Caltech,
An Entrepreneurial Leader

Dr. Kenneth A. Pickar
J. Stanley Johnson Professor
Visiting Professor of Mechanical Engineering
March 1, 2000
Outline of Talk

• Change and disruptive technology
• What makes an Entrepreneur?
• What are the experiences of some successful Caltech Entrepreneurs?
• What is Caltech doing now to encourage Entrepreneurship?
• Thoughts on the 21st Century
Two Major Drivers of Change

- War
- Technology
War as a Driver of Change

- **WW1**
  - Aviation

- **WW2**
  - Jet aircraft
  - Radar
  - Nuclear energy

- **Cold War**
  - Semiconductors and Computers
  - Missiles, Communication Satellites
  - Internet
Technology as a driver of change

Fundamental Law

Technology → change → opportunity

Always opportunities but there are times when opportunity abounds
Moore's Law
Technological Capability

System trends in terms of cost per mip

Year

Capability

Price Per Mip (dollars)

Overall Trend

System trends in terms of cost per mip

Overall Trend

Price Per Mip (dollars)


$1,000,000 $100,000 $10,000 $1,000 $100 $10 $1
Data network transmission costs 1980–1997

- Direct modem connection
- Dial-up local internet access
- Direct leased line (T-1)

Constant 1995 Dollars per Megabit (logarithmic scale)
Hard drive: size up, price down

*Average for all hard drives, including those on servers. †Average for desktops only.
Internet Hosts
1987–2002E (Millions)
What is a disruptive technology?

Then change became “disruptive”
Disruptive? Look at the effects. . .

Good companies fail

Companies that do all the right things
- are well-managed and progressive
- listen to their customers
- study and act on market trends
- invest significant resource in R&D
- allocate capital to provide the best return

Be considered industry models for their success

. . . and then collapse under attack from much smaller entrepreneurial companies
Examples of Casualties

- DEC
- IBM (early 90s)
- Wang
- Xerox (70s)
- Vacuum tube companies
- Sears Roebuck
- US Steel
Why do they fail?

Cannot respond to disruptive technologies, which destroy old markets and skills and create new ones.

This provides openings for new companies to be created
It has happened before...

- Wagons to Railroad
- Steam Power to Electric Power
- Gas Illumination to Electric Lighting
- Horses to Automobiles
- Vaudeville to Radio, TV, Movies
- Tubes to Transistors
- Transistors to Integrated Circuits
New technologies lead to new business models

Degree of Business Transformation

Focus Level

Network

Enterprise

Process

Low

High

1980’s

Statistical Quality

1990’s

Process Reengineering

Courtesy Steve Flynn
What happened?

- Re-engineering
- Down-sizing
- Outsourcing

These low tech, painful-but-necessary actions resulted in increased competitiveness. . .but
But what’s happening now?

Degree of Business Transformation

Network
Enterprise
Process

Level

Low
High

1980’s
1990’s
2000’s

Process Reengineering
Learning and Intellectual Capital Processes
Business Architecture

“New Economy” Commerce

R&D

Statistical Quality

1980’s
1990’s
2000’s

Courtesy Steve Flynn
Beginning in the late 90s...

The Internet

- The mother of all disruptive technologies
- Created in Universities
- 30 years to reach take-off (same as Xerography!)
- Affects all processes and all functions of all businesses
- Creates new niches, values, networks, customers, personnel skills, government relationships, marketing, distribution, etc.
Consider the Internet questions asked by a traditional company. . .

- Who are the customers of the future?
- Can we serve them with our present Business Architecture, our present people?
- How do we need to change?
- How much time do we have?
- Can we move fast enough?
Exploiting these opportunities

Entrepreneurship is required to create *New* ways of thinking

*But... What is an Entrepreneur?*
Outline of Talk

- Change and disruptive technology
- What makes an Entrepreneur?
- What are the experiences of some successful Caltech Entrepreneurs?
- What is Caltech doing now to encourage Entrepreneurship?
- Thoughts on the 21st Century
Characteristics of Entrepreneurs

- Single minded visionaries
- Driven - high energy and enthusiasm (not 9 to 5)
- Original thinkers - creative
- Very perseverant - stubborn
- Risk takers
- Dissatisfied, impatient
What does Caltech do (or not do) to enable Entrepreneurship?

First, let’s consider the students we seek. . .
What does Caltech look for in its students?

“You have that passion for math and science; you have the grades and test scores. Your main goal is to be in the best possible academic environment you can find. . .”

-From the web site
Additionally Caltech has...

• An Academic Research Science and Engineering orientation
  - pushing the frontiers of knowledge
  - training the next generation of professors
• No Business school
• No Law school
• No Medical School
Caltech’s many positives for the student with an Entrepreneurial flair...

• Leading edge research in many subjects creates many possibilities
• JPL gives additional technology mass, quality and spin-out opportunities
• Professors are entrepreneurs of science
• We honor “quirky independence” and “Out-of-the-box” creativity
Also

- Enthusiastic (my own observation)
- Honor system - integrity
- Small size
- Multicultural diversity
- Challenging yet nurturing
- Lots of organizations to support students
Caltech students *are* the digital generation

Used to Internet Time

Accustomed to risk taking

The place is here!
As for the Faculty, Professors already run small entrepreneurial businesses!

- Marketing: to Funding Agencies
- “Production:” Research results
- Human resources: Employee Hiring, Development, Outplacement
- Operations: running labs
- Financial: multi-million dollar budgets, investment decisions
- Strategic planning
And yet... Our number of professor-entrepreneurs is very few

- Motivated by science
- Desire for deeper knowledge vs. "good enough"
- Time horizon difference
- Tough place to leave
Outline of Talk

- Change and disruptive technology
- What makes an Entrepreneur?
- What are the experiences of some successful Caltech Entrepreneurs?
- What is Caltech doing now to encourage Entrepreneurship?
- Thoughts on the 21st Century
What can we learn from history?

Consider a few Caltech entrepreneurs—there are many more that could be mentioned.
Techers Sell for Billions

Ortel Corporation (NASDAQ: ORTL) became the latest jackpot in the Internet game when Lucent Technologies (NYSE:LU) announced this week a $3 billion acquisition deal for the optical-electronic company. Ortel is the pioneer in semiconductor laser and fiber optics technology. Its technology allows inline TV suppliers to build high-performance systems using fiber optics. The deal will give Lucent state of the art communication technology, giving it a large advantage in the lucrative online access market.

Under the terms of the deal, each share of Ortel will be bought for $3.1355 shares of Lucent. Based on Lucent's closing price last week, the deal is valued at approximately $2.95 billion. Ortel Corporation was founded by three people from Caltech, Israel Ury, who had just finished his Ph.D in applied physics, Nahav Bar-Chaim, who was then a post-doc, and Dr. Amnon Yariv, who is still at Caltech, founded the company in 1980. The company stemmed from research in semiconductor laser at Caltech.

Around 1986, using optical methods for communication became widely known. Semiconductors and powered electronically and can be fabricated to emit lights of any desired wavelength, because the obvious of source for fiber optics.

"All of a sudden, the ability of the laser to turn itself on and off with current became an important issue," said Dr. Yariv, "and we got involved with that issue." In the ensuing race between modular lasers, higher and higher speed, the Caltech team achieved results..."
Chester Carlson
Stan Johnson
Horace Gilbert
Arnold Beckman
And then there is....

Genius

Madness
Case in point—a Caltech Grad

- Very poor background
- Stayed home from school on washdays (because he had only one pair of pants)
- Got his MS in Earthquake Engineering
- Became a Master Trader
- Real Estate Magnate
  
  *bought and sold Real Estate worth $8.5B/year*

There’s more...
• Private jet, Mercedes Benz (2), Rolls Royce (4)

• 53m Yacht

• Art collection included Rodin, Monet, Picasso

• When wife left him, he offered the Vancouver opera company $20,000 for permission to publicly beg for his wife’s forgiveness during intermission

But...
Became insolvent, so he

- Started a pirate radio station
- Purchased
  - a match factory
  - a theme park company
  - a Beatles museum
  - a bar in Denver
  - an Australian satellite launch company

Then he went too far...
• Used his partners’ deposit on a real estate deal for his own private purposes

• After 61 civil lawsuits, convicted of fraud
Not everyone in e-commerce is successful!
Is this a discussion that occurs in your house??

Mike Keefe
The Denver Post
dePIXion Features
Outline of Talk

- Change and disruptive technology
- What makes an Entrepreneur?
- What are the experiences of some successful Caltech Entrepreneurs?
- What is Caltech doing now to encourage Entrepreneurship?
- Thoughts on the 21st Century
Technology Transfer Office
Industrial Relations Center
Entrepreneur's Club
Center for Women Entrepreneurs
Caltech-Loyola Collaboration in Law and Technology
Student Investment Fund
Caltech Classes
Some Recent Caltech Spin-out Companies

- Clinical Microsensors
- CYRANO Sciences, Inc.
- XENCOR
- ViaSpace Technologies
- rainfinity
- PROLINX
- Synopsys
- Sonin Technologies
- Arroyo Optics
- GeometricX
- Welcome to the XEN
- SONIC Innovations
- Takeoff Sciences
- CHIROSCIENCE
- I
- Holoplex
- Genesoft, Inc.
- HighTower
- Myricom
Some Recent Caltech Spin-out Companies
Technology Transfer Office
Industrial Relations Center
Entrepreneur's Club
Center for Women Entrepreneurs
Caltech-Loyola Collaboration in Law and Technology
Student Investment Fund
Caltech Classes
Technology Transfer Office
Industrial Relations Center
Entrepreneur's Club
Center for Women Entrepreneurs
Caltech-Loyola Collaboration in Law and Technology
Student Investment Fund
Caltech Classes
Technology Transfer Office
Industrial Relations Center
Entrepreneur's Club
Center for Women Entrepreneurs
Caltech-Loyola Collaboration in Law and Technology
Student Investment Fund
Caltech Classes
Technology Transfer Office
Industrial Relations Center
Entrepreneur's Club
Center for Women Entrepreneurs
Caltech-Loyola Collaboration in Law and Technology
Student Investment Fund
Caltech Classes
Relations with Pasadena/Southern California Community

- Incubators
- Venture Capitalists
- Angels
- Universities
- Infrastructure
- Entertainment
- Aerospace
- Telecommunications
Virtuous Cycle

Caltech Basic Research and Education

Corporate

Spin-out

New product

New Company

Profits

IPO Wealth

Taxes

Taxes

Philanthropy

Research funding
Outline of Talk

- Change and disruptive technology
- What makes an Entrepreneur?
- What are the experiences of some successful Caltech Entrepreneurs?
- What is Caltech doing now to encourage Entrepreneurship?
- Thoughts on the 21st Century
Thoughts on the 21st century

- Caltech is a strong, highly successful culture
- Radical change will not happen
- Caltech’s focus on the most exciting areas in Science and Engineering will germinate many new Entrepreneurial opportunities
  - Biology
  - Computer science and communications
  - “Beyond Moore’s Law” computing
  - Micro electronic/mechanical devices
- Basic Research will benefit
Thoughts on the 21st century

- Caltech will become more strongly linked to both high tech businesses and Venture Capitalists locally, nationally and world wide.

- With practice, the spin off of Caltech companies will become a managed process.
Thoughts on the 21st century

- Caltech will lag industry (and some other Universities) in the application of new teaching technologies

Is there a disruptive technology that could affect us?
The present frenetic business growth linked to the stock market will not last...
The present frenetic business growth linked to the stock market will not last...
The present frenetic business growth linked to the stock market will not last...
But independently of markets, the Technology change is real, meaning the Entrepreneurial opportunity is real

- Completely new Business models
- Internet Infrastructure
- B2B Commerce
- Genomics
- Full Human High Bandwidth Connectivity
- Human Function Enhancement
**Conclusion**

- Caltech is working to nurture Entrepreneurship
- We probably won’t do much harm!
- Our biggest assets
  - is an admissions process which admits the best and the brightest and . . .
  - an academic program which is designed to bring out the best of them (in all respects)
- Living at the right time and place in history
And finally, Caltech’s first Entrepreneur: Amos Throop (1811–1894)
Acknowledgements

- J. Stanley and Mary W. Johnson
- I’ve had conversations with many Caltech’ers including students, alumni, faculty. I would like to thank them all.
- Archives
  Bonnie Ludt
- Library
  Louisa Toot
- Digital Media Center
  Wayne Waller, Carolyn Patterson
**Some References**

- Mary Terrall Oral History: Interview with Horace Gilbert, Caltech Archives 1979
- Mary Terrall Oral History: Interview with Arnold O. Beckman, 1981
- American Heritage of Invention and Technology Winter 1989 Vol.4, No.3
- The Amos Gager Throop Collection
  Shelley Erwin, Carol H. Buge, editors
- Simon Ramo, “The Business of Science” Hill and Wang, 1988

Lecture to be posted at [http://www.its.caltech.edu/~kpickar/](http://www.its.caltech.edu/~kpickar/)