Three-Dimensional Concurrent Engineering: Clockspeed-based Principles for Product, Process, and Supply Chain Development

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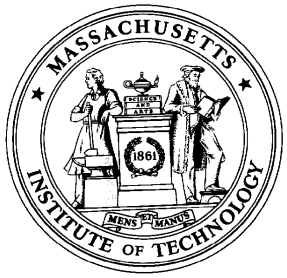

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I. Introduction & Motivation

II. Fruit Flies & Clockspeed

III. Supply Chain Design/Development matters

IV. 3-D Concurrency--an architectural approach

V. 3-D Concurrency--two at a time

VI. Conclusions

Three-Dimensional Concurrent Engineering: Product/Process Development on a Supply Web

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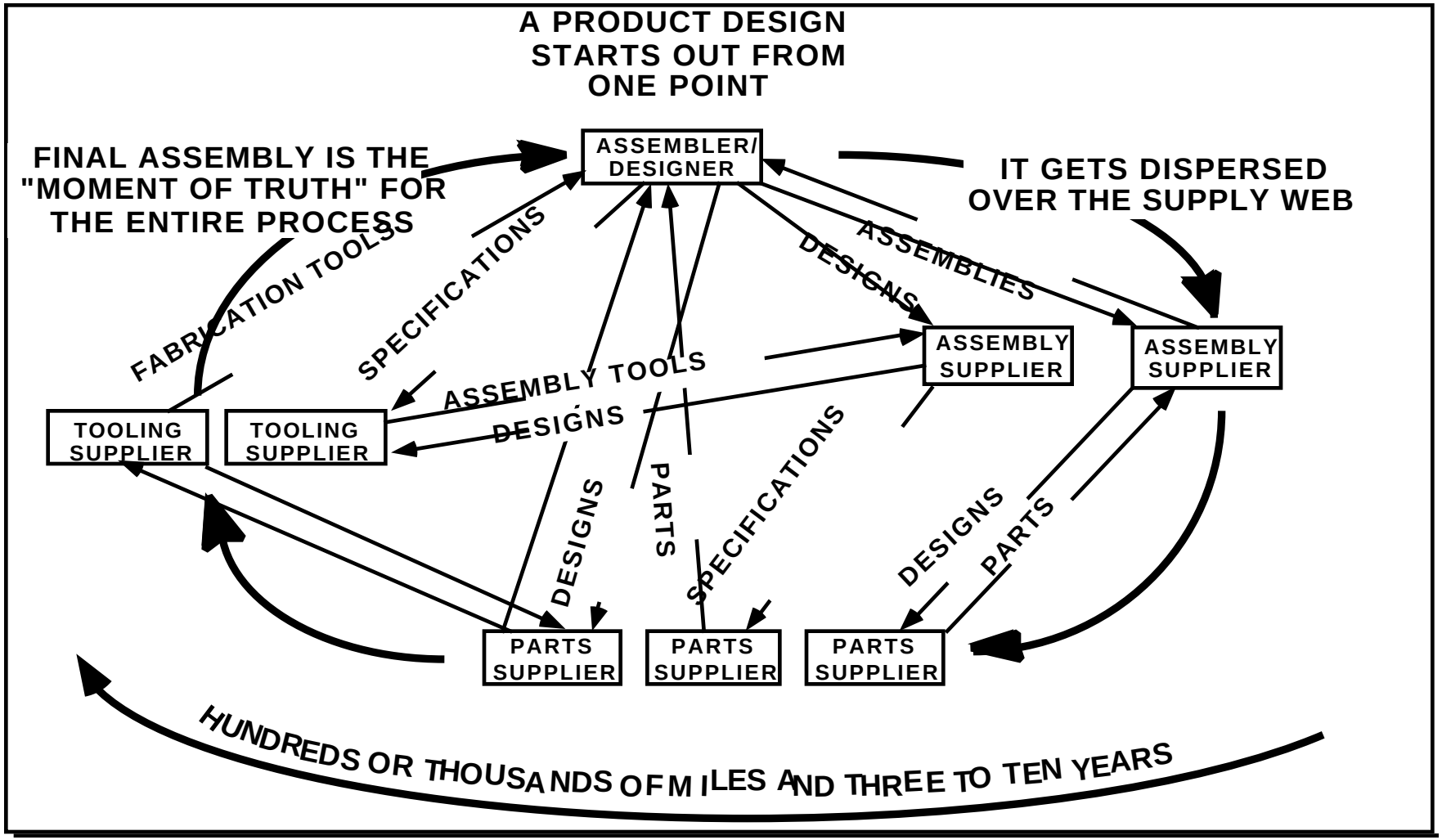

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Supply Chain Design in a Fast-Clockspeed World
Study the Industry Fruitflies

Evolution in the natural world:

FRUITFLIES
evolve faster than
MAMMALS
evolve faster than
REPTILES

THE KEY TOOL:

Cross-SPECIES Benchmarking of Dynamic Forces

Evolution in the industrial world:

INFOTAINMENT evolves faster than
MICROCHIPS evolve faster than
AUTOS evolve faster than
SPACECRAFT evolve faster than
AIRCRAFT evolve faster than
SHIPS evolve faster than
MINERAL EXTRACTION

THE KEY TOOL:

Cross-INDUSTRY Benchmarking of Dynamic Forces

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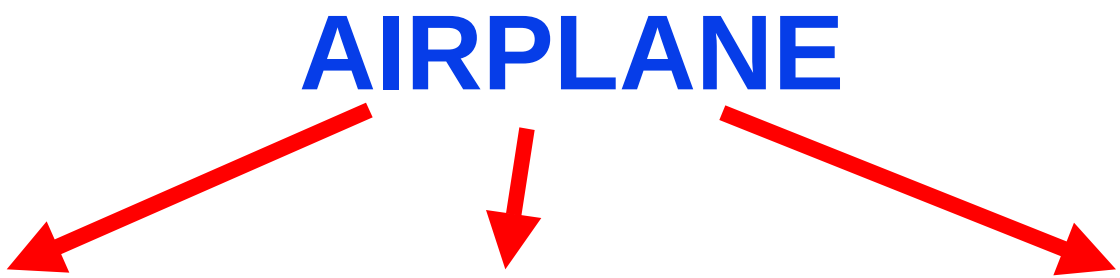
AIRCRAFT CLOCKSPEED IS A COMPOSITE OF AIRFRAMES, ENGINES, & AVIONICS



AIRFRAME
slow clockspeed

ENGINES
medium clockspeed

ELECTRONICS
fast clockspeed

HYPOTHESIS: MOST AIRCRAFT FIRMS OPERATE AT ***AIRFRAME CLOCKSPEEDS***; IN THE FUTURE THEY WILL NEED TO RUN AT ***ELECTRONICS CLOCKSPEED.***

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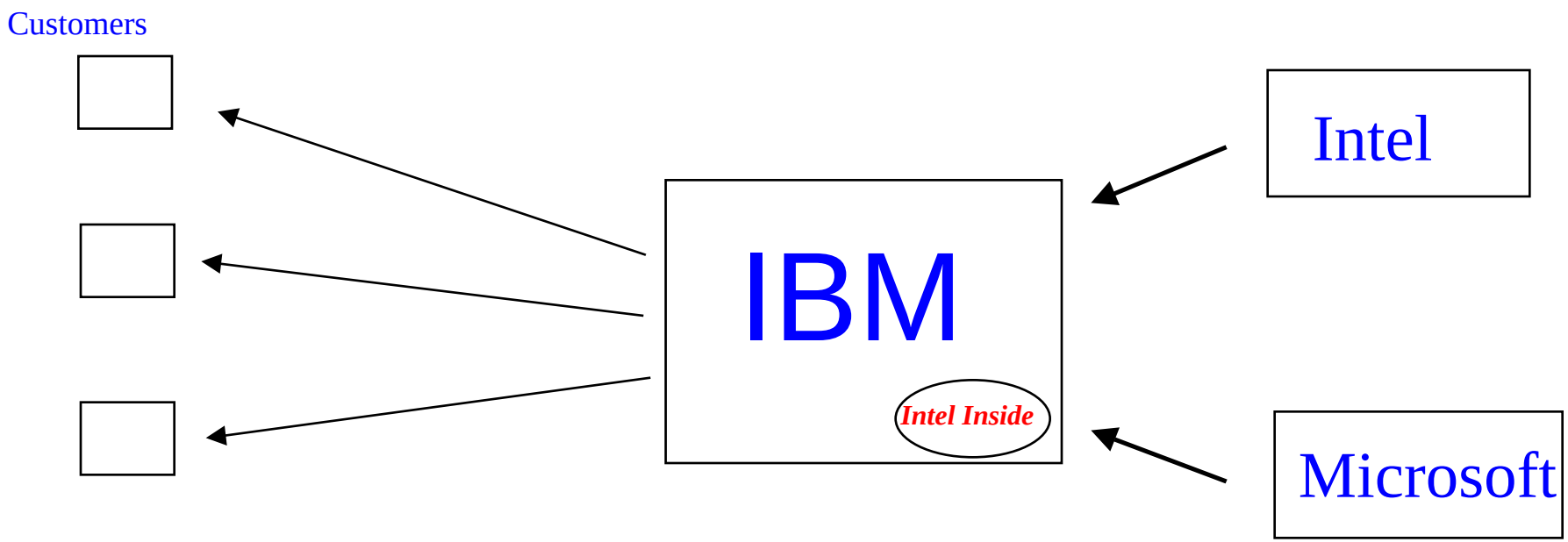
The Strategic Leverage of Supply Chain Design:

Who let Intel Inside?

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



The Outcome:

A phenomenonally successful product design

A disastrous supply chain design (for IBM)

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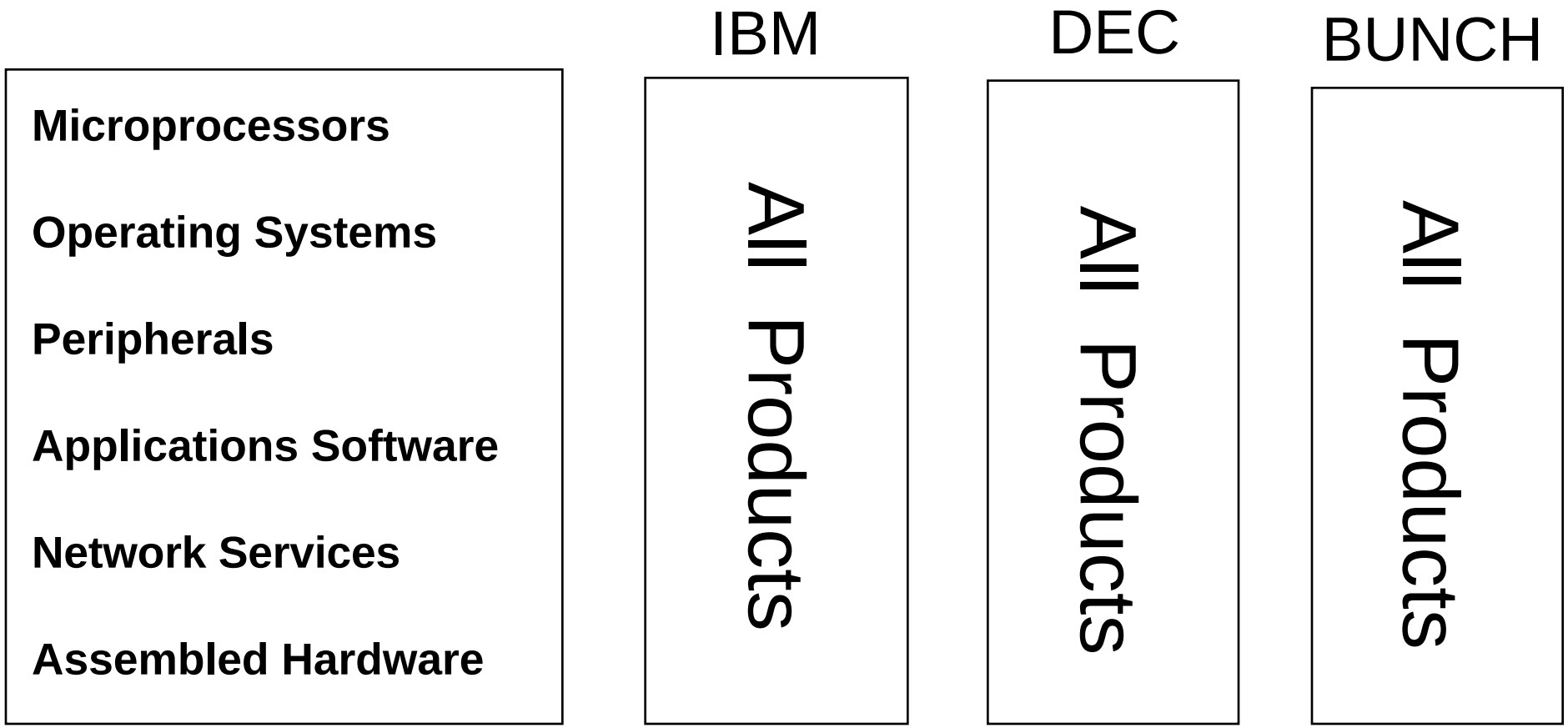
Vertical Industry Structure with *Integral* Product Architecture

Computer Industry Example, 1975-85



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

Horizontal Industry Structure

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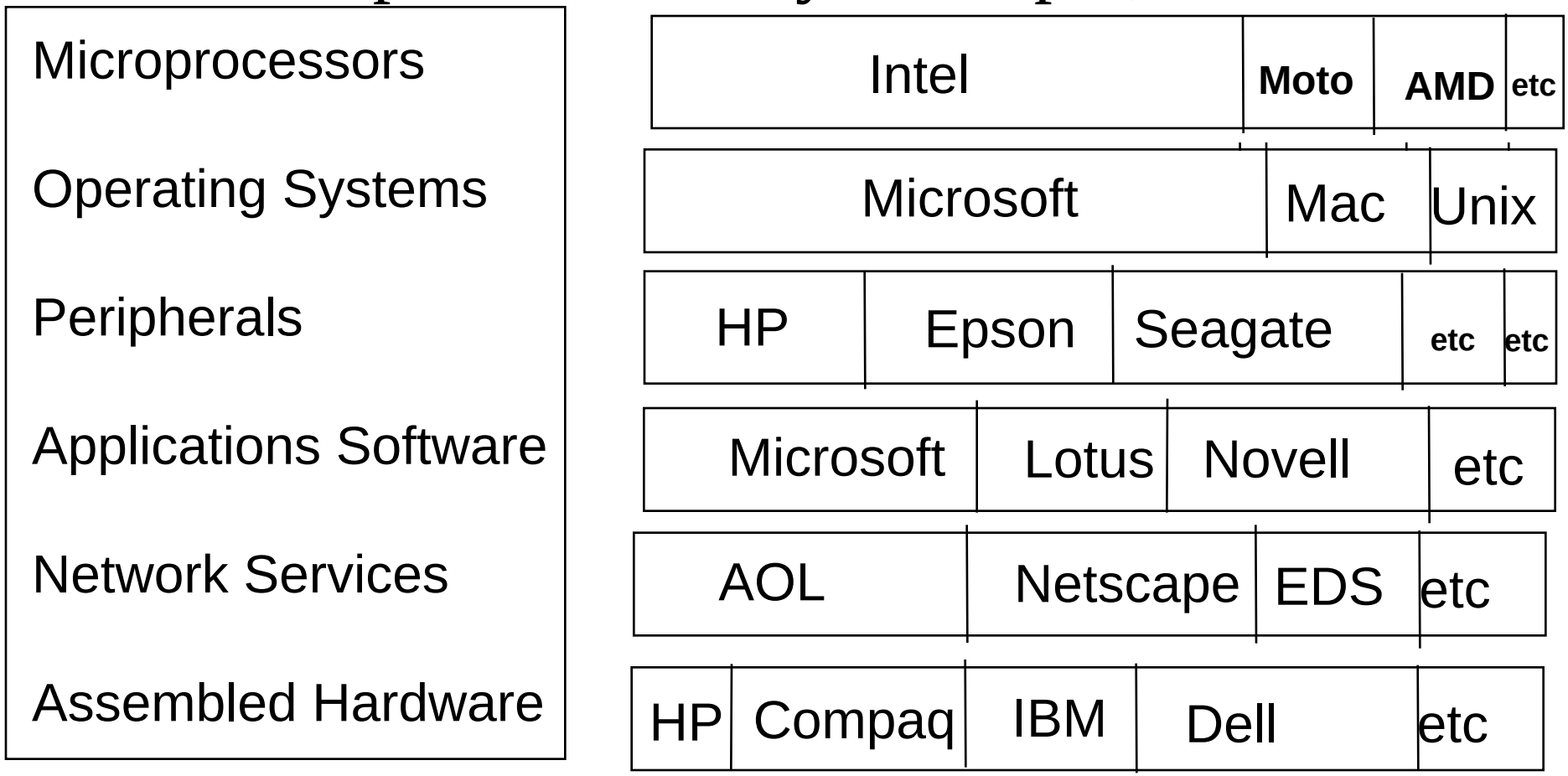
with *Modular* Product Architecture

Computer Industry Example, 1985-95



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

THE DYNAMICS OF PRODUCT ARCHITECTURE AND INDUSTRY STRUCTURE:

THE DOUBLE HELIX

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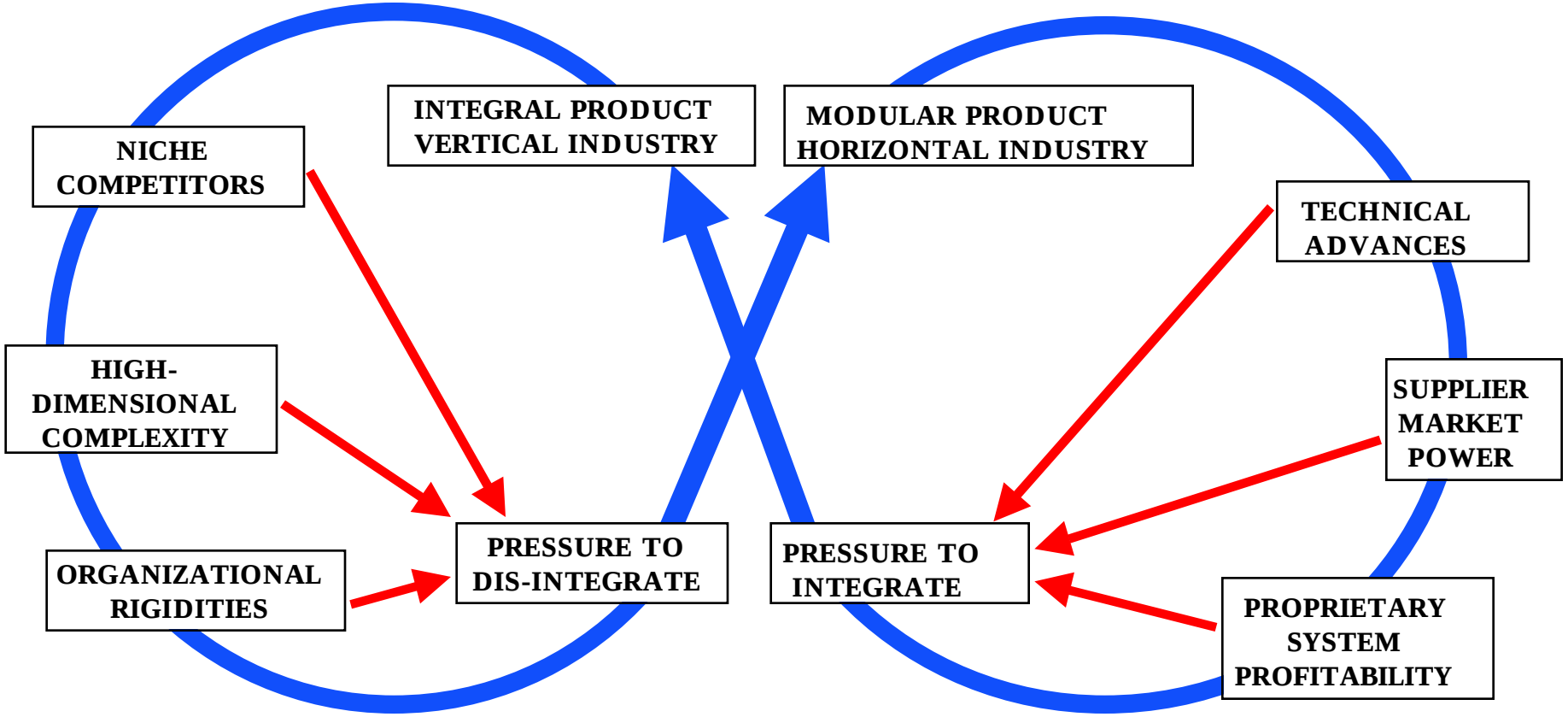

Fine & Whitney, "Is the Make/Buy Decision Process a Core Competence?"

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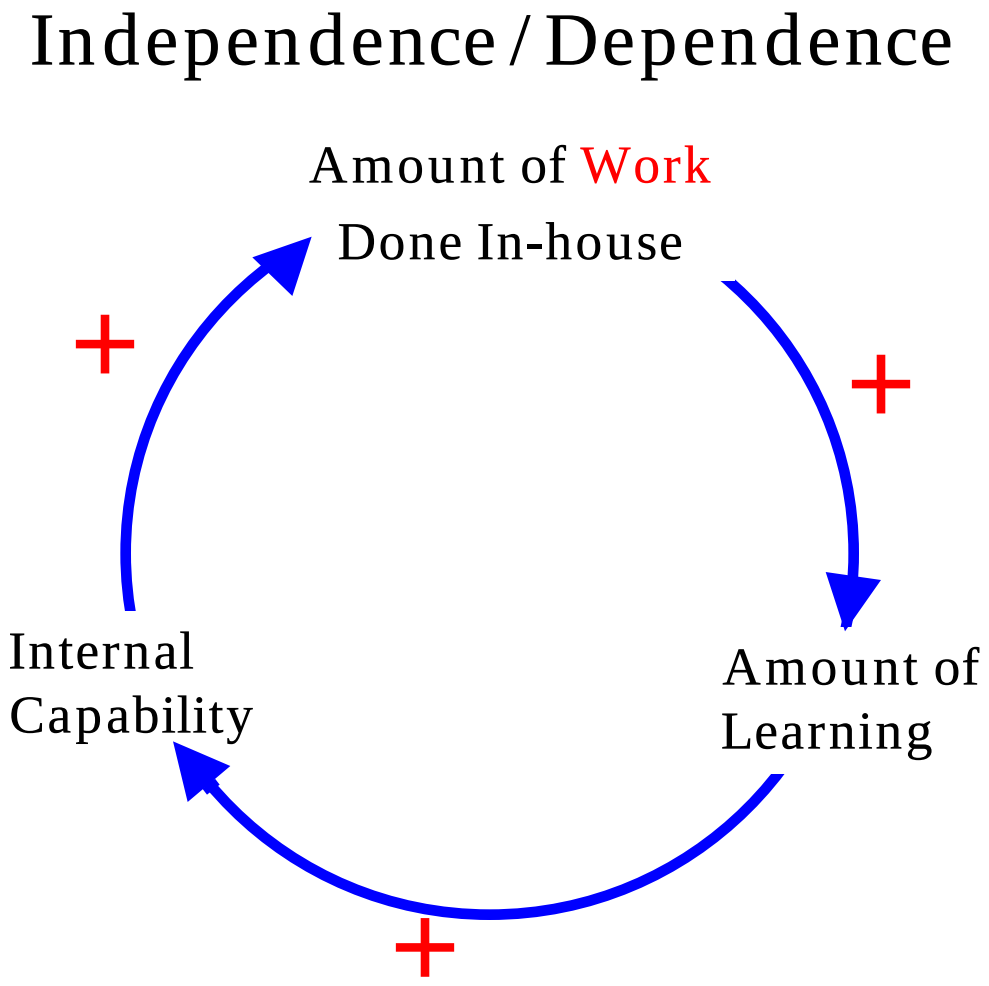
In/Outsourcing: Sowing the Seeds of Competence Development & Location

1. In/Outsourcing generates **dependence for knowledge** or **dependence for capacity**

2. In/Outsourcing determines the **location** of superior capabilities



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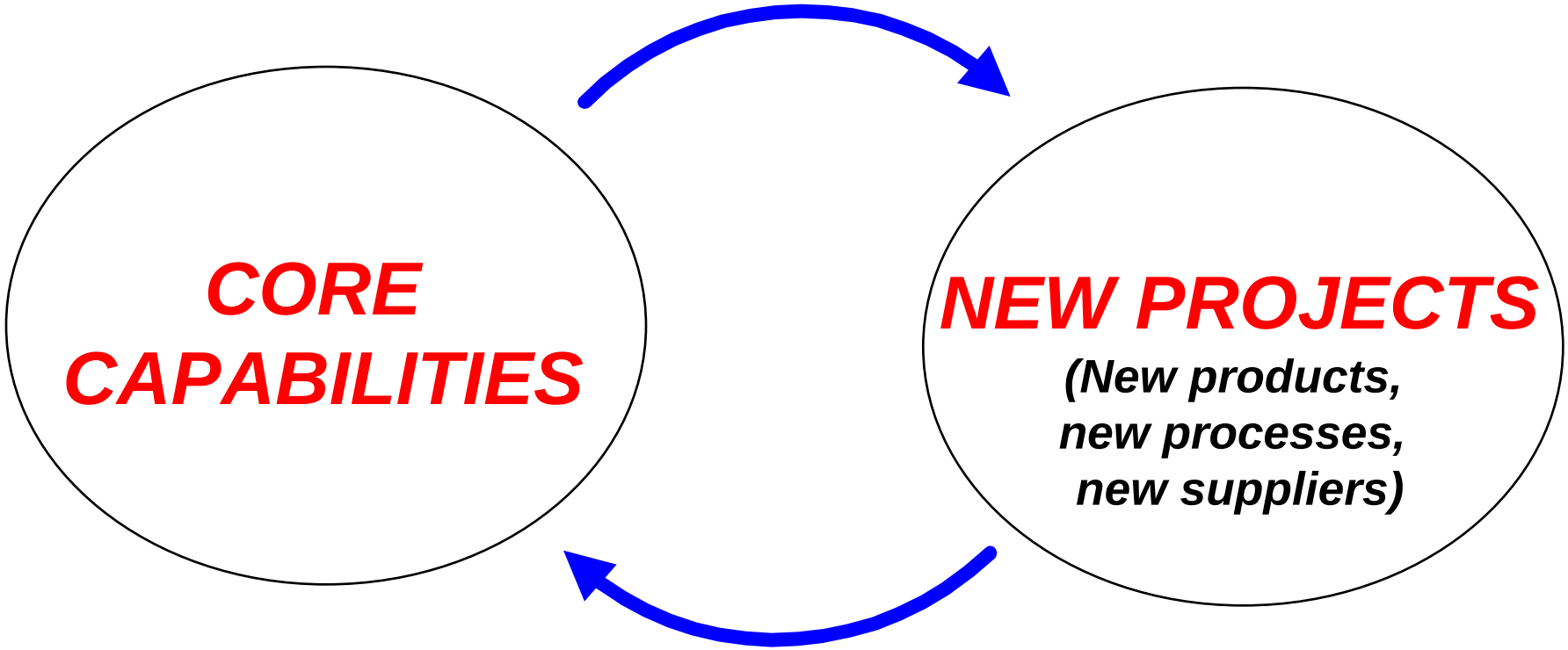
Dynamics between New Projects and Core Capability Development



Leonard-Barton, *Wellsprings of Knowledge*

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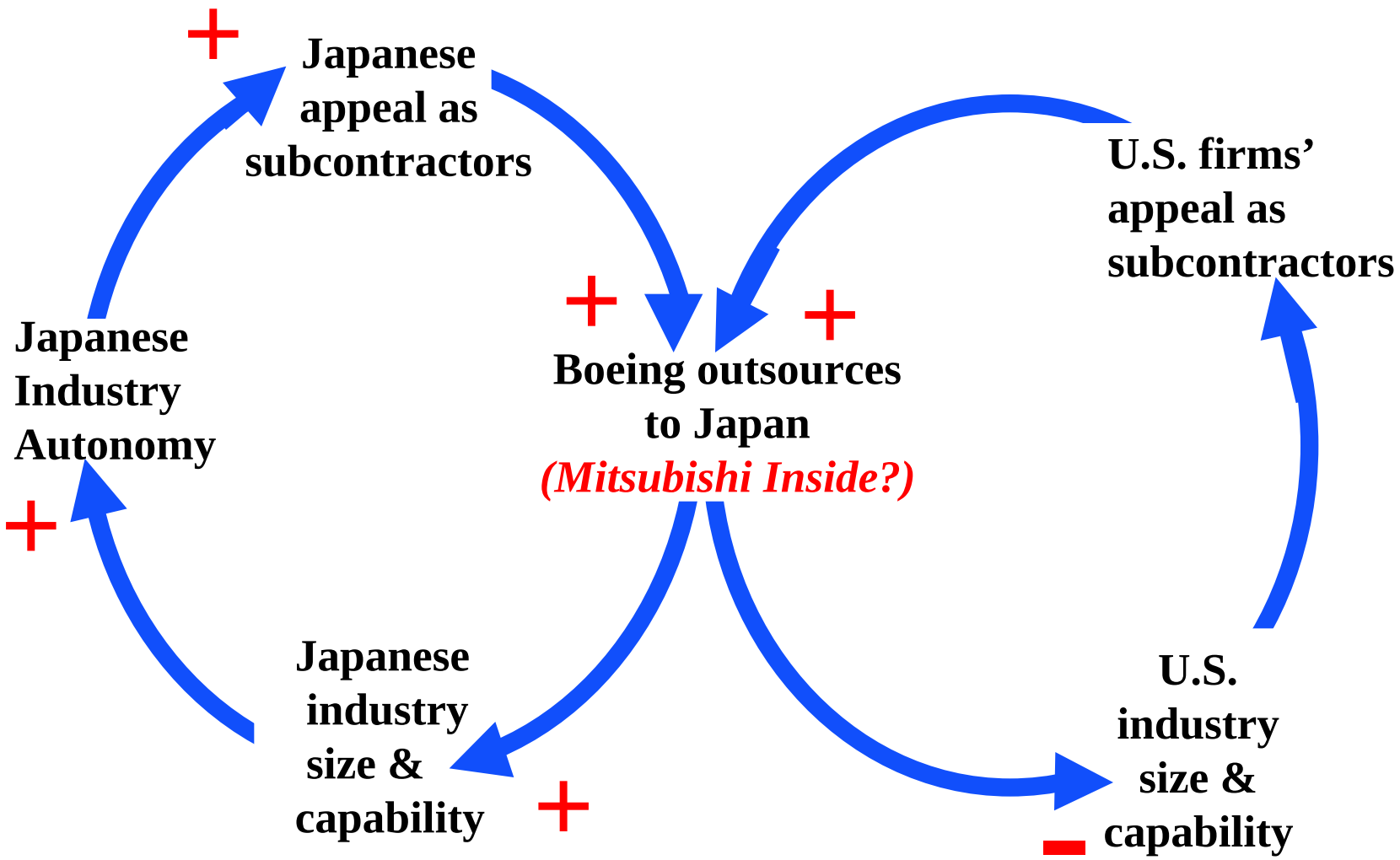
Technology Dynamics in Aircraft: Boeing, Japan Inc, and DoD



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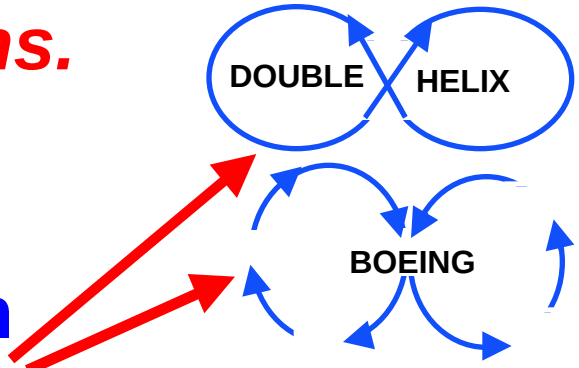
SUPPLY CHAIN DESIGN IS *THE* META-CORE COMPETENCY

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

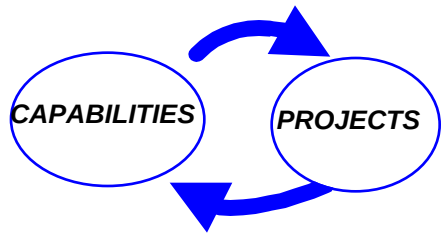


KEY SUB-COMPETENCIES:

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

2. **Anticipating Windows of Opportunity**

3. **3-D Concurrent Engineering:**
   Product, Process, Supply Chain



Fortune Favors the Prepared Firm

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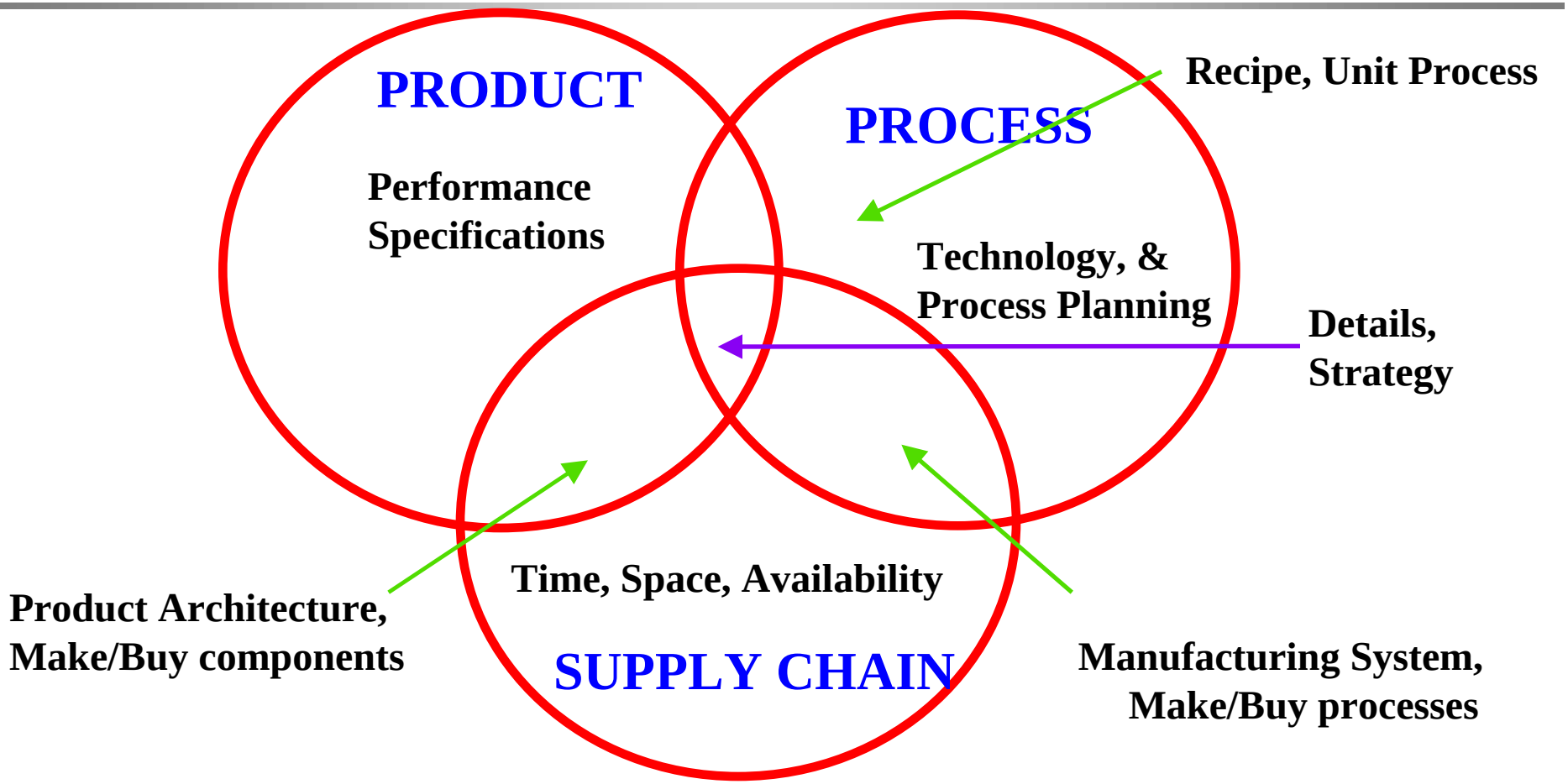
3-D CONCURRENT ENGINEERING



THE CHALLENGE:

TAKING PURCHASING OUT OF THE GHETTO

KEY CONCEPT FOR 3-D CE PRODUCT, PROCESS, AND SUPPLY CHAIN ARCHITECTURES

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

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

Modular architectures **feature separation among the elements**

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

PRODUCT ARCHITECTURE

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Integral product architecture:
principal components have multiple functions

- **Example: claw hammer head**
  (drives and removes nails)
- **Example: airplane wing**
  (provides air lift and holds fuel)
- **Example: motorcycle frame**
  (body structure, engine, gas tank)

Modular product architecture:
interchangeable components have single functions

- **Example: stereo systems**
- **Example: desktop personal computers**
- **Example: bicycles**

SUPPLY CHAIN ARCHITECTURE

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Integral supply-chain architecture
features close proximity among its elements

- **Proximity metrics: Geographic, Organizational Cultural, Electronic**
  - **Example: Toyota city**
  - **Example: AT&T and Lucent**
  - **Example: IBM mainframes & Hudson River Valley**

Modular supply-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**

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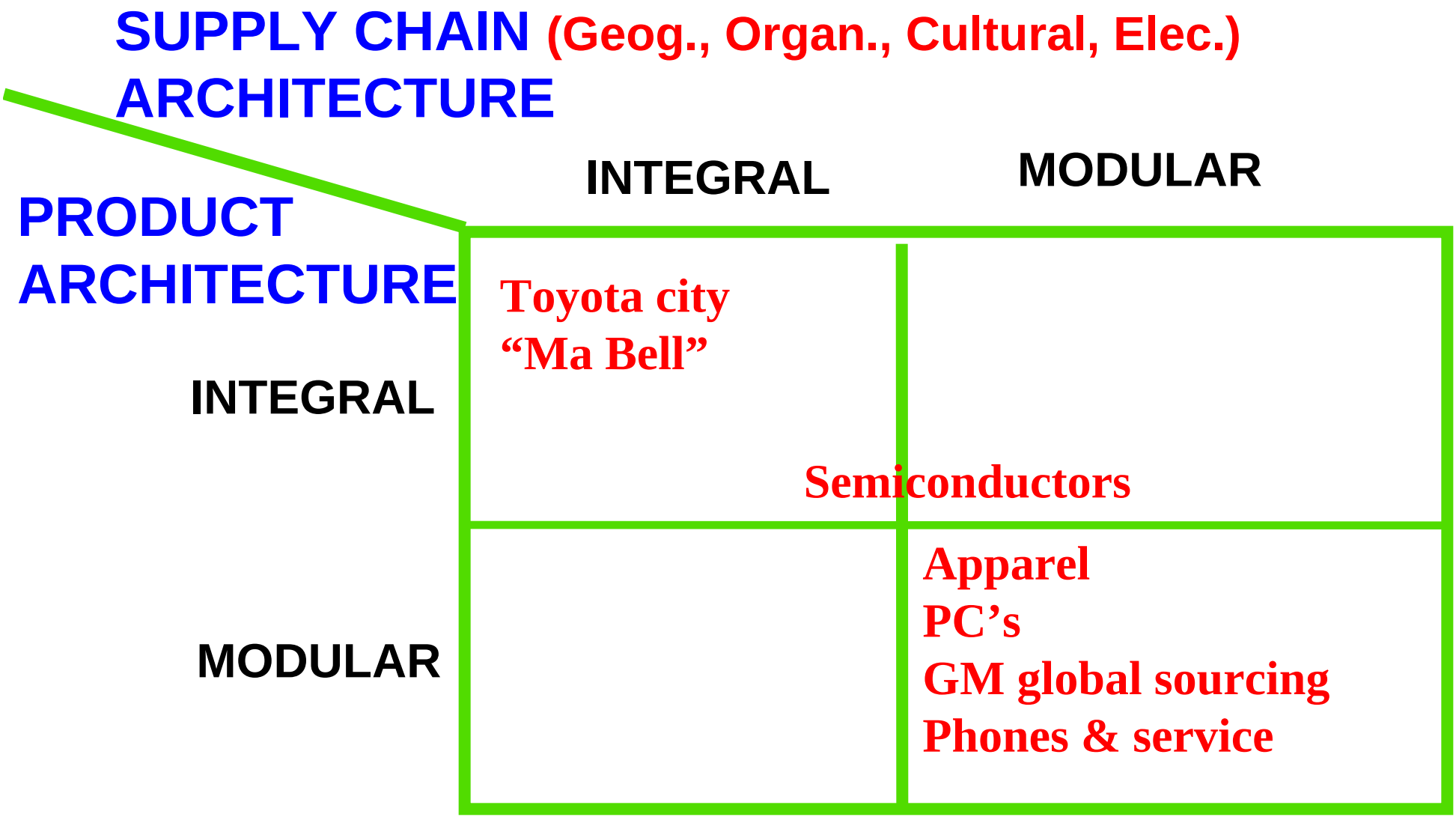
CONCURRENT ARCHITECTURE DESIGN FOR PRODUCT AND SUPPLY CHAIN

(Hypothesis: On Diagonal is statically optimal)



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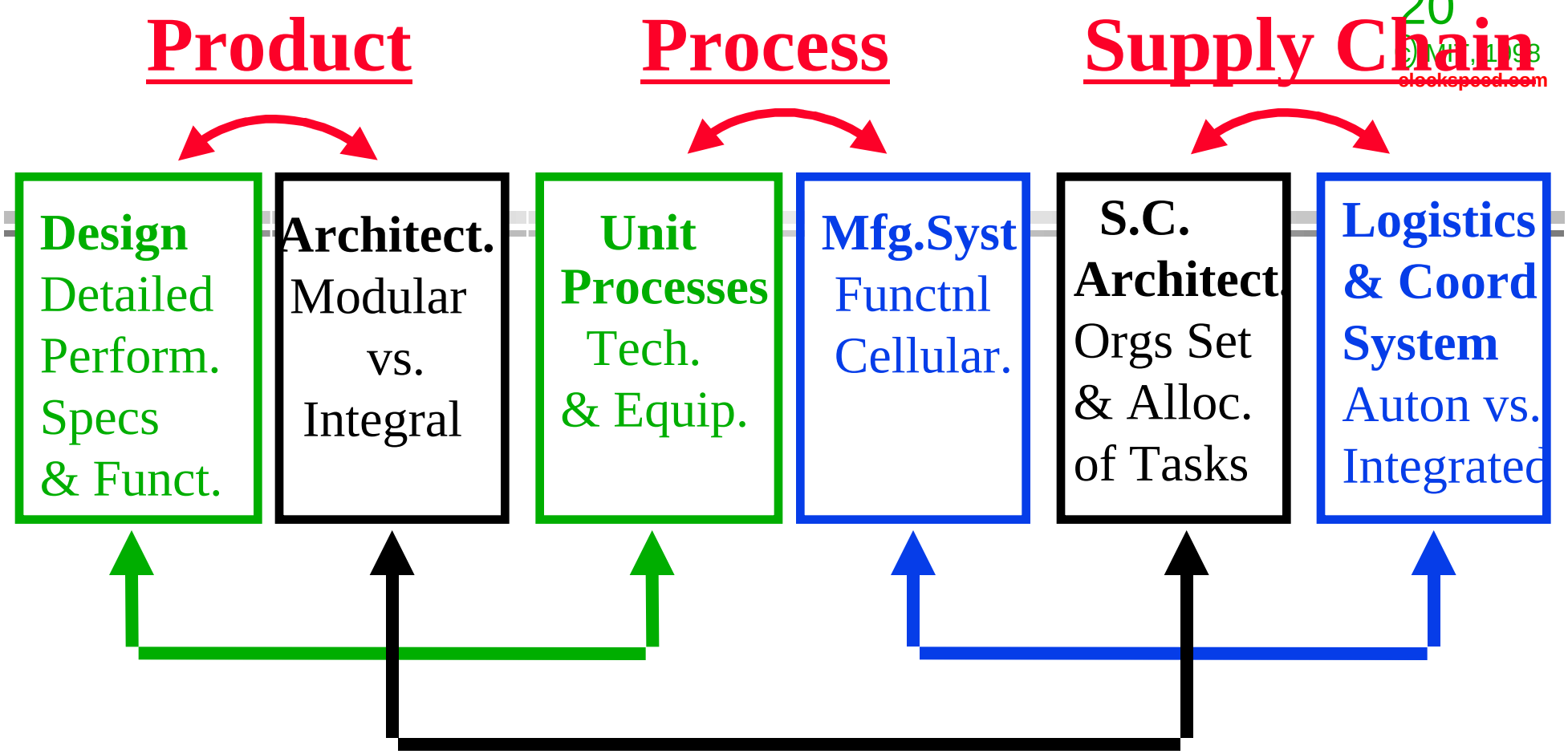
STRATEGY IN 3-D: CASE EXAMPLES

Boeing: Static 3-D in Plane Projects
Dynamic, Strategic Supply Chain,
unintegrated w/ Product & Process

Intel: Modular Product vs. Process
Integral Process and Supply Chain

Chrysler: Modular Product & Supply Chain
(weak on process?)

Toyota: Integral 3-D in Nagoya
(weak on global 3-D?)



- Focus
- Architecture
- Technology

A 3-D CE decision model illustrating the *imperative* of concurrency

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IMPLICATIONS

- **Firms**

  Supply Chain Design

  IS A STRATEGIC ACTIVITY, and

  SOME TOOLS ARE AVAILABLE:

  - CLOCKSPEED-BASED BENCHMARKING

  - 3-D CONCURRENT ENGINEERING

- **Sustainment**

  The slower the clockspeed, the longer the sustainment cycle, the higher the cost impact of (Three-Dimensional) Design for Sustainment

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IMPLICATIONS

- **Labor**

  There are significant returns to understanding the dynamics of capabilities & projects

- **Government**

  Supply Chain Design

  IS A STRATEGIC ACTIVITY, and

  SOME TOOLS ARE AVAILABLE:

  - CLOCKSPEED-BASED BENCHMARKING

  - 3-D CONCURRENT ENGINEERING