



Technology Investing in the New Age Plenary Session

**Workshop on Interconnections within High Speed Digital Systems
Santa Fe, New Mexico**

May 5, 2004

Background Context: *Historical Innovation Coming Largely From Research Labs*

- **Death of Innovation,**
April 1997, Business Communications Review
- **Bell Labs spun out with Lucent**
 - » what about the future?
 - » 1% of gross revenues for basic research: fluctuations in gross revenues?
- **Examples of Bell Labs Technical Innovation**
 - » Transistor
 - » Information Theory
 - » UNIX
 - » C and C++ Software Programming Languages
 - » Maser/laser
 - » Cellular telephony
 - » Optical fiber
 - » RJ11/RJ45 connector

What Is the Problem?

- **The Economics of Innovation**
 - » True technical innovation fuels small business economic growth
 - » Technical innovation is imbedded in new products that meet real customer needs, generate profits and revenues in growing markets, and can continue to fund innovation
 - » Small businesses are a major source of new jobs, new wealth
- **The Nature of Innovation**
 - » True Innovation Is Rare: Einstein Had Two-Three Ideas
 - » Relatively Easy to Infringe/Coopt Innovative Ideas at an Early Stage by patents, trade secrets, hiring people
- **The Problem with Funding Innovation**
 - » Funding For basic research is always difficult to defend
 - » Increasing scrutiny of basic research funding
 - Universities
 - Government laboratories
 - Corporate laboratories
 - » Venture capital Is not funding innovation
- **What Are New Funding Sources for Basic Research?**
 - » Angel investors
 - » Restructured venture capital funds

If Not Venture Capital, Who Will Fund Innovation?

- **US Government**
 - » **DOD: DARPA et al**
 - » **NSF**
 - » **DOE**
 - » **NIST**
 - » **SBIRs**
- **Universities via endowment**
- **Corporations**
 - » **research labs**
 - » **applied research in product groups**
 - » **universities**

Innovation Life Cycle Issues for Computers

- Innovation occurs in cycles or wave
 - » Innovation <-> consolidation
 - » Different design points and different technologies lead to new successful business in every cycle
- Computer Industry Cycles
 - » 1965: peak sales for mainframes--IBM
 - » 1972: peak sales for minicomputers—DEC, HP
 - » 1979: peak sales for personal computers--Apple
 - » 1986: peak sales for workstations--SUN
 - » 1996-onward: cellular phones and workstations based on RISC/UNIX/LINUX—Nokia, Dell

Innovation Life Cycle Issues for Networking

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- **Data networking**
 - » 1965-1975: dial up and private line modems, hard wired terminals—Paradyne, Codex, General Data Comm, Racal Milgo
 - » 1975-1985: X.25 Wide Area Networks, T1—Hughes, Telenet, Timplex, NET
 - » 1985-1995
 - Workgroup Ethernet hubs: 3Com, Synoptics
 - Frame Relay and ATM Networking: Stratacom Fore Systems
 - Routers: Cisco, Wellfleet
 - » 1995-2005: Switched Ethernet, routers—Foundry, Juniper
 - » 1995-2005: storage networking—Veritas, EMC, Network Appliance, Brocade
- **Voice networking**
 - » 1965-1985: stored program control mechanical switching—Lucent
 - » 1975-1995: digital switching—NorTel
 - » 1995—onward: Excel, Telica

Venture Capital Structural Issues

- **Venture Fund Life Cycle**
 - » Seven year life: need to invest in first three to four years to harvest by the end of year seven
- **Venture Capital Staff Backgrounds**
 - » Strong bias toward investment banking, management consulting, operations: not strong technically, little background in basic research
- **Serial vs Parallel Investing**
 - » Invest in those that made money previously: does this lead to funding innovation? More of the same, incremental innovation
- **Boom vs Bust**
 - » \$1M valuation per engineer in 1999—no sales, \$10M-\$100M in cumulative operating losses
 - » \$5M-\$10M per round in 2002-2005—money for sales and marketing and manufacturing, no money for funding technical innovation

Venture Capital Fund Educational Background of General Partners

	Number of GPs	Percent of GPs*
Total (20 A-list Venture Funds)	180	100%
Undergraduate: Science/Engineering	115	63.9%
MBA	116	64.4%
Masters: Science/Engineering	52	28.9%
PhD: Science/Engineering	10	5.6%

What Does the Evidence Show?

- Information Sources
 - » Initial Public Offerings: 1993-2002
 - » Select Mergers & Acquisitions: 1993-2002
- Define Innovation
 - » Five point scale: T1 Highest, T5 Lowest
- Data Analysis
- Data Interpretation

Information Sources on IPOs

- 1993-2002 Initial Public Offerings
 - » Morgan Stanley Technology IPO Yearbook
 - » 1303 IPOs 1993-2002
 - » Discards
 - Spinoffs, Recaps: Lucent, Agere, Agilent
 - eCommerce: eBay
- 1993-2002 Mergers and Acquisitions
 - » 213 acquisitions by Cisco, Lucent, Nortel et al
 - » Cisco effect: 14 acquisitions 1993-1996

Technology Innovation Ranking Definitions

Technology Ranking	Criteria
T1	New technology representing a fundamental departure from anything existing previously, whose commercialization made possible an entirely new (and important) business market
T2	Fundamental technology improvement in an existing product category (ie, disruptive technology)
T3	Non-trivial technical improvements in existing product categories -- coming from extension of existing technologies.
T4	Modest improvement in existing technologies; ie, by repackaging a combination of already-commercialized technologies in novel ways
T5	No new technology, but able to successfully market existing technology. Alternatively, companies developing new business models using well-established Internet technologies

Data Analysis Questions: Is Investing in Innovation Profitable?

- IPO valuations higher with higher technical innovation?
- Post IPO, what happens to valuations?
- Over three years or more post IPO, what about relative valuations?

Data Analysis: IPOs By Technology Ranking and by Time Period

Technology Ranking	1993-1996			1997-2002			Ratio 97-02/93-96: Companies Per Year
	# Companies	% Of Total Companies	Companies Per Year	# Companies	% Of Total Companies	Companies Per Year	
T1	5	1.1%	1.3	2	0.5%	0.3	0.27
T2	15	3.3%	3.8	3	0.9%	0.5	0.13
<i>COMBINED T1/2</i>	20	4.4%	5.0	5	1.4%	0.8	0.17
T3	117	25.7%	29.3	42	11.4%	7.0	0.24
T4	301	66.2%	75.3	320	87.0%	53.3	0.71
T5	17	3.7%	4.3	1	0.3%	0.2	0.04
Total	455	100.0%	113.8	368	100.0%	61.3	0.54

Source: Morgan Stanley [Technology IPO Yearbook](#); Signal Lake Analysis

Data Analysis: IPO Companies For 1997-2002

Mean and Median Per-Company Values

As of 12/31/2002*

Technology Ranking	% Change versus Original IPO Value			% Change versus Original IPO Value		
	Mean 12/31/02 Value \$MM	Mean Index		Median 12/31/02 Value \$MM	Median Index	
T1/T2	\$1,039	266	-2.2%	\$600	759	73.9%
T3	\$1,210/ \$726**	310/ 186**	15.0%/ -34.4%**	\$286	362	-28.1%
T4	\$320	82	-29.8%	\$70	89	-64.3%
T5	N/A	N/A	N/A	N/A	N/A	N/A
Total	\$390	100	-27.8%	\$79	100	-62.6%

Source: Morgan Stanley Technology IPO Yearbook; Signal Lake Analysis

* Companies acquired prior to 12/31/02 are valued at year-end 2002 at their acquisition price

** After excluding E-Tek, MMC and Galileo

Higher Valuations and Profits Correlate with Higher Innovation

- Is Innovation More Profitable? YES
 - » Higher IPO valuations accrue to the higher technical innovation ranking companies
 - » Post IPO, higher valuations stick
- Changes over time in relative valuation?
 - » Valuations HIGHER for higher innovation

Quandary

More background: www.signallake.com/innovation/

- **Substantial decrease in the level of innovation, despite**
 - » \$3B invested in 1993 by all venture funds
 - » \$50B+ invested in 2002 by all venture funds
 - » Data indicating that the public financial markets reward businesses with technical innovation
- **Is this due to**
 - » Life cycle factors?
 - » Venture capital funding behavior?

Some Preliminary Thoughts on Restructuring Venture Capital for Funding Technical Innovation

- **Current Venture Funds**

- » Early stage: 60%+ IRR historically-> in a portfolio of ten funded companies, two are writeoffs, six recoup their investment, and two pay for all the rest 10X
- » Mid to late stage: 30%-40% IRR historically
- » Potential for down rounds->last round owns everything: is this ethical (public markets do not allow this!)?

- **Angel Investor Funds**

- » Appropriate size and scale
- » \$200K per year for 3-5 years
- » Exit: Triage or fund to commercial operation

- **Elephant Funds**

- » Disruptive innovation
- » Hundreds of millions in committed capital
- » Initial small placements, triage, those that progress to commercial success get the bulk of the funds