terman who promoted interactions and connections with industry

Stanford followed a model of investing in new faculty by promoting “Steeples of Excellence”

Stanford is an international university with students from all parts of the globe. (1/2 of graduate students are from outside US)

6753 undergraduates  8093 graduate students  1410 faculty members
Founded in 1939 after Terman suggested that David Packard and Bill Hewlett return to the West Coast to start a new company. HP set the unique culture of Silicon Valley by investing in the community and the university.
HP Mission Statement regarding Stanford - 1987

Mission Statement:

- Hewlett-Packard is committed to enhancing and supporting the mutual and strategic interests of Stanford and HP; building new partnerships on the base of our traditional relationship with Stanford students, faculty and administration. We expect to continue and expand our efforts to increase Stanford's position as a premier educational and research institution in keeping with Stanford's strategic priorities.
David Packard, Bill Hewlett, and Bill Gates 1996

Passing the torch to the next generation.

David Packard and Bill Hewlett met with Bill Gates at the dedication of the Gates Computer Science Building.
Silicon Valley looses a mentor and friend

David Packard wanted to give all of his people - not just the managers - a chance to have a fulfilling career.
From HP to Google

Prelude
Cyrus Elwell, immigrant from Australia founds Federal Telegraph 1911

The $100 Idea
Sigurd and Russel Varian invent the Klystron start Varian 1935

Fred Terman persuades Hewlett and Packard to return to Bay Area
Bill Hewlett and David Packard start HP in garage in Palo Alto 1939

Stanford Research Park established by Terman 1951
Stanford Shopping Center created an income source 1955

Disk Storage IBM - 1955
Integrated Circuits Fairchild 1957
Laser company Spectra Physics 1962 (R. Byer joins SP in 1964)

“Silicon Valley” coined by Don Hoefler in 1971

Adv Computing SUN, Silicon Graphics Inc 1982
Biotechnology Genentech
Software Adobe (S. Byer joins in 1987)
Personal Computer Apple
Internet Yahoo! 1994
Search Engines Google

Silicon Valley Goes Global 1990’s
Example of Stanford Spin-off companies

<table>
<thead>
<tr>
<th>Company</th>
<th>Annual Revenue</th>
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<tbody>
<tr>
<td>Hewlett Packard</td>
<td>$80 billion</td>
</tr>
<tr>
<td>Cisco Systems</td>
<td>$22</td>
</tr>
<tr>
<td>Sun Microsystems</td>
<td>$11</td>
</tr>
<tr>
<td>Yahoo</td>
<td>$3.6</td>
</tr>
<tr>
<td>Google</td>
<td>$3.2</td>
</tr>
<tr>
<td>KLA-Tencor</td>
<td>$2.1</td>
</tr>
<tr>
<td>Varian</td>
<td>$0.9</td>
</tr>
<tr>
<td>Silicon Graphics</td>
<td>$0.7</td>
</tr>
</tbody>
</table>

Dozens of companies formed at the PEAK OF THE BUBBLE in 2000 are no longer in existence.

Of all start-up companies, only 1 in 10 are profitable, 3 in 10 stay alive and the balance go out of existence.
Silicon Valley Today

Total revenues in the Valley

- The 10 largest companies: $600 billion
- The ~3000 small companies: $90 billion

Stanford University spin-offs

- Of 3500 small companies, 1000 are spin-offs
  - Average # employees: ~20
  - Revenue per employee: ~250k
  - Revenue for small spin-offs: $10 billion

- Of all large companies, ~1/3 are spin-offs
  - Revenue for 100 large Co's: $200 billion

~ $400 billion dollars in revenue or approximately one-third of the Silicon Valley revenue is spin-off from Stanford University.
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Silicon Valley - factors for success

Stanford’s contribution to Silicon Valley

The Myth
Technology transfer from Stanford to companies fueled the growth of Silicon Valley

The Question
What fraction of companies have used Stanford Technology either directly or indirectly in their business?
Stanford’s Contribution to Silicon Valley

The Answer

Of the >1000 Companies SPUN-OUT from Stanford University

ONLY 5%

Or

1 in 20

HAVE USED TECHNOLOGY DERIVED FROM Stanford University!
Stanford's contribution to Silicon Valley

<<technology>> the myth
<<educated students>> the fact

Probably the single most important contribution Stanford University has made to the development of Silicon Valley was to attract and to educate talented students, many of whom elected to remain in the Bay Area.
Silicon Valley—Factors for Success

FACTORS for SUCCESS

Entrepreneurial Attitude

Land Resources

Educated People

$ Venture Capital $

Lawyers!

Risk taking encouraged—FAILURE allowed!!

Government R&D Labs
(LBNL, LLNL, AMES, SLAC)

DIVERSE

and mobile work force with global reach!
Silicon Valley—Factors for Success

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SUCCESS is CELEBRATED!
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The Future
Internationalization of Silicon Valley

The Silicon Valley model is successfully adapted to regional economies

• Seed the region with young entrepreneurs who have studied and worked abroad

  Associations with scientists, engineers and business leaders have led to presentations and discussions around the world.

The University and Silicon Valley – education at the interface.

Examples of Global Regions visited

- Quebec, Canada 1992
- Minnesota, USA 1993
- Sendai Japan 1994
- Hinschu, Taiwan 1996
- Sydney, Australia 1996
- Oslo, Norway 1997
- KSVF, Osaka, Japan 1998
- RIKEN, Tokyo, Japan 1999
- CREOL, Orlando, Florida 1999
- Bay Area Economic Forum 2000
- Vienna, Austria 2000
- Barcelona, Spain 2001
- Agilent, Palo Alto 2003
- Sendai, Japan 2006
- Ottawa, Canada 2007
- Barcelona, Spain 2008
- Venezuela, South America 2008
Creating New Global Valleys

The Globalization of Silicon Valley

Creating New Valleys

• Adapt the model to reflect regional history, customs and practices

  • Build on regional strengths

• Form associations to facilitate university, industry, and government interactions

• Seed the region with young entrepreneurs who have studied and worked abroad

  • Encourage a DIVERSE and mobile work force with a wide range of skills

• Create a knowledge society by investments in the regional educational institutions at all levels

Encourage risk taking, tolerate failure, CELEBRATE SUCCESS
Spotlight on Munich

IN THIS SECTION we will take you on a tour of some of the main areas of Munich’s Scientific Community, with an analysis of the country's growing biotech industry. We will introduce you to companies, institutions and universities showing their strengths, specialties and recruitment opportunities available.

http://helix.nature.com/spotlight/munich
This is part of a continuing series profiling companies and institutes in specific regions.
Can Kyoto become a version of Silicon Valley?
SENDAI - The Tera-Photonics Project

Build ‘Steeples of Excellence’  Be international in scope.
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The Future
Terman established research park in 1951 -- only 50 acres at beginning

Idea was not considered of value; but Varian and then HP moved into the park. 50 years later the Stanford Research Park is 660 acres and over 40 companies. However, use has moved from light manufacturing to legal firms and offices. Some space set aside to facilitate start-up opportunities. Revenue taxes go to City of Palo Alto.

Terman conceived of the Stanford Shopping Center in 1955

Today, one of the most successful centers in Bay Area. Provides ~1/3 of Palo Alto City income from taxes on sales proceeds.

Joint ventures with local cities are of value to the broader community and to the region. However, success takes time ~ 50 years.
First industrial relations program established in 1955
Aeronautics and Astronautics forms joint activities with companies
In 1961 EE Department starts Solid State Industrial Affiliates Program

Goal of Industrial Relations program is to support teaching and research
and facilitated access to ideas and to students

University provides
Facilitated Access to research
Introduction to educated students
Neutral meeting ground for companies

Companies provide
Annual support for teaching and research
Motivation for promising research topics

Students benefit by interactions with company scientists and engineers
University benefits by new ideas and support for interactions
Companies benefit from facilitated access to ideas and students
Stanford adopts de-centralized Industrial Affiliates model with faculty members responsible for forming and operating the Programs

Today more than 45 separate programs on Campus involving more than 400 companies with a global reach.
Technology Transfer – Building relationships
Professor Richard Zare, Chemistry - Inventor

“I am someone who dreams about making revolutionary changes in the world through science.”

Richard Zare describes himself as a frustrated inventor. “I’m a person with all types of ideas and enthusiasms, most of which don’t work. But that’s the nature of discovery and research,” he concedes.

Yet with 83 invention disclosures received at Caltech, Professor Zare can claim approximately three invention disclosures a year since his arrival at Stanford in 1977. That’s hardly the stuff of failure. Still, he insists, it always comes as a surprise when something works.

An invention that has proven to work perfectly is laser-induced fluorescence detection. Professor Zare first became interested in lasers as a graduate student at UC Berkeley. “People said the laser was a solution in search of a problem,” he recalls. But he was keenly interested in the action of light, and he thought if he could use lasers to bring molecules from their unexcited ground state to an excited state, they would fluoresce, revealing their structure. This would also offer a way, he thought, to separate and detect the molecules in a mixture.

His patent for the laser-induced fluorescence detection was licensed by Beckman Coulter, which sponsored the research program and has used the invention in its commercial electrophoresis instruments for more than a decade.

Another of Professor Zare’s inventions that allows for extraordinarily sensitive sampling of materials is a means of detection called “cavity ring-down.” By placing a sample between two mirrors, he explains, you can create an optical cavity that causes light to bounce back and forth, which amplifies the presence of whatever absorbs in the sample. Using a pulse of light, scientists can observe the rate at which the light inside the optical cavity dies away or “rings down,” providing a way to precisely measure the concentration of the components in the sample.

Licensed to Picarro, a company Professor Zare and one of his graduate students started for the purpose of commercializing this invention, this tool could have almost unlimited uses, from health care to agriculture to bioterrorism. Using a simple breath test, for example, we might be able to detect whether a person has a cold or the flu — even before the symptoms are evident. “In the confined quarters of a submarine or a ship, say, it could matter a great deal to know whether someone is going to become sick,” he muses. “I’m someone who dreams about making revolutionary changes in the world through science,” he reflects.

Richard Zare is the Margaret and Blanche Willbur Professor in Natural Science with an appointment in the Department of Chemistry and a courtesy appointment in the Department of Physics.
Gordon Kino is trying to use a tiny optical microscope to peer inside the human body. If he succeeds, this revolutionary technique could replace some surgical biopsies—allowing doctors to detect cancer or other illness without an invasive surgical procedure.

“We did some work in this area eight or nine years ago,” Professor Kino remarks. “But we had trouble getting much support for it. Now medical people are much more convinced that physicists and engineers can help them.”

To date, of the 40 Inventions Professor Kino has disclosed, the one that has proven to be most lucrative is another means of seeing—the ultra-fast confocal scanning optical microscope. Used primarily in the semiconductor industry, this invention makes it possible to view cross sections of a semiconductor device. But the right depth of field diameter correct? Are there any flaws that will interfere with its function?

“The technique had been around for a while,” Professor Kino remarks. The microscope uses a Nipkow disc with multiple pinholes through which light is projected, and an objective lens that focuses the light and illuminates the object. But previous versions relied on a single pinhole, which made for a slow, laborious process by dramatically increasing the number of pinholes and making improvements that eliminated the need to re-align the microscope for each new view. Professor Kino and his students were able to patent a new and improved invention that is still in widespread use nearly two decades later.

Still, the road between invention and commercial application is often marked by detours. Professor Kino’s optical recording system utilizing a solid immersion lens is a perfect example of how much can go wrong before something goes right.

Intended to significantly increase the amount of information that can be written on an optical storage medium, the technology was first licensed to a startup that hoped to commercialize a new class of rewritable mass storage products. But insurmountable technical difficulties halted the project. Now, the technology is being considered by a large corporation for future generation storage products and has potential to be incorporated into a standard. Professor Kino points out that the experience “certainly illustrates the fact that what you demonstrate in a university is one thing. In industry if you want to make thousands and thousands of something that are exactly alike, it’s a different story.”

Gordon Kino is the W.M. Keck Foundation Professor of Electrical Engineering, Emeritus (active)
Bob Byer is using a laser he invented to detect gravitational waves in the universe. “We’ve learned how to make our lasers as low noise as possible,” he explains, “which allows us to make very difficult, very precise measurements.”

“We invented this laser to allow us to do fundamental research. Yet when applied to the production line of the joint strike fighter aircraft, it allowed very precise measurements and doubled the production rate, saving $250 million over the production run of the aircraft.”

From laser light shows to semiconductor manufacturing and more, Professor Byer’s laser and nonlinear optical material inventions have found an enormous variety of applications. Now a laser he invented 20 years ago is slated to be part of USA – Laser in Space Antenna – when it launches in 2012 on a mission designed to measure the gravitational waves of massive black holes in the universe.

Never undertake a project unless it is manifestly important and nearly impossible.
OTL reaches $1 billion cumulative income Nov 2005

Office of Technology Licensing was founded In 1969

The model for the Office is to bring technologies to the commercial market by building long term relations with companies.

More than 400 companies have licensed from Stanford since inception.

Successful inventions include:

- The Cohen-Boyer gene splicing
- FM frequency synthesizer (Yamaha)
- Fiber amplifier (Litton)

START-UPS
While Stanford entrepreneurs are still starting companies, the economy clearly has negatively affected the Silicon Valley entrepreneurial ecosystem. Venture capital investments steeply declined and investors are becoming more cautious. Yet licenses to take upstart companies involved equity: Biorix Technologies, General MEMS, Lumen Therapeutics, Lyman Technologies, Optimation, Pharmacia, Rex, Medtronic, Synchron, Nortel.

NEW DISCLOSURES
In calendar year 2004, we received 350 new technology disclosures. Approximately 40% were in the life sciences and 52% were in the physical sciences, including computer science technologies. Our work with the Stanford Biodesign Network’s Biomedical Technology Innovation Program also generated 14 disclosures from students as part of their coursework.

STANFORD TRADEMARK ENFORCEMENT FUND
The Chief Financial Officer and General Counsel of Stanford recommended that Stanford provide a permanent source of funding for extraordinary cases associated with the protection of the Stanford name and associated logos and trademarks. Based on their recommendation, the President and Provost approved the creation of the Stanford Trademark Enforcement Fund (STEF). Initial funding for the STEF comes from 5% of the department and school shares of net revenue OTL receives. For FY2004-05, we transferred $251,814 to STEF.

BIRDSEED FUND
The OTL Birdseed Fund, administered by the Dean of Research, has provided small amounts of money (typically up to $25,000) to fund prototype development or modest in-kind or in-practice experiments for underwritten technologies. This year, the Birdseed Fund funded six new projects, for a total of 39 projects funded to date. The rate of licensing of Birdseed funded inventions is about the same as unfunded inventions (60%) but without the funding, many of those inventions would likely have remained unfunded.

RESEARCH INCENTIVE FUND
In the past seven years, the Dean of Research has used the OTL research incentive funds to fund over 1,100 seed research projects in all parts of the University. Primarily for assistant professors, research grants of $20,000 to $30,000 were used to fund 12 projects, including Professor of Communication Science Professor’s Digitally-Mediated Person Recognition, Professor of Mechanical Engineering J. Christian Gerdes’ A Nano-Fuel Inspired Approach to Self-Propelled Vehicles, and Professor of Neurology Christine Wijman’s Selective Cerebral Hypothermia in Acute Stroke.
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The Future
The 1990’s: Managing Conflicts - Serving the Community

Licensing
Licensing to “start-up” companies

Investments
Investments in “start-up” companies

Equity Acquisition
Equity in lieu of cash as compensation

Conflict of Interest
Conflict of Commitment and Interest

The University is an institution of public trust that must maintain integrity in all aspects of its mission to educate students and to gain and apply knowledge through research and innovation.
### Guidelines for Technology Licensing to 'start-up' Companies

*(approved by the Senate on November 8, 1990)*

<table>
<thead>
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<th><strong>Goals</strong></th>
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<tr>
<td>Recognize and manage conflict of interest questions</td>
</tr>
<tr>
<td>Remove focus on exclusive or non-exclusive licensing</td>
</tr>
<tr>
<td>Allow equity in lieu of cash in licensing deals</td>
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<table>
<thead>
<tr>
<th><strong>Principles</strong></th>
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<tr>
<td>Faculty are committed to teaching/research at the University</td>
</tr>
<tr>
<td>Quality of interactions with faculty and students is maintained</td>
</tr>
<tr>
<td>Recognize and establish procedures for managing conflicts</td>
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<tr>
<td>Conflict of interest issues:</td>
</tr>
<tr>
<td>Commitment of time and intellectual energy</td>
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<tr>
<td>Financial decisions</td>
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<tr>
<td>Student training</td>
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<tr>
<td>Hiring decisions</td>
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<tr>
<td>Independence of the department or program</td>
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<tr>
<td>Possible coercive influence over colleagues</td>
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</tbody>
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<table>
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<tr>
<th><strong>Procedures</strong></th>
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</thead>
<tbody>
<tr>
<td>OTL determines that technology is to be licensed</td>
</tr>
<tr>
<td>OTL informs faculty member, chair, and dean of potential deal</td>
</tr>
<tr>
<td>Faculty member prepares written statement that addresses conflicts of interest</td>
</tr>
<tr>
<td>Chair consults with OTL and makes recommendation to Dean</td>
</tr>
<tr>
<td>Dean makes decision on suggested licensing arrangement</td>
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</table>
Guidelines for Stanford University Investments in 'start-up' companies involving Stanford faculty

Stanford may not invest if faculty member has line management role.

Stanford may invest if faculty member has equity position if:

1. Stanford is a passive investor.

2. Stanford investment is limited to 10%.

3. No Stanford officer is a member of the board, or an officer, or has equity in the company.

4. Subject to case by case approval of the Provost; Any future licensing requests subject to approval.
Equity Acquisition in Technology Licensing Agreements

Stanford University may accept equity as one form of compensation for license rights, subject to a conflict of interest review if appropriate.

One third (1/3) of the Net Equity will be issued to the Inventor(s) as the Inventor(s)'s Shares. Following issuance of Net Equity, it shall be the sole responsibility of the Inventor(s) to manage the Inventor(s)'s Shares.

The remaining two thirds (2/3) of Net Equity will be issued to the University as the University Share. The OTL Research and Fellowship Fund, administered by the Vice Provost and Dean of Research and Graduate Policy, will receive the University Share.

All equity received by the University will be managed by Stanford Management Company.
**Conflict of Commitment**
Stanford faculty members owe their primary professional allegiance to the University...

**Conflict of Interest**
A conflict of interest depends on the situation, and not on the character or actions of the individual.

Conflicts of interest are common and practically unavoidable in a modern research university.

Faculty members should conduct their affairs so as to avoid or minimize conflicts of interest, and must respond appropriately when conflicts of interest arise.

Stanford University is an institution of public trust: Faculty must respect that status and conduct their affairs in ways that will not compromise the integrity of the University.
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The Future
Sustained economic growth through Visionary Innovation was the paradigm of the 20th century.

From railroads to air transportation, the radio to cellular telephones, The internet to world wide telecommunications.

Innovation is the engine that will fuel future economic growth.

The Bottom Line

A role of the Universities, Industry and Government in the Knowledge Society is to Create Wealth on a global scale through visionary innovation.
Research - a global perspective

Today: 1/3 of R&D in the US 1/3 in Europe 1/3 in Asia

20 years: ~ 1/4 in US 1/4 in Europe 1/2 in Asia
Transfer of University Innovation to Industry: Paths and Pitfalls

Silicon Valley goes Global
Stanford University - a Global reach

The spirit of Stanford University
Steeples of Excellence
Support global economic development
Educate Students with a global reach