Is The Make/Buy Decision a Core Competence?

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Outline

I. Necessity of outsourcing, importance of supply webs
II. Generic nature of the outsourcing process
III. Formalization of this process
    foundation in system engineering
    two kinds of dependency
    definition of “outsourcability”
IV. Examples
V. Conclusions

Vertical Integration Used to be Good

- Now, outsourcing is good
- Outsourcing creates dependencies
- Knowledge has to be managed up and down the supply chain
- Most companies do not understand the requirements for smart outsourcing and do not appreciate the risks

Drivers of Make-Buy

- “Cost”
- others...

- Are there risks?

Dependency and Outsourcing

- Modern products are so complex that no company has all the skills needed
- Companies are dependent on each other for many crucial things - and some are even proud of it!
- Make/buy decisions are made for both **product components** and for "**manufacturing infrastructure**": machines, CAD, MRP

Four Stories

- Manufacturing managers unable to design a toy assembly line
- Switching suppliers for a “washer”
- HWP discovers what laid-off managers were doing (Ed Anderson and Geoff Parker: **From Buyer to Integrator: The Transformation of the Supply-chain Manager in the Vertically Disintegrating Firm)**
- Shifting jobs to Mexico generates 1000% overhead

Can We Make These Cars?

Customer Demand / Per Shift:
One Shift = 6 min.

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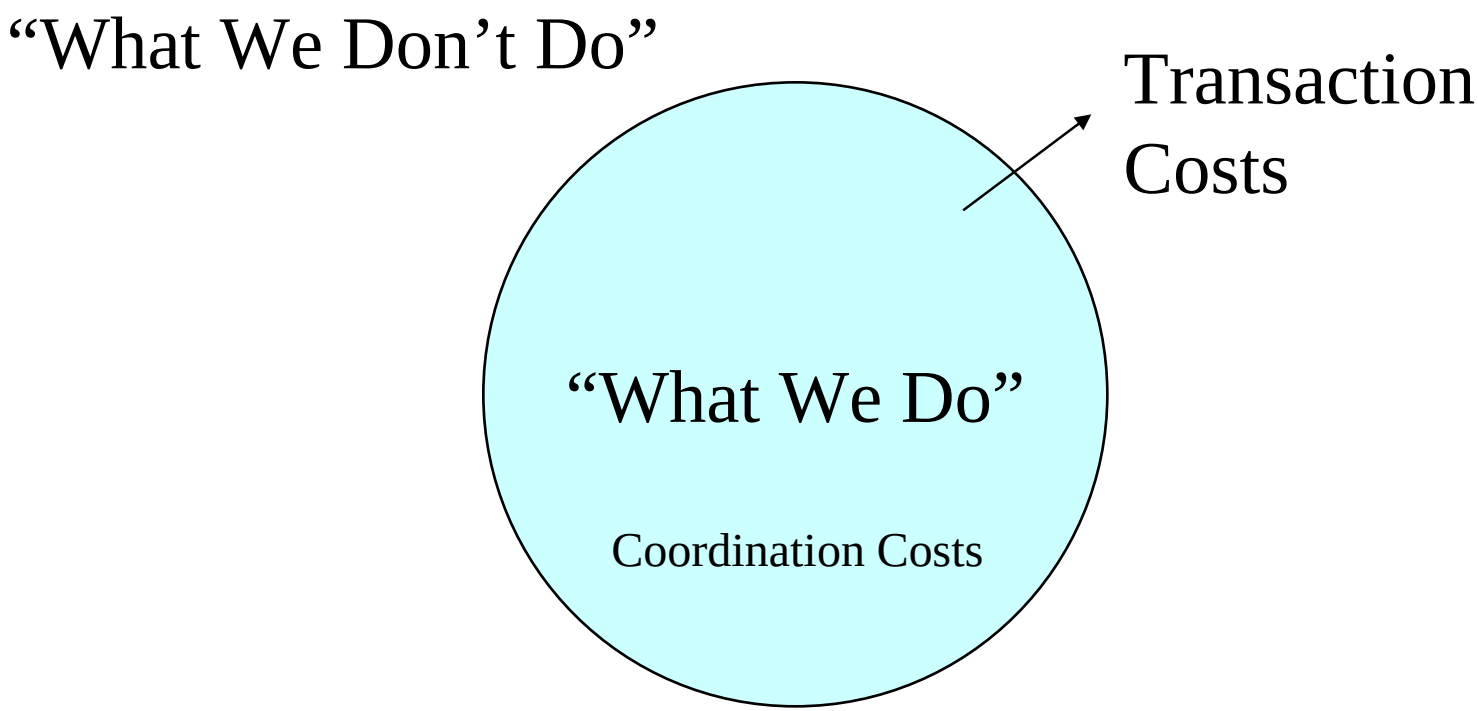
Sedan	Semi	Race car	Truck
6	2	2	2

Theory of the Firm



Two Views of the Make-Buy Dilemma

"You learn by trying not by buying."

- Product/process integration
- First access to new technology
- Keep new methods from leaking out
- "Mastery itself is the prize"

"Our business is cars, not robots."

- The US has a robust vendor base
- There is economy of scale
- Can capitalize on vendors' learning
- Focus on the core business

It is not obvious who is right.

Outsourcing and Architecture

- Product architecture and outsourcing interact
  - interfaces must be defined and managed
- Architecture of supply chain must correspond to architecture of product (C. H. Fine)
- Many criteria influence choices of architecture which in turn influence outsourcing options and problems
  - System integration
  - Design and manufacturing methods
  - Power management
  - Politics
  - Knowledge management

Integral and Modular Architectures

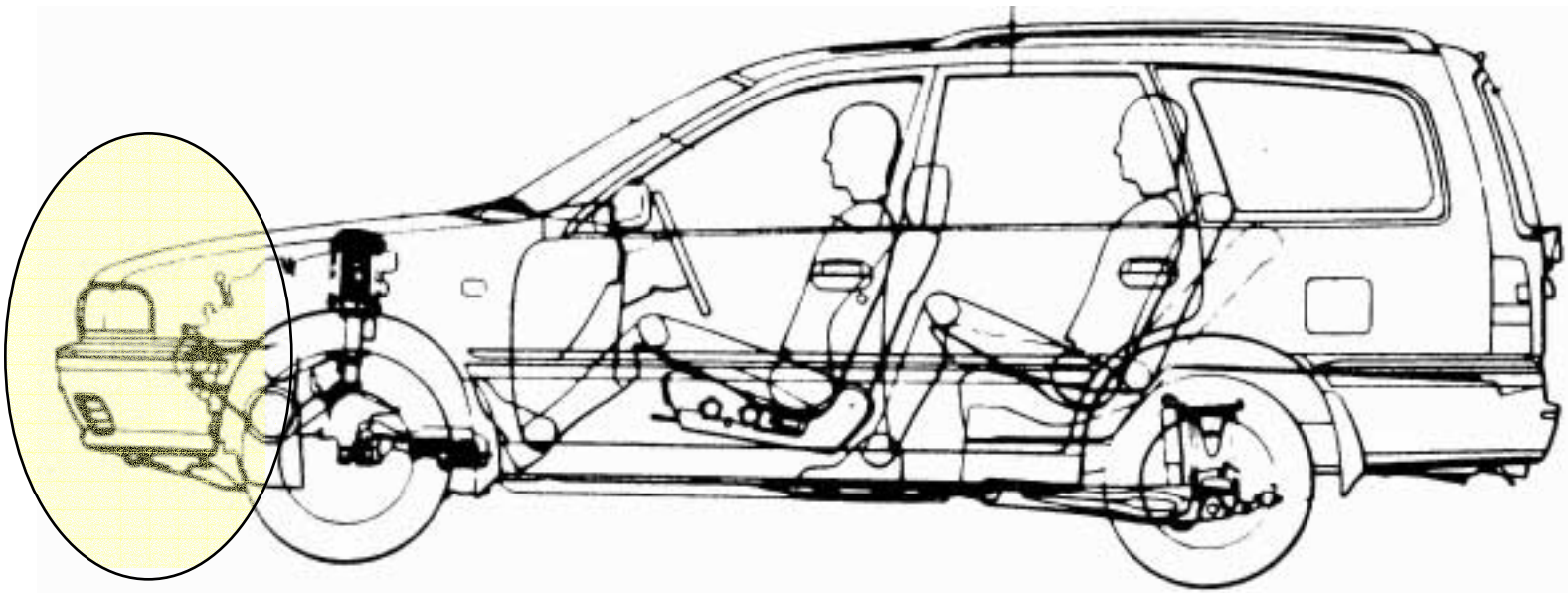
- Integral = functions shared by physical elements
- Examples...
- Some reasons integral is used...

- Modular = each function is delivered by a separate element
- Examples...
- Some reasons modular is used...

Is either kind of architecture “better” than the other?
Or are all architectures more or less integral?

Three Kinds of Modules

Module by design (could be a coherent system)
Module by manufacture (could be a connected set of parts)
Module by use (could contain user functions)
(Baldwin and Clark, “Design Rules”)



Front module contains parts of several systems

Product and Organizational Architectures

- Rear wheel drive IC engine car
  - Engine dept, transmission dept, brake dept, ABS dept, packaging dept
- Electric car with one motor and transmission
  - Motor dept, transmission dept, brake dept, ABS dept, packaging dept
- Electric car with motor at each wheel
  - Motor(s) dept, *no* brake dept, ABS dept merged with computer dept
  - "Don't even tell them about that, they'll throw you out"

Airbus: Architecture Driven by Politics

- Airbus Industrie is a consortium that shares revenue and profits according to a work-content formula
- This formula is based on a decomposition of the plane
  - wings to British Aerospace
  - fuselages to Deutsche Aerospace (DASA)
  - tail sections to CASA (Spain) (now owned by DASA)
  - final assembly and integration to Aerospatiale
- The A380 is a challenge
  - The wings will be too big to transport to Toulouse by air
  - No land in Hamburg for final interior dressing
  - Final decision: truck to river, onto barge, to Bordeaux, truck again to Toulouse

An Emerging Trend

- In many industries, first tier suppliers are starting to consolidate ("tier 0.5"), horizontally integrating and technically deepening
- The source of their growing power is their ability to create "coherent systems" and exploit synergies
  - Brakes and chassis control systems in cars
  - Industrial gas, liquid, and power systems in chip factories
  - In some cases, these systems reach up to the customer directly
- OEMs focus more on customer needs and think tier 1 and below are just "manufacturers" or suppliers

The Car Is a Collection of High-Technology Systems

Customer satisfaction is provided by these systems

MANAGEMENT
- SAFETY
- ENERGY
- OPERATIONS

POWER TRAIN
- ENGINE
- TRANSM
- FUEL
- EMISSIONS

COMMUNICATION AND CONTROL
- INTERNAL
- EXTERNAL

AMBIENCE
- ENTERTAINMENT
- COMFORT

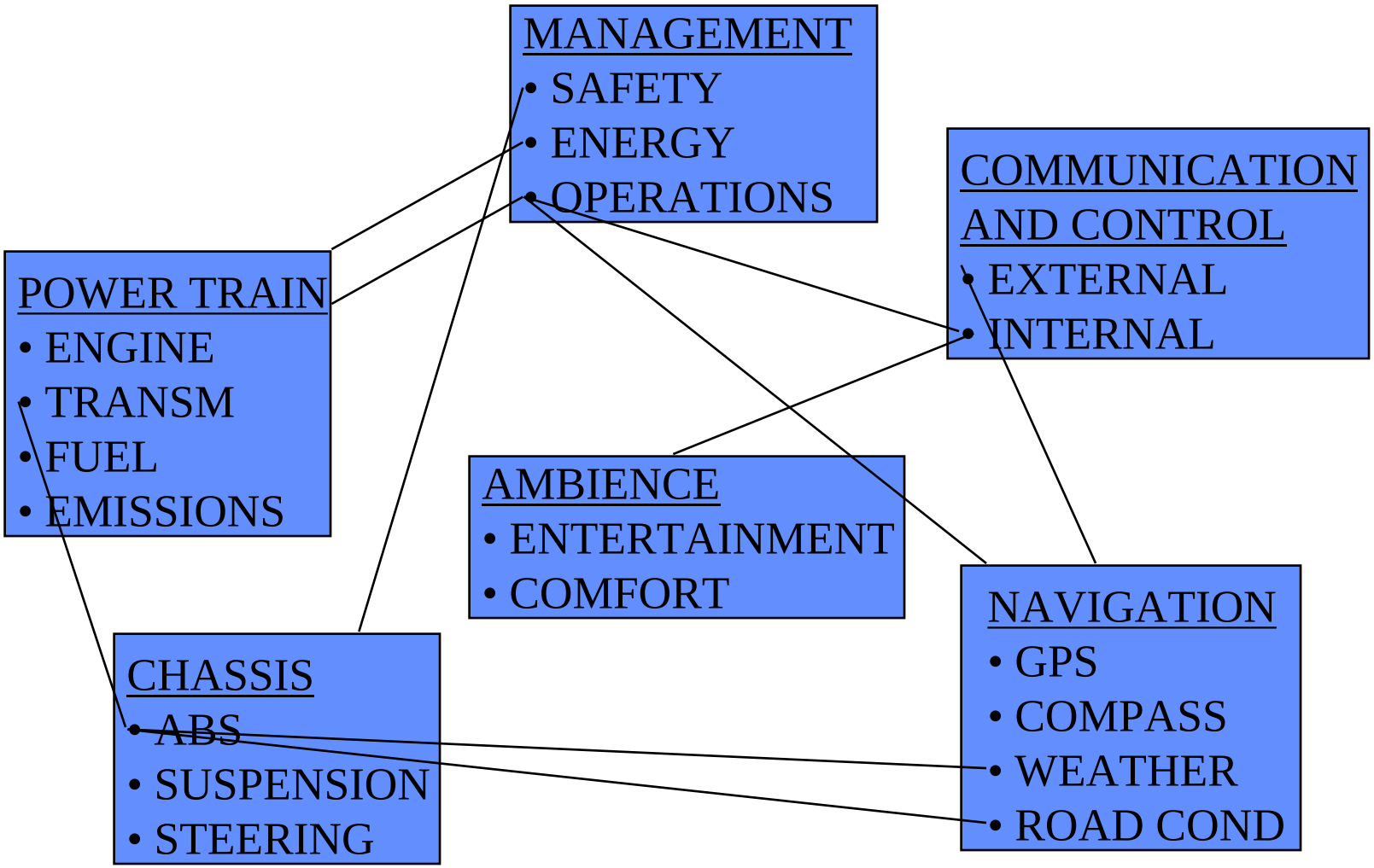
CHASSIS
- ABS
- SUSPENSION
- STEERING

A car is a self-mobile cordless computer network with peripherals like engine block, seats, glass, etc.

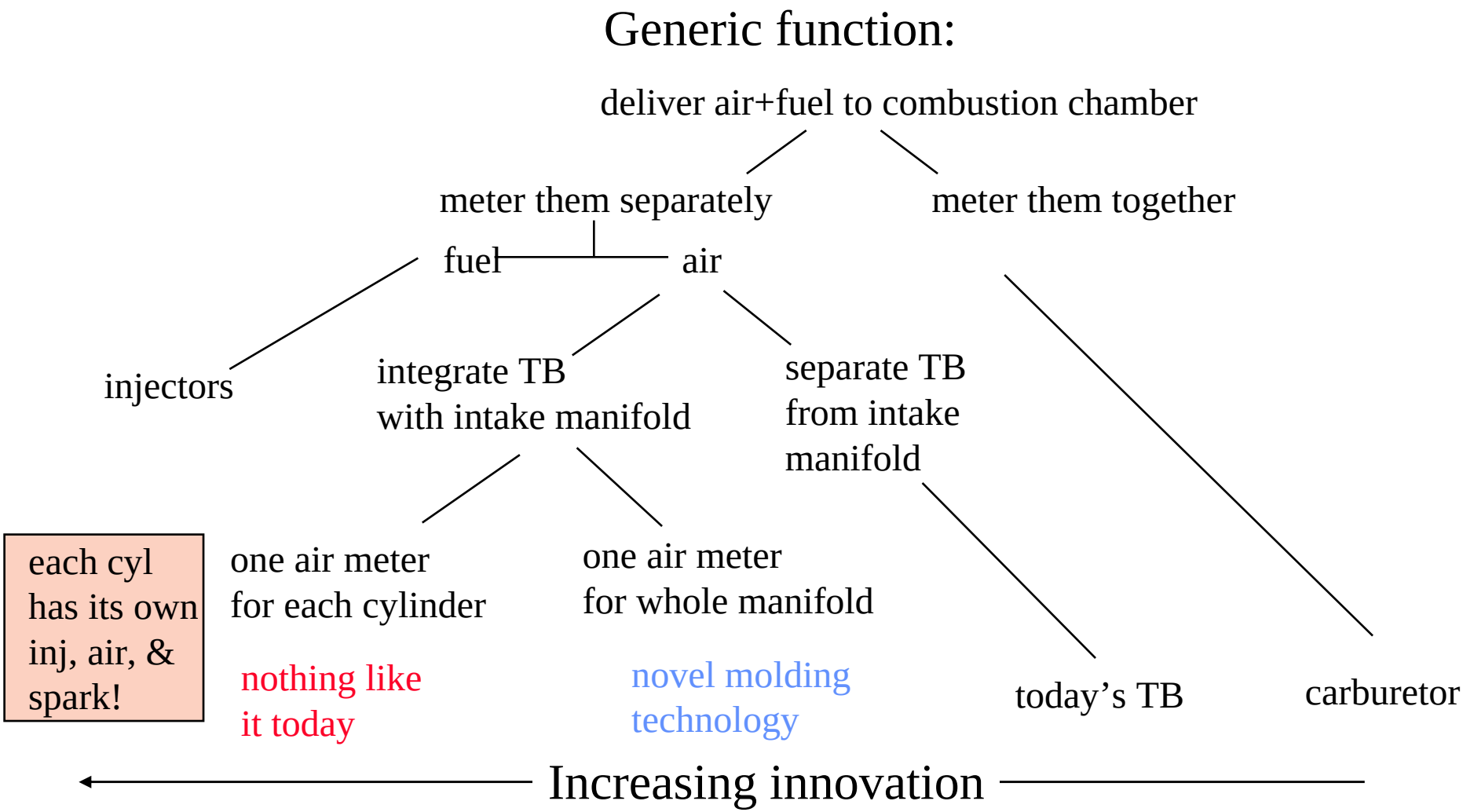
NAVIGATION
- GPS
- COMPASS
- WEATHER
- ROAD COND

These Systems are Highly Interlinked

NOTE: THERE ARE MANY LINKS INSIDE EACH BOX!



Different Architecture Brings Different Outsourcing Options and Restrictions

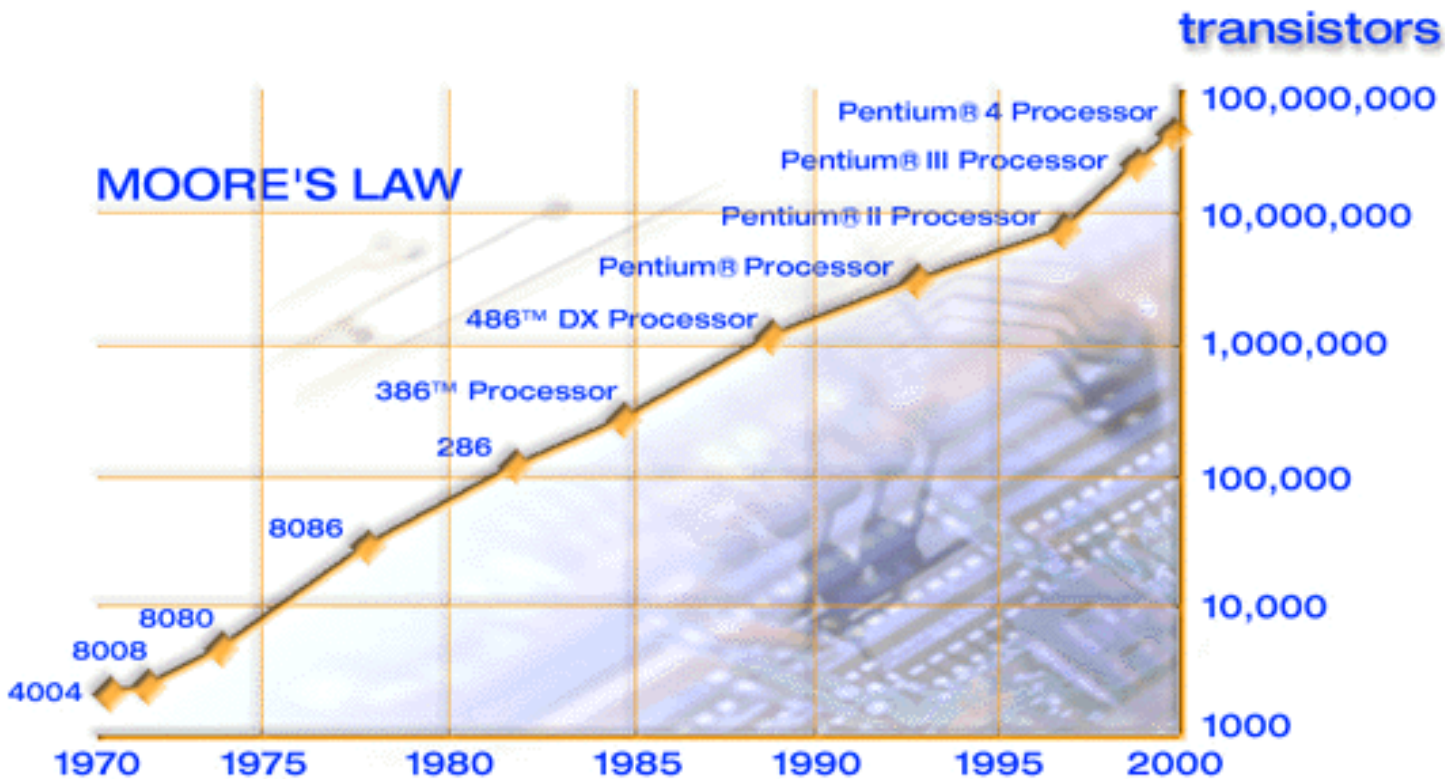


Integration Driven by Power

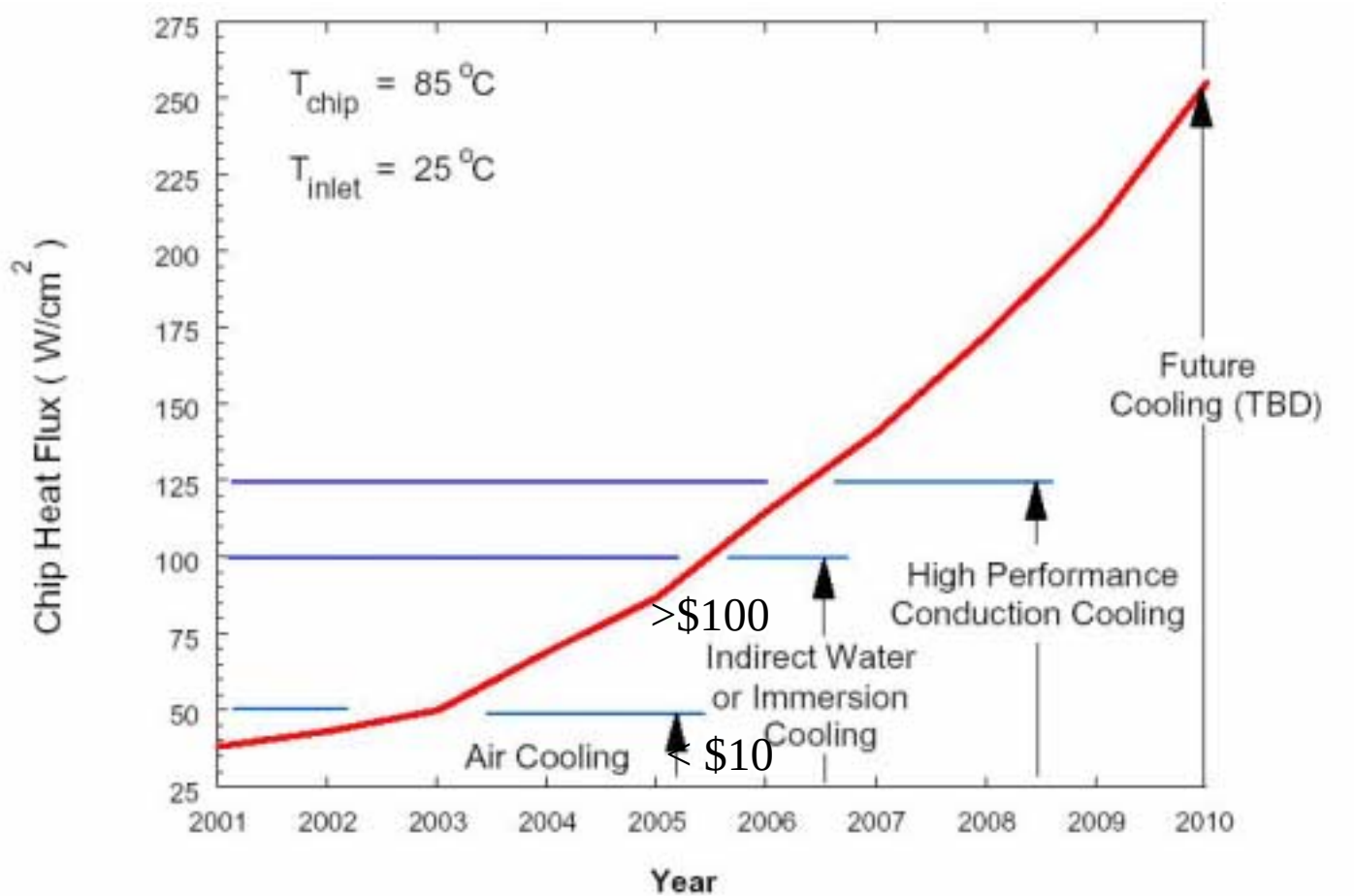
- Whitney's theory says high power drives integration*
- Moore's Law drives rise in heat generated in CPUs
- Cost of managing heat has reached economic limit
- Evidence that it is happening (Intel):
  - Patents on fans
  - Investments in software and heat transfer solutions
  - Close cooperation with PC designers
  - Major shift in marketing strategy to de-emphasize processor speed
  - Ref: SDM Thesis by Sam Weinstein, March 2004

*"Why Mechanical Design Cannot be Like VLSI Design," *Research in Engineering Design*, 1996 (8), pp 125-138

Moore's Law


transistors
MOORE'S LAW
Pentium® 4 Processor
Pentium® III Processor
Pentium® II Processor
Pentium® Processor
486™ DX Processor
386™ Processor
286
8086
8080
8008
4004
100,000,000
10,000,000
1,000,000
100,000
10,000
1000
1970
1975
1980
1985
1990
1995
2000

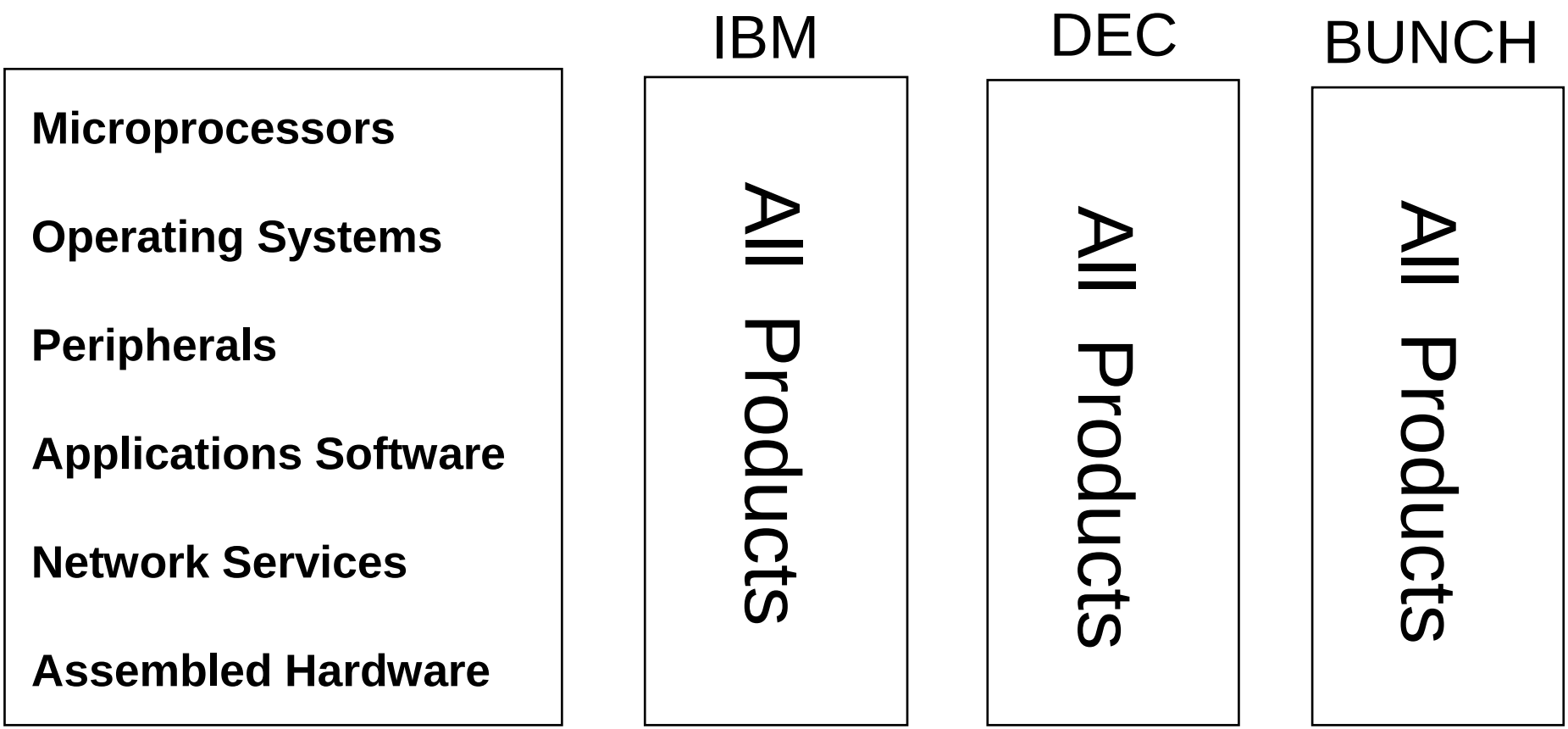
Cost of Thermal Management



Vertical Industry Structure Driven by Technology

with *Integral* Product Architecture

Computer Industry Example, 1975-85

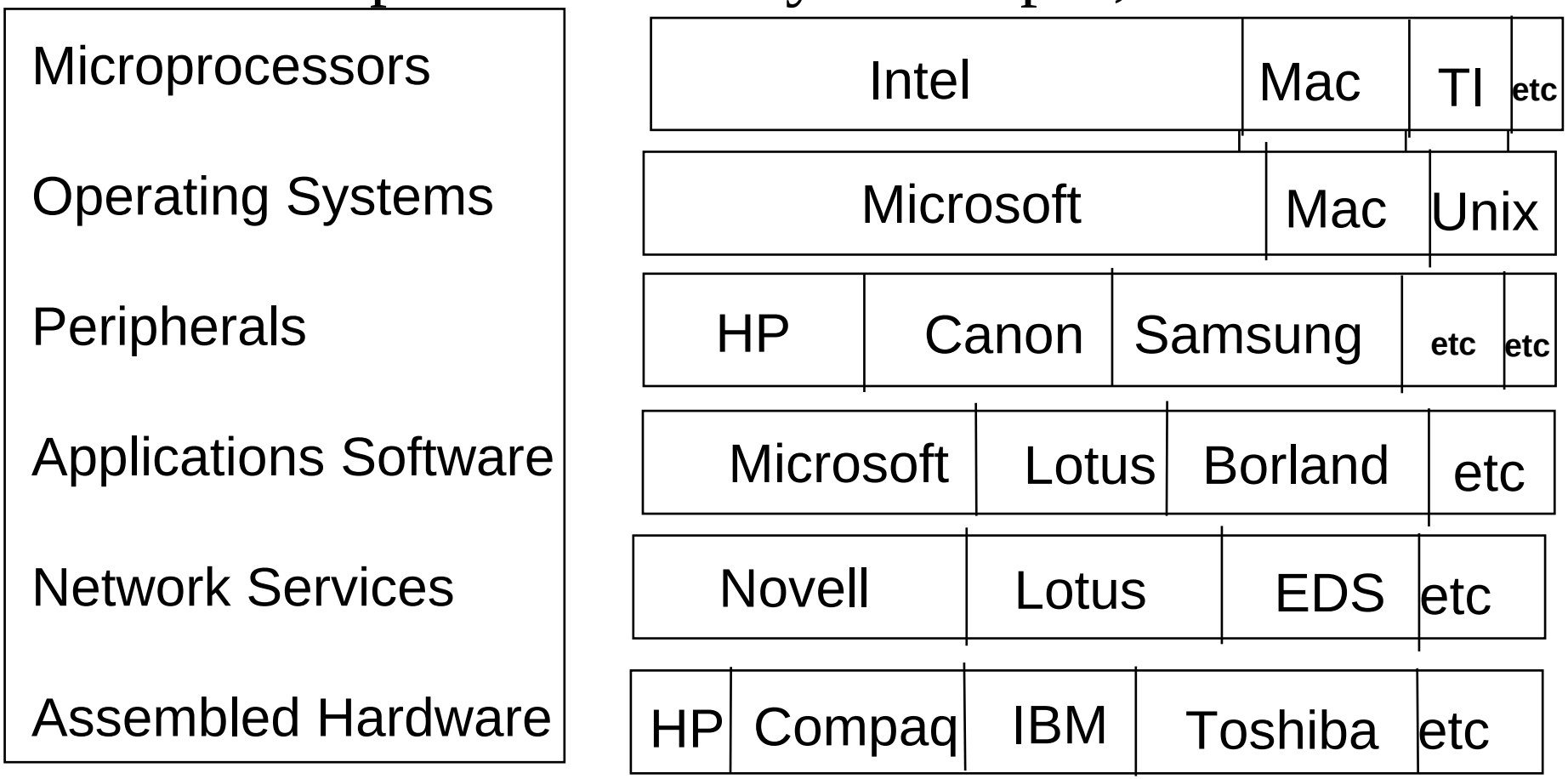


(A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

Horizontal Industry Structure Reshaped by Technology and Standards

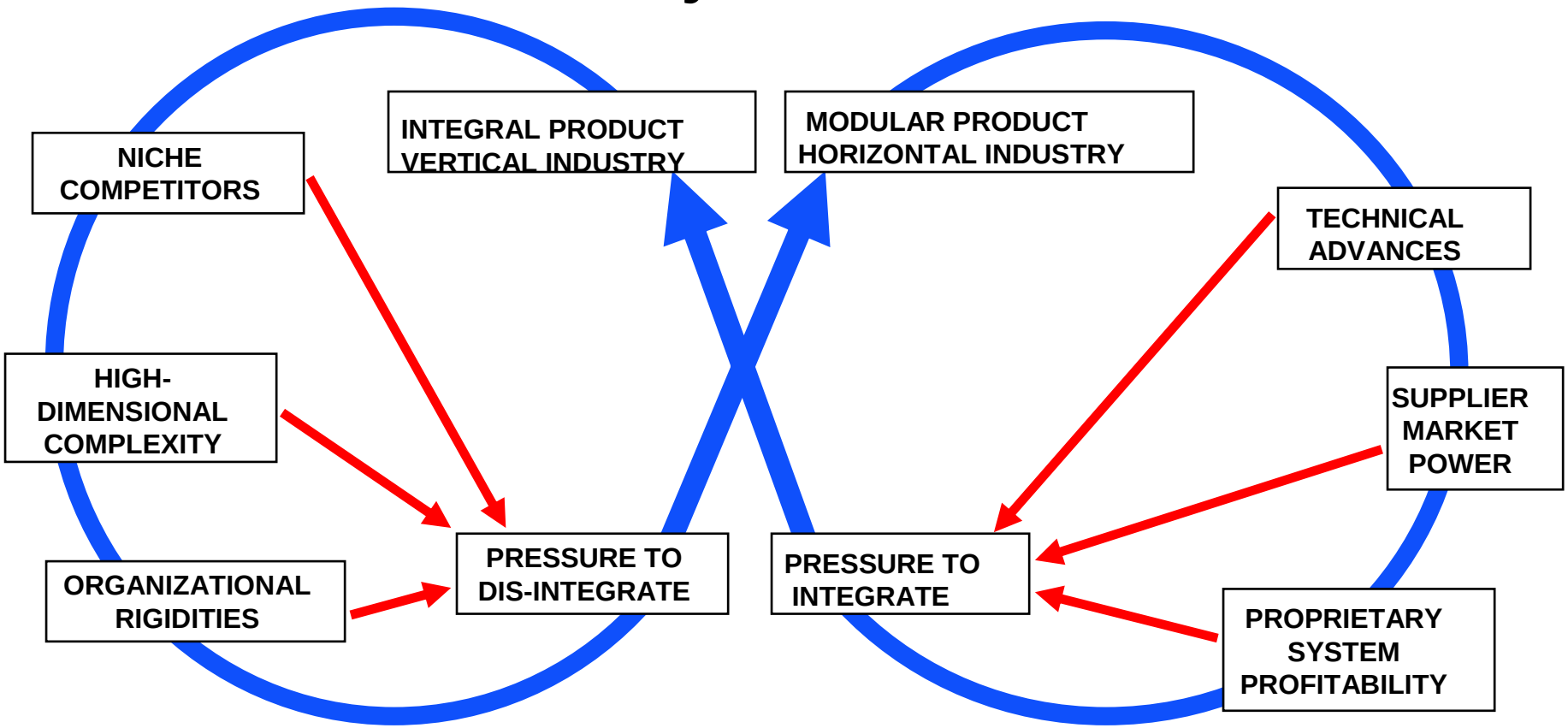
with *Modular* Product Architecture

Computer Industry Example, 1985-95



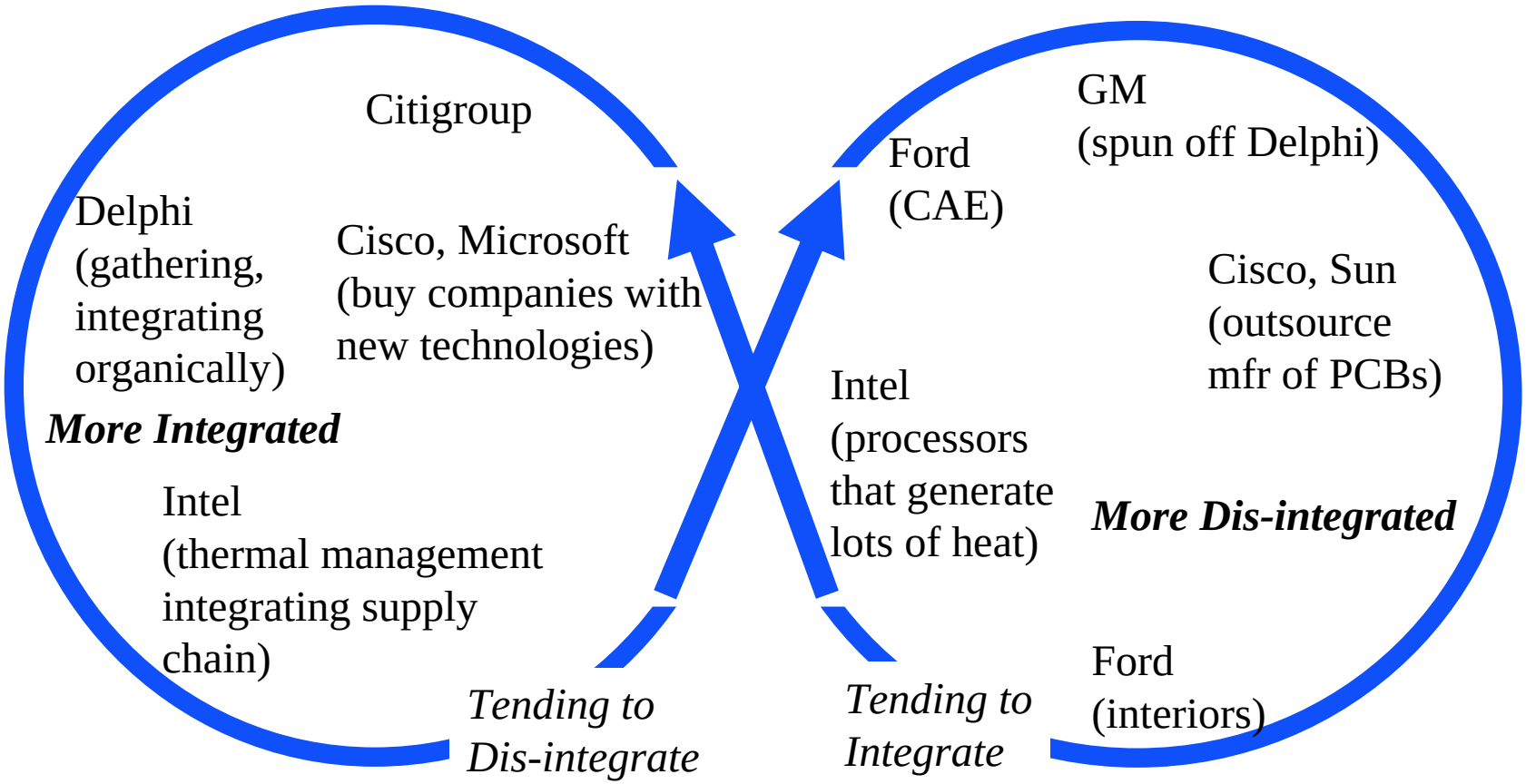
(A. Grove, Intel; and Farrell, Hunter & Saloner, Stanford)

The Double Helix: The Dynamics of Product Architecture and Industry Structure



Christensen "The Drivers of Vertical Disintegration" HBS working paper, Oct 1994
Fine & Whitney, "Is the Make/Buy Decision a Core Competence?" MIT Working Paper, March 1995

Recent Examples



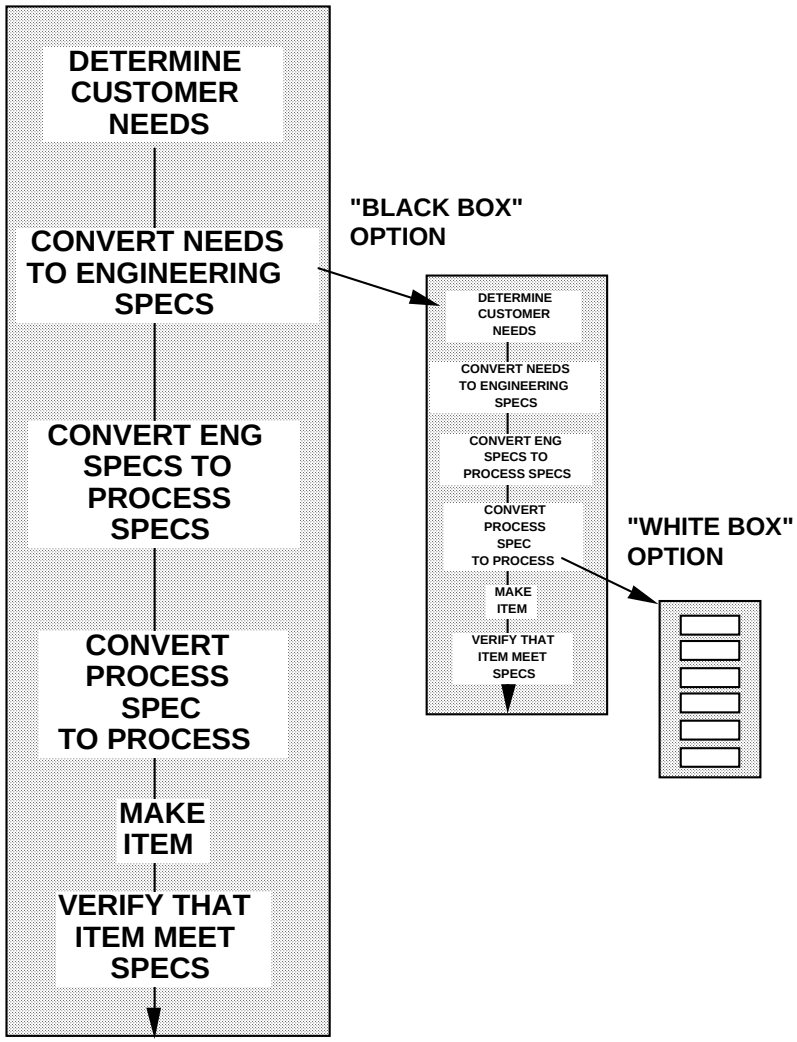
Summary

- Outsourcing relates to
  - knowledge and learning
  - dependency and power
  - organization
  - system coherence
  - *architecture*
- Products, organizations, supply chains, and industries have architectures
- Architecture is volatile

Make-Buy Frameworks

- Link make-buy to system engineering
- Link make-buy to product architecture
- Classify dependencies that make-buy could create
- Combine these ideas into a framework for assessing make-buy decisions
- Place some of our examples in the framework
- Sum things up

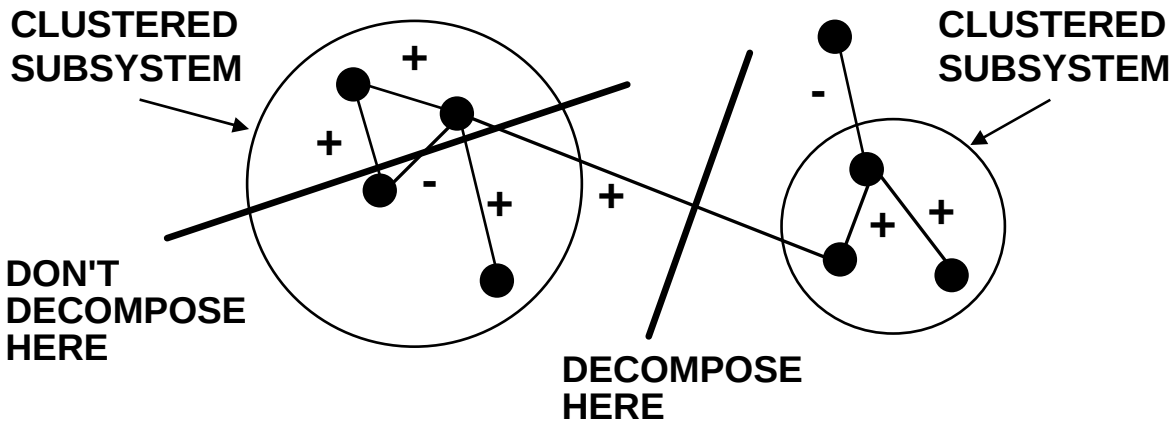
The Product Development Process



At each stage:

- Break down into sub-systems
- Write specifications
- Seek “sources” and choose
- Transmit spec
- Obtain item
- Verify compliance with spec
- Both “customer” and “source” could be internal or external
- Either way, the process and skills are the same

Principles of System Engineering



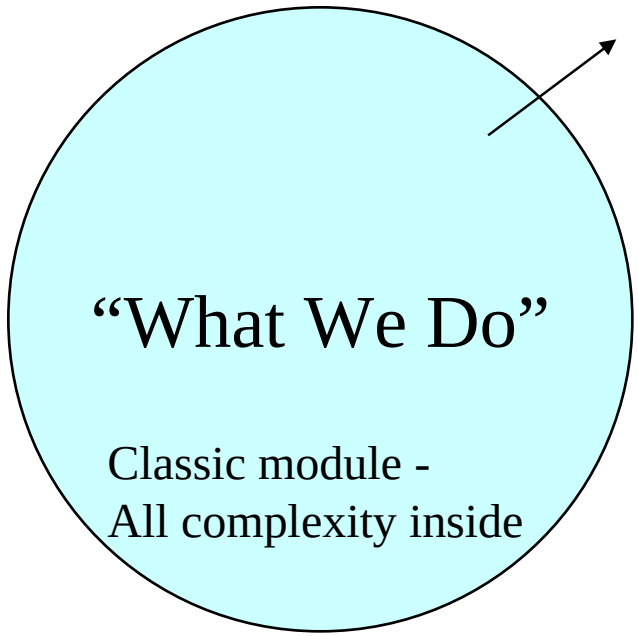
Make subsystems from things that are tightly related

Keep relations between subsystems simple, few, and easy to define

Alexander, C. “Notes on the Synthesis of Form,” Harvard University Press, 1964
Rechtin, E., “Systems Architecting,” Prentice-Hall, 1991

Theory of the Firm's Relation to Modularity

"What We Don't Do"



Transaction Costs - managed by keeping interfaces simple and clear via interface docs called contracts

Design = Outsourcing = System Engineering

Design	Outsourcing	System Engineering
Determine requirement	Determine need	Determine top requirement
Break into sub-requirements	Write spec	Break into subreq’mts
Find someone to fill req’mt	Find someone to fulfill spec	Assign subreq
Assess fulfillment	Assess fulfillment	Assess fulfillment

Make-Buy Criteria

1. Buy what you can't make (necessity)
2. Buy what someone else makes cheaper (low bid)
3. Buy what someone else makes better (opportunity)
4. Make what matters most to the customer (visibility)
5. Make what matters most to the technical memory of the company (strategy)

Condense to two choices:

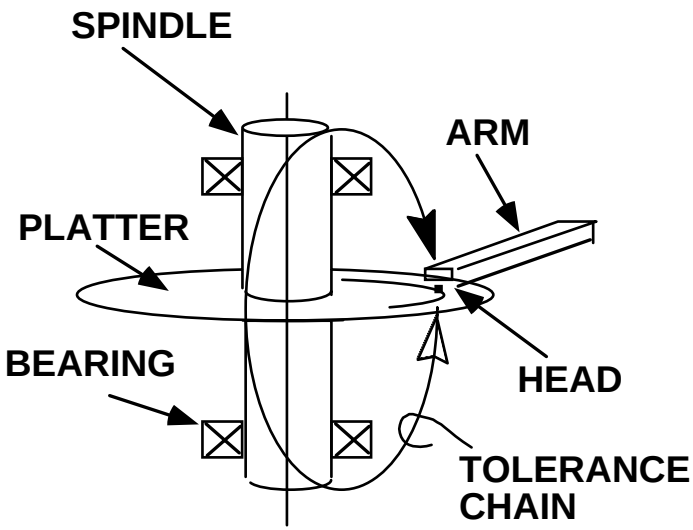
- Be dependent for capacity (you could make it)
- Be dependent for knowledge (you can't make it)

Examples of Dependency

Disk drives: dependent for knowledge

Half shafts: dependent for capacity

Disk Drive Engineering and Outsourcing



METRICS:

VOLUME
WEIGHT
$/MEGABYTE

Each major element was obtained from a different source, including assembly. The company is no longer in this business.

Toyota as an Example

Toyota appears to buy most car parts and make much of its infrastructure

It could have made the choice many other ways

Toyota appears to have performed triage on the things it buys and on the suppliers themselves

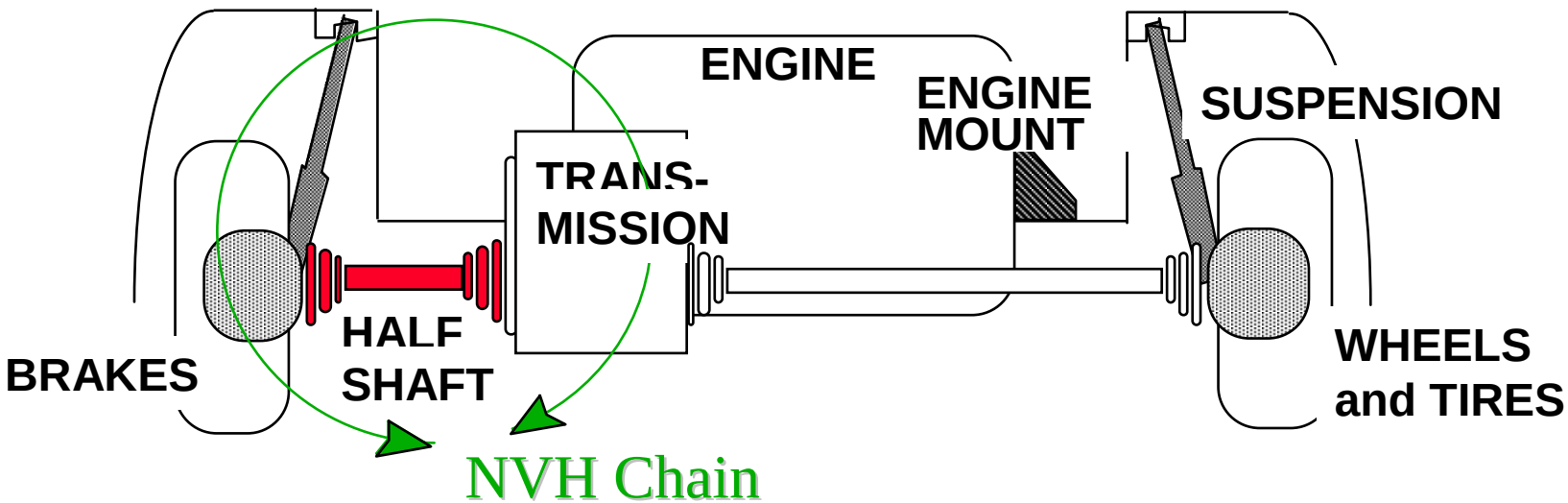
- black box (supplier does it all)
- grey box (co-design)
- white box (build to print)
- cf Taka Fujimoto: “Origin and Evolution of Black Box Practice in the Japanese Auto Industry”

How does Toyota retain skills when it outsources?

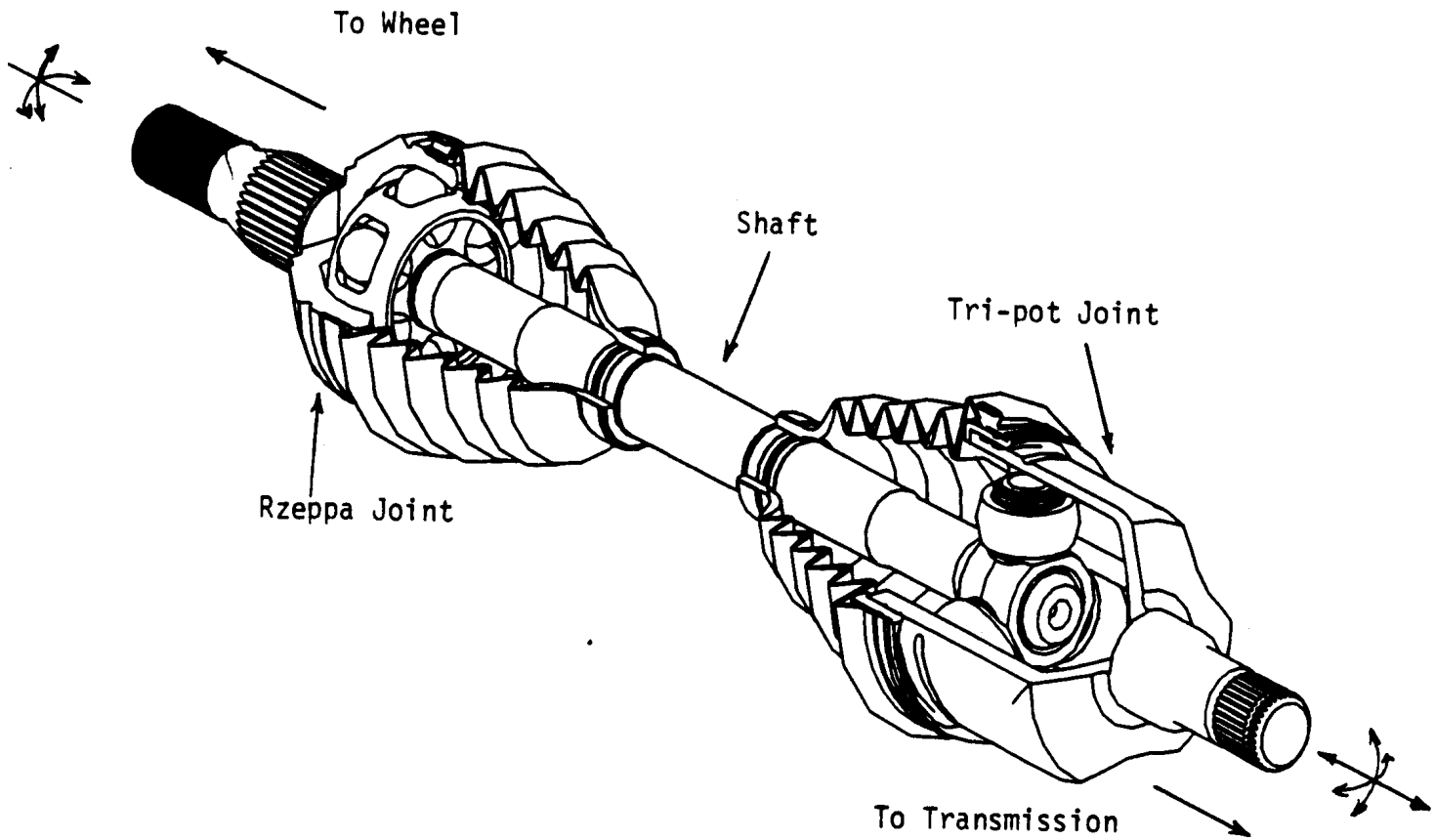
Car NVH Illustrates KC Distribution Through a Chain of Elements

A Toyota specification for an outsourced drive shaft contains a vibration specification

In fact, the drive shaft is one of many elements in a complex system that delivers the noise, vibration, and harshness KC



Half Shaft with Constant Velocity Joints



Is System Engineering Toyota's Main Skill?

Toyota has chosen to outsource many components

But it keeps control of many key manufacturing and design technologies; for example:

- machines for dies and engine parts
- CAD technologies, especially info management

Are these choices related?

Is Toyota's dependence on Denso a problem?

“Coherent Systems”

- Examples
  - Any self-contained, testable module that delivers a measurable function, plus the knowledge to design, make, and test it
  - A software suite such as Microsoft Office
  - A patent network
  - A product plus its customer support system
- What they offer to the owner
  - Control (over performance, cost, changes and “improvements,” diagnosis, underlying product or process knowledge)
  - Customer reliance on the whole and inability of customer to deconstruct
  - Efficiency of delivery
  - Barrier to entry by competitors
  - A form of complementary asset (required to exploit the main assets)
- The risks in breaking them
  - Loss of control, knowledge, synergy, barrier, future exploitation

Degrees of Outsourcability

ITEM IS LESS OUTSOURCABLE BECAUSE IT IS LESS DECOMPOSABLE

- GENUINE COMMODITY WITH STANDARD INTERFACES (ANSI, NEMA, ETC) BOUGHT FROM CATALOG
- DECOMPOSABLE ITEM WITH A FEW WELL-DEFINED INTERFACES
- ITEM CONTAINS BUYER'S PROPRIETARY TECHNOLOGY
- ITEM MUST BE INTEGRATED WITH ITEMS MADE IN-HOUSE OR BOUGHT ELSEWHERE
- ITEM IS THE "CORE" WITH WHICH MANY OTHERS MUST BE INTEGRATED
- ITEM CONTAINS MANY MUTUALLY INTEGRATED KEY CHARACTERISTICS WHOSE DEFINITION AND MANUFACTURE REQUIRE IN-HOUSE DECISIONS, TRADEOFFS, AND KNOWLEDGE

MORE IN-HOUSE KNOWLEDGE NEEDED IT IS INTEGRATION KNOWLEDGE

Degrees of Dependency

CAN IDENTIFY QUALIFIED BIDDERS

CAN WRITE COMPETENT SPECIFICATION

CAN EVALUATE BIDS

CAN VERIFY THAT ITEM MEETS SPEC

CAN IMPROVE BID

CAN HELP SUPPLIER TECHNICALLY

CAN HELP SUPPLIER OPERATIONALLY

CAN IMPROVE ITEM AFTER RECEIPT

CAN MAKE IN-HOUSE

DEPENDENT FOR KNOWLEDGE

IF YOU GET OFF THE BUS, CAN YOU EVER GET BACK ON??

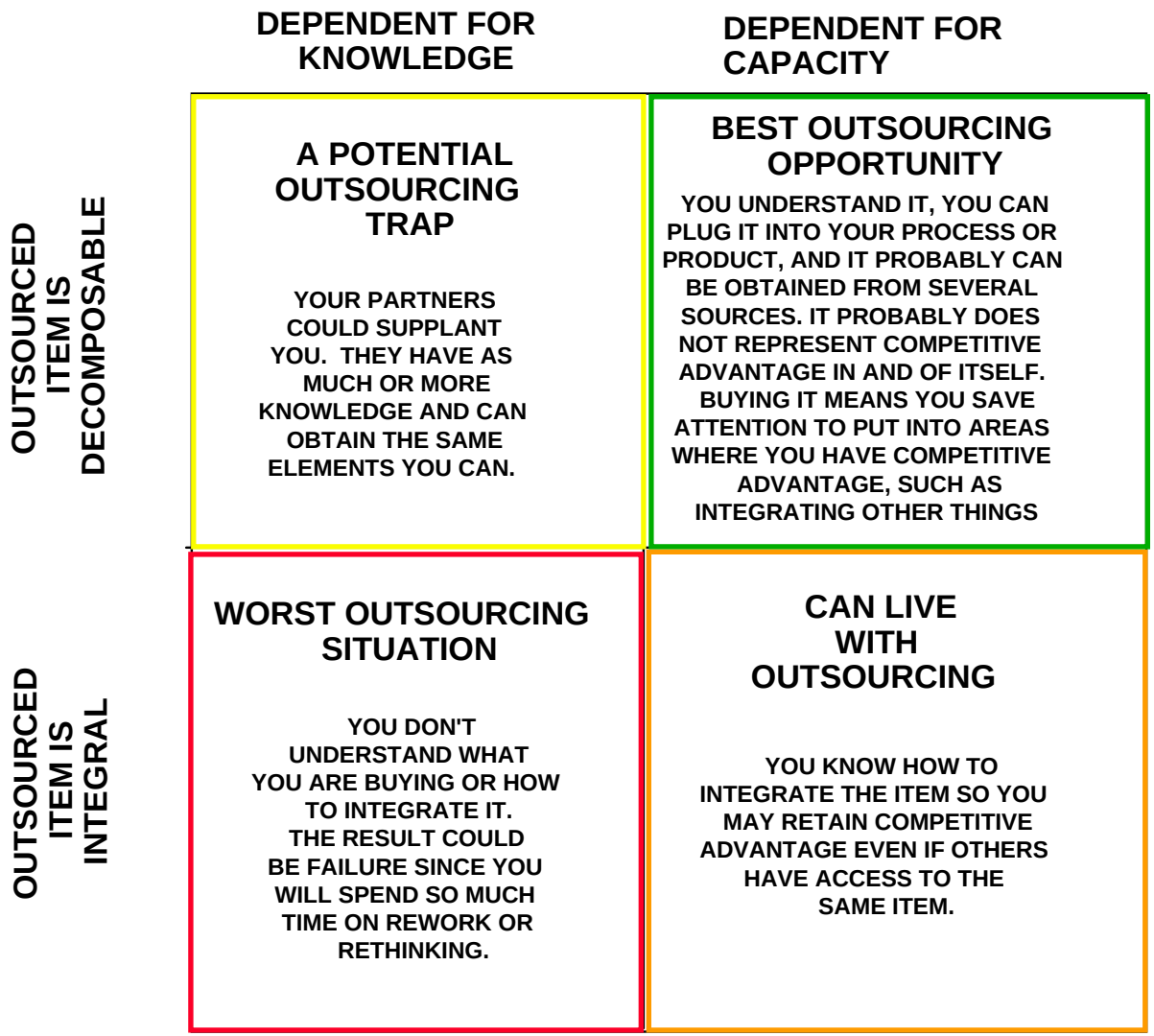
DEPENDENT FOR CAPACITY

WHAT'S THE MINIMUM THAT'S ECONOMICAL TO RETAIN??

Questions to Ask Before Outsourcing

- How well do we understand our own product?
- How sensitive is our product's performance to details of the outsourced item's performance?
- Who is the technological leader? Us? Them?
- Could important technological advances occur in the outsourced item? Who will own them?
- Who will maintain the core competence if we outsource?
- Are we creating a future holdup situation?
- What are the criteria for a competent supplier?
- Can the supplier deconstruct our coherent system and reconstruct it in his domain?

Matrix of Dependency and Outsourcing



Outsourcing Pro and Con

- Pro
  - Provides competitive alternatives
  - Allows contact with different sources and kinds of knowledge
  - Augments in-house capabilities
  - Augments in-house capacity
  - Reminds everyone that there is no monopoly on skill or knowledge
- Con
  - Decentralizes things that need central oversight
  - Breaks chains of delivery of quality
  - Disperses responsibility and accountability
  - Opens the door to conflicts of interest
  - Devolves power, especially power based on coherence in performance, processes, or knowledge
  - Fosters the illusion that everything is plug and play and that cost is the only differentiator
  - Fosters the illusion that risk can be eliminated while reward can be retained

Conclusions

Outsourcing seems necessary, but is it "good"?

System coherence and integration potential is
a possible guide on what to make vs buy

The choice of what to make and what to buy has long term strategic implications especially where system control conveys market power

The main long term core competency may in fact be the ability to make the make/buy decision

No such decision is permanent

Additional Reading

Have a look at my web page:

http://web.mit.edu/ctpid/www/Whitney/papers.html

on which you will find, among other things, a paper by Charles Fine and myself called

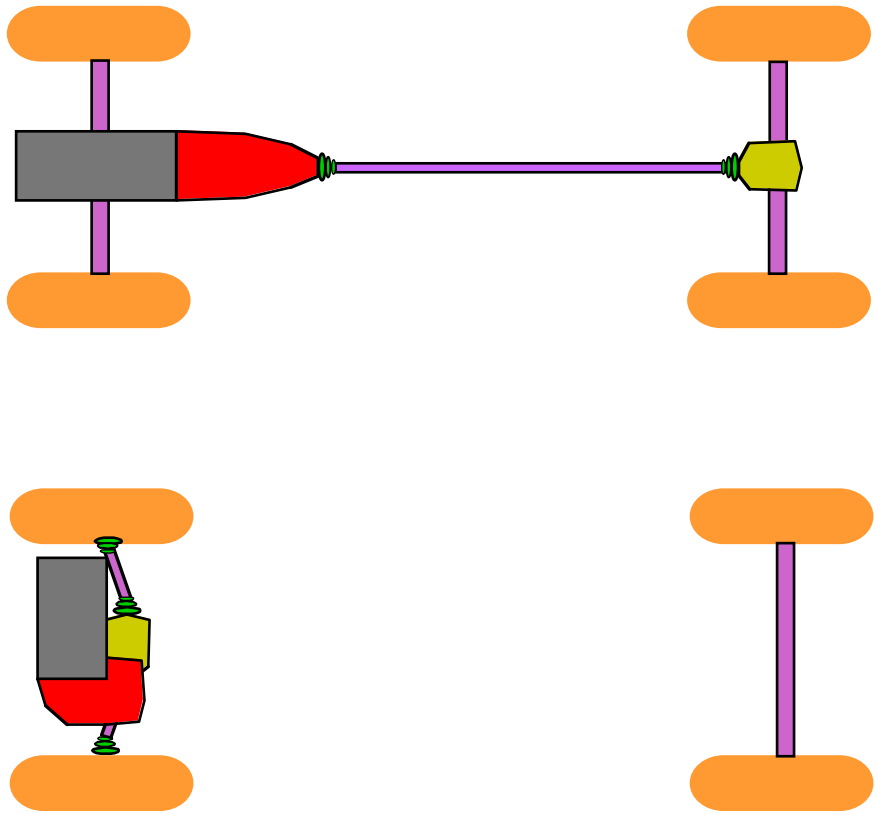
“Is the Make-buy Decision a Core Competence?”

The HP Pavilion: Where Does HP Add Value?*

- R&D-Intel, Microsoft, Component Mfrs (HP)
- Manufacturing-SCI Systems, Intel
- Sales-CompUSA, Best Buy, etc
- Service-3rd party maintenance providers
- HP adds value in information management, bringing it all together, knowing the "sweet spots in the components, understanding the market."

- *"Managing Against the Clock: Lessons from the IT Industry," by Prof Haim Mendelson, Stanford U Business School, presented at the MIT Symposium "Creating and Managing Corporate Technology Supply Chains, May 12, 1998

Front and Rear Wheel Drive Architectures



fwd & rwd

Outsourcing Driven by System Integration

- Car industry suppliers gaining power by assembling coherent systems
  - interiors (seats, entertainment, instrument panel)
  - chassis (ABS, active suspension, steering, engine controls
  - see Ward's articles on Bosch-AlliedSignal and VarityKelsey-Hayes
- Delphi will offer complete drive/brake by wire
- Boeing will offer similar products
- Ford is taking back interiors integration