

Roadmaps on Shifting Terrain: How to Gamble if you Must

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Excerpts from



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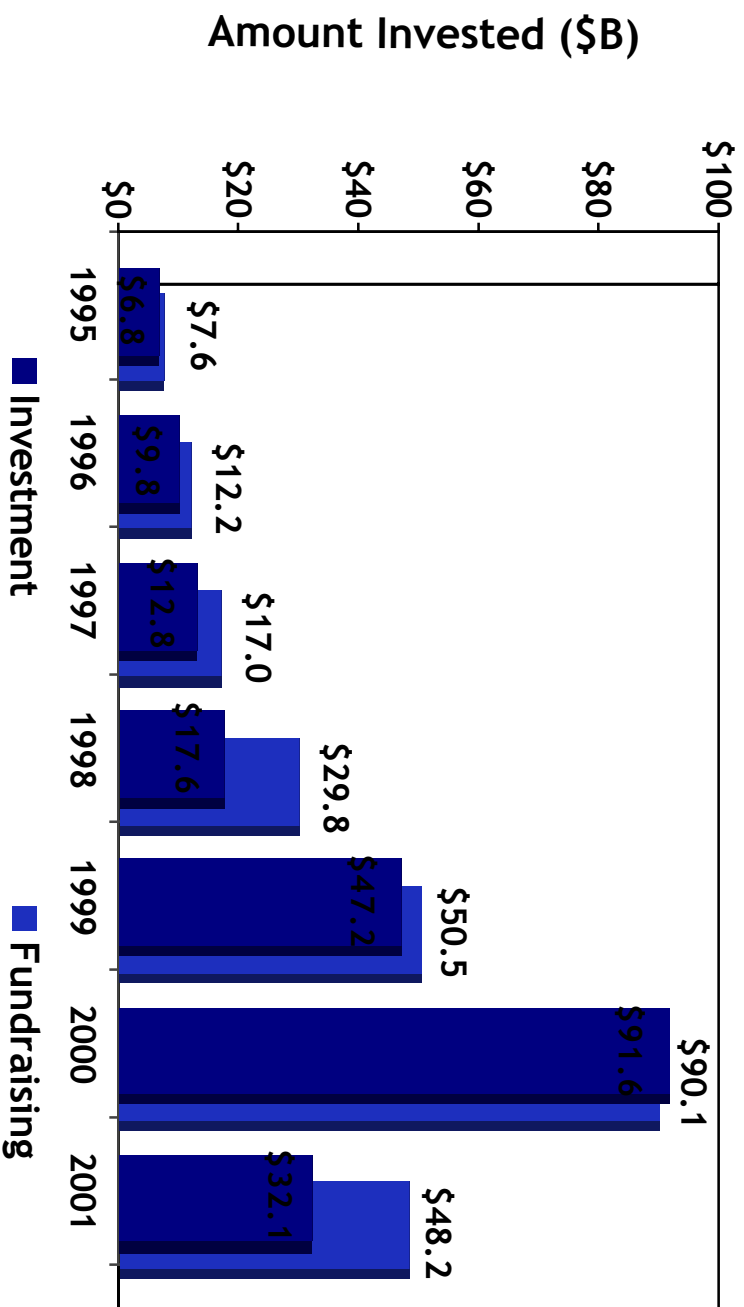
The VC "LANDSCAPE" in 2000

	<u>1980</u>	<u>1990</u>	<u>2000</u>
# of VC Firms in Existence	87	375	693
# of Professionals	1035	3794	8368
# of First Time VC Funds Raised	24	14	164
# of VC Funds Raised This Year	57	82	497
VC Capital Raised This Year (\$B)	2.08	3.20	105.05
Avg VC Fund Size Raised This Year (\$M)	36.5	39.0	211.4

Source: Vinod Khosla & NVCA Yearbook 2001; Venture Economics

The Committed Capital Bubble

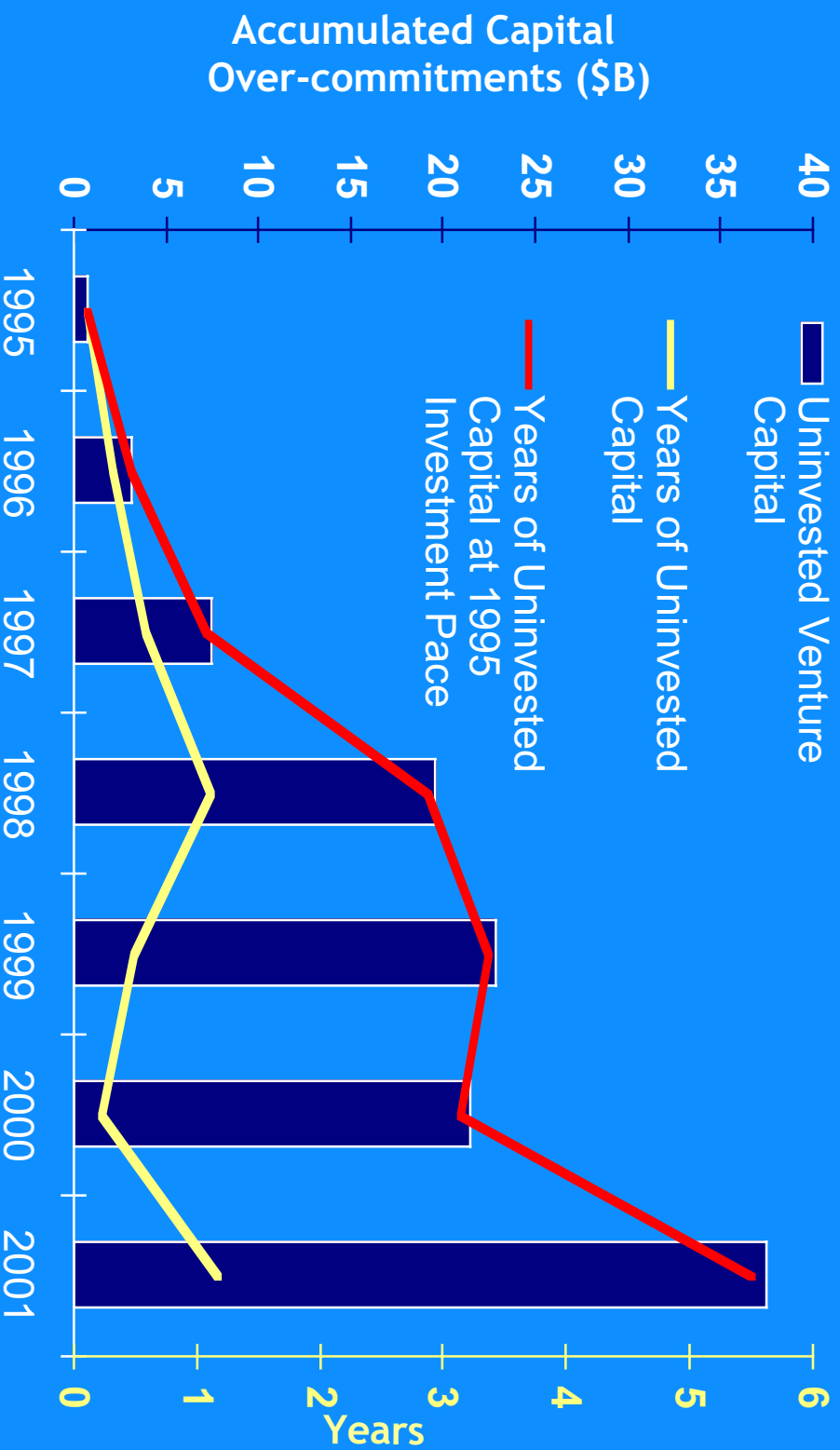
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Fundraising vs. Amount Invested

Source: Vinod Khosla & VentureOne

The Committed Capital Bubble

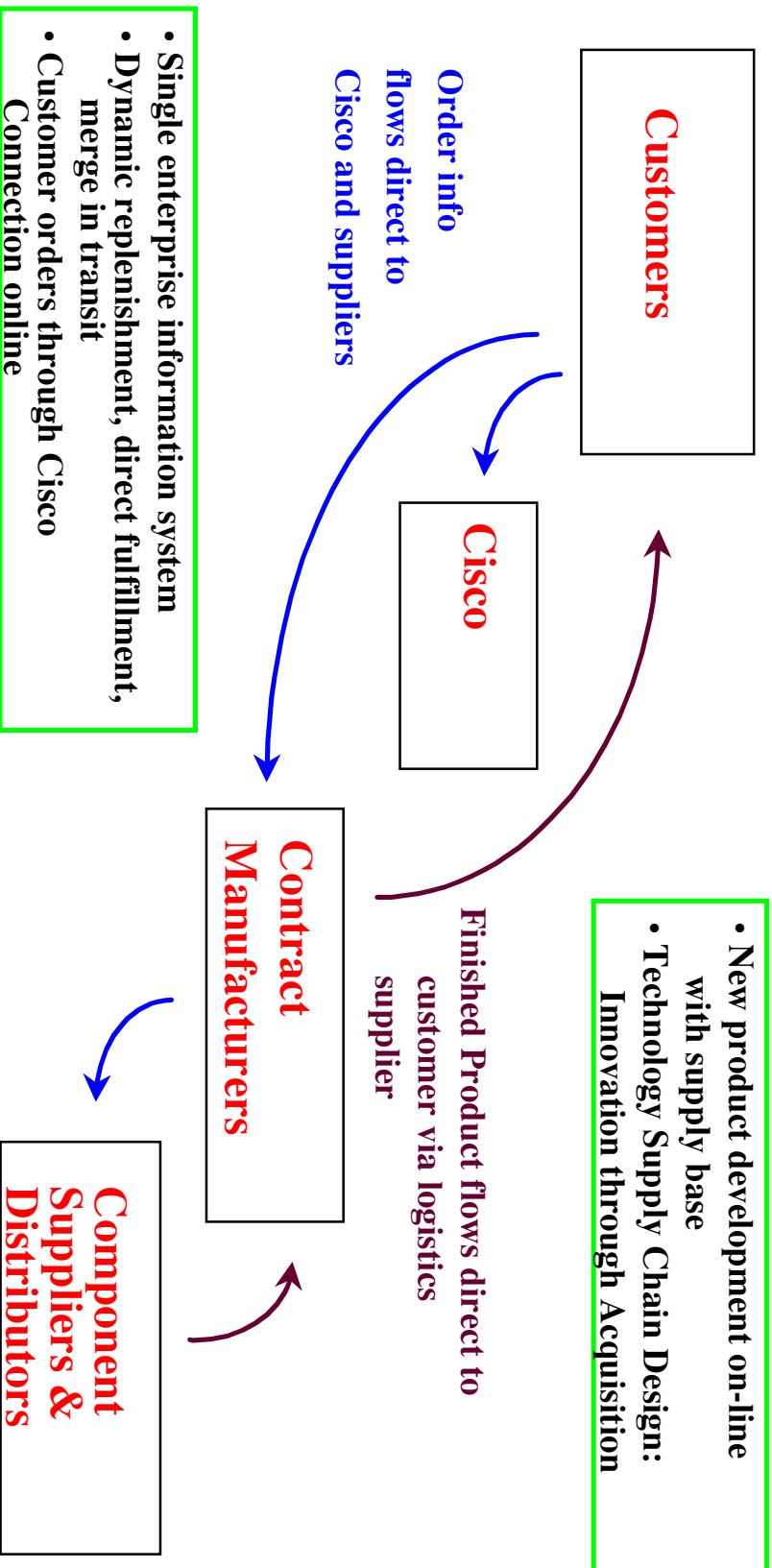


Source: Vinod Khosla & VentureOne

Where to invest all this capital?

A Case Study: End-to-End Integration in Cisco's Fulfillment Supply Chain

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Basic Design Principle: Arm's length Relationship with Fulfillment Chain Partners

Cisco's Strategy for

Technology Supply Chain Design

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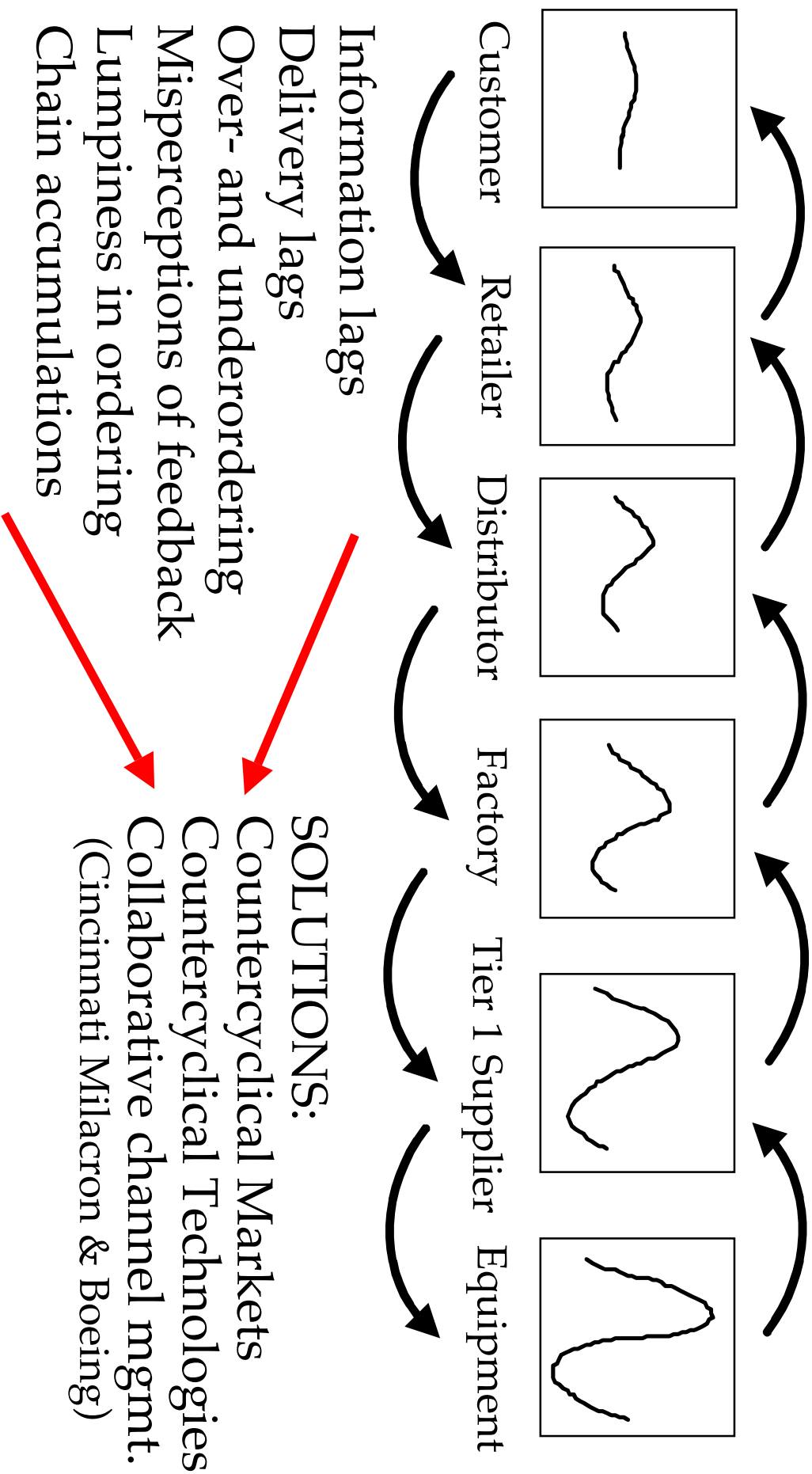
1. Integrate technology around the router to be a communications network provider.
2. Leverage acquired technology with
 - sales muscle and reach
 - end-to-end IT
 - outsourced manufacturing
 - market growth
3. Leverage venture capital to supply R&D

Basic Design Principle: Acquisition

Relationship with Technology Chain Partners

Volatility Amplification in the Supply Chain: "The Bullwhip Effect"

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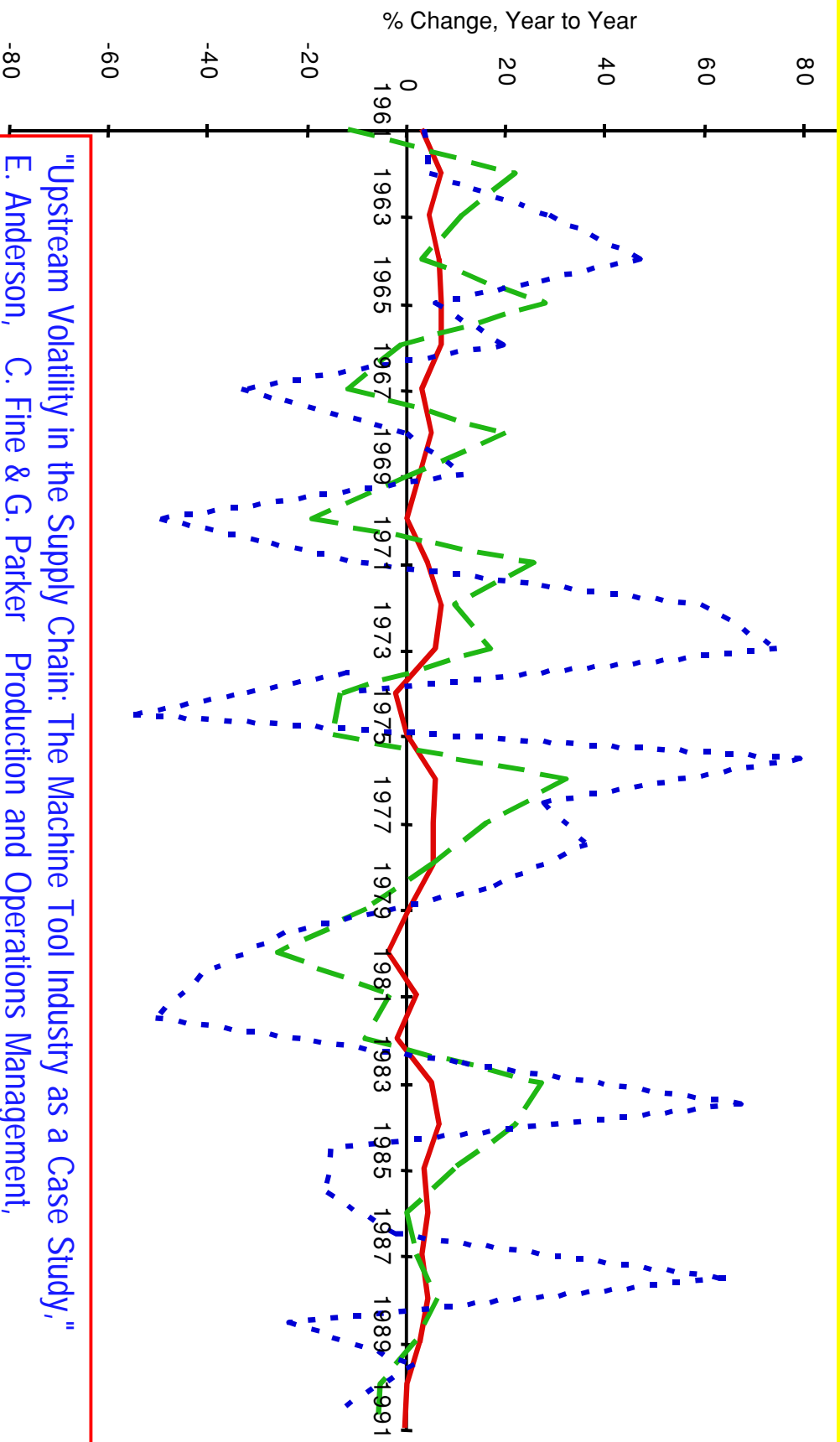


Supply Chain Volatility Amplification: Machine Tools at the tip of the Bullwhip

— % Chg. GDP
 - - - % Chg. Vehicle Production Index
 - - - % Chg. Net New Orders Machine Tool Industry

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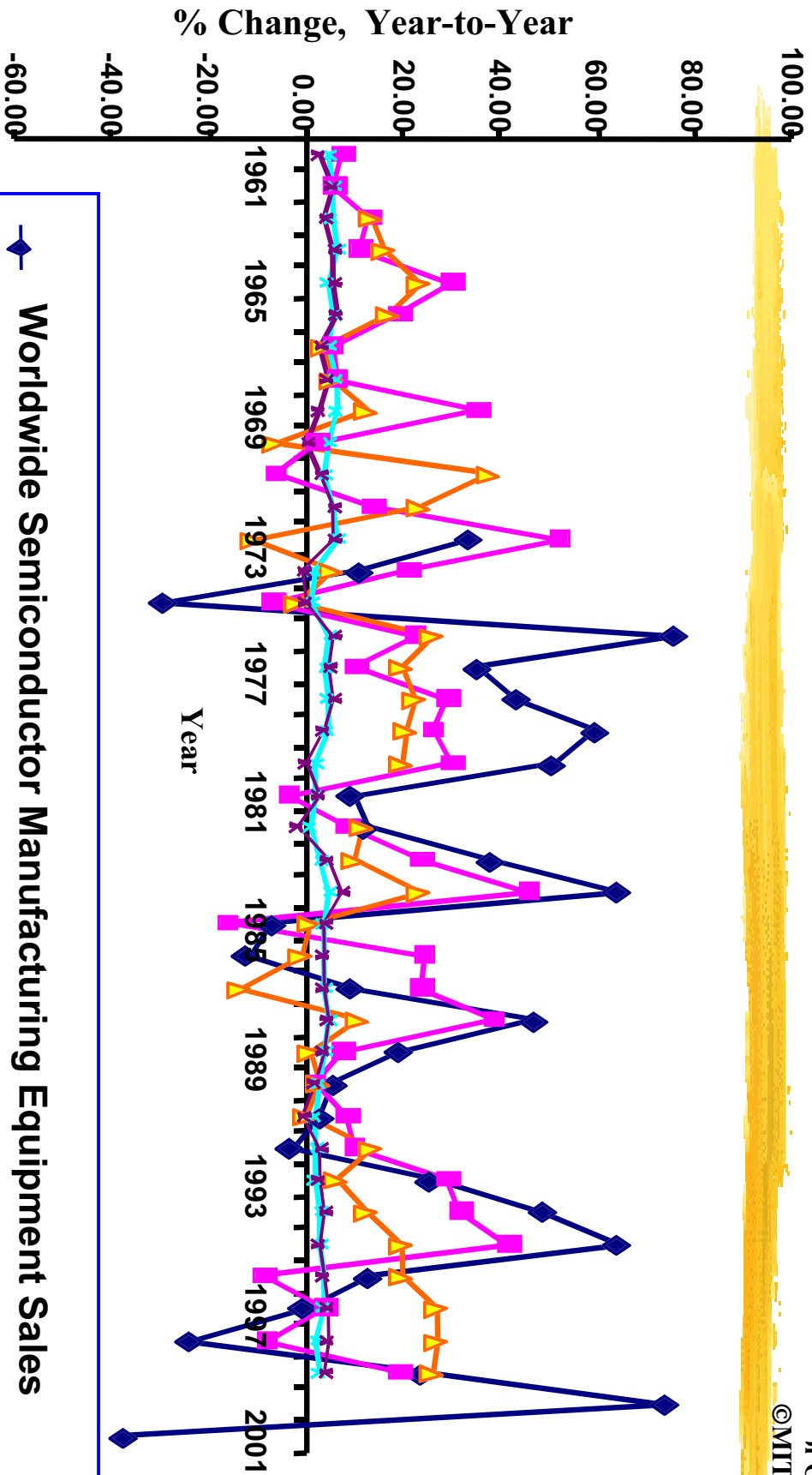
“We are experiencing a 100-year flood.” J. Chambers, 4/16/01



"Upstream Volatility in the Supply Chain: The Machine Tool Industry as a Case Study,"
 E. Anderson, C. Fine & G. Parker *Production and Operations Management*,
 Vol. 9, No. 3, Fall 2000, pp. 239-261.

Volatility in the Electronics & Semiconductor Supply Chain

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- ◆ Worldwide Semiconductor Manufacturing Equipment Sales
- Worldwide Semiconductor Shipments
- ▲ Electronics, Computing and Communications Equipment Output
- ★ GDP World
- ✱ GDP USA

LESSONS FROM A FRUIT FLY:

CISCO SYSTEMS

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1. KNOW YOUR LOCATION IN THE VALUE CHAIN
2. UNDERSTAND THE DYNAMICS OF VALUE CHAIN FLUCTUATIONS
3. THINK CAREFULLY ABOUT THE ROLE OF VERTICAL COLLABORATIVE RELATIONSHIPS
4. INFORMATION AND LOGISTICS SPEED DO NOT REPEAL BUSINESS CYCLES OR THE BULLWHIP.

Bonus Questions:

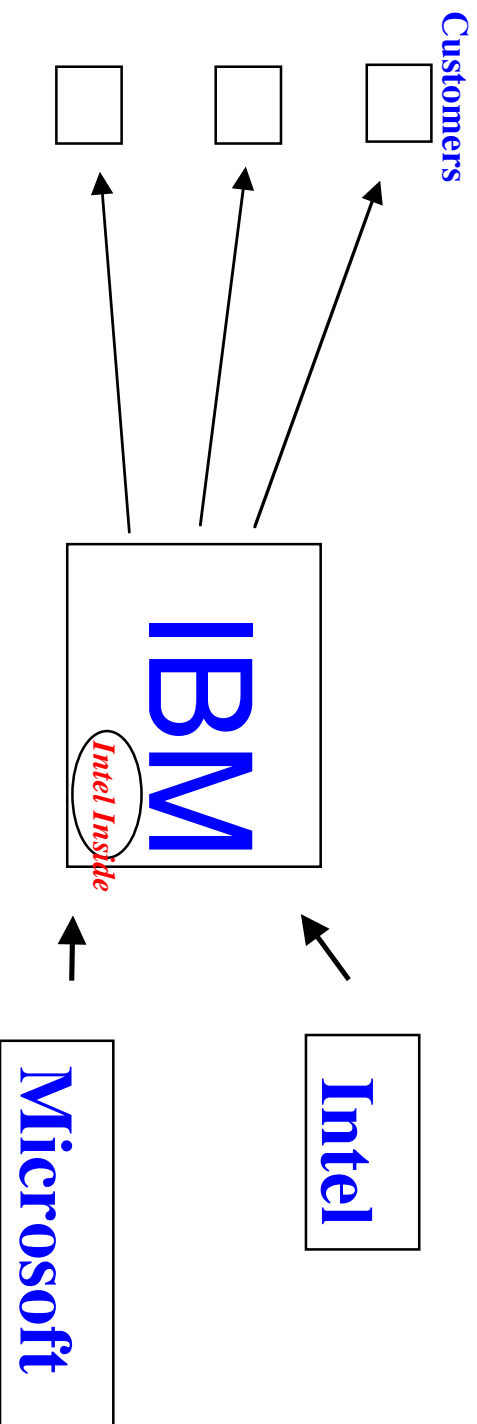
- A. How does clockspeed impact volatility?
- B. Who plays the role of “equipment supplier” in the supply chain for capital?

The Strategic Leverage of Value Chain Design:

Who let Intel Inside?

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1980: IBM designs a product, a process, & a value chain



The Outcome:

A phenomenally successful product design

A disastrous value chain design (for IBM)

LESSONS FROM A FRUIT FLY: *THE PERSONAL COMPUTER*

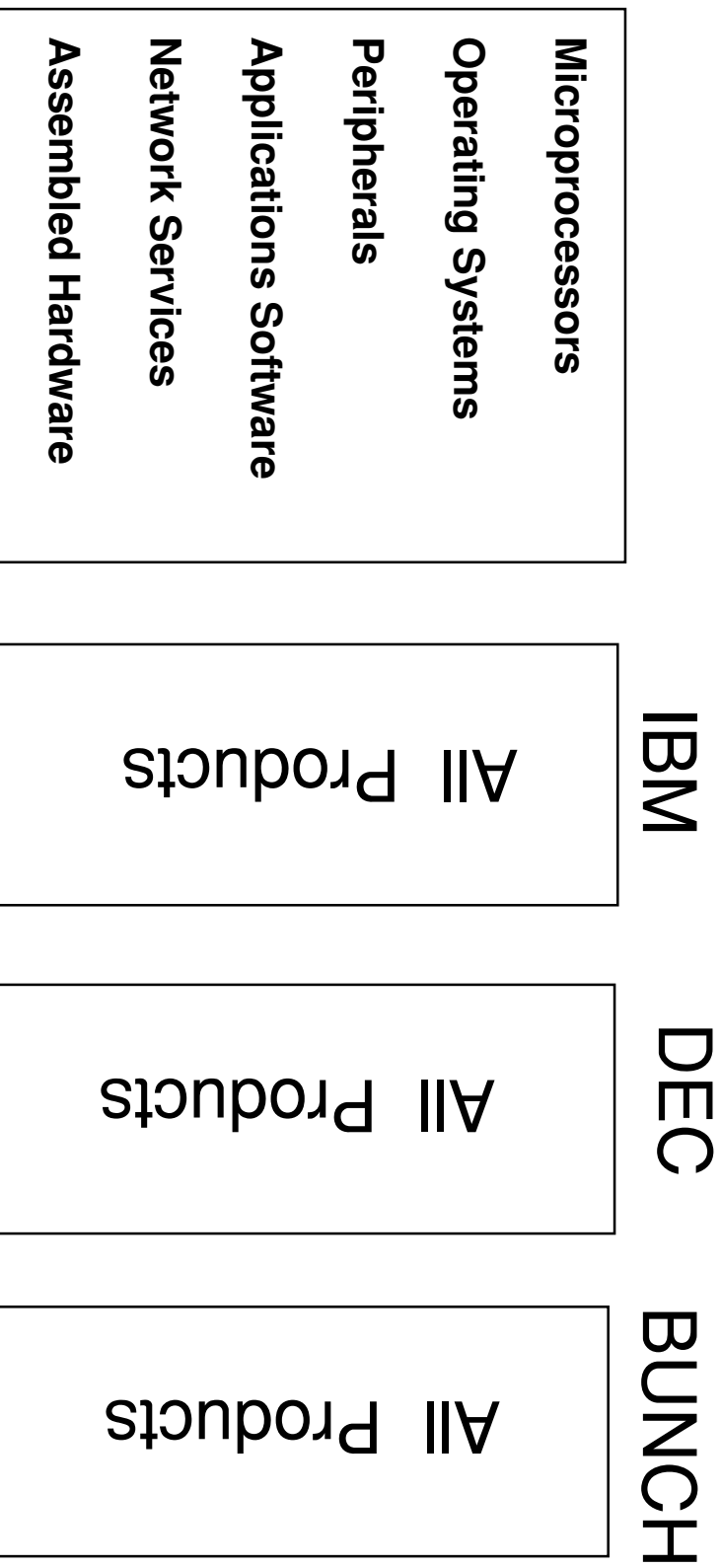
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1. BEWARE OF *INTEL INSIDE*
(Regardless of your industry)
2. MAKE/BUY IS **NOT** ABOUT WHETHER IT IS
TWO CENTS CHEAPER OR *TWO DAYS FASTER*
TO **OUTSOURCE** VERSUS **INSOURCE**.
3. VALUE CHAIN DESIGN CAN DETERMINE
THE FATE OF **COMPANIES** AND **INDUSTRIES**,
AND OF **PROFIT** AND **POWER**
4. THE LOCUS OF VALUE CHAIN CONTROL
CAN SHIFT IN **UNPREDICTABLE** WAYS

Vertical Industry Structure with *Integral* Product Architecture

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Computer Industry Structure, 1975-85



(A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

Horizontal Industry Structure with *Modular* Product Architecture

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Computer Industry Structure, 1985-95

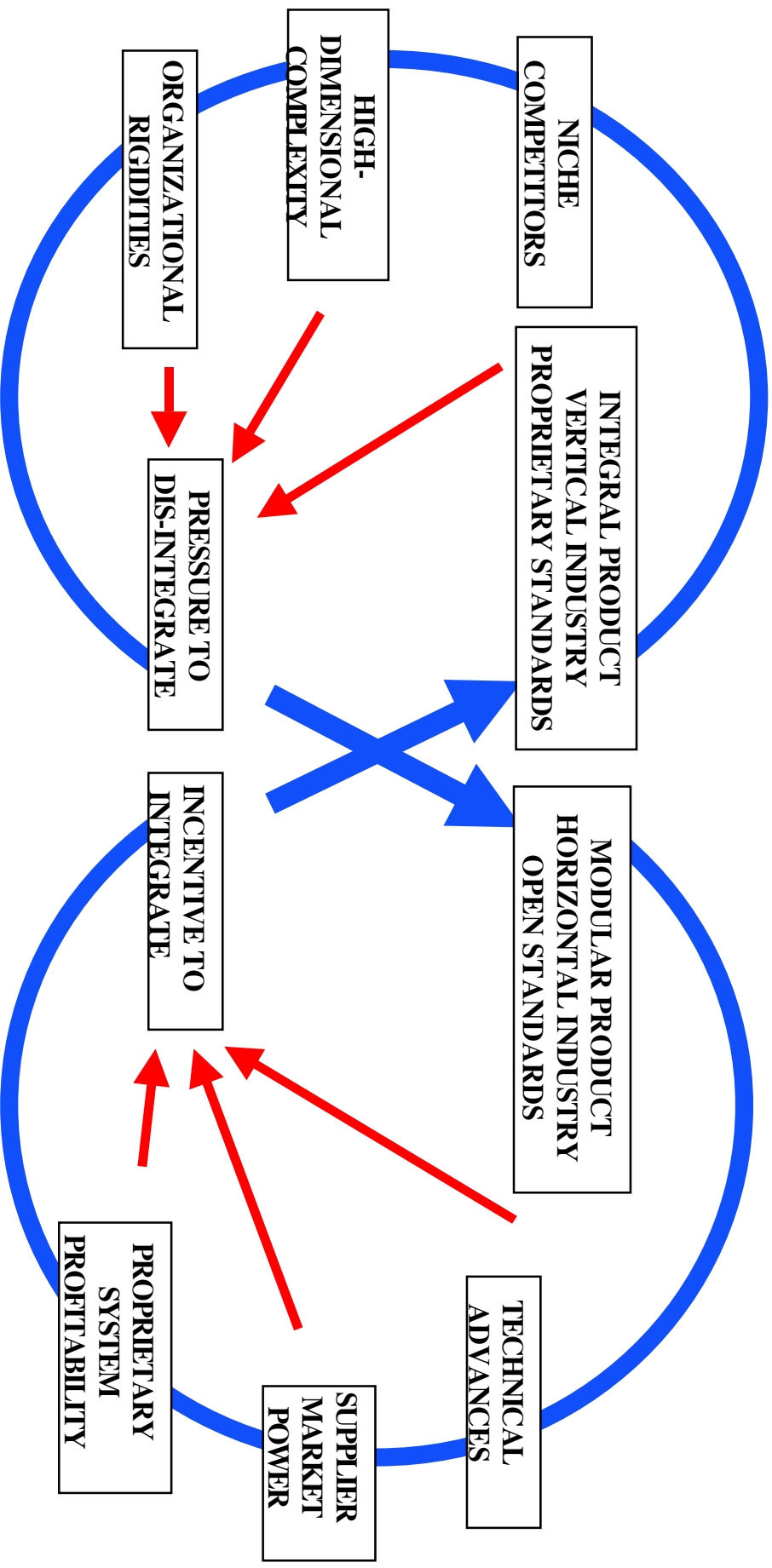
Microprocessors	Intel	Moto	AMD	etc
Operating Systems	Microsoft	Mac	Unix	
Peripherals	HP	Epson	Seagate	etc etc
Applications Software	Microsoft	Lotus	Novell	etc
Network Services	AOL/Netcape	Microsoft	EDS	etc
Assembled Hardware	HP	Compaq	IBM	Dell etc

(A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

THE DYNAMICS OF PRODUCT ARCHITECTURE STANDARDS, AND VALUE CHAIN STRUCTURE:

THE DOUBLE HELIX

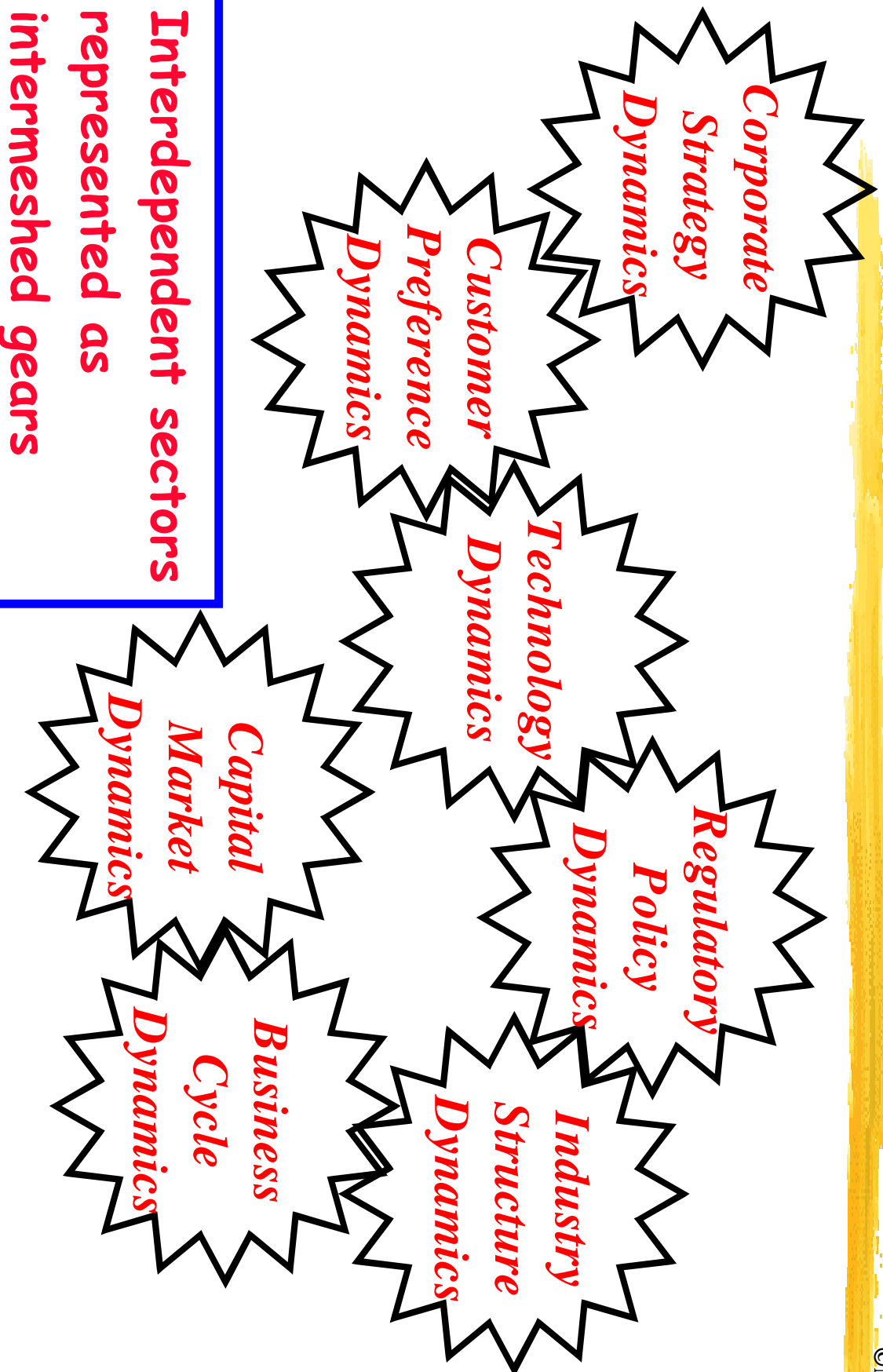
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Fine & Whitney, "Is the Make/Buy Decision Process a Core Competence?"

Dynamic Analysis to Support Industry & Technology Roadmapping

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Proposed MIT Communications Roadmap Consortium

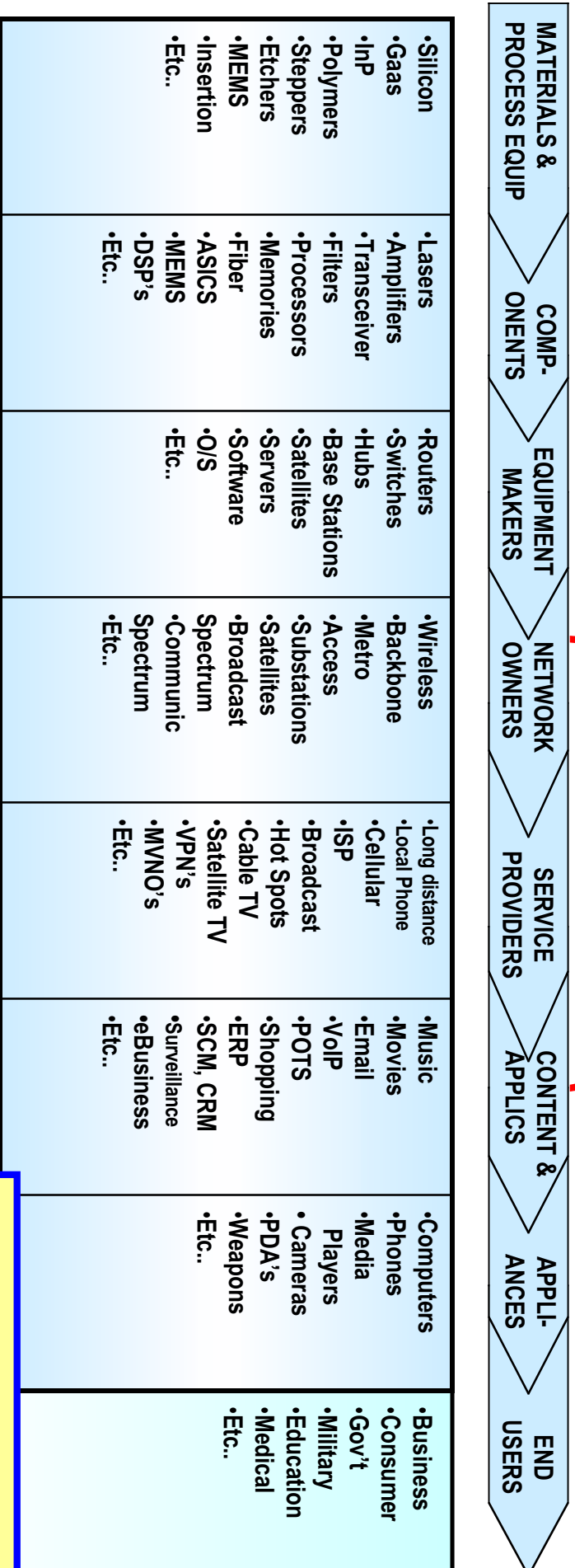
MPC, MTL

RLE

LCS

ITC

eBusiness,
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Oxygen, ©MIT 2003
Media Lab



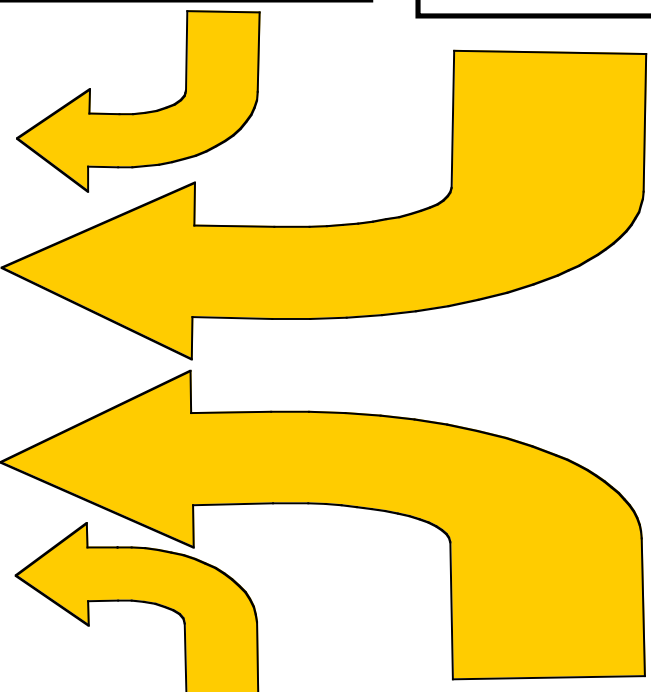
Prof. C. Fine, MIT

Roadmapping Communications: What are the Premises?

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Communications
Value Chain is in
ill health
**(ROADKILL
MAPPING?)**

Vertical
disintegration is
the dominant
structure. Silo
execs tend to focus
on their own
narrow slices.
Most industry
consortia are
within-silo.



**SOME VALUE CHAIN
COORDINATION COULD
SPEED GROWTH.**

Silos in the value
chain are
interdependent
(integrality).

Absence of
leadership and
coordination across
an interdependent
value chain creates
uncertainty, risk,
and reluctance to
invest.

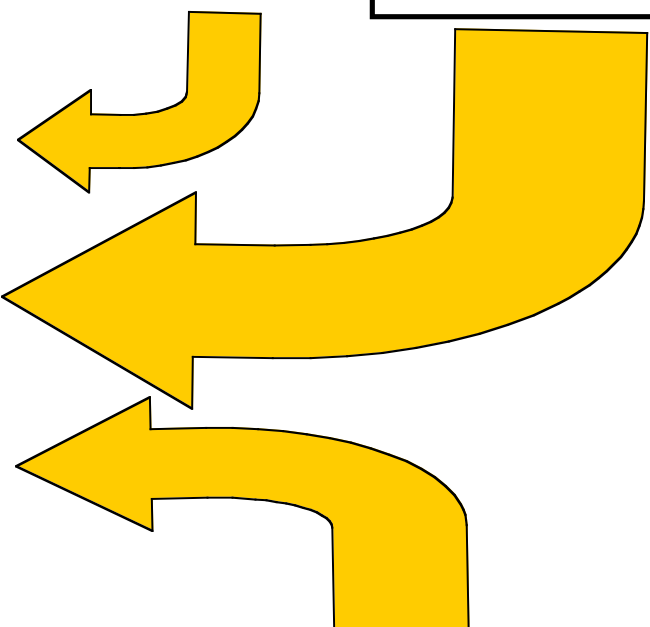
**HOW TO ACHIEVE COORDINATION IN
THE ABSENCE OF VERTICAL INTEGRATION?**

Roadmapping Communications: What are the Premises?

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Technology dynamics,
Industry dynamics, and
Regulatory dynamics
are interdependent.

Technology and
industry roadmapping
are typically done by
different people



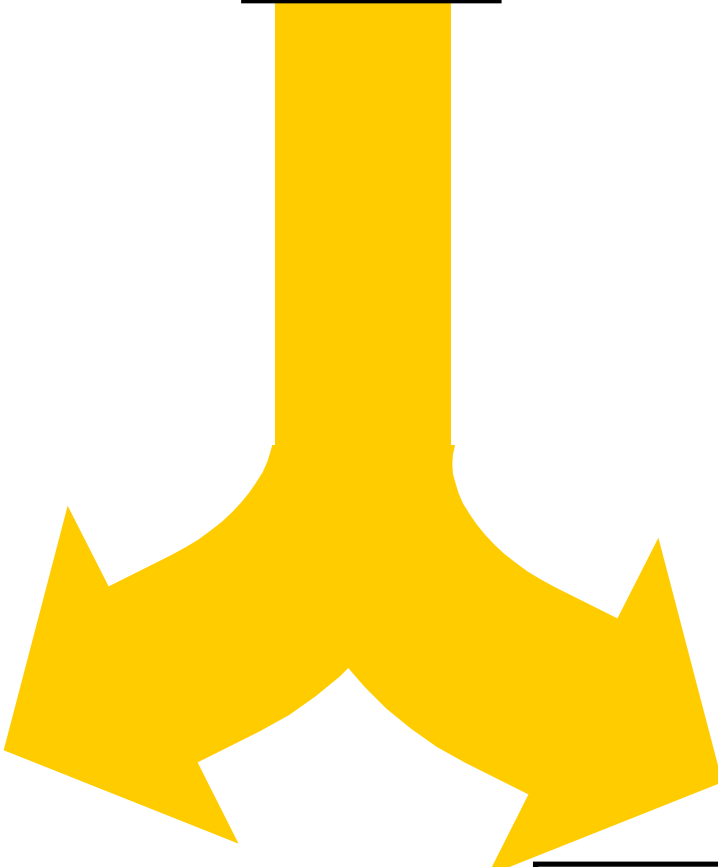
SLA roadmaps provided
productive coordination in
semiconductors, but
focused only on technology
& a narrow slice of the
value chain. Industry
growth was assumed.
--> Not a good model for
Communications.

Productive roadmapping must encompass
multiple links of the value chain, a
multidisciplinary team, and the co-
evolution of technology, industry, and
regulatory policy.

**“If you come to a fork in the Road[map], Take it.”
--Yogi Berra**

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**INFORMATION
WANTS TO
BE SHARED**
==> Difficult content
business models



**Internet explosion
Wireless Explosion
Connectivity Explosion
File Sharing Explosion**

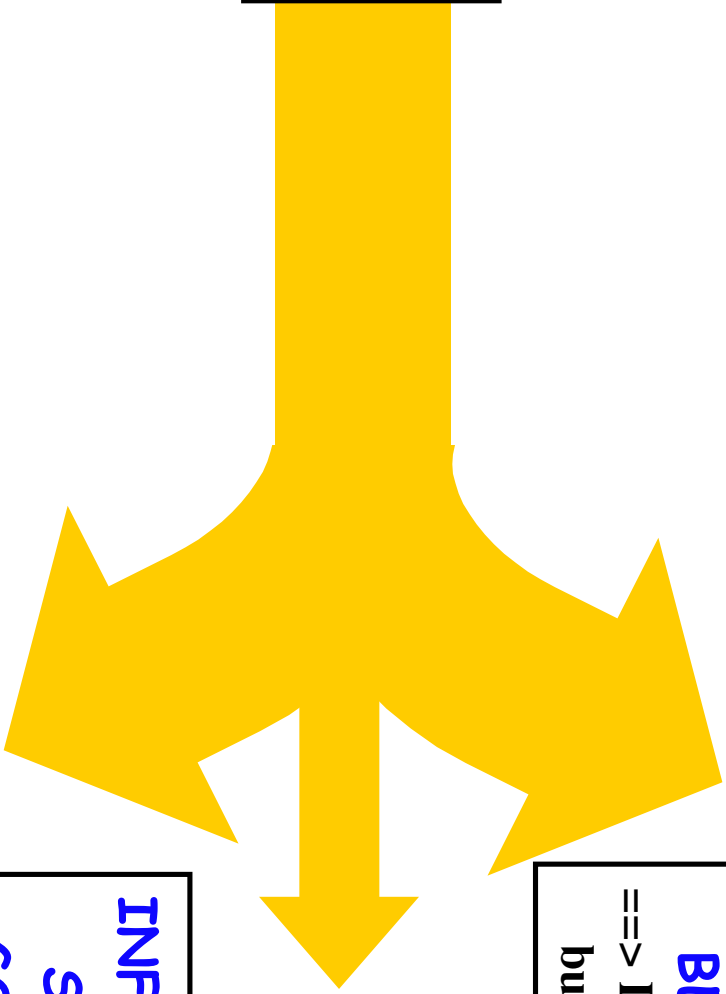
**INFORMATION
SHARERS
GO TO JAIL**
==> Poverty of
The Commons

**“If you come to a fork in the Road[map], Take it.”
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**Internet explosion
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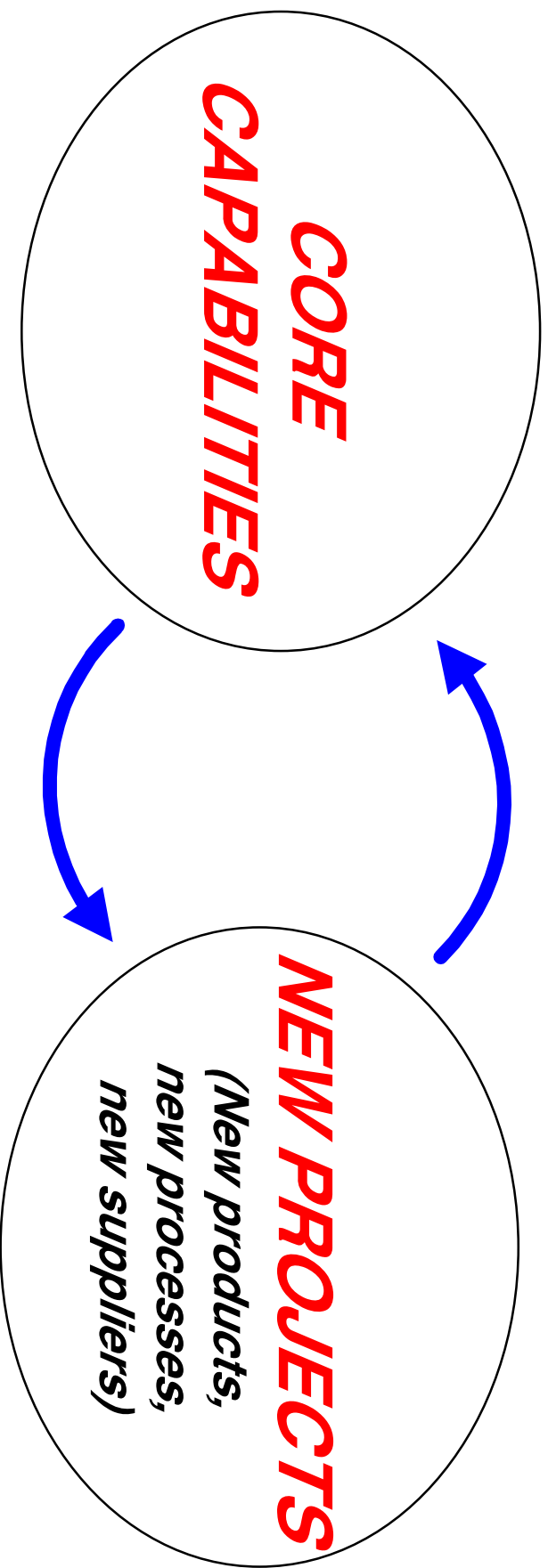
**Is there a
third way?
(Quantum
Roadmap)**

**INFORMATION
SHARERS
GO TO JAIL**
==> Poverty of
The Commons

Clockspeed drives Business Strategy Cadence

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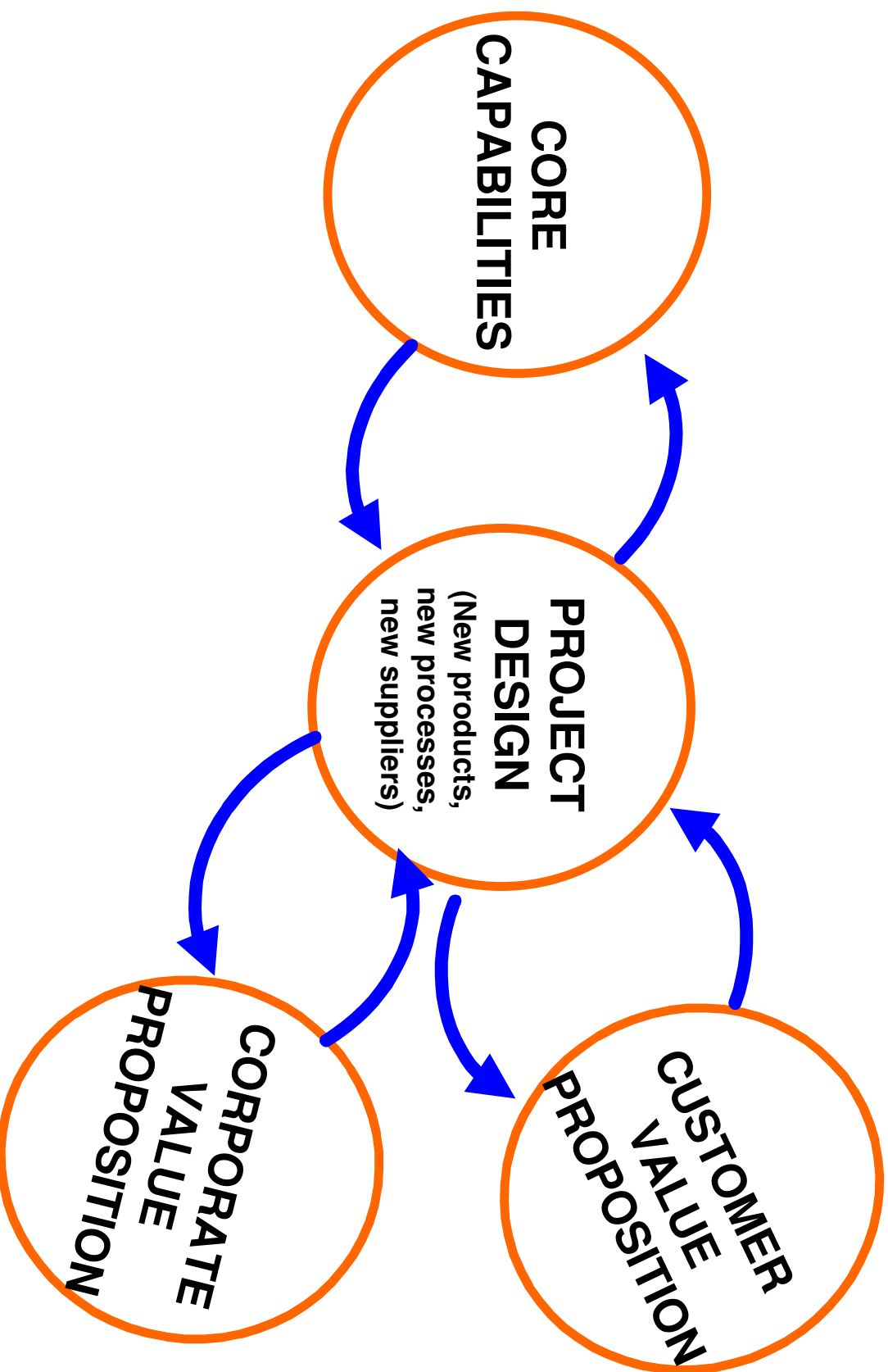
Dynamics between **New Projects** and **Core Capability** Development: **PROJECTS MUST MAKE MONEY AND BUILD CAPABILITIES**



Leonard-Barton, *Wellsprings of Knowledge*

Projects Serve Three Masters: Capabilities, Customers, & Corporate Profit

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ALL COMPETITIVE ADVANTAGE IS TEMPORARY

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Autos:

Ford in 1920, *GM* in 1955, *Toyota* in 1990

Computing:

IBM in 1970, *DEC* in 1980, *Wintel* in 1990

World Dominion:

Greece in 500 BC, *Rome* in 100AD, *G.B.* in 1800

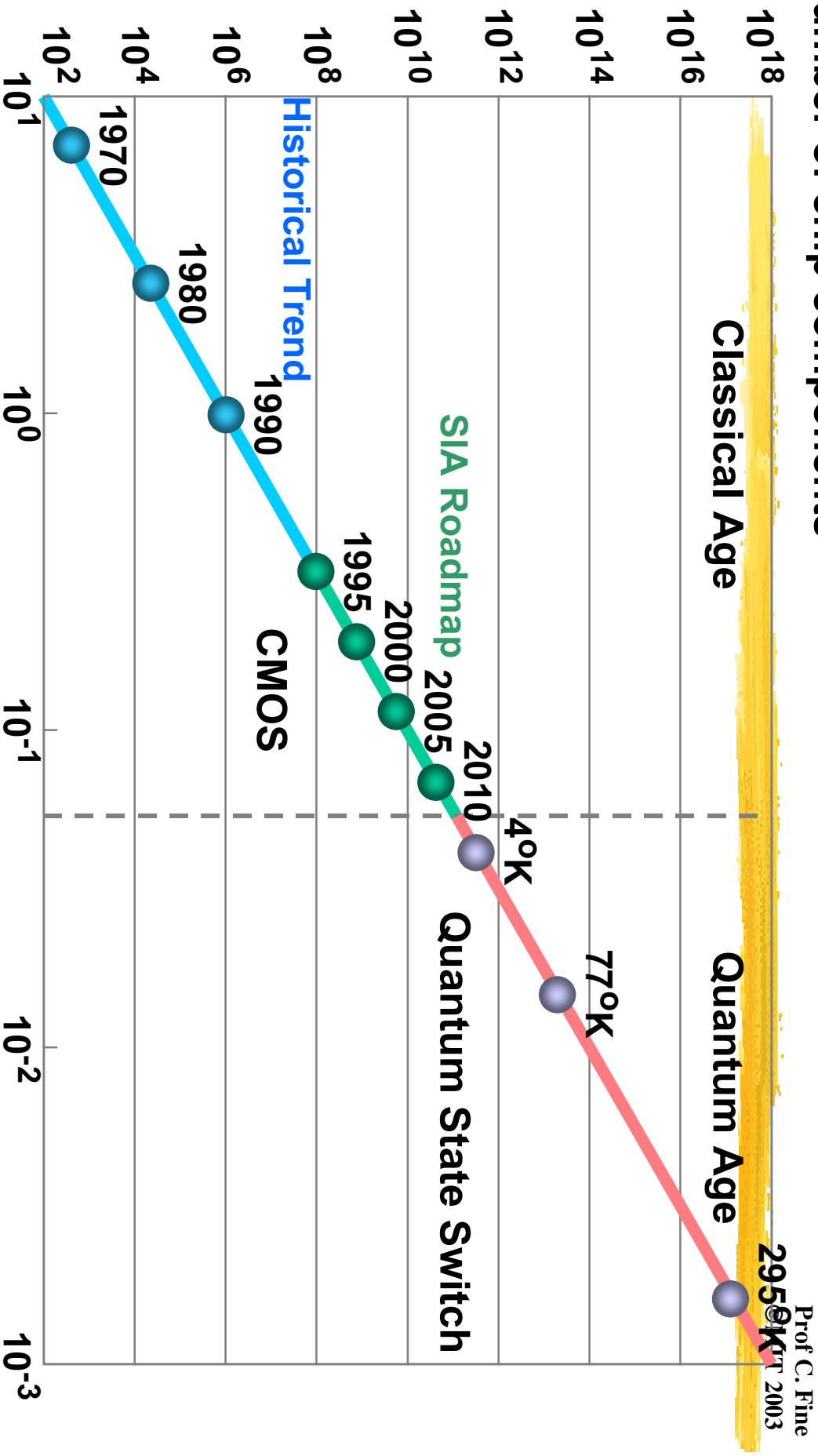
Sports:

Bruins in 1971, *Celtics* in 1986, *Yankees* no end

The faster the clockspeed, the shorter the reign

Roadmap for Electronic Devices

Number of chip components



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2950K

Classical Age

Quantum Age

Quantum State Switch

SIA Roadmap 2005

CMOS

Historical Trend

Feature size (microns)

Horst D. Simon

LAWRENCE BERKELEY NATIONAL LABORATORY

International Technology Roadmap for Semiconductors '99

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Year	2005	2008	2011	2014
Technology (nm)	100	70	50	35
DRAM chip area (mm ²)	526	603	691	792
DRAM capacity (Gb)	8		64	
MPU chip area (mm ²)	622	713	817	937
MPU transistors (x10 ⁹)	0.9	2.5	7.0	20.0
MPU Clock Rate (GHz)	3.5	6.0	10.0	13.5

Disk Drive Development

1978-1991

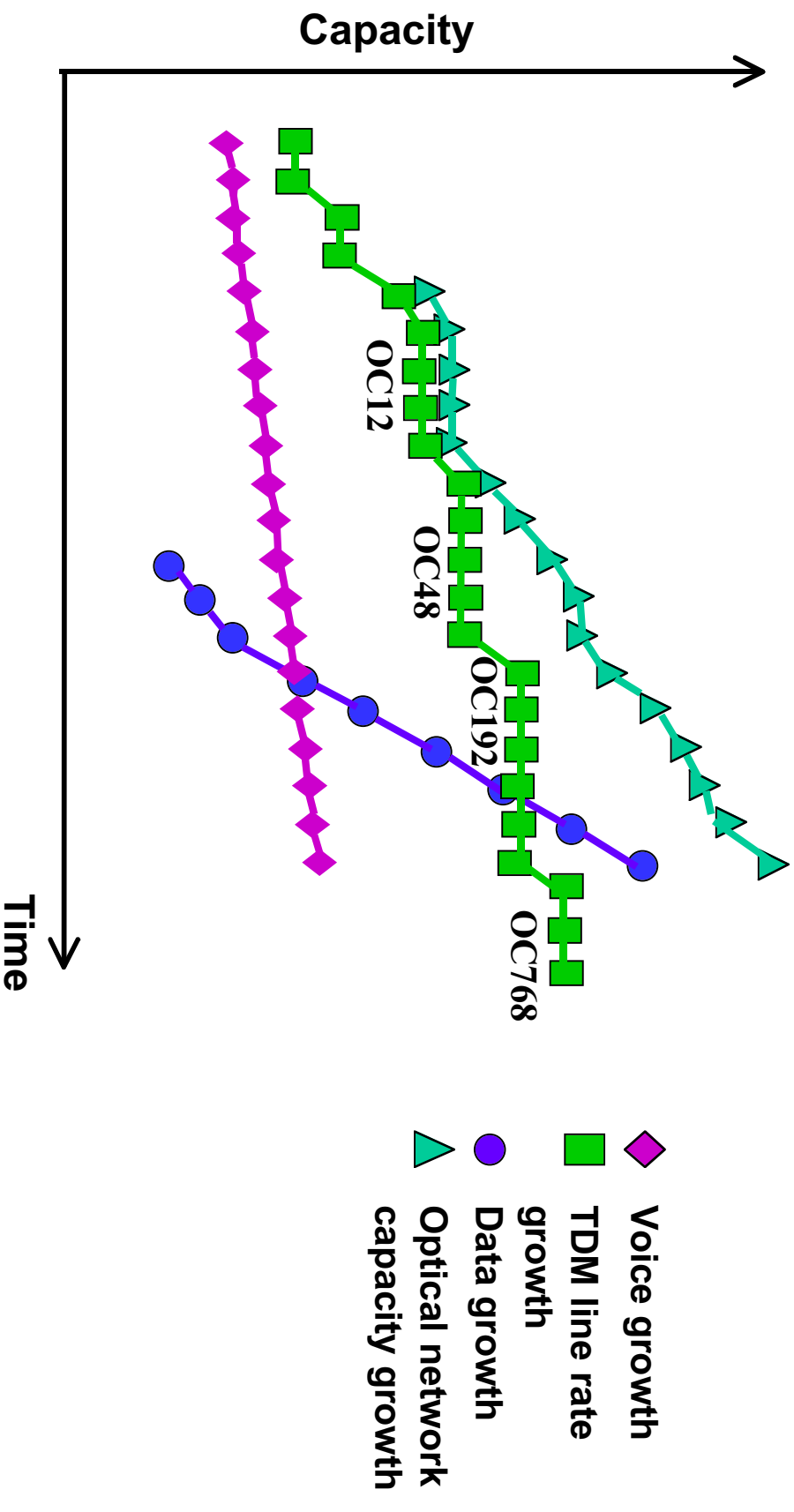
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Disk Drive Generation	Dominant Producer	Dominant Usage	Approx cost per Megabyte
14"	IBM	mainframe	\$750
8"	Quantum	Mini-computer	\$100
5.25"	Seagate	Desktop PC	\$30
3.5"	Conner	Portable PC	\$7
2.5"	Conner	Notebook PC	\$2

From 1991-98, Disk Drive storage density increased by 60%/year while semiconductor density grew ~50%/year. Disk Drive cost per megabyte in 1997 was ~ \$.10

Optical Networking is Keeping Up!

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“Killer Technologies” of the Information Age:
Semiconductors, Magnetic Memory, Optoelectronics

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“We define a ‘killer technology’ as one that delivers enhanced systems performance of a factor of at least a hundred-fold per decade.”

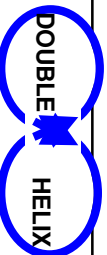

C.H.Fine & L.K. Kimerling, “Biography of a Killer Technology: Optoelectronics Drives Industrial Growth with the Speed of Light,” published in 1997 by the Optoelectronics Industry Development Association, 2010 Mass Ave, NW, Suite 200, Wash. DC 20036-1023.

Killer Question:

Will Integrated Optics evolve linearly like Semiconductors with Moore’s Law or like Disk Drives with repeated industry disruptions?

Optical Technology Evolution: Navigating the Generations with an Immature Technology

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	1	2	3	4	5
Timeline	Now	Starting	Starting	3-5 years	5-15 years
Stage	Discrete Components	Hybrid Integration	Low-level monolithic integration	Medium Monolithic integration	High-level monolithic integration
Examples	MUX/ DEMUX	TX/RX module OADM	TX/RX module OADM	OADM, Transponder Switch Matrix	Transponder
Core Technologies	FBGs, Thin-film, fused fiber, mirrors	Silicon Bench, Ceramic substrates	Silica Silicon Inp	InP, ??	InP, ??
How many Functions?	1	2-5	2-5	5-10	10-XXX
Industry Structure	Integrated	Integrated/ Horizontal	Integrated/ Horizontal		

Dr. Yanming Liu, MIT & Corning

All Conclusions are *Temporary*

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Clockspeeds are increasing almost everywhere
Value Chains are changing rapidly

