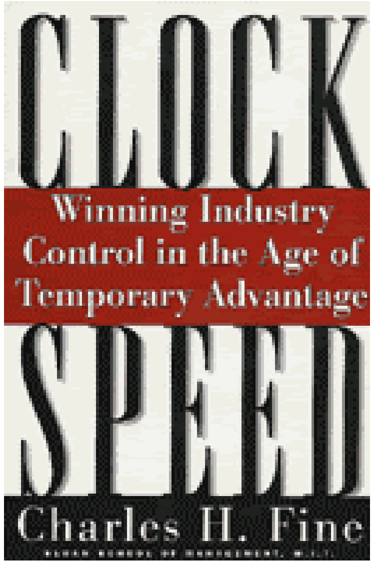
Value Chain Roadmapping for Communications and Media

Excerpts from



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One View (the consumer's) of the Communications Value Chain

Prof C. Fine

Form (Size, Weight, Ergonomics)

O/S (Windows, Linux, Palm)

HW system (OEM, ODM, CEM)

Bundled Apps (phone, MP3, IM, etc.)

Appliance
(Phone, Camera, Laptop, PDA, TV, Missile, MP3 Player)

Network (CDMA, WiFi, Sonet, IP, Cable)

Equipment (Lucent, Ericcson, Cisco)

Access
(Wireless, POTS, ISP, Satellite, Cable, HotSpot)

Channel (KaZaA, AOL/TW, MTV)

Artist (Madonna, NBA, Spielberg, SAP, Self)

Openness (EFF, RIAA/DMCA, TCPA)

Content & Applications
(Music, Movies, Email, VoIP, Shopping, ERP, SCM, CRM, Banking, IM, Surveillance, Photos, Games)

C O N S U M E R

Another View of the Communications Value Chain

Prof C. Fine

MATERIALS & PROCESS EQUIP	COMP-ONENTS	EQUIPMENT MAKERS	NETWORK OWNERS	SERVICE PROVIDERS	CONTENT & APPLICS	APPLI-ANCES	END USERS
•Silicon •Gaas •InP •Polymers •Steppers •Etchers •MEMS •Insertion •Etc..	•Lasers •Amplifiers •Transceiver •Filters •Processors •Memories •Fiber •ASICS •MEMS •DSP's •Etc..	•Routers •Switches •Hubs •Base Stations •Satellites •Servers •Software •O/S •Etc..	•Wireless •Backbone •Metro •Access •Substations •Satellites •Broadcast Spectrum •Communic Spectrum •Etc..	•Long dist. •Local •Cellular •ISP •Broadcast •Hot Spots •Cable TV •Satellite TV •VPN's •MVNO's •Etc..	•Music •Movies •Email •VoIP •POTS •Shopping •ERP •SCM, CRM •Surveillance •eBusiness •Etc..	•Computers •Phones •Media Players • Cameras •PDA's •Weapons •Etc..	•Business •Consumer •Gov't •Military •Education •Medical •Etc..

Roadmapping Communications: What are the Premises?

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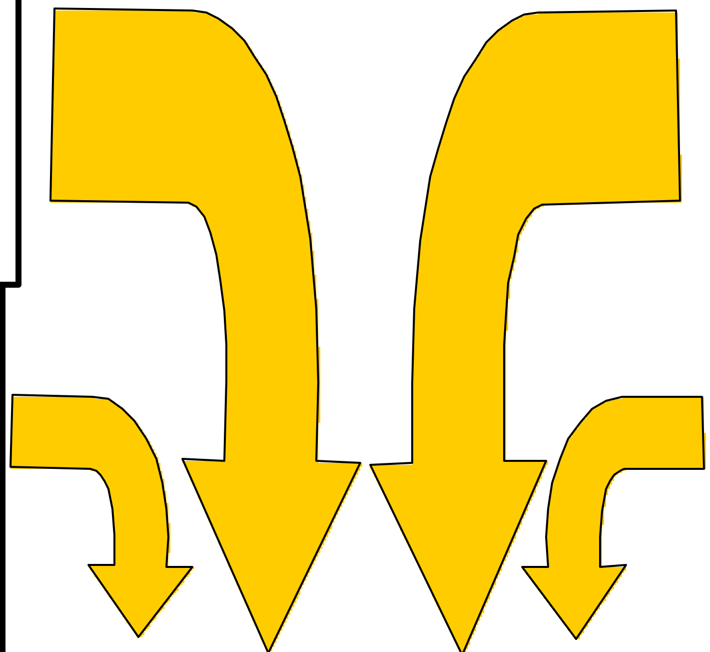
Communications Value Chain is in ill health
(ROADKILL MAPPING?)

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



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.

SOME VALUE CHAIN COORDINATION COULD SPEED GROWTH.

HOW TO ACHIEVE COORDINATION IN THE ABSENCE OF VERTICAL INTEGRATION?

Roadmapping Communications: What are the Premises?

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

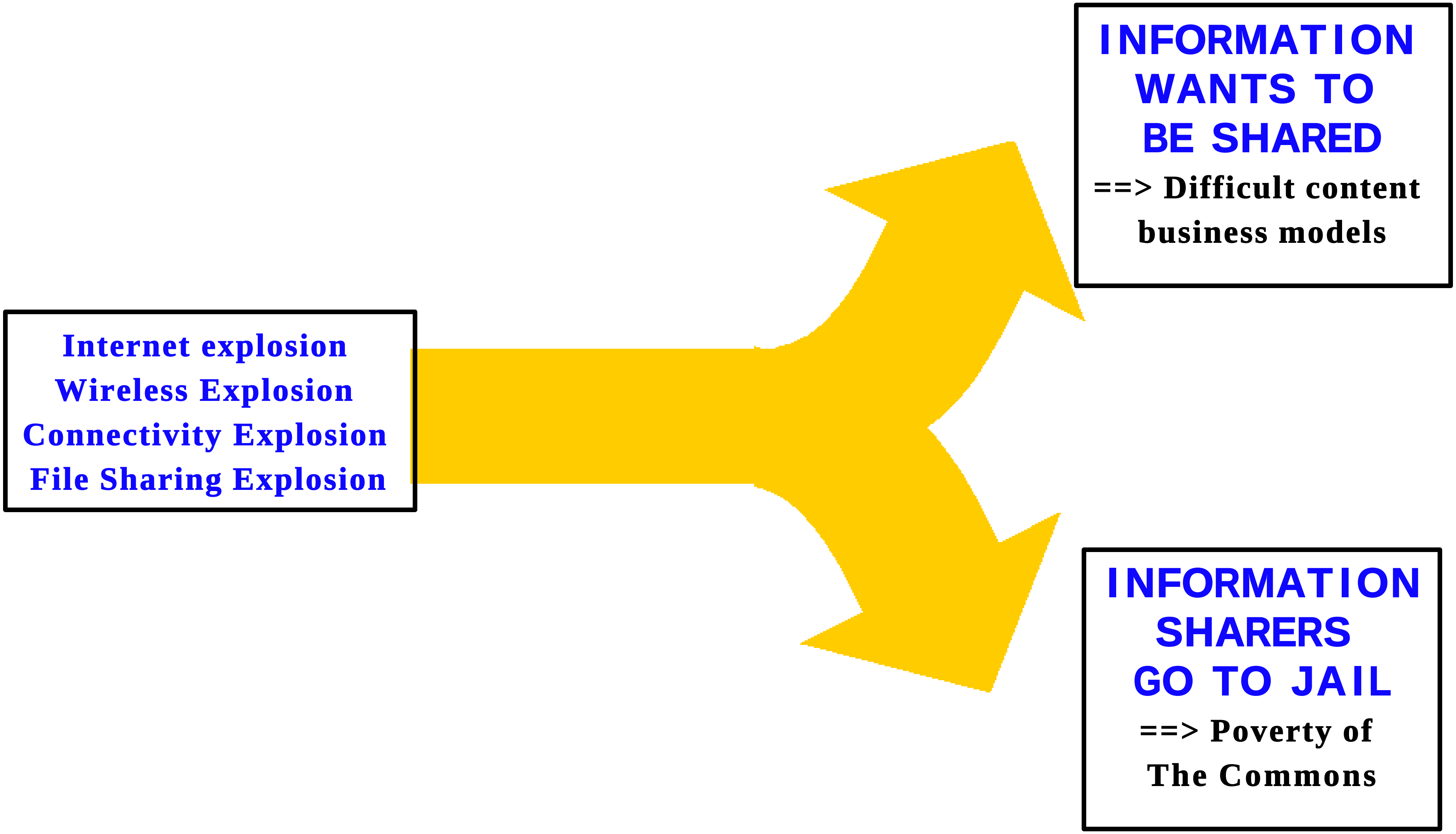
Technology and industry roadmapping are typically done by different people

SIA 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.

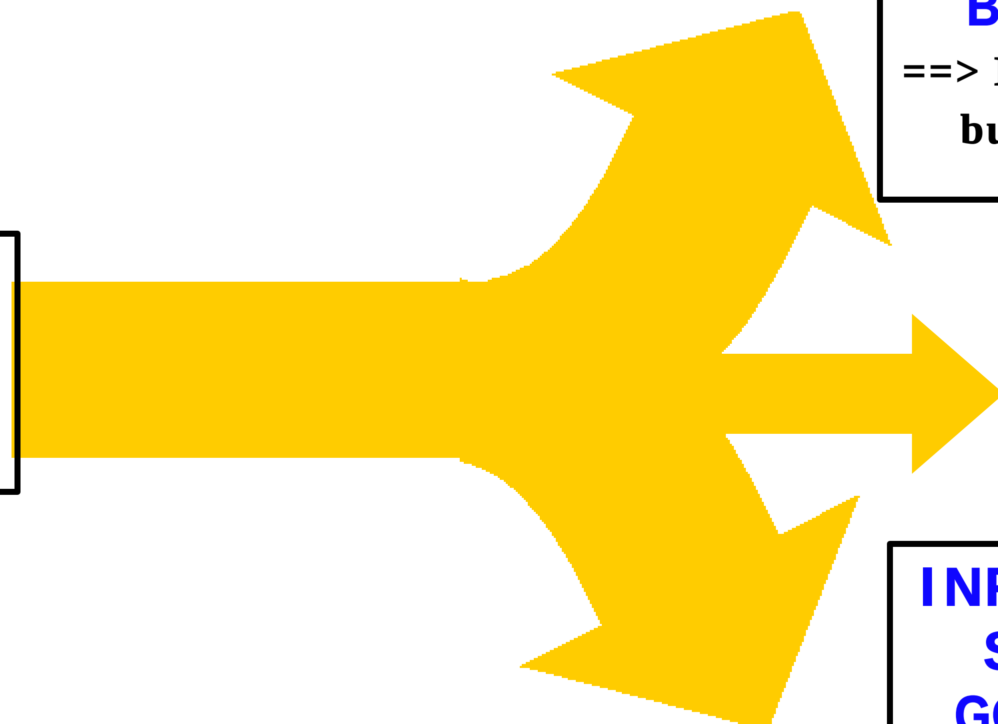
Productive roadmapping must encompass multiple links of the value chain, a multidisciplinary team, and the co-evolution of technology, industry, and regulatory policy.

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



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

Internet explosion
Wireless Explosion
Connectivity Explosion
File Sharing Explosion

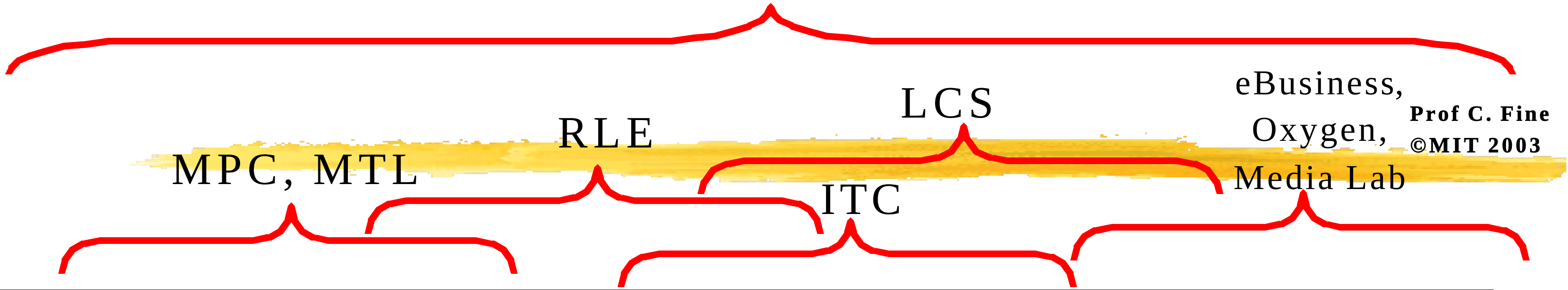


INFORMATION WANTS TO BE SHARED
==> **Difficult content business models**

Is there a third way? (Quantum Roadmap)

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

Proposed MIT Communications Roadmap Consortium



MATERIALS & PROCESS EQUIP	COMP-ONENTS	EQUIPMENT MAKERS	NETWORK OWNERS	SERVICE PROVIDERS	CONTENT & APPLICS	APPLI-ANCES	END USERS
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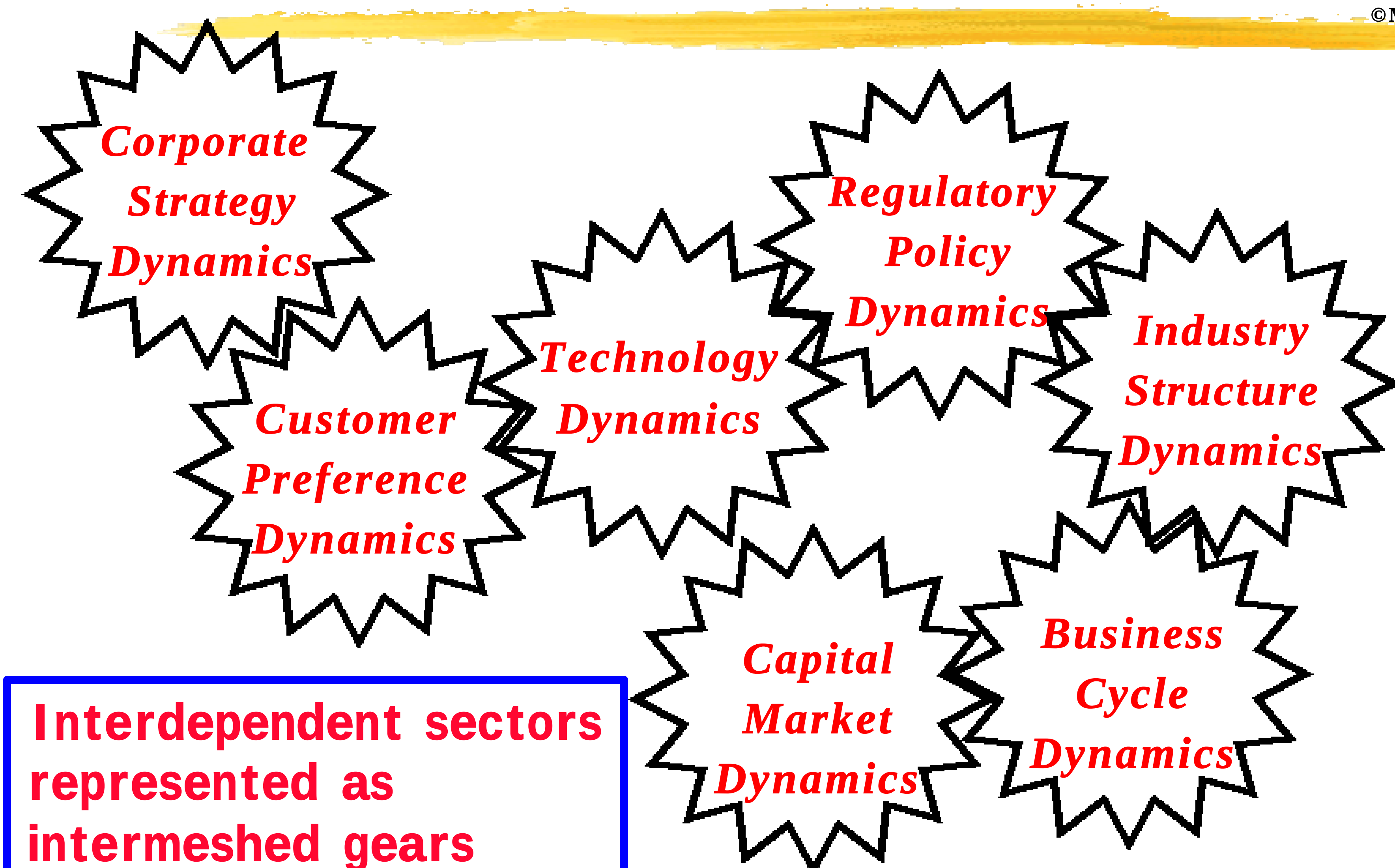
CROSS-INDUSTRY CHALLENGES

Digital Rights (**"To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries;" U.S. Constitution, Article 1, Section 8, Clause 8**)

Access Architecture

Prof. C. Fine, MIT

Dynamic Analysis to Support Industry & Technology Roadmapping



Interdependent sectors represented as intermeshed gears

Roadmap Components: Dynamic Analyses

Prof C. Fine

- **Business cycle dynamics (e.g., the bullwhip effect)**
- **Industry structure dynamics (e.g., double helix in *Clockspeed*)**

3. Corporate strategy dynamics (e.g., dynamic matching of customer needs with corporate opportunities)

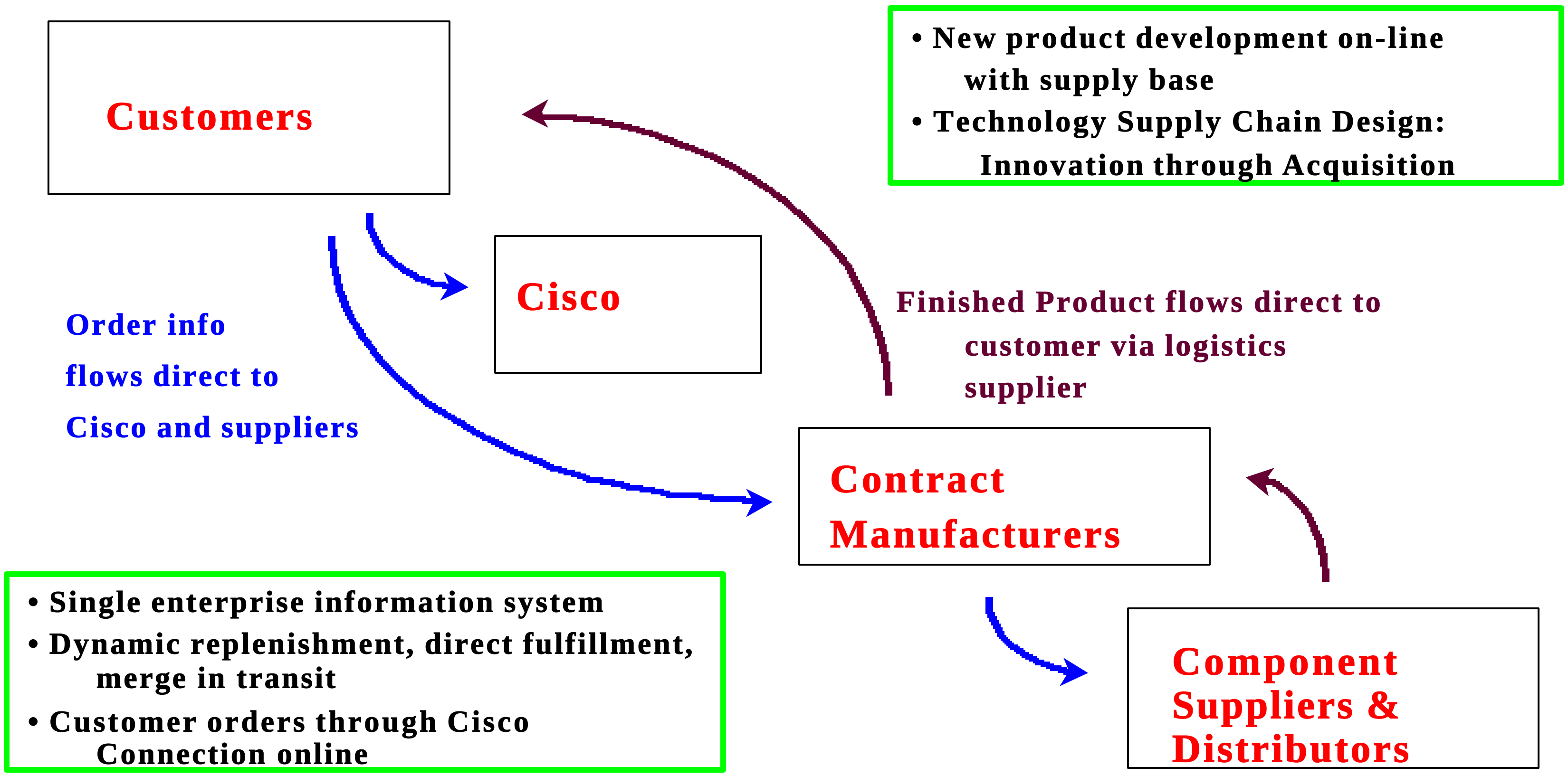
4. Customer Preference Dynamics

5. Technology dynamics (e.g., the Semiconductor Industry Assoc. roadmap built around Moore's law)

6. Regulatory Policy Dynamics (Cross-National, Cross Sector)

7. Capital Markets Dynamics

Cisco's End-to-End Integration for its Fulfillment Supply Chain



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

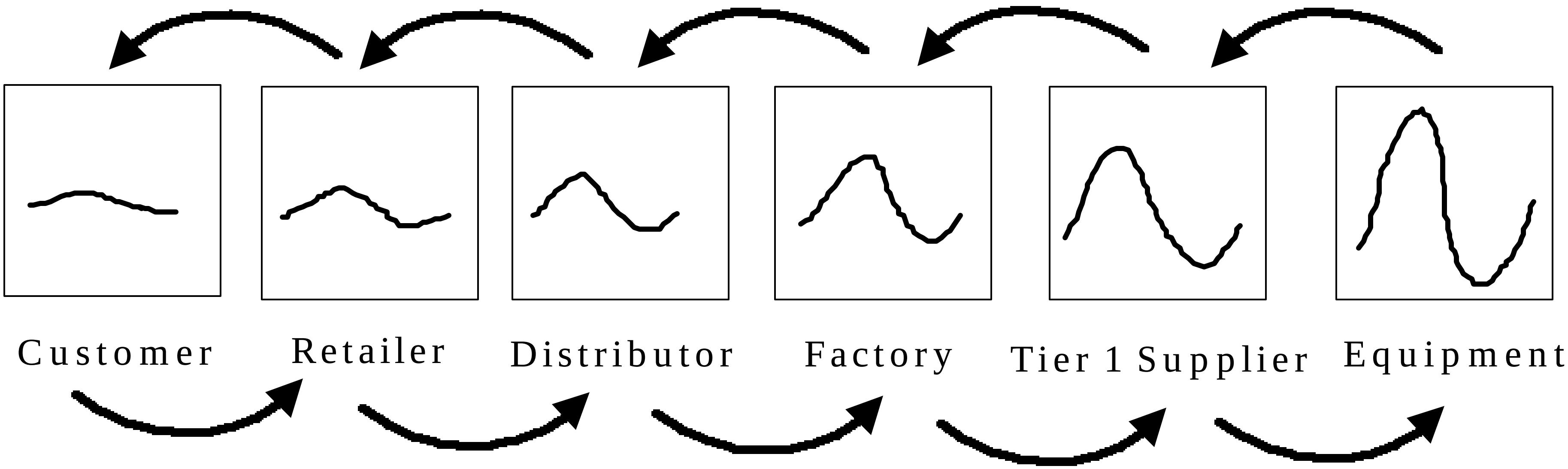
Cisco's Strategy for Technology Supply Chain Design

- 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"



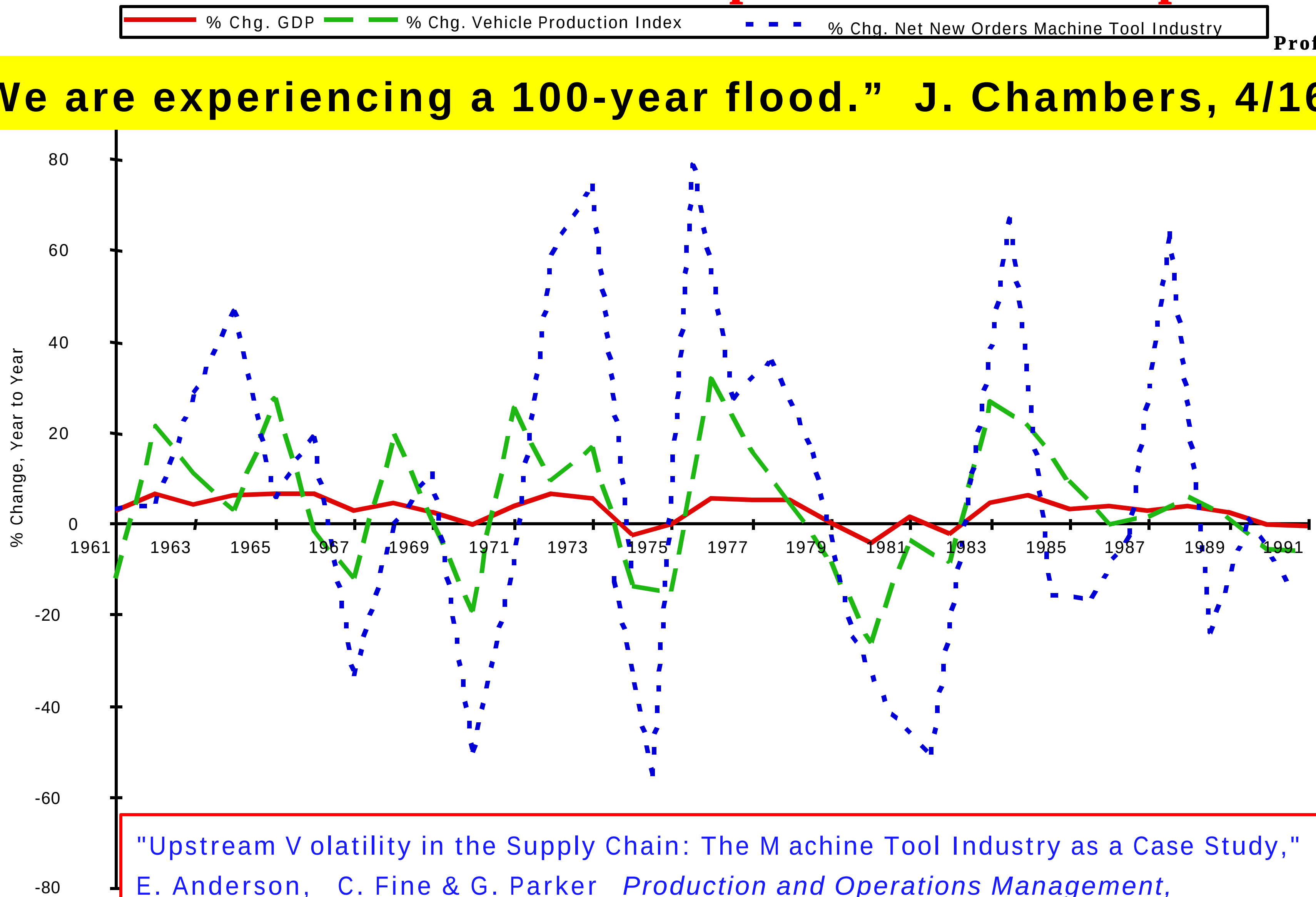
Information lags
Delivery lags
Over- and underordering
Misperceptions of feedback
Lumpiness in ordering
Chain accumulations

SOLUTIONS:
Countercyclical Markets
Countercyclical Technologies
Collaborative channel mgmt.
(Cincinnati Milacron & Boeing)

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

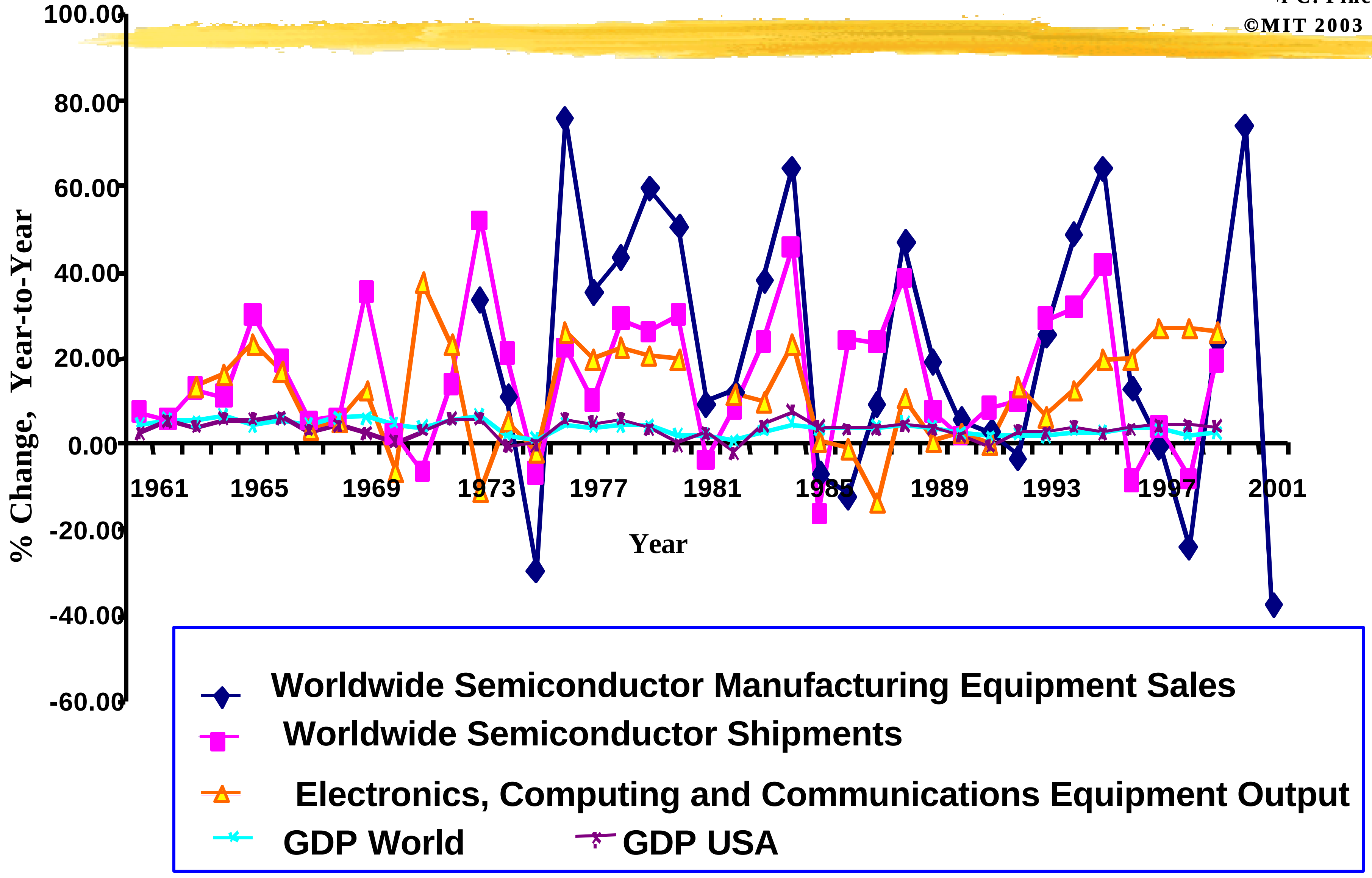
Prof C. Fine

"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 & Semiconductors Supply Chain



LESSONS FROM A FRUIT FLY:

CISCO SYSTEMS

- 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 Question:

How does clockspeed impact volatility?

Roadmap Components: Dynamic Analyses

- Business cycle dynamics
  (e.g., systems dynamics-like models of the bullwhip effect)
- Industry structure dynamics
  (e.g., double helix in *Clockspeed*)

3. Corporate strategy dynamics (e.g., dynamic matching of customer needs with corporate opportunities)
4. Customer Preference Dynamics
5. Technology dynamics (e.g., the Semiconductor Industry Assoc. roadmap built around Moore's law)
6. Regulatory Policy Dynamics
   (Cross-National, Cross Sector)

The Strategic Leverage of Value Chain Design:

Who let Intel Inside?

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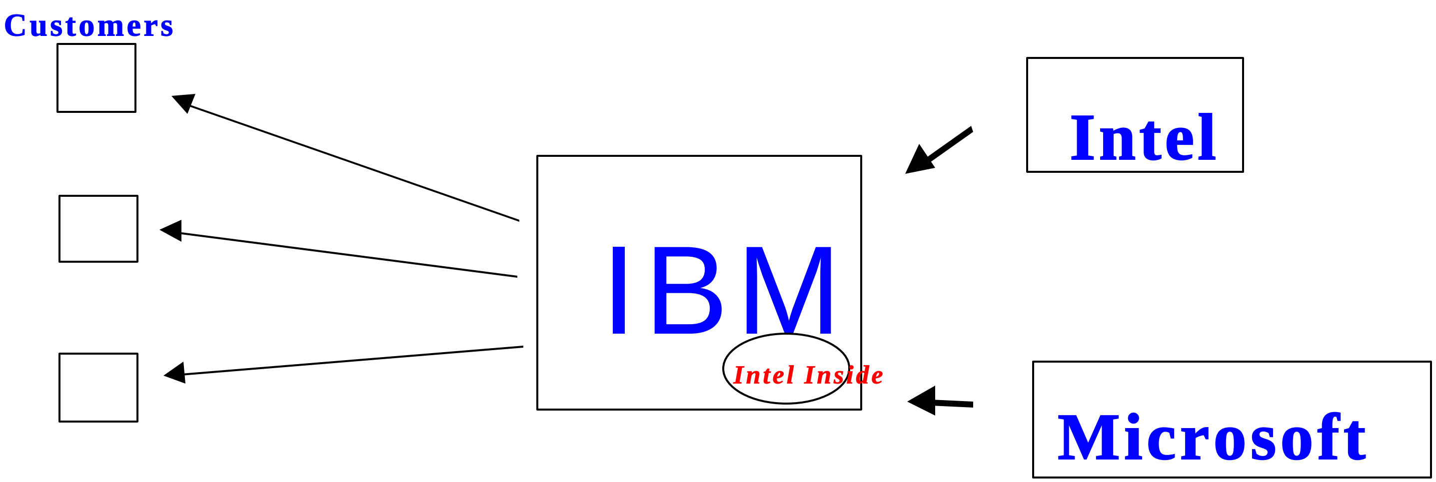
1980: IBM designs a product, a process, & a value chain



The Outcome:

A phenomenonally successful product design

A disastrous value chain design (for IBM)

LESSONS FROM A FRUIT FLY:

THE PERSONAL COMPUTER

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.**

- **DEVELOPMENT PARTNERSHIP 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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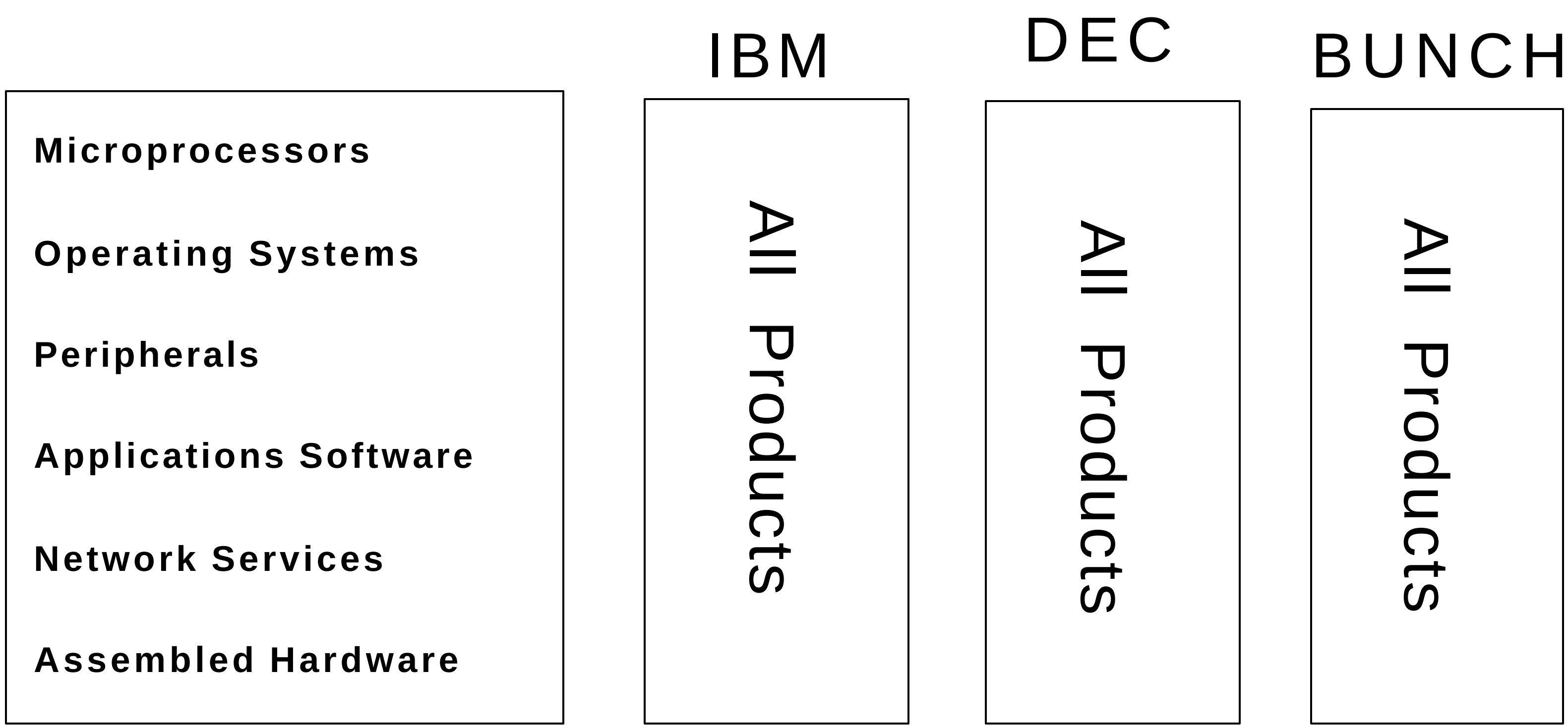
Computer Industry Structure, 1975-85



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

Horizontal Industry Structure with *Modular* Product Architecture

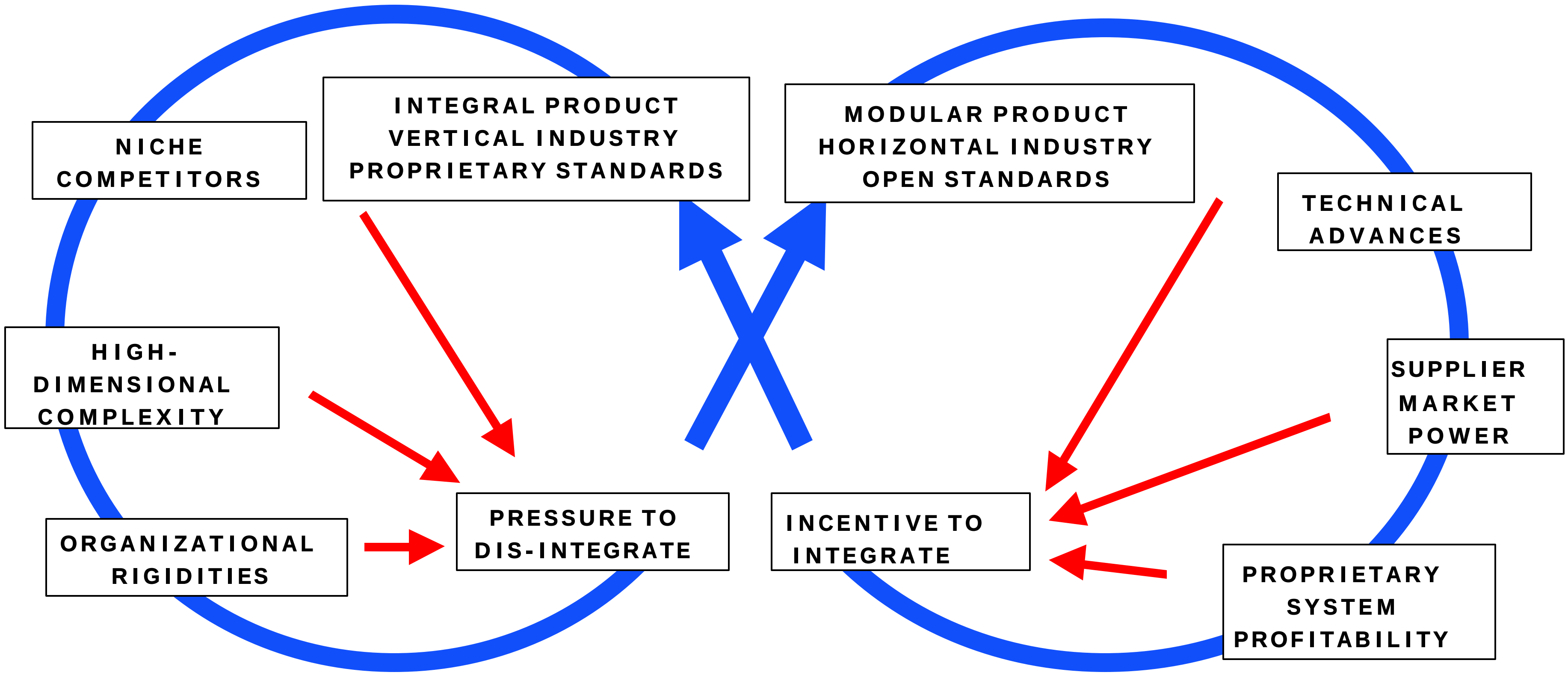
Computer Industry Structure, 1985-95

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/Netscape	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



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

Roadmap Components: Dynamic Analyses

- **Business cycle dynamics (e.g., systems dynamics-like models of the bullwhip effect)**
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6. Regulatory Policy Dynamics (Cross-National, Cross Sector)

ALL COMPETITIVE ADVANTAGE IS TEMPORARY

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

VALUE CHAIN DESIGN:
Three Components

1. Insourcing/OutSourcing

(The Make/Buy or Vertical Integration Decision)

2. Partner Selection

(Choice of suppliers and partners for the chain)

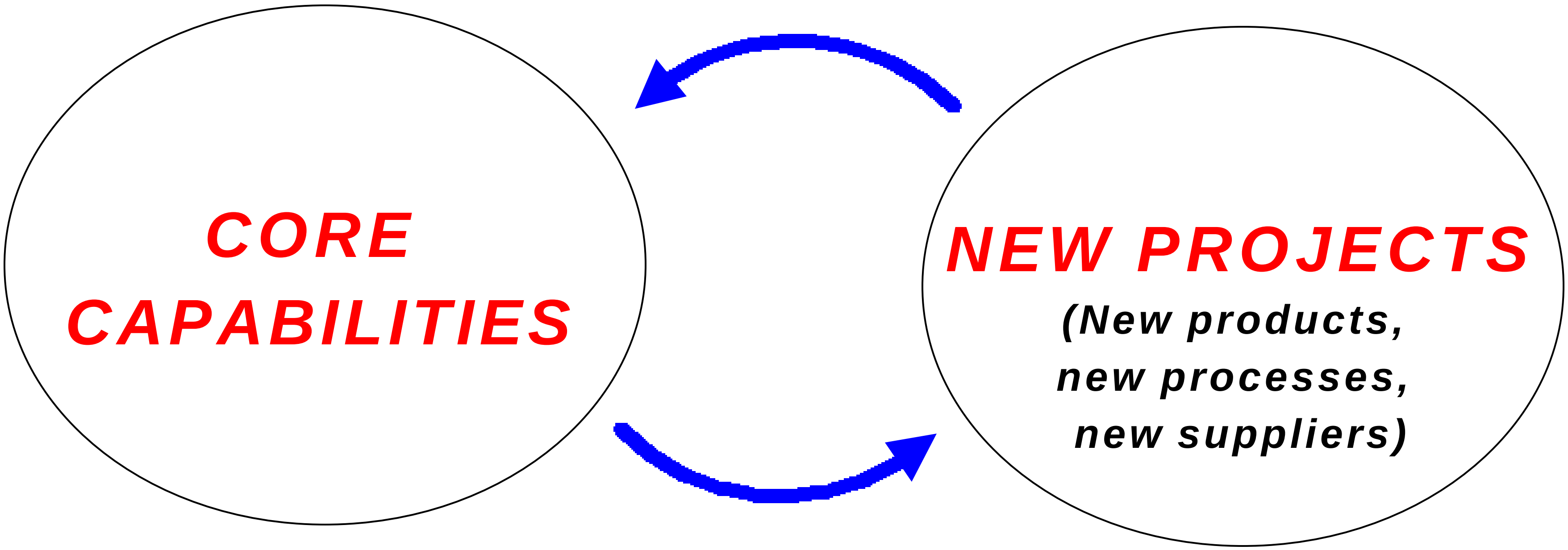
3. The Contractual Relationship

(Arm's length, joint venture, long-term contract, strategic alliance, equity participation, etc.)

Clockspeed drives *Business Strategy Cadence*

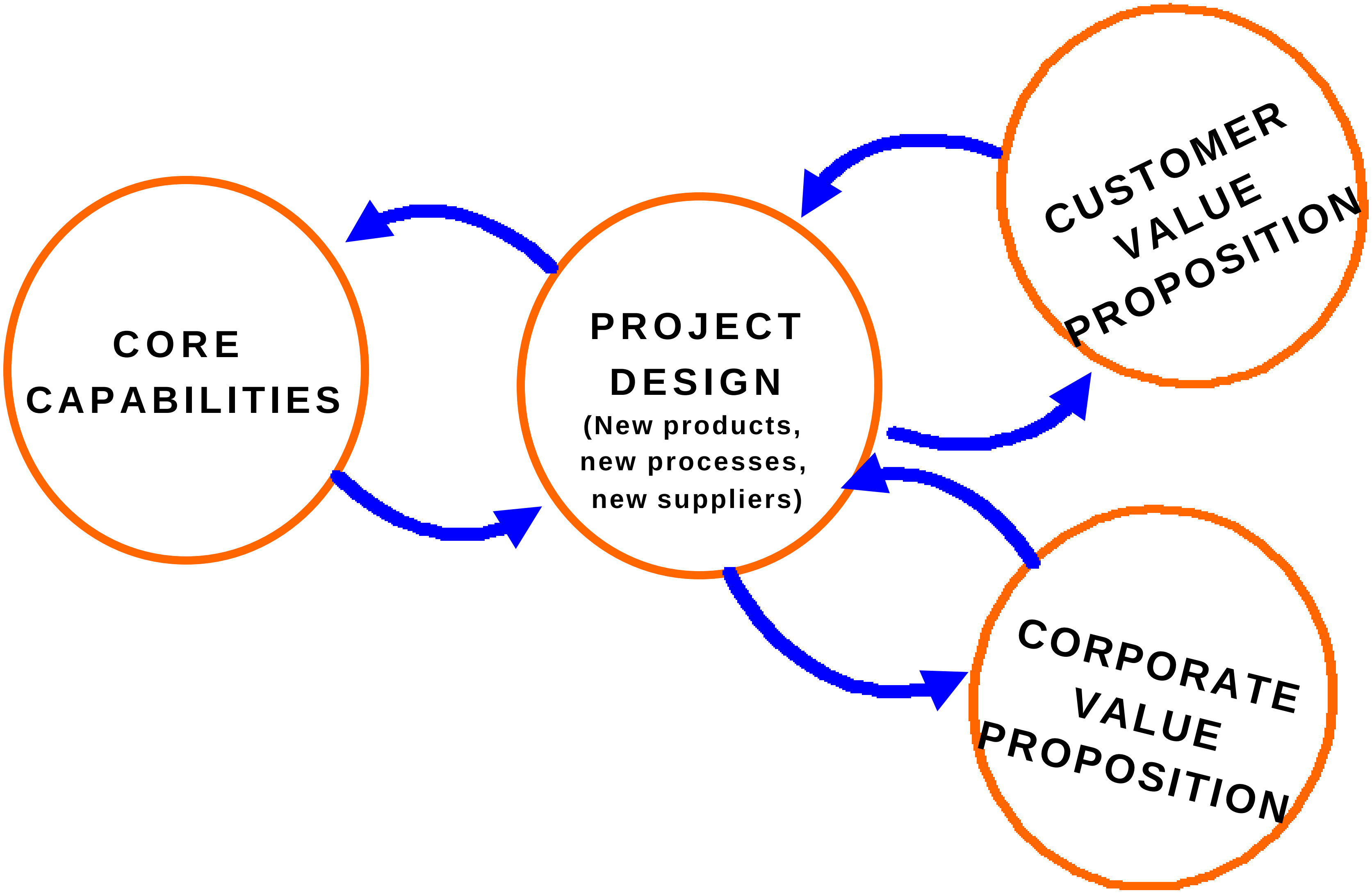
Prof C. Fine

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

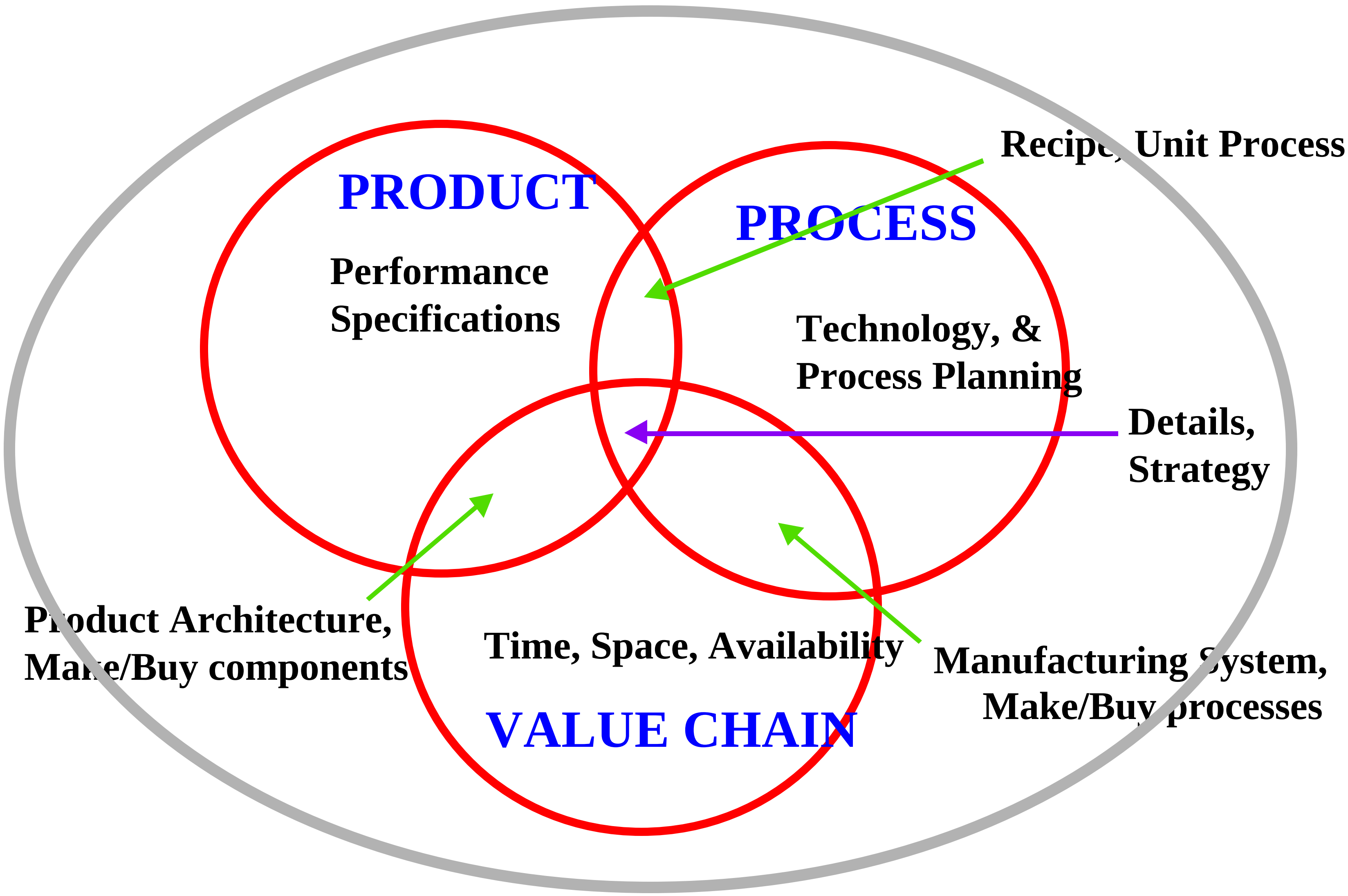


Leonard-Barton, *Wellsprings of Knowledge*

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



IMPLEMENTATION OF *PROJECT DESIGN:* FRAME IT AS 3-D CONCURRENT ENGINEERING



ARCHITECTURES IN 3-D
INTEGRALITY VS. *MODULARITY*

Integral product architectures **feature close coupling among the elements**

- **Elements perform many functions**
- **Elements are in close spacial proximity**
- **Elements are tightly synchronized**

- Ex: jet engine, airplane wing, microprocessor

Modular product architectures **feature separation among the elements**

- **Elements are interchangeable**
- **Elements are individually upgradeable**
- **Element interfaces are standardized**
- **System failures can be localized**

- Ex: stereo system, desktop PC, bicycle

VALUE CHAIN ARCHITECTURE

Integral value-chain architecture
features close proximity among its elements
- **Proximity metrics: Geographic, Organizational**
  Cultural, Electronic
  - **Example: Toyota city**
  - **Example: Ma Bell (AT&T in New Jersey)**
  - **Example: IBM mainframes & Hudson River Valley**

Modular value-chain architecture features multiple,
interchangeable supplier and standard interfaces
- **Example: Garment industry**
- **Example: PC industry**
- **Example: General Motors' global sourcing**
- **Example: Telephones and telephone service**

ALIGNING ARCHITECTURES: BUSINESS SYSTEMS & TECHNOLOGICAL SYSTEMS

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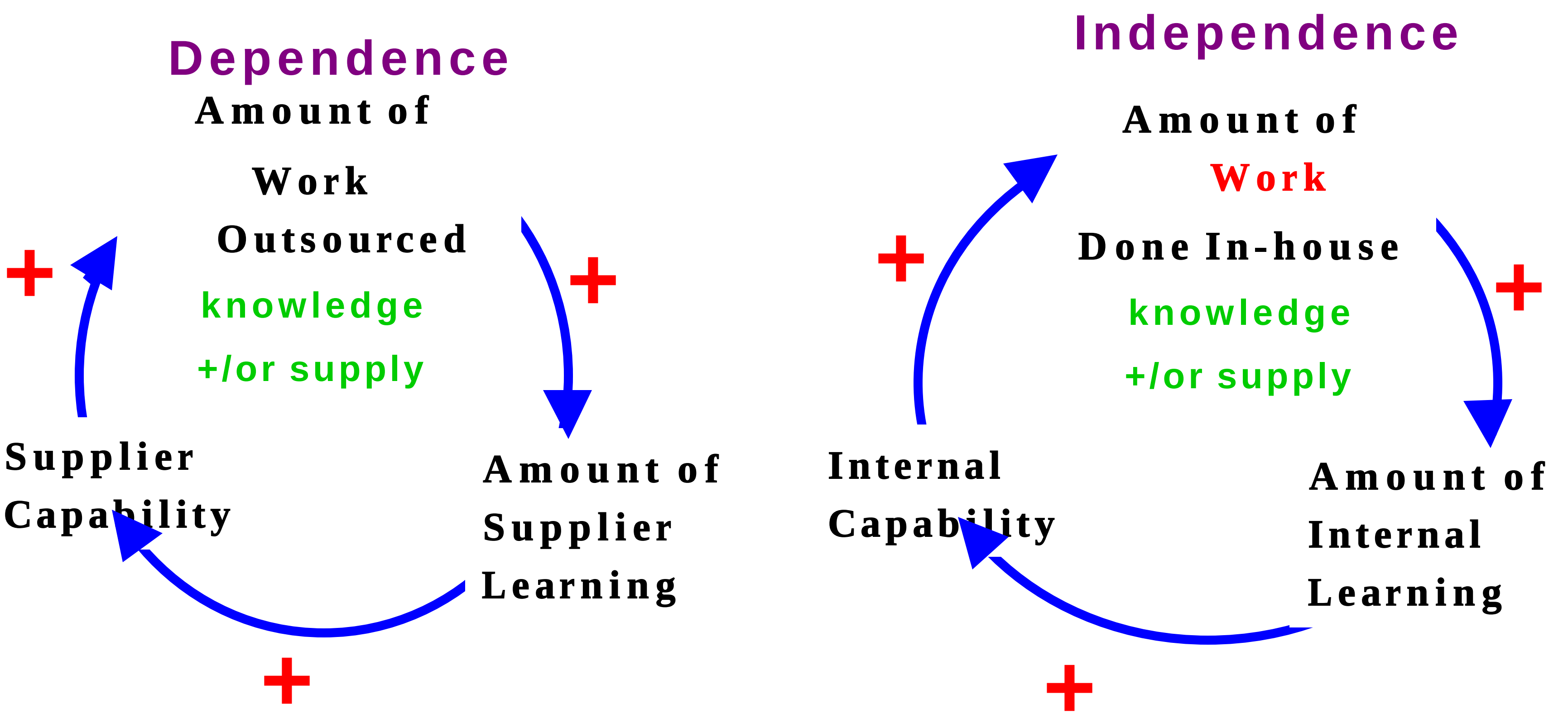
BUSINESS SYSTEM/SUPPLY CHAIN ARCHITECTURE
(Geog., Organ., Cultural, Elec.)

INTEGRAL ⟷ MODULAR

TECHNOLOGY/PRODUCT ARCHITECTURE: INTEGRAL ↕ MODULAR

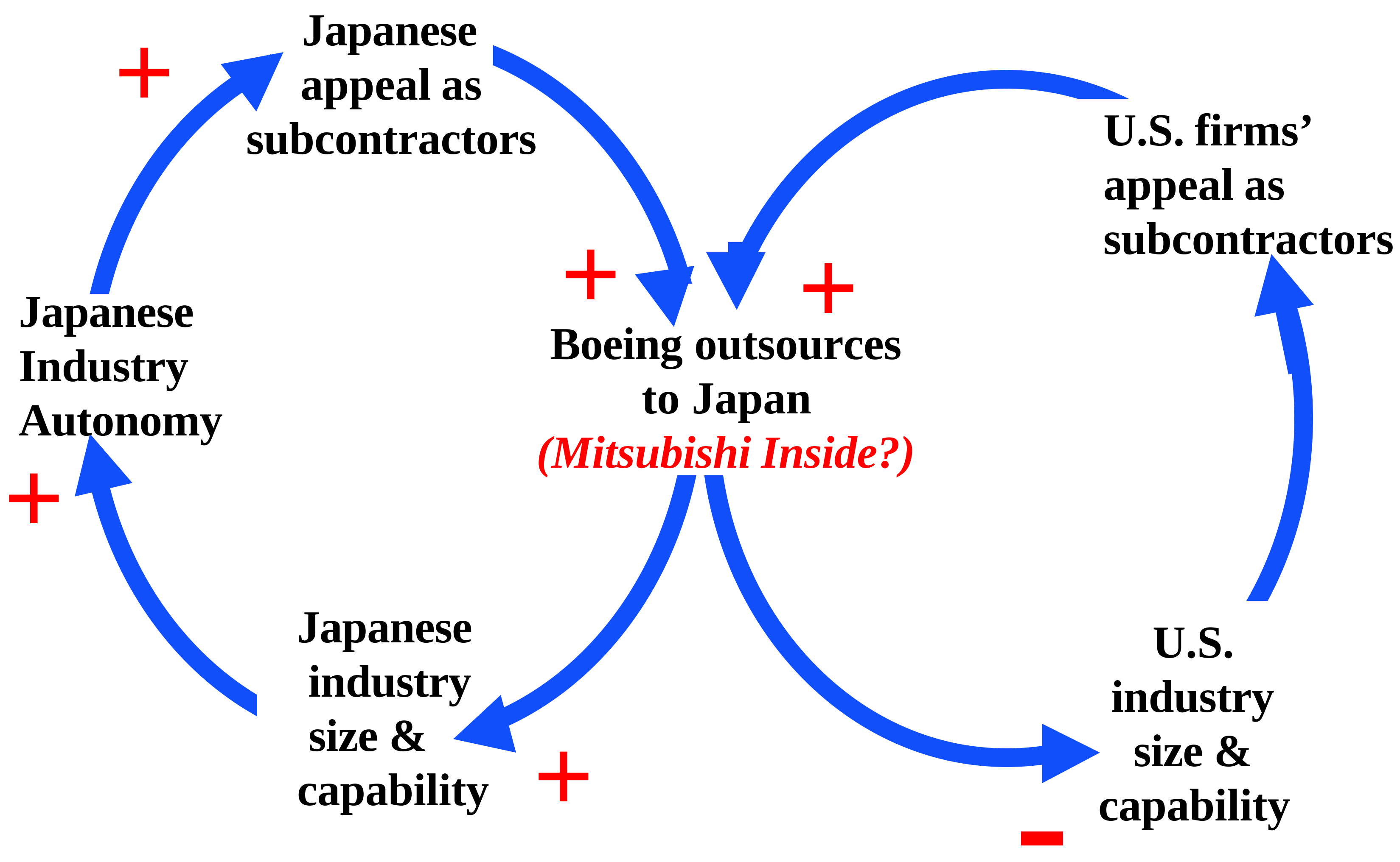
	INTEGRAL		MODULAR
INTEGRAL	Microprocessors Mercedes & BMW vehicles	Lucent Nortel	Polaroid
	MSFT Windows	Chrysler vehicles	Cisco
MODULAR	Digital Rights/ Music Distribution		Dell PC'S Bicycles

In/Outsourcing: Sowing the Seeds of Competence Development to develop dependence for knowledge or dependence for capacity

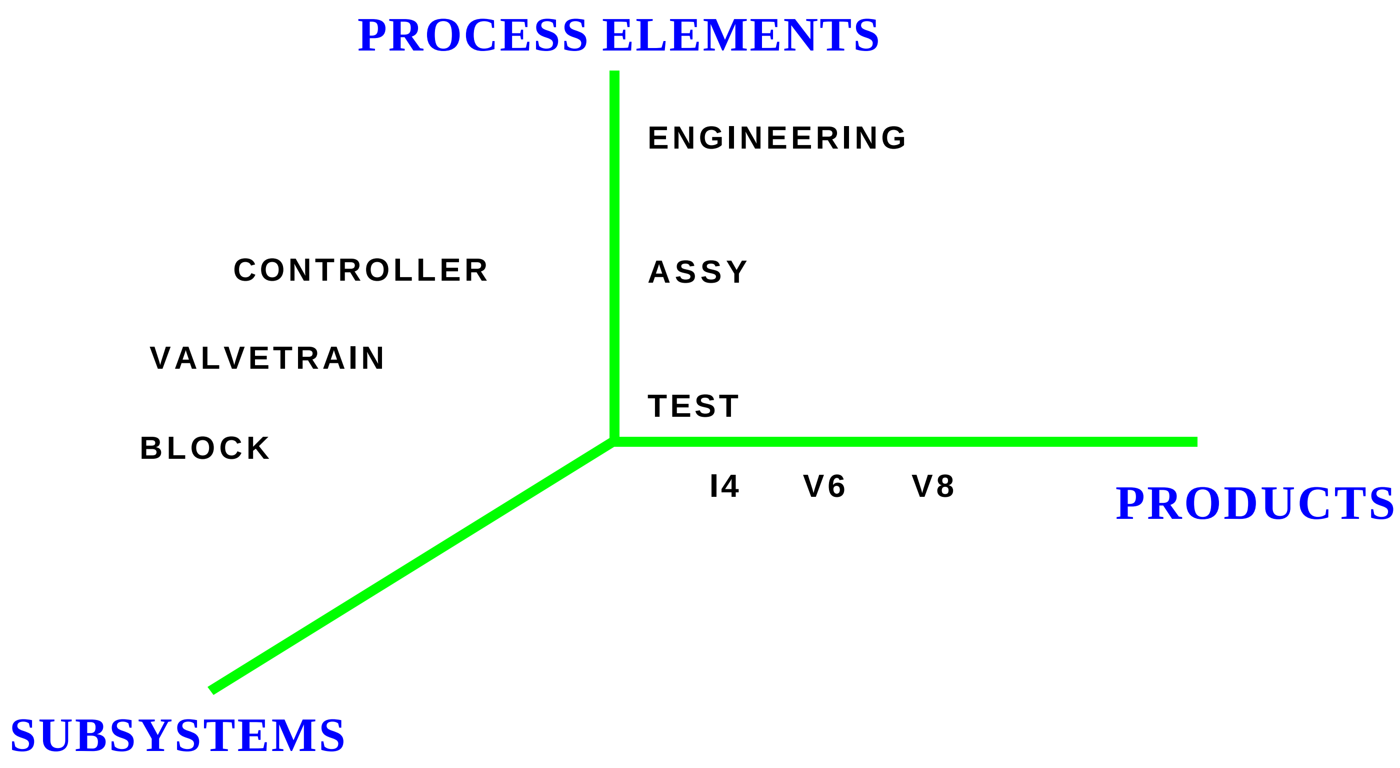


Technology Dynamics in the Aircraft Industry:
LEARNING FROM THE DINOSAURS

Prof C. Fine



SOURCEABLE ELEMENTS

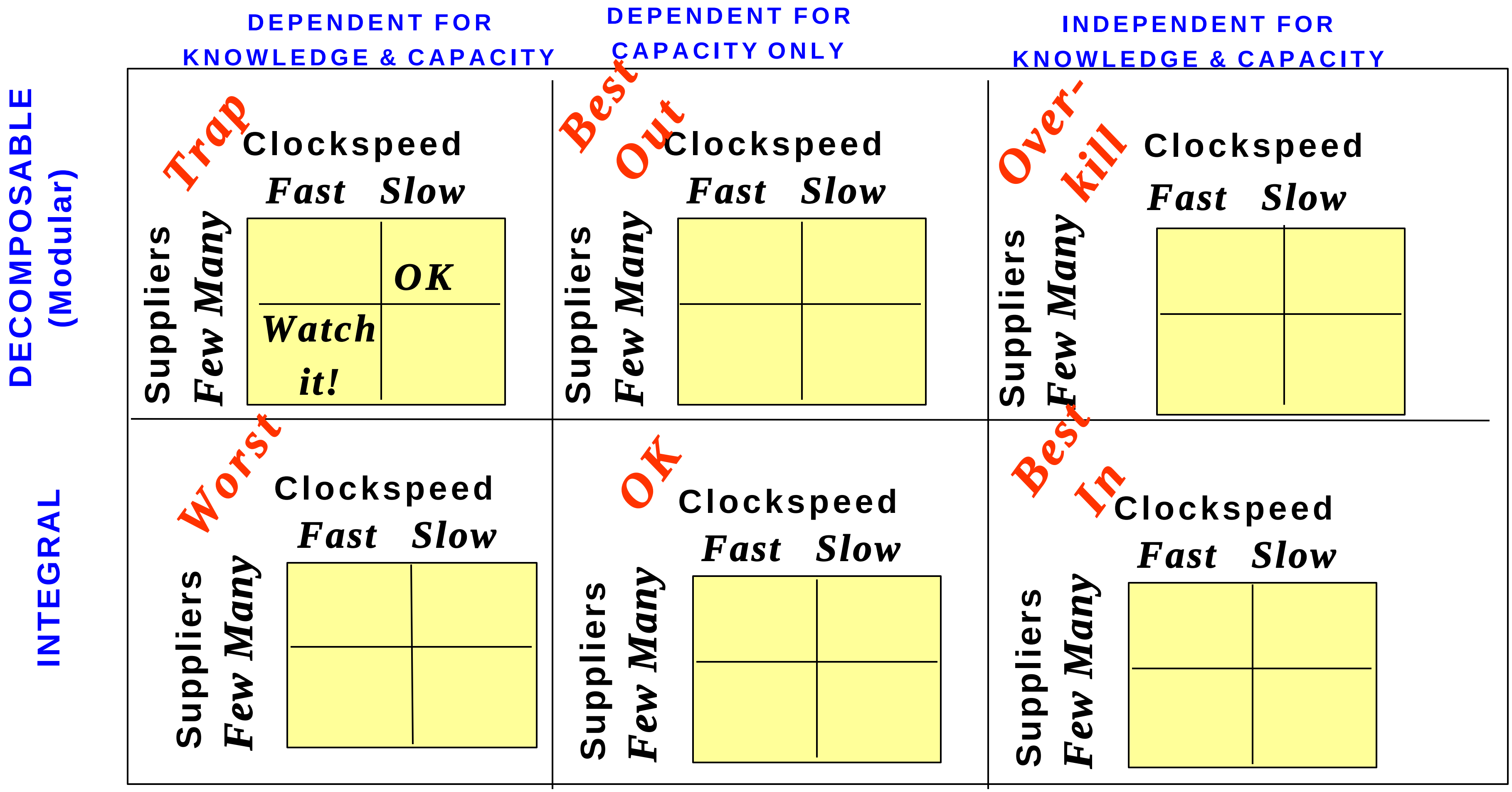


Strategic Make / Buy Decisions: Assess Critical Knowledge & Product Architecture

	DEPENDENT FOR KNOWLEDGE & CAPACITY	INDEPENDENT FOR KNOWLEDGE & DEPENDENT FOR CAPACITY	INDEPENDENT FOR KNOWLEDGE & CAPACITY
ITEM IS INTEGRAL	A POTENTIAL OUTSOURCING TRAP	BEST OUTSOURCING OPPORTUNITY	OVERKILL IN VERTICAL INTEGRATION
ITEM IS MODULAR	WORST OUTSOURCING SITUATION	CAN LIVE WITH OUTSOURCING	BEST INSOURCING SITUATION

Adapted from Fine & Whitney, “Is the Make/Buy Decision Process a Core Competence?”

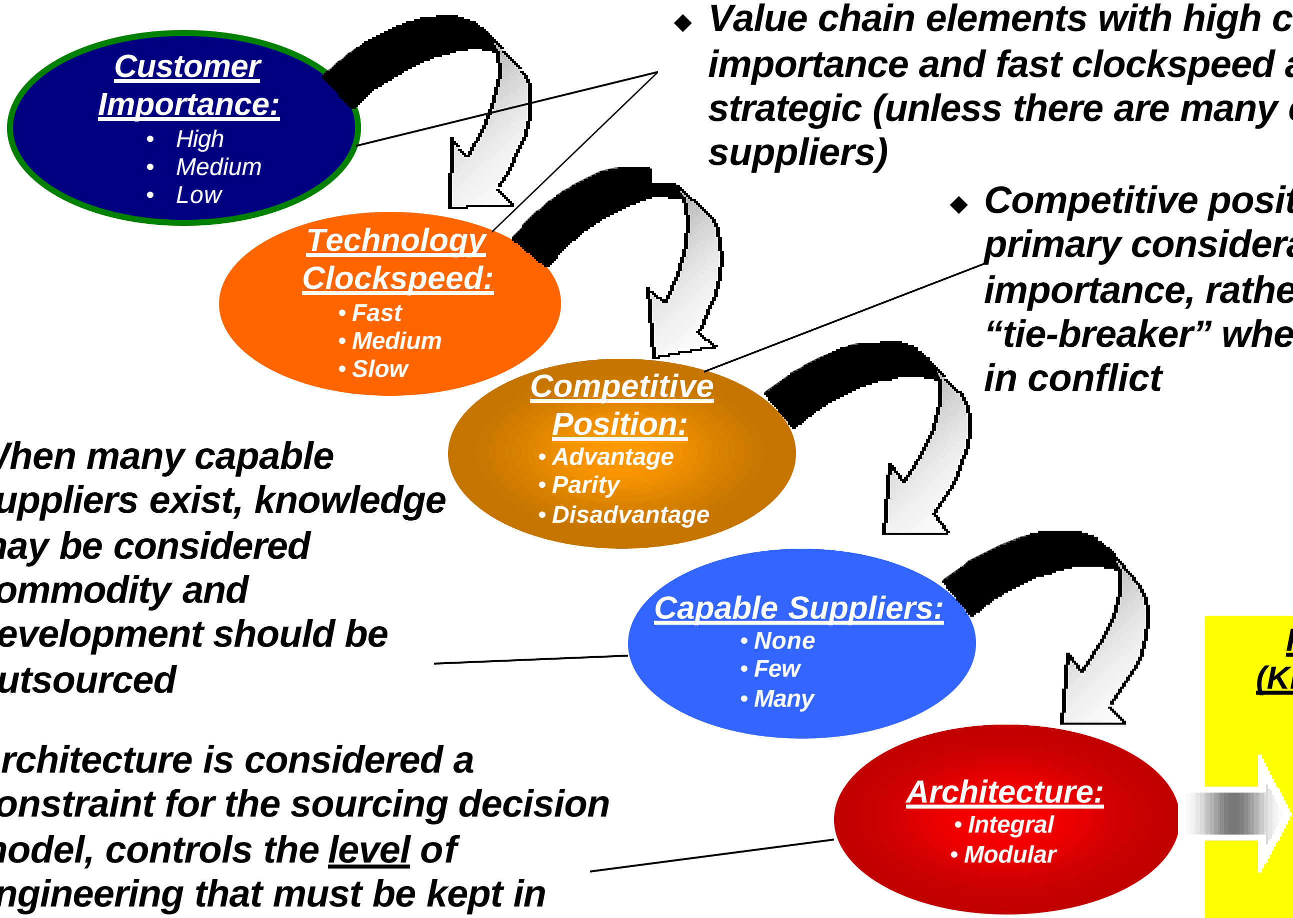
Strategic Make/Buy Decisions: Also consider Clockspeed & Supply Base Capability



Adapted from C. Fine, *Clockspeed*, Chap. 9

Qualitative analysis of strategic importance uses five key criteria

Prof C. Fine



- *Value chain elements with high customer importance and fast clockspeed are generally strategic (unless there are many capable suppliers)*
- *Competitive position is seldom the primary consideration for strategic importance, rather it serves as a "tie-breaker" when other criteria are in conflict*
- *When many capable suppliers exist, knowledge may be considered commodity and development should be outsourced*
- *Architecture is considered a constraint for the sourcing decision model, controls the level of engineering that must be kept in house for integration purposes*

Possible Decisions (Knowledge & Supply):
- Insource
- Outsource
- Partner/Acquire
- Partial Insource
- Partial Outsource
- Invest
- Spin Off
- Develop Suppliers

Model developed by GM Powertrain, PRTM, & Clockspeed, Inc.

Every decision requires qualitative and quantitative analysis to reach a conclusion

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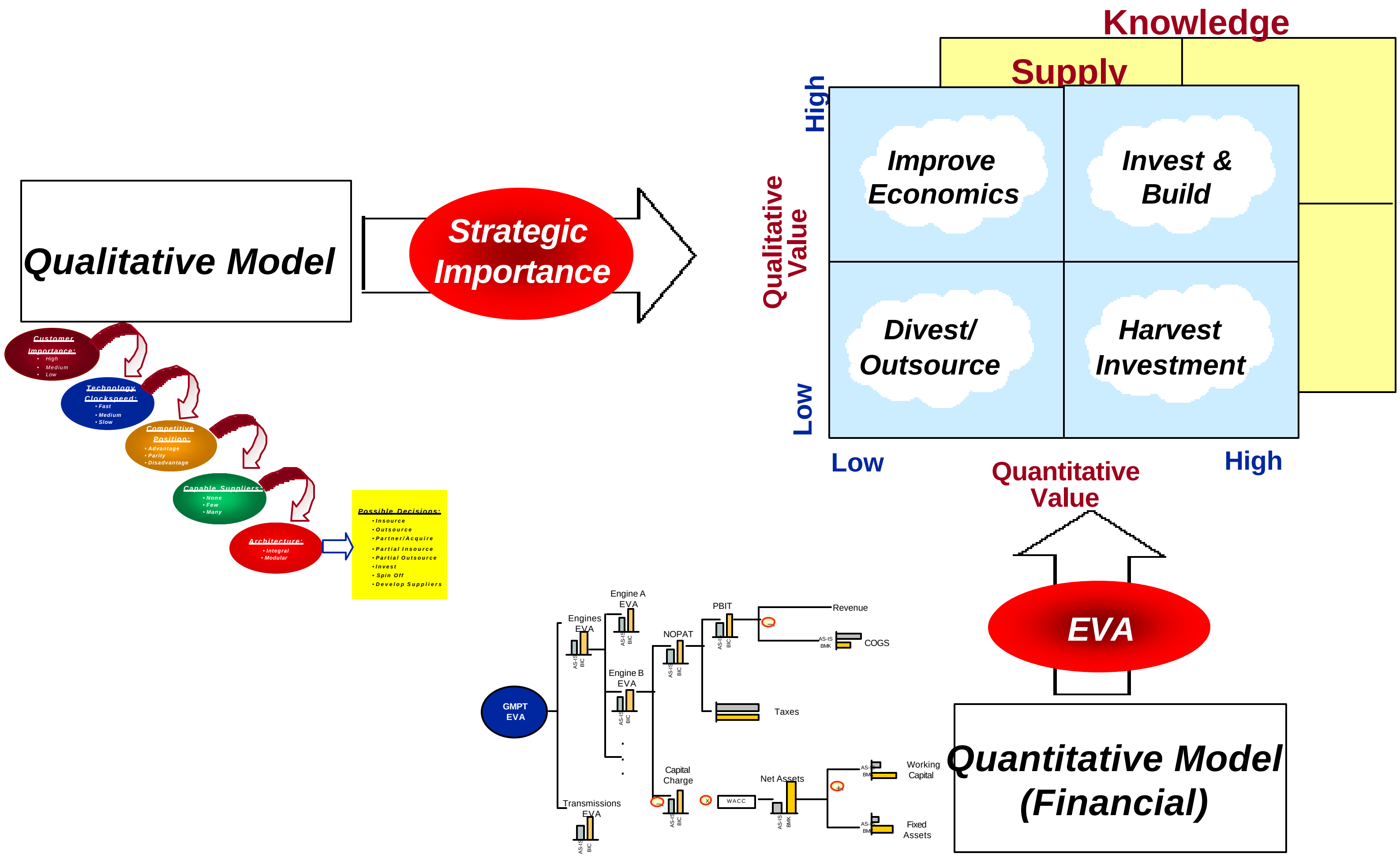


Model developed by GM Powertrain, PRTM, & Clockspeed, Inc.

VALUE CHAIN DESIGN IS *THE ULTIMATE* CORE COMPETENCY

Prof C. Fine

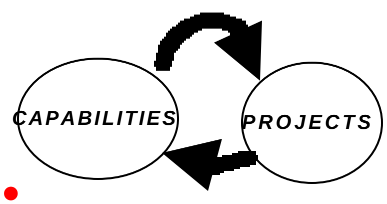
Since all advantages are temporary,
the only lasting competency is to continuously build and assemble capabilities chains.

KEY SUB-COMPETENCIES:

1. Forecasting the dynamic evolution of market power and market opportunities

2. Anticipating Windows of Opportunity

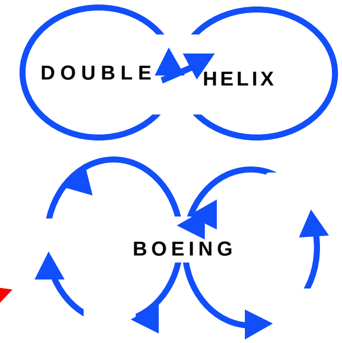
3. 3-D Concurrent Engineering:
Product, Process, Value Chain

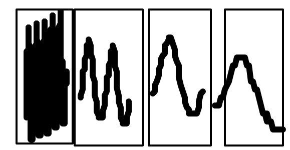


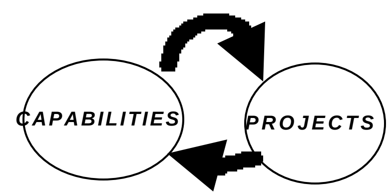
Fortune Favors the Prepared Firm

PROCESS FOR VALUE CHAIN DESIGN

1. Benchmark the Fruit Flies
2. Map your Supply Chain
   - -Organizational Value Chain
   - -Technology Value Chain
   - -Competence Chain
3. Dynamic Chain Analysis
   at each node of each chain map
4. Identify Windows of Opportunity
5. Exploit Competency Development Dynamics
   with 3-D Concurrent Engineering







OPTICAL TELECOM VALUE CHAIN: MINI CASE EXAMPLE

NORTEL NETWORKS plays at at least three levels of the Optical Network Telecom value chain:

- **Network design & installation**
- **Modules (OC-192 network elements)**
- **Components (lasers, amplifiers)**

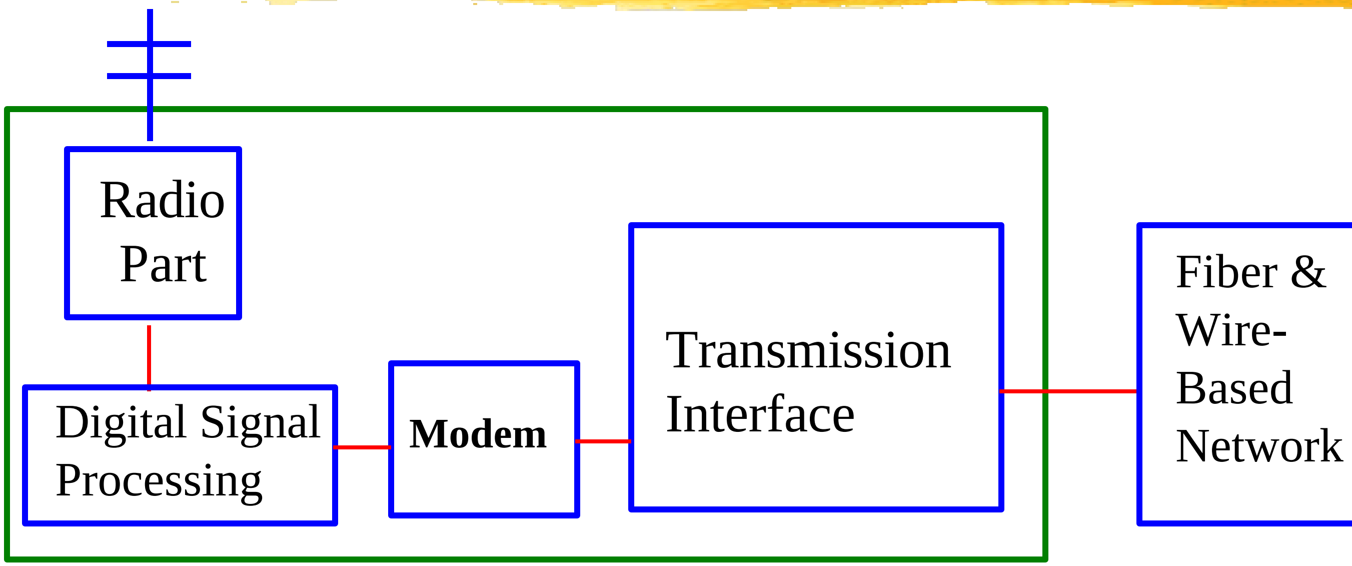
QUIZ: Should Nortel sell their components business?

Hint: How likely are the scenarios of:

- **An *Intel Inside* effect in components?**
- **Networks become sufficiently modular as to be assembled by the customer?**

WIRELESS VALUE CHAIN:MINI CASE EXAMPLE

Wireless Base Stations (WSB'S) comprise 4 key subsystems:



WSB architectures are
-integral & proprietary
Suppliers include: Nortel, Moto, Ericsson, Siemens, Nokia
Disruptive Modem advances (e.g., MUD) can double Base Station Capacity

Modular WSB's might
(1) Stimulate new WSB entrants (ala Dell)
(2) Stimulate standard subsystem suppliers
(3) lower prices to the network operators
(4) Speed base station performance imp.
(5) Increase demand for basestations due to improved price-performance ratios.

Roadmap Components: Dynamic Analyses

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6. Regulatory Policy Dynamics (Cross-National, Cross Sector)

Customer Preference Drivers

(adapted from Sadek Esener, UCSD and Tom O'Brien, Dupont "Macro-Trends" process)

- **Population**
  - Aging, Growth
- **Awareness**
  - of Environment/Energy costs, Personal Health
  - of consumption possibilities & disparities

3. **Globalization**
   - of commerce, culture, knowledge, disease, terrorism
4. **Clusters**
   - urbanization
   - wealth
   - affinity/ethnic groups
5. **Technology**
   - cheap computation, pervasive connectivity
   - technology at the molecular (nano) level
     (life sciences, electronics, polymers)

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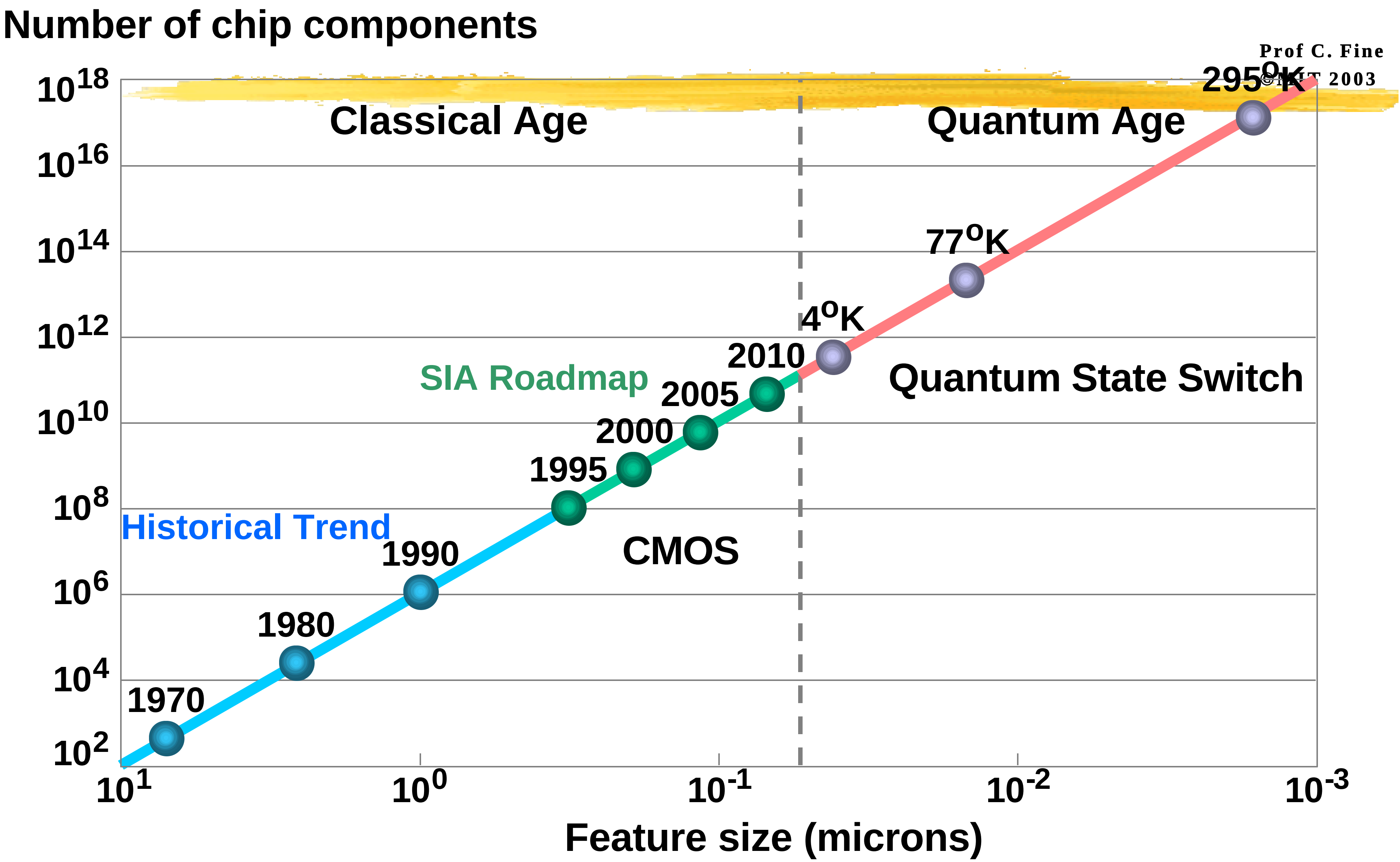
Roadmap for Electronic Devices



International Technology Roadmap for Semiconductors '99

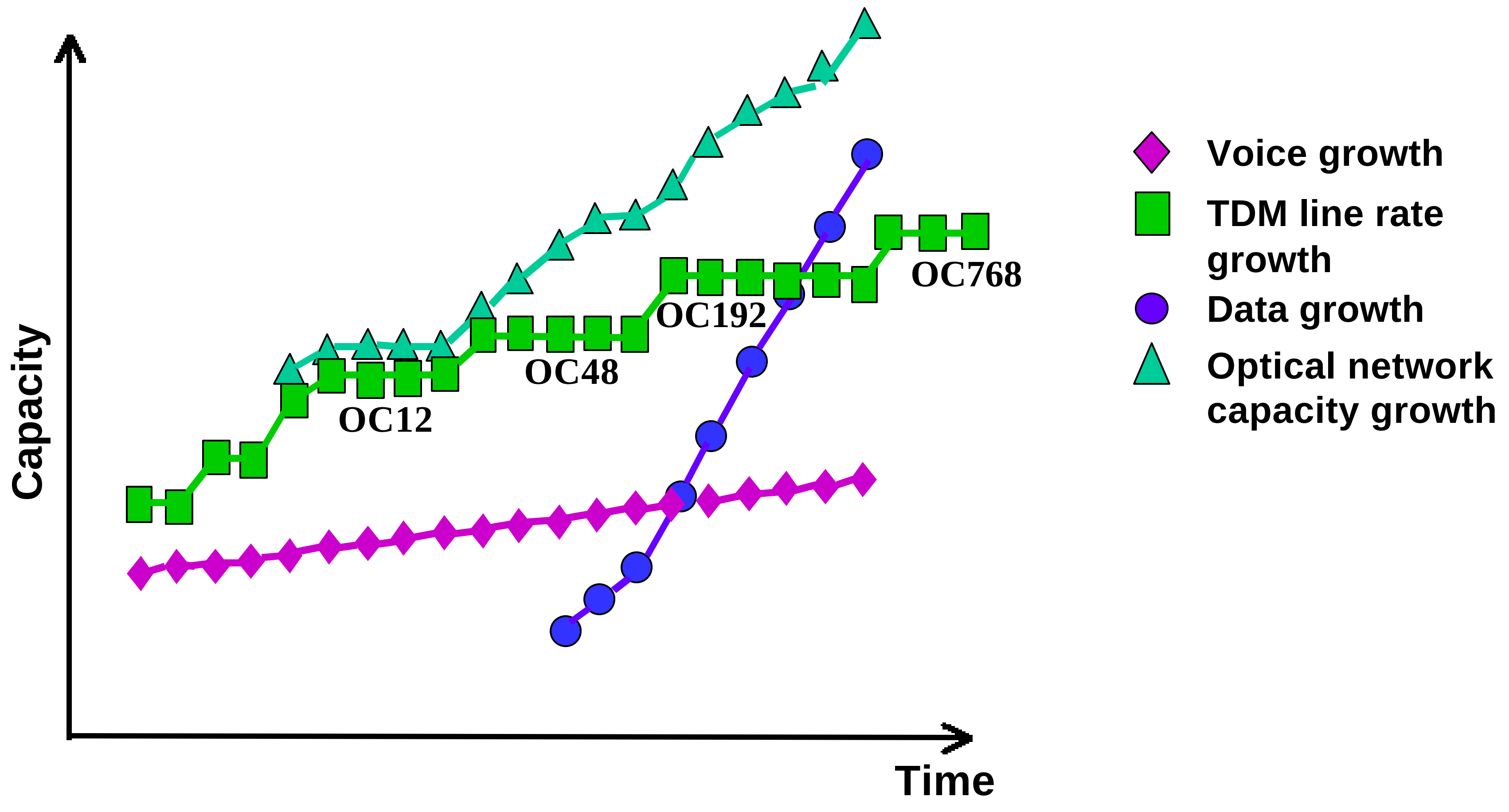
Year	2005	2008	2011	2014
Technology (nm)	100	70	50	35
DRAM chip area (mm^2)	526	603	691	792
DRAM capacity (Gb)	8		64	
MPU chip area (mm^2)	622	713	817	937
MPU transistors ($x10^9$)	0.9	2.5	7.0	20.0
MPU Clock Rate (GHz)	3.5	6.0	10.0	13.5

Disk Drive Development 1978-1991

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!



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

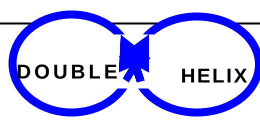
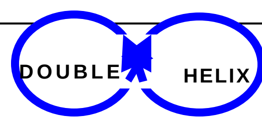
"We define a *'killer technology'* as one that delivers enhanced systems performance of a factor of at least a hundred-fold per decade."

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 Develoment 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?

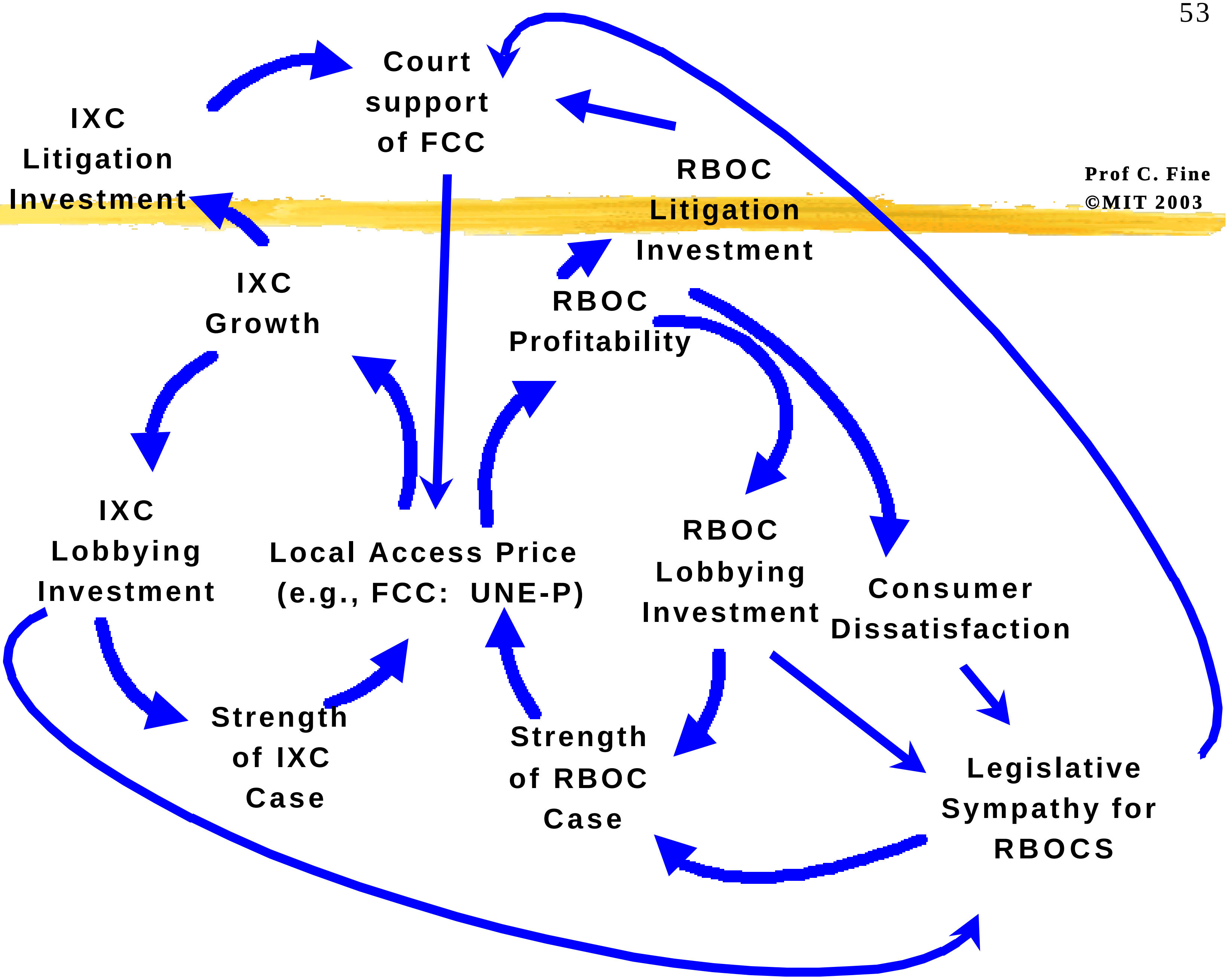
Optical Technology Evolution: Navigating the Generations with an Immature Technology

	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 Techno-logies	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		

Roadmap Components: Dynamic Analyses

- Business cycle dynamics
  (e.g., systems dynamics-like models
  of the bullwhip effect)
- Industry structure dynamics
  (e.g., double helix in *Clockspeed*)

3. Corporate strategy dynamics (e.g., dynamic matching of customer needs with corporate opportunities)
4. Customer Preference Dynamics
5. Technology dynamics (e.g., the Semiconductor Industry Assoc. roadmap built around Moore's law)
6. Regulatory Policy Dynamics
   (Cross-National, Cross Sector)


Court support of FCC
IXC Litigation Investment
RBOC Litigation Investment
IXC Growth
RBOC Profitability
IXC Lobbying Investment
Local Access Price (e.g., FCC: UNE-P)
RBOC Lobbying Investment
Consumer Dissatisfaction
Strength of IXC Case
Strength of RBOC Case
Legislative Sympathy for RBOCS

All Conclusions are *Temporary*

Clockspeeds are increasing almost everywhere

Value Chains are changing rapidly