Lean Supply Chain Management Principles and Practices

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Lean Supply Chain Management Learning Points

- Lean supply chain management represents a new way of thinking about supplier networks
- Lean principles require cooperative supplier relationships while balancing cooperation and competition
- Cooperation involves a spectrum of collaborative relationships & coordination mechanisms
- Supplier partnerships & strategic alliances represent a key feature of lean supply chain management

Theory: Lean Represents a "Hybrid" Approach to Organizing Interfirm Relationships

- "Markets" (Arm's Length): **Lower production costs, higher coordination costs**
  - **Firm buys (all) inputs from outside specialized suppliers**
  - **Inputs are highly standardized; no transaction-specific assets**
  - **Prices serve as sole coordination mechanism**
- "Hierarchies" (Vertical Integration): **Higher production costs, lower coordination costs**
  - **Firm produces required inputs in-house (in the extreme, all inputs)**
  - **Inputs are highly customized, involve high transaction costs or dedicated investments, and require close coordination**
- "Lean" (Hybrid): **Lowest production and coordination costs; economically most efficient choice-- new model**
  - **Firm buys both customized & standardized inputs**
  - **Customized inputs often involve dedicated investments**
  - **Partnerships & strategic alliances provide collaborative advantage**

Dominant conventional approach: Vertical integration, arm's length relationships with suppliers

Lean Supply Chain Management Differs Sharply from Conventional Practices (I)

ILLUSTRATIVE CHARACTERISTICS	CONVENTIONAL MODEL	LEAN MODEL
Number & structure	Many; vertical	Fewer; clustered
Procurement personnel	Large	Limited
Outsourcing	Cost-based	Strategic
Nature of interactions	Adversarial; zero-sum	Cooperative; positive-sum
Relationship focus	Transaction-focused	Mutually-beneficial
Selection criteria	Lowest price	Performance
Contract length	Short-term	Long-term
Pricing practices	Competitive bids	Target costing
Price changes	Upward	Downward
Quality	Inspection-intensive	Designed-in

Lean Supply Chain Management Differs Sharply from Conventional Practices (II)

ILLUSTRATIVE CHARACTERISTICS	CONVENTIONAL MODEL	LEAN MODEL
Delivery	Large quantities	Smaller quantities (JIT)
Inventory buffers	Large	Minimized; eliminated
Communication	Limited; task-related	Extensive; multi-level
Information flow	Directive; one-way	Collaborative; two-way
Role in development	Limited; build-to-print	Substantial
Production flexibility	Low	High
Technology sharing	Very limited; nonexistent	Extensive
Dedicated investments	Minimal-to-some	Substantial
Mutual commitment	Very limited; nonexistent	High
Governance	Market-driven	Self-governing
Future expectations	No guarantee	Considerable

Lean Supply Chain Management Principles Derive from Basic Lean Principles

- Focus on the supplier network value stream
- Eliminate waste
- Synchronize flow
- Minimize both transaction and production costs
- Establish collaborative relationships while balancing cooperation and competition
- Ensure visibility and transparency
- Develop quick response capability
- Manage uncertainty and risk
- Align core competencies and complementary capabilities
- Foster innovation and knowledge-sharing

Mutually-Reinforcing Lean Practices Translate these Principles into Action

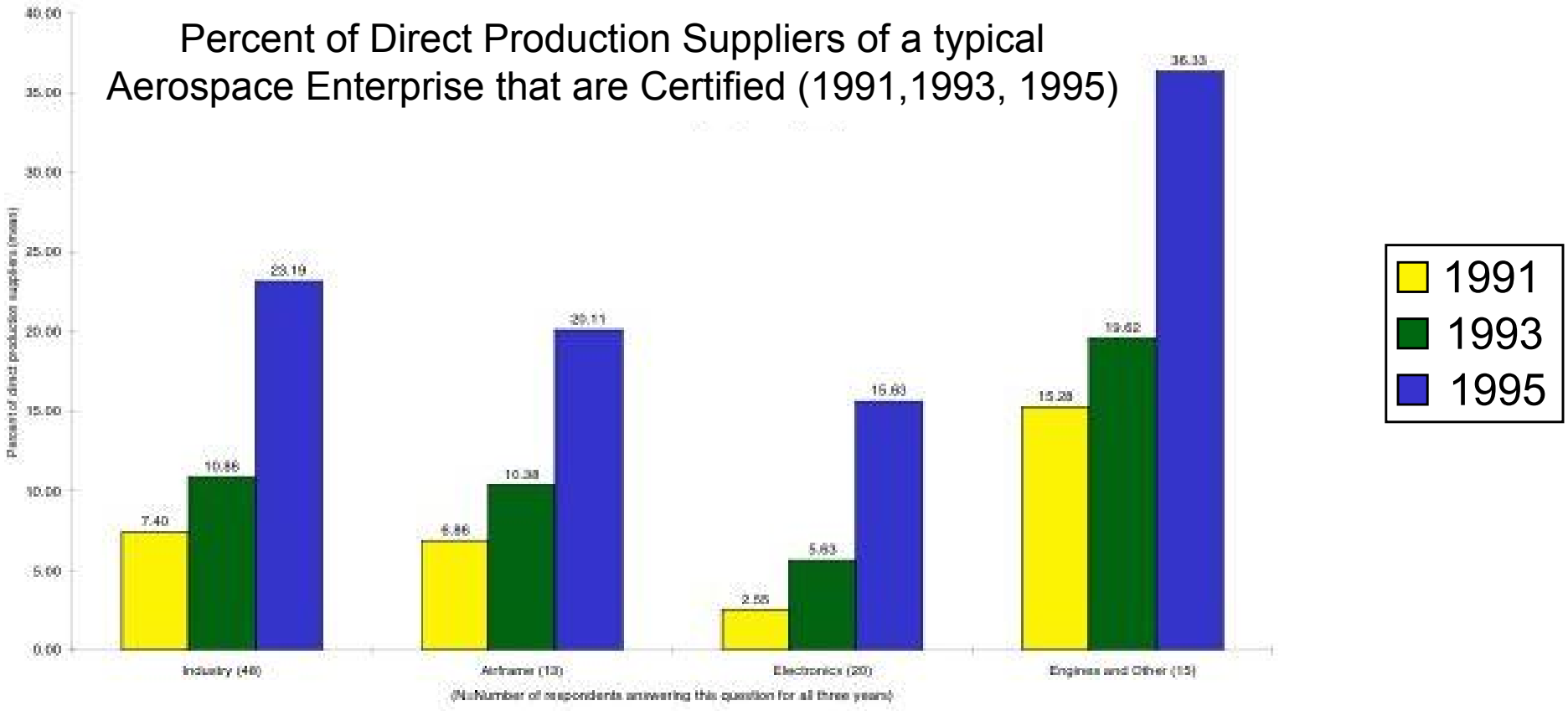
Design supplier network architecture	• Design of supplier network driven by strategic thrust • Fewer suppliers; "clustered control" • Supplier selection based on performance
Develop complementary supplier capabilities	• Ensured process capability (certification) • Targeted supplier development (SPC, Kaizen) • Greater responsibilities delegated to suppliers
Create flow and pull throughout supplier network	• Linked business processes, IT/IS infrastructure • Two-way information exchange & visibility • Synchronized production and delivery (JIT)
Establish cooperative relationships & effective coordination mechanisms	• Joint problem-solving; mutual assistance • Partnerships & strategic alliances • Open and timely communications • Increased interdependence & "shared destiny"
Maximize flexibility & responsiveness	• Seamless information flow • Flexible contracting • Rapid response capability
Optimize product development through early supplier integration	• Integrate suppliers early into design & development IPTs • Collaborative design; architectural innovation • Open communications and information sharing • Target costing; design-to-cost
Integrate knowledge and foster innovation	• Knowledge-sharing; technology transfer • Aligned technology roadmaps

Synchronized Production and Delivery

Synchronized Production and Delivery Throughout the Supplier Network is a Central Lean Concept

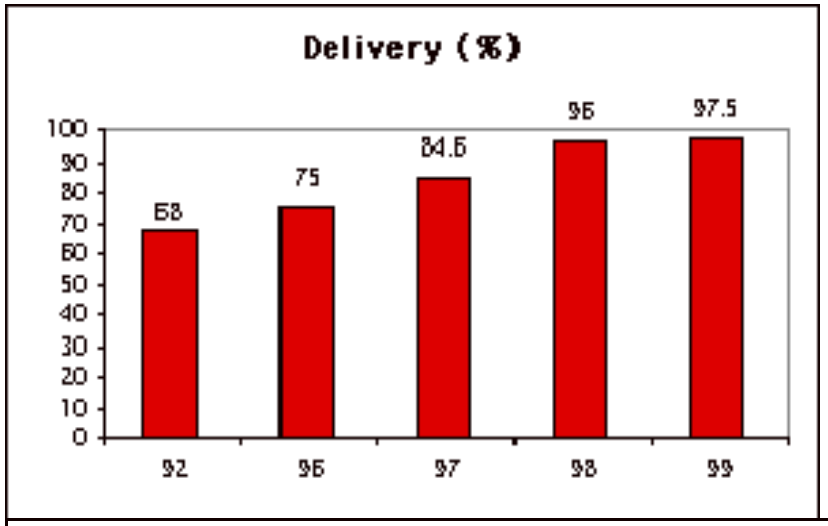
- Integrated supplier lead times and delivery schedules
- Flows from suppliers pulled by customer demand (using takt time, load leveling, line balancing, single piece flow)
- Minimized inventory through all tiers of the supply chain
- On-time supplier delivery to point of use
- Minimal source or incoming inspection
- Effective two-way communication links to coordinate production & delivery schedules
- Striving for zero quality defects essential to success
- Greater efficiency and profitability throughout the supplier network

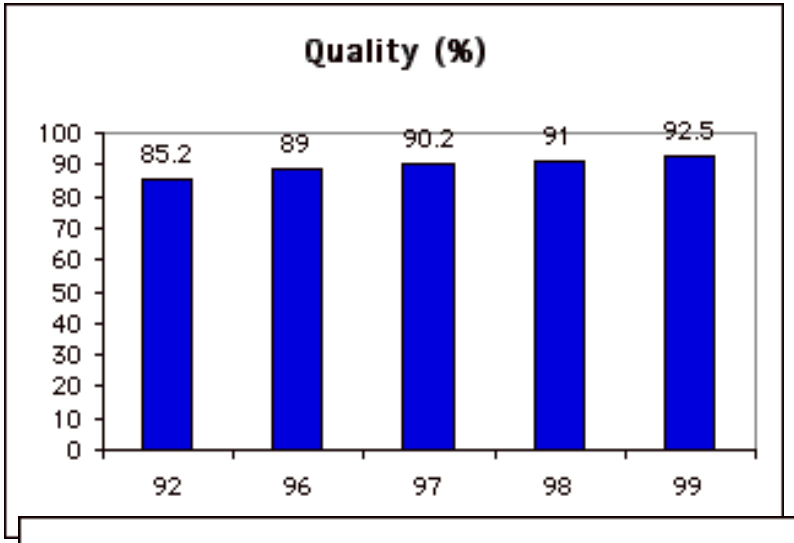
Supplier Certification has been an Important Early Enabler of Achieving Synchronized Flow in Aerospace

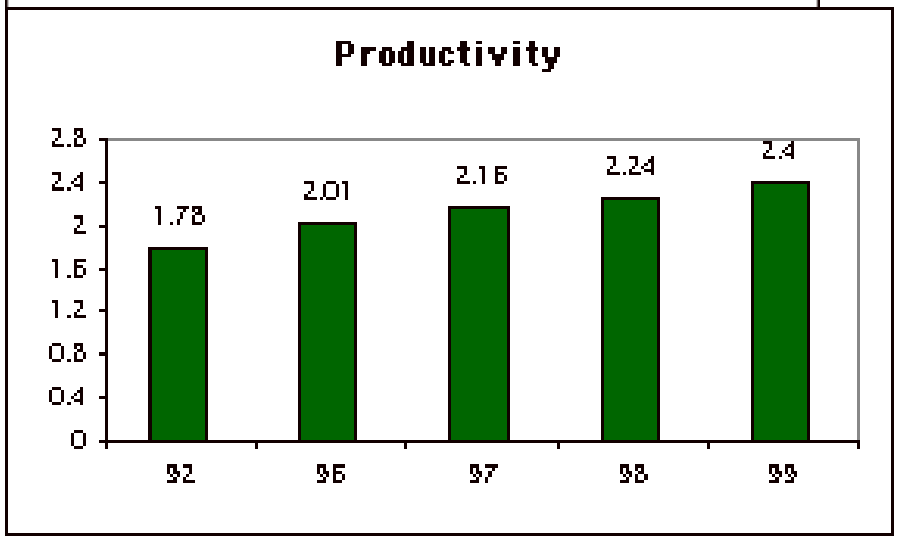


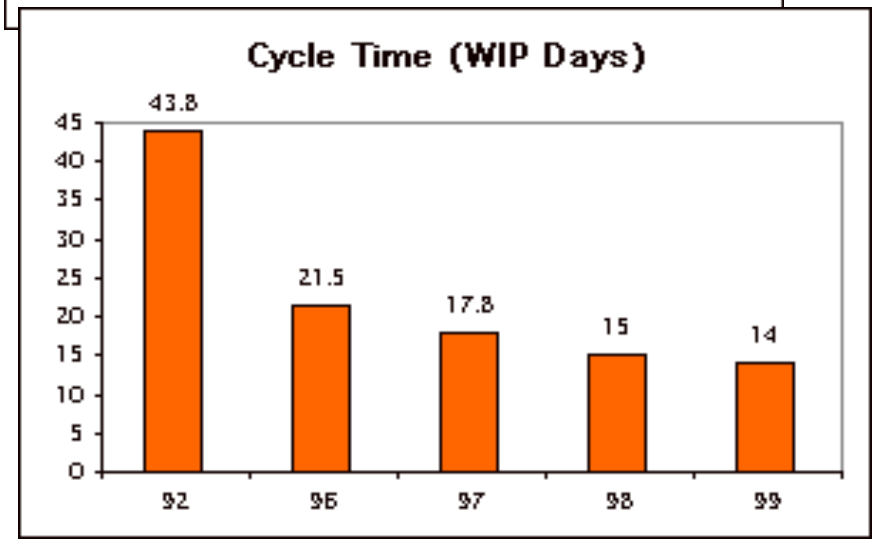
Source: LAI

Concrete Example: Engine Parts Casting Supplier Worked with Customer Company to Achieve Synchronized Flow









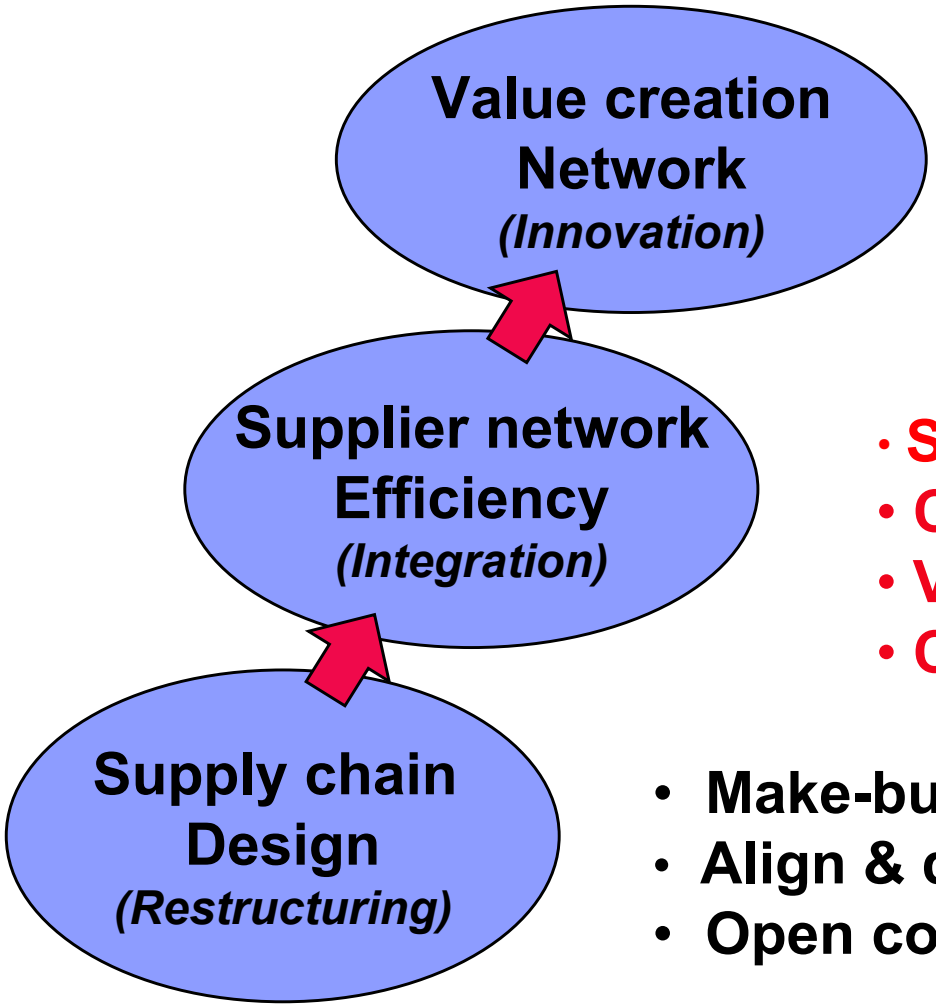
Source: LAI

Mastering & Integrating Lean Basics with Prime was Necessary for Achieving Synchronized Flow

- 6S -- Visual factory
- Total productive maintenance
- Quality control
- Process certification
- Mistake proofing
- Setup reduction
- Standard work
- Kaizen

Partnerships and Strategic Alliances

Paradigm Shift in Supply Chain Management Thinking: Evolving Lean Supplier Networks



- Early supplier integration into design
- Alignment of technology roadmaps
- Knowledge integration & fostering innovation across supplier network

- Supplier partnerships & alliances
- Common objectives
- Value stream mapping
- Continuous improvement

- Make-buy linked to corporate strategic thrust
- Align & develop supplier capabilities
- Open communications

Lean Supplier Networks Offer Significant Competitive Advantages

- Exhibit superior performance system-wide -- greater efficiency, lower cycle time, higher quality
- Not an accident of history but result of a dynamic evolutionary process
- Not culture dependent but are transportable worldwide
- Can be built through a proactive, well-defined, process of change in supply chain management

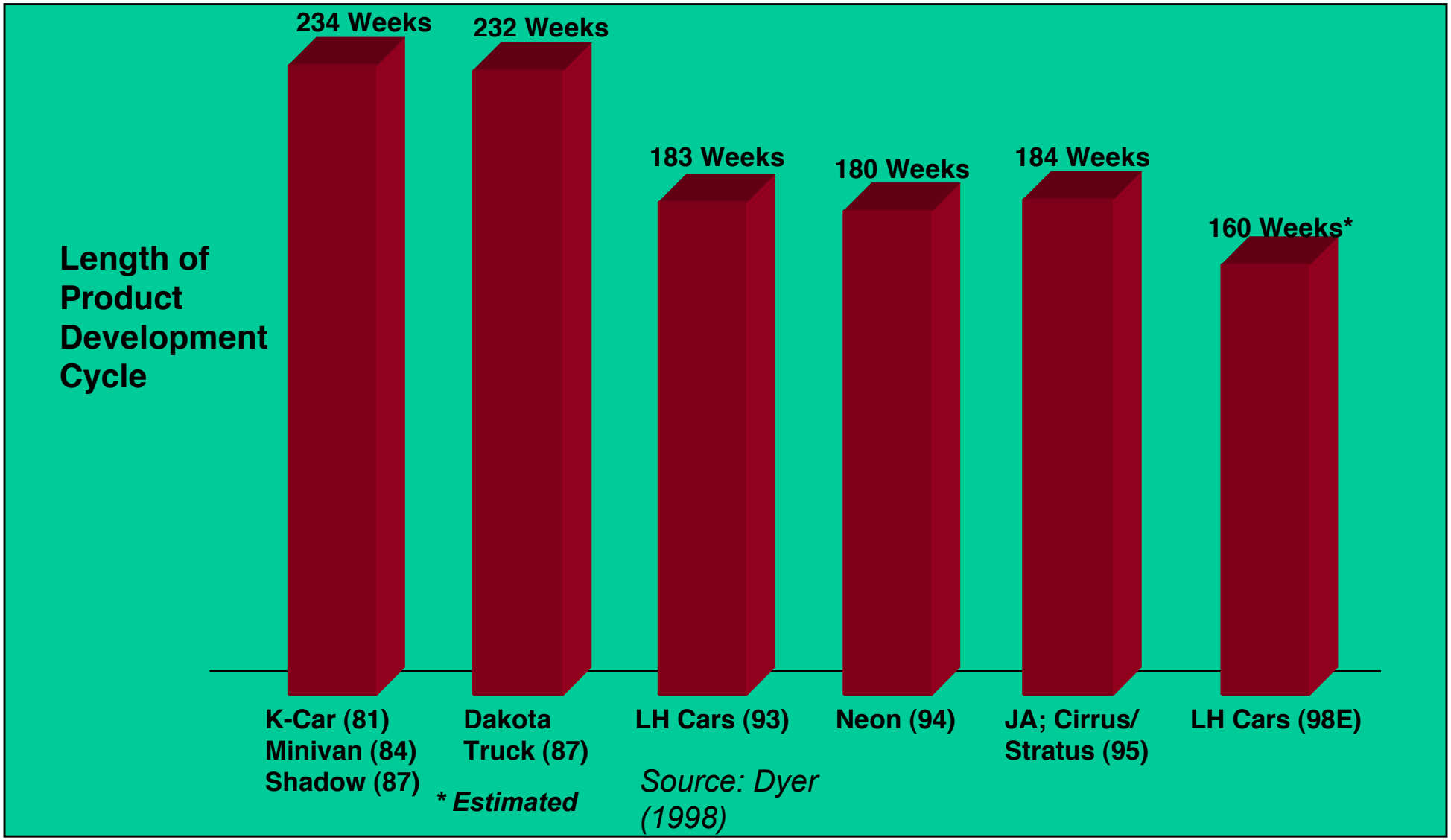
Supplier Partnerships & Strategic Alliances Bring Important Mutual Benefits

- Reduced transaction costs (cost of information gathering, negotiation, contracting, billing)
- Improved resource planning & investment decisions
- Greater production predictability & efficiency
- Improved deployment of complementary capabilities
- Greater knowledge integration and R&D effectiveness
- Incentives for increased innovation (through cost-sharing, risk-sharing, knowledge-sharing)
- Increased mutual commitment to improving joint long-term competitive performance

Major Lean Lessons

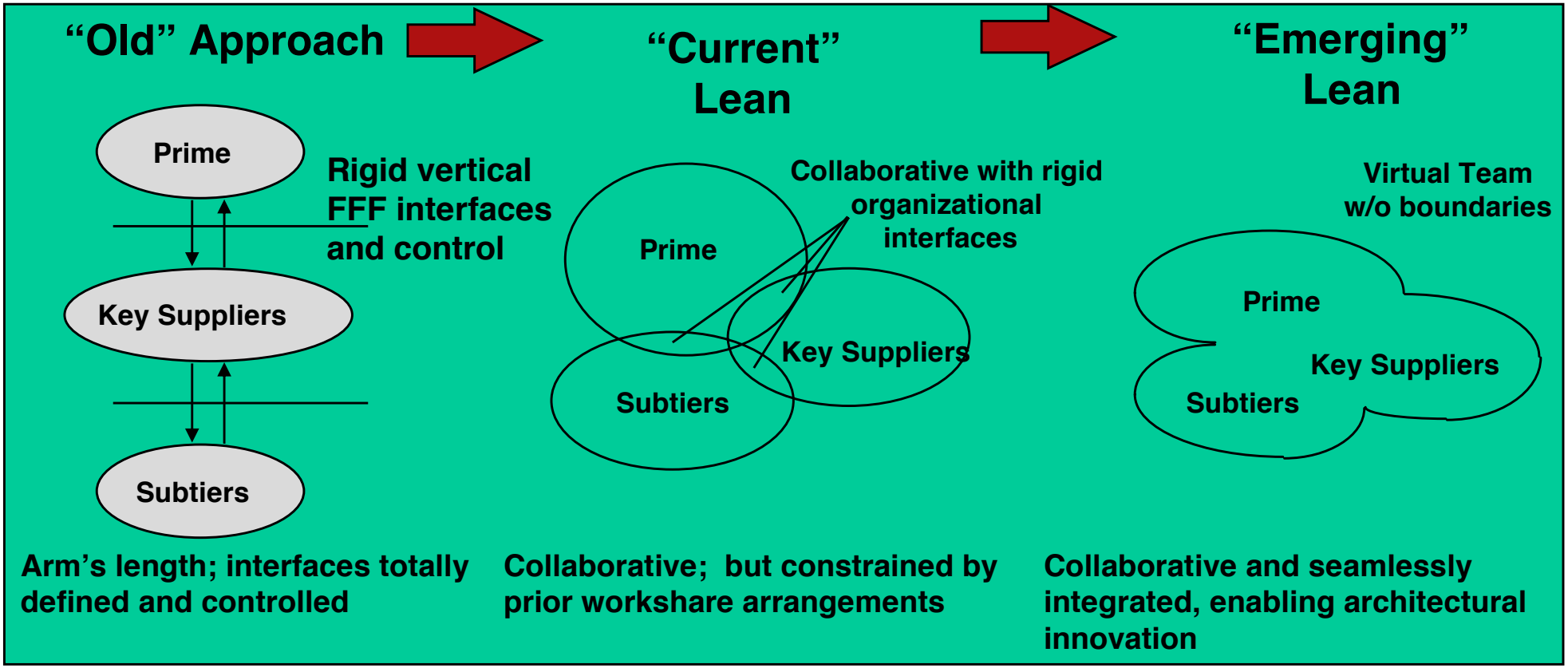
- Supply chain design linked to corporate strategic thrust
  - Fewer first-tier suppliers
  - Greater supplier share of product content
- Strategic supplier partnerships with selected suppliers
  - Trust-based relationships; long-term mutual commitment
  - Close communications; knowledge-sharing
  - Multiple functional interfaces
- Early supplier integration into design
  - Early and major supplier role in design
  - Up-front design-process integration
  - Leveraging supplier technology base for innovative solutions
- Self-enforcing agreements for continuous improvement
  - Target costing
  - Sharing of cost savings

Chrysler: Supplier Partnerships Speed Development



Integrate suppliers early into design and development IPT's

Evolution of Early Supplier Integration in the Aerospace Industry



ARCHITECTURAL INNOVATION: Major modification of how components in a system/product are linked together

- Significant improvement in system/product architecture through changes in form/structure, functional interfaces or system configuration
- Knowledge integration over the supplier network (value stream perspective ; prime-key suppliers-subtiers; tapping supplier technology base)

Strategic Emphasis on Fostering Innovation for Value Creation across Enterprise Networks

- Transform "tribal regimes" (today's transaction-intensive supplier networks) into "innovation networks" (learning networks with shared goals)
  - Collaborative networks
  - Enhanced flexibility
  - Responsiveness to emerging needs
- Emphasis on:
  - Innovations in system & cross-platform integration (primes)
  - Modular & architectural innovation (supplier networks)

Summary of Key Practices Enabling Architectural Innovation

- Pre-sourcing; long-term commitment
- Early supplier integration into IPTs; IPPD; co-location; joint design & configuration control
- Leveraging technology base of suppliers (key suppliers; tooling suppliers; subtiers)
- Workshare arrangements optimizing supplier core competencies
- Retaining flexibility in defining system configuration
- Open communications; informal links; knowledge-sharing
- Target costing; design to cost
- Supplier-capability-enhancing investments
- Incentive mechanisms (not to compete agreements; long-term warranty); maintaining trade secrets
- Government part of the team; relief from military standards and specifications

Electronic Integration of Supplier Networks: Early Results

Challenge: **Electronic integration of supplier networks for technical data exchange as well as for synchronization of business processes**

- **Important success factors include:**
  - **Clear business vision & strategy**
  - **Early stakeholder participation (e.g., top management support; internal process owners; suppliers ; joint configuration control)**
  - **Migration/integration of specific functionality benefits of legacy systems into evolving new IT/IS infrastructure**
  - **Great care and thought in scaling-up experimental IT/IS projects into fully-functional operational systems**
- **Electronic integration of suppliers requires a process of positive reinforcement -- greater mutual information exchange helps build increased trust, which in turn enables a closer collaborative relationship and longer-term strategic partnership**
- **Close communication links with overseas suppliers pose a serious security risk and complex policy challenge**

Quick Review of Aerospace Progress

- **Aerospace industry has made important strides in supplier integration, but this is only the beginning of the road**
  - **Production: Supplier certification and long-term supplier partnerships -- process control & parts synchronization**
  - **Development: Early supplier integration into product development critical**
  - **Strategic supply chain design is a meta core competency**
- **Implementation efforts have required new approaches**
  - **Re-examination of basic assumptions (e.g., make-buy)**
  - **New roles and responsibilities between primes and suppliers**
  - **Communication and trust fundamental to implementation**
- **Aerospace community faces new challenges and opportunities**
  - **Imperative to take "value stream" view of supplier networks**
  - **Focus on delivering best lifecycle value to customer**
  - **Need to evolve information-technology-mediated new organizational structures for managing extended enterprises in a globalized market environment**

Lean Supplier Networks Offer Significant Competitive Advantages

- **Exhibit superior performance system-wide -- greater efficiency, lower cycle time, higher quality**
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- **Can be built through a proactive, well-defined, process of change in supply chain management**

Key Questions for Enterprise Management (1)

- Does the size, structure and composition of the supplier network reflect your enterprise's strategic vision?
- Has your enterprise created partnerships and strategic alliances with key suppliers to strengthen its long-term competitive advantage?
- Are suppliers integrated into your enterprise's product, process and business development efforts?

Key Questions for Enterprise Management (2)

- Is your enterprise actively fostering innovation across your supplier network?
- Are you integrating knowledge throughout your enterprise value stream?
- Has your enterprise established mutually-beneficial arrangements with suppliers to ensure flexibility and responsiveness to unforeseen external shifts?
- Does your enterprise have in place formal processes and metrics for achieving continuous improvement throughout the extended enterprise?

Supplier Partnerships Driven by Strategic Corporate Thrust to Develop Integrated Supplier Networks

KEY PRACTICES	BEFORE	AFTER
Reduced and streamlined supplier base		
• Number of direct production suppliers	542	162
Improved procurement efficiency		
• Procurement personnel as % of total employment (%)	4.9	1.9
• Subcontracting cycle time (days)	13	7
Improved supplier quality and schedule		
• Procurement (dollars) from certified suppliers (%)	0	75
• Supplier on-time performance (% of all shipments)	76.4*	83.0
Established strategic supplier partnerships		
• Procurement dollars under long-term agreements(%)	0	95
• "Best value" subcontracts as % all awards	50.0	100.0

Source: LAI

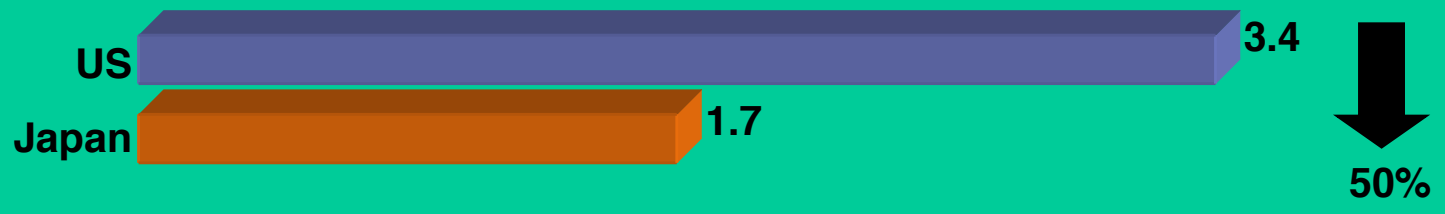
Focus on Early Supplier Integration

Historic opportunity for achieving BEST LIFECYCLE VALUE in aerospace weapon system acquisition through early supplier integration into design and development process

- **Nearly 80% of life cycle cost committed in early design phase**
- **Design and development of complex aerospace systems calls on core capabilities of numerous suppliers, providing as much as 60%-70% of end product value**
- **Supplier network represents an enormous beehive of distributed technological knowledge & source of cost savings**
- **What are better ways of leveraging this capability for more efficient product development in aerospace sector?**
- **Worldwide auto industry experience provides critical lessons**

Lean Difference: Auto Industry

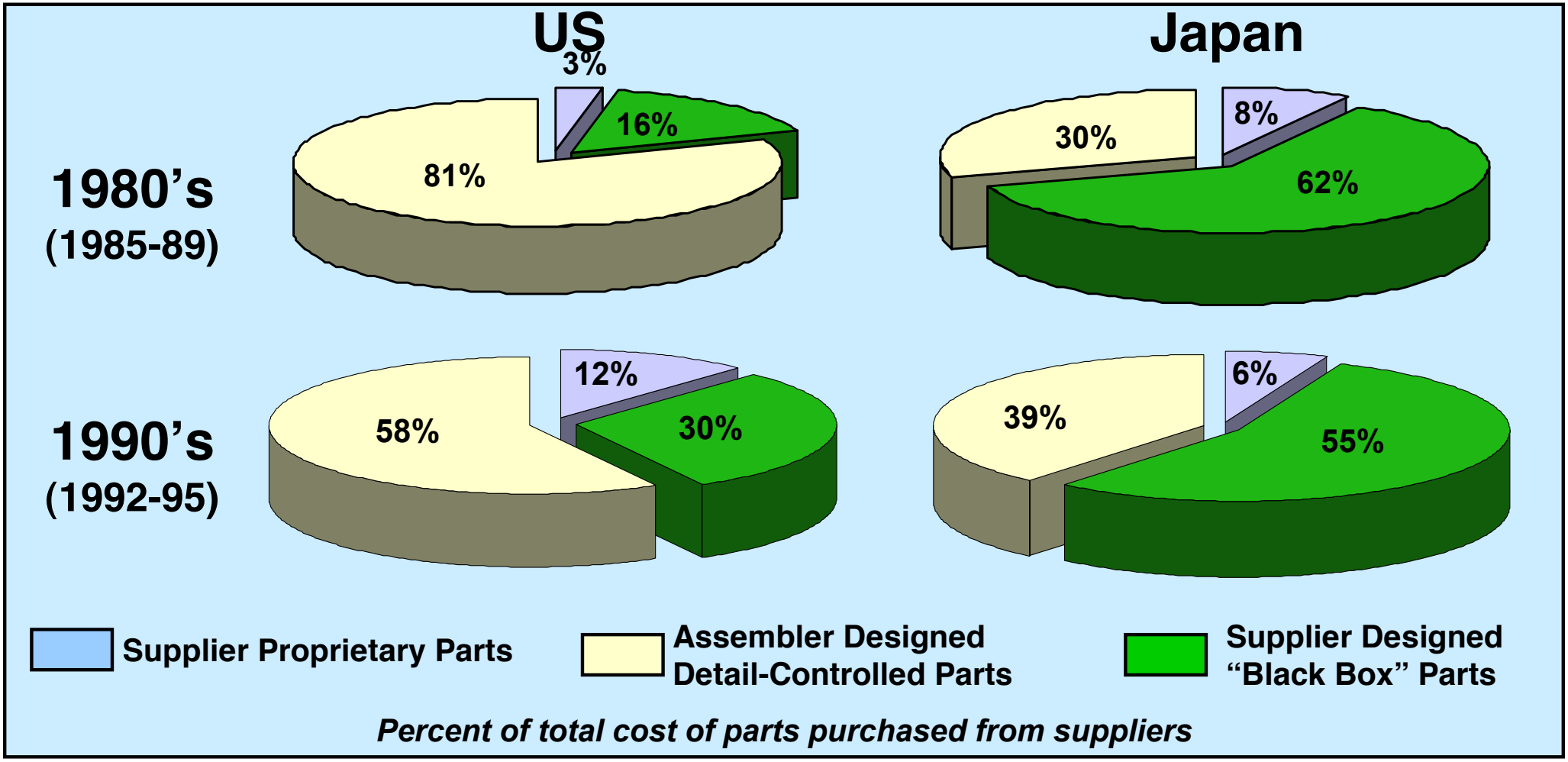
Lean Difference: Significantly lower development cost and shorter cycle time

Average engineering hours per new car (millions of hours)	
Average development cycle time per new car (months)	
Prototype lead time (months to first engineering prototype)	

Source: Clark, Ellison, Fujimoto and Hyun (1995); data refer to 1985-89.

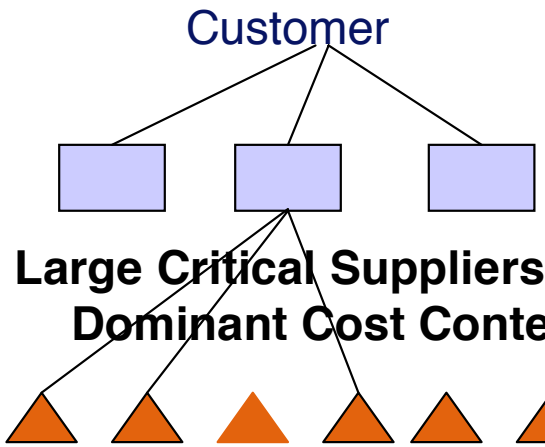
Lean Difference: Auto Industry Supplier Role in Design

Lean difference starts with significant supplier role in design and development



Focus on Total Value Stream Transformation*

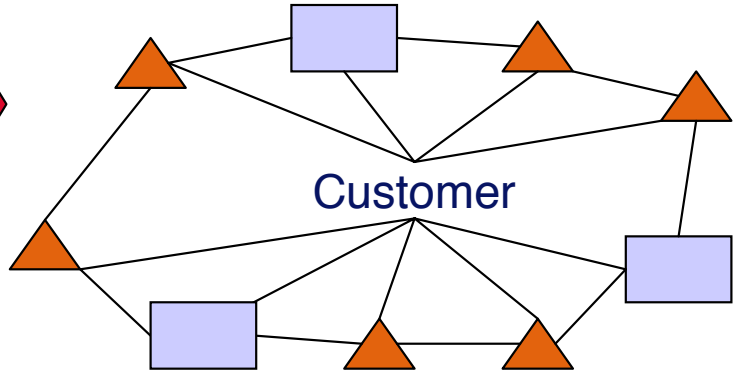
Traditional Bilateral Focus



Large Critical Suppliers with Dominant Cost Content

Lower-tier Suppliers Left to Competitive Pressures to Drive Continuous Improvement

Value Stream Transformation Focus



Direct Involvement to Foster Improvement throughout the Value Stream

*Builds on and extends Paul Cejas, Donnita Bennett and Susan Moehring, "A Value Stream Approach to Weapon Systems Affordability," Presentation at the Lean Aerospace Initiative (LAI) Joint Workshop in Dallas, TX (31 January 2001).

Collaborative Enterprise Supplier Networks

Collaborative Advantage[1]

4 Elements of the Extended Enterprise

1. Designing the **boundaries** of the firm (i.e. the "Governance Profile"

2. Investing in "**Dedicated** (relationship-specific) **Assets**"

3. Inter-organizational **Knowledge-sharing**

4. Inter-organizational **Trust**

[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

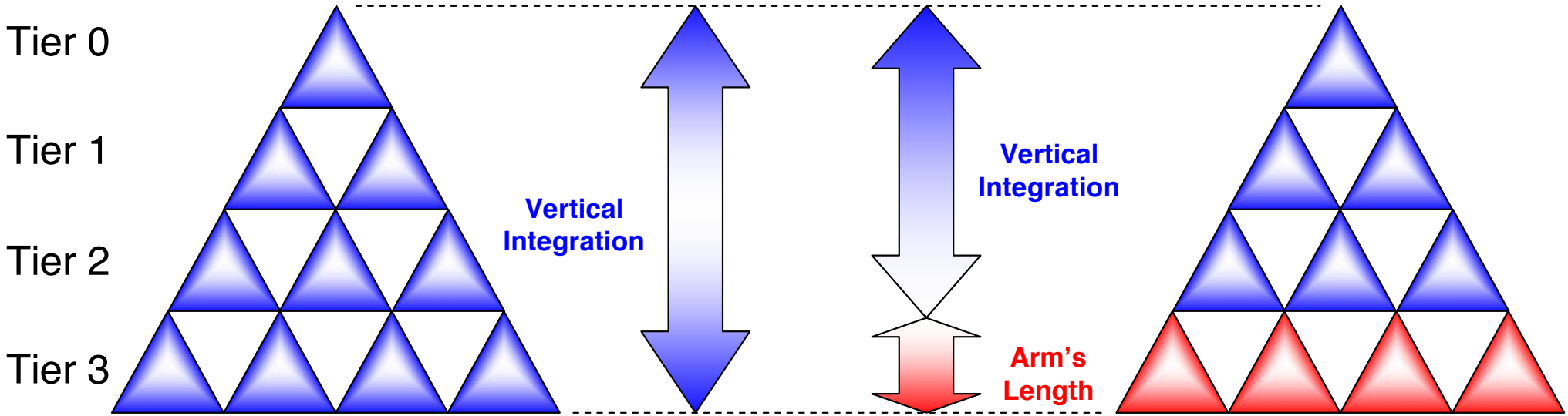
Integration-Disintegration Pressures

Firms have always been better than markets in coordinating **complex tasks**.

Specialization increases the costs of communication and **coordination**, increasing incentive to in-source

Productivity grows with the division of labor. **Specialization** gives access to Economies of Scale

Markets have always been better than firms in achieving **productivity**.



[1]*Source: "Collaborative Advantage" by Jeff Dyer*

Collaborative Advantage[1]

Integration Liabilities

- **Loss of High-Powered Incentives**
  - No strong connection between output and rewards
  - Difficult to "fire" a sister division
  - Less access to residual profits
- **Loss of Scale and Access to Outside Customers**
  - Loss of economies of scale
  - Loss of information from external customers who provide ideas
  - Catch-22: prohibited from selling superior products outside, however, if not differentiated, then buyers won't purchase products from competitors.
- **Loss of Strategic Flexibility**
  - Inability to raise capital
- **Higher Labor Costs**
  - Larger firms tend to pay higher wages and have stronger labor unions

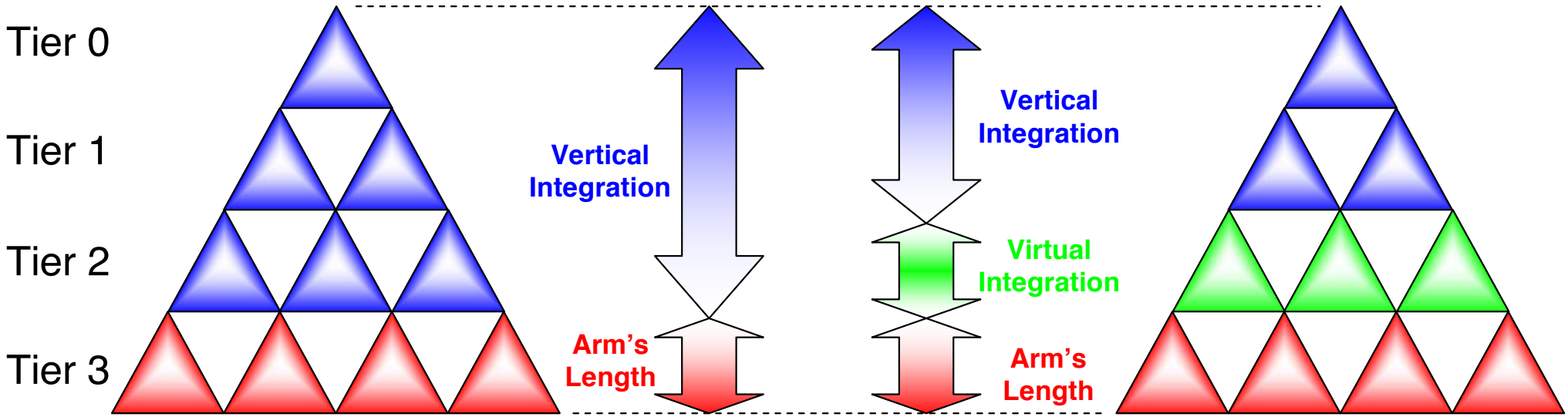
[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

Collaboration Pressures

Integration causes:
- Loss of Incentives
- Loss of Scale
- Loss of customer access
- Inability to Raise Capital
- Higher Labor Costs

Arm's Length Outsourcing causes:
- Less technology development
- Less Risk-sharing



[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

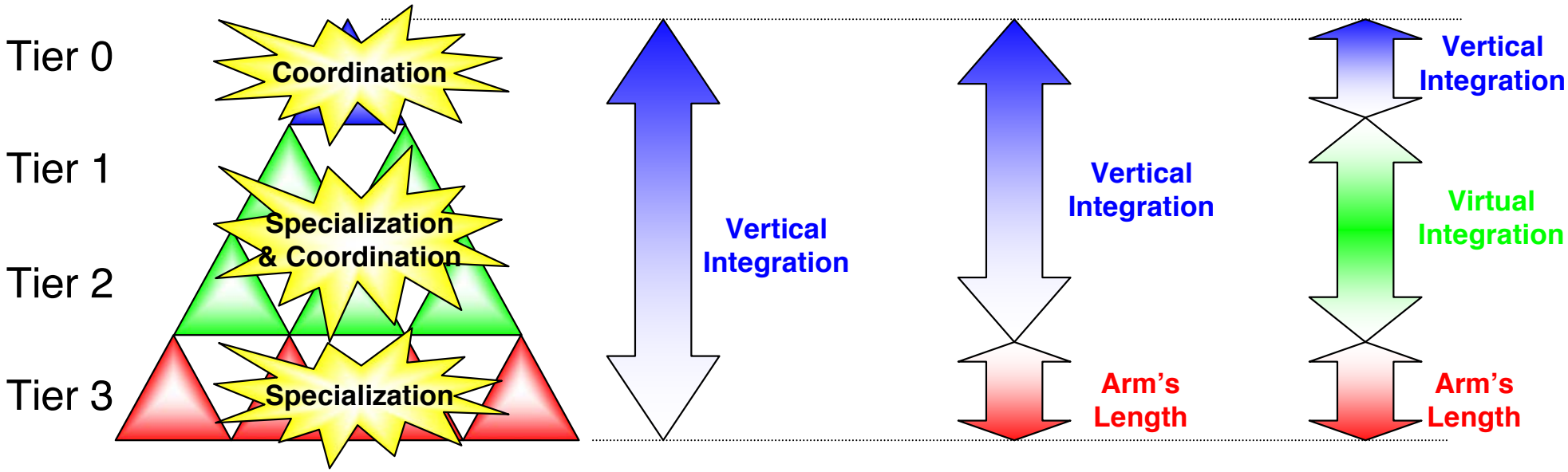
Current Trends

Key Trends:	Result:	Implication:
1. Advancement in Information Technology 2. Growth in Knowledge and increased Product Complexity	Pressures for greater **Specialization** of Economic Activities	Vertical Integration is less desirable
3. Increased Customization of Demand	Pressures for greater **Coordination** of Economic Activities	Arm's Length Relationships are less desirable

[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

Summary of "Governance Profiles"



Governed internally by Hierarchy

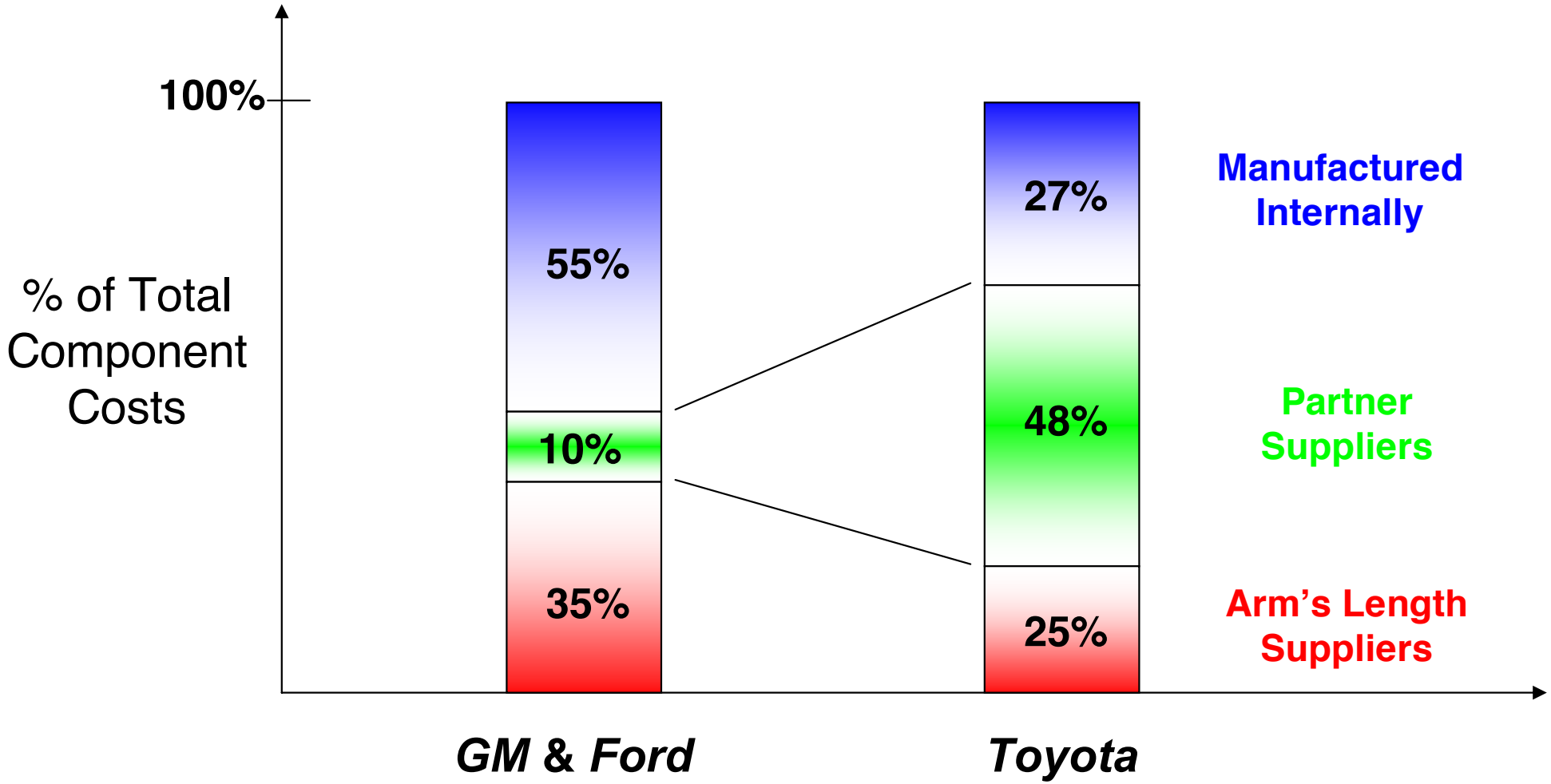
Governed externally by Legal Contracts

Governed externally by Trust and Implicit Long-Term Agreements

[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

Example "Governance Profiles"

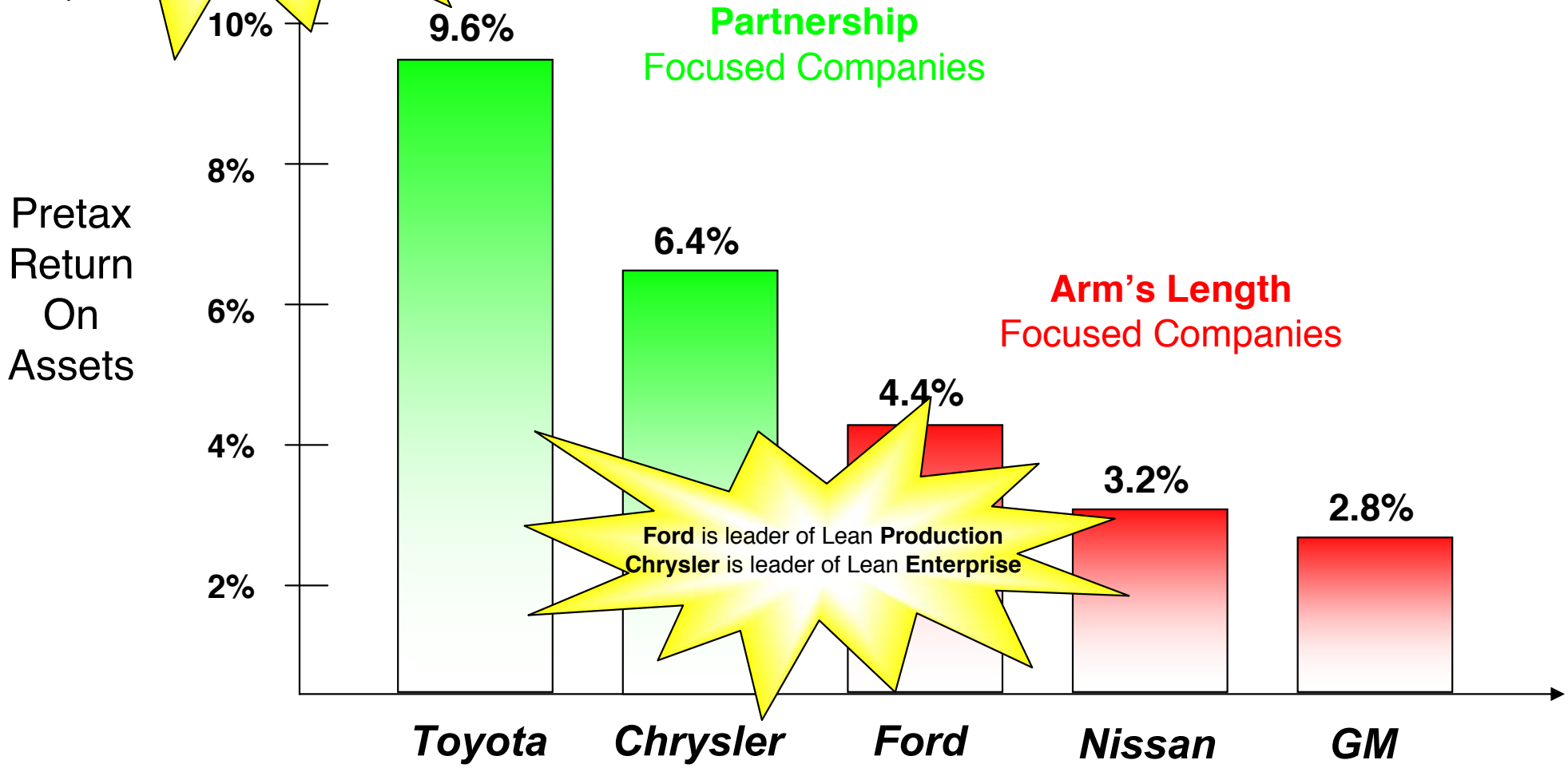


[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

Profitability (1982-1998)

Toyota is **twice as profitable**, and Toyota's Suppliers are **50% more profitable** than other Japanese or US suppliers.



[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

"Governance Profile Summary"

Relationship	Relationship Characteristics	Driver	Products	Governance Method	Supplier Characteristics
Vertical Integration		Coordination		Governed Internally by Hierarchy	
Virtual Integration	**High:** •Dedicated Investments •Knowledge-Sharing •Trust	Coordination & Specialization	Differentiated, Complex	Governed Externally by Trust and Implicit Long-Term Agreements	High Quality / Low Quantity (2) Suppliers
Arm's Length	**Low:** •Dedicated Investments •Knowledge-Sharing •Trust	Specialization	Commodity	Governed Externally by Legal Contracts	Low Quality / High Quantity Suppliers

Getting firms to **Specialize** is much less difficult than getting them to **Collaborate**

[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

"Virtual Integration – 3 Ingredients"

- **Dedicated Asset Investments**
  - **Investment in factories, equipment, processes and people that are customized to a particular customer or supplier.**
- **Knowledge-Sharing Routines**
  - **Proprietary Knowledge**
- **Inter-firm Trust**
  - **History of following-through on promises and commitments and refusal to take advantage, even when it has the chance.**

[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

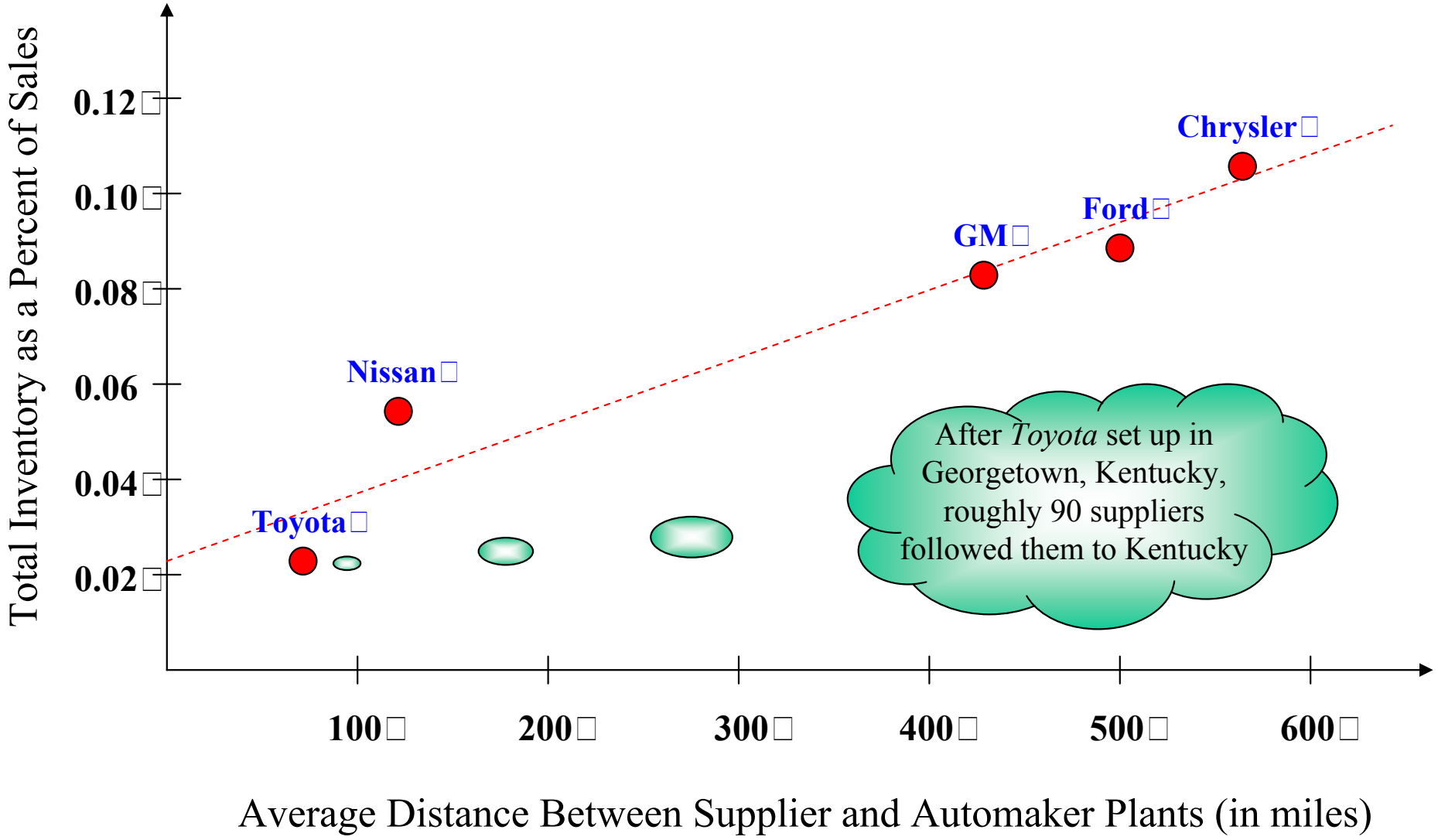
Dedicated Assets

- **Dedicated Asset Investments**
  - **Investment in factories, equipment, processes and people that are customized to a particular customer or supplier.**
- **Three types of Dedicated Assets:**
  - Site **Specialization**
  - Physical Asset **Specialization**
  - Human **Specialization**
- **Toyota's two types of suppliers:**
  - ***Affiliated suppliers*** **(Kankei Kaisha).**
    - **Toyota has a minority stock ownership position.**
    - **They transfer employees (*Guest Engineers*)**
    - **20% of top managers were former Toyota employees**
    - **They average only 30 miles distance**
  - ***Independent Suppliers*** **(Dokuritsu Kaisha)**

[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

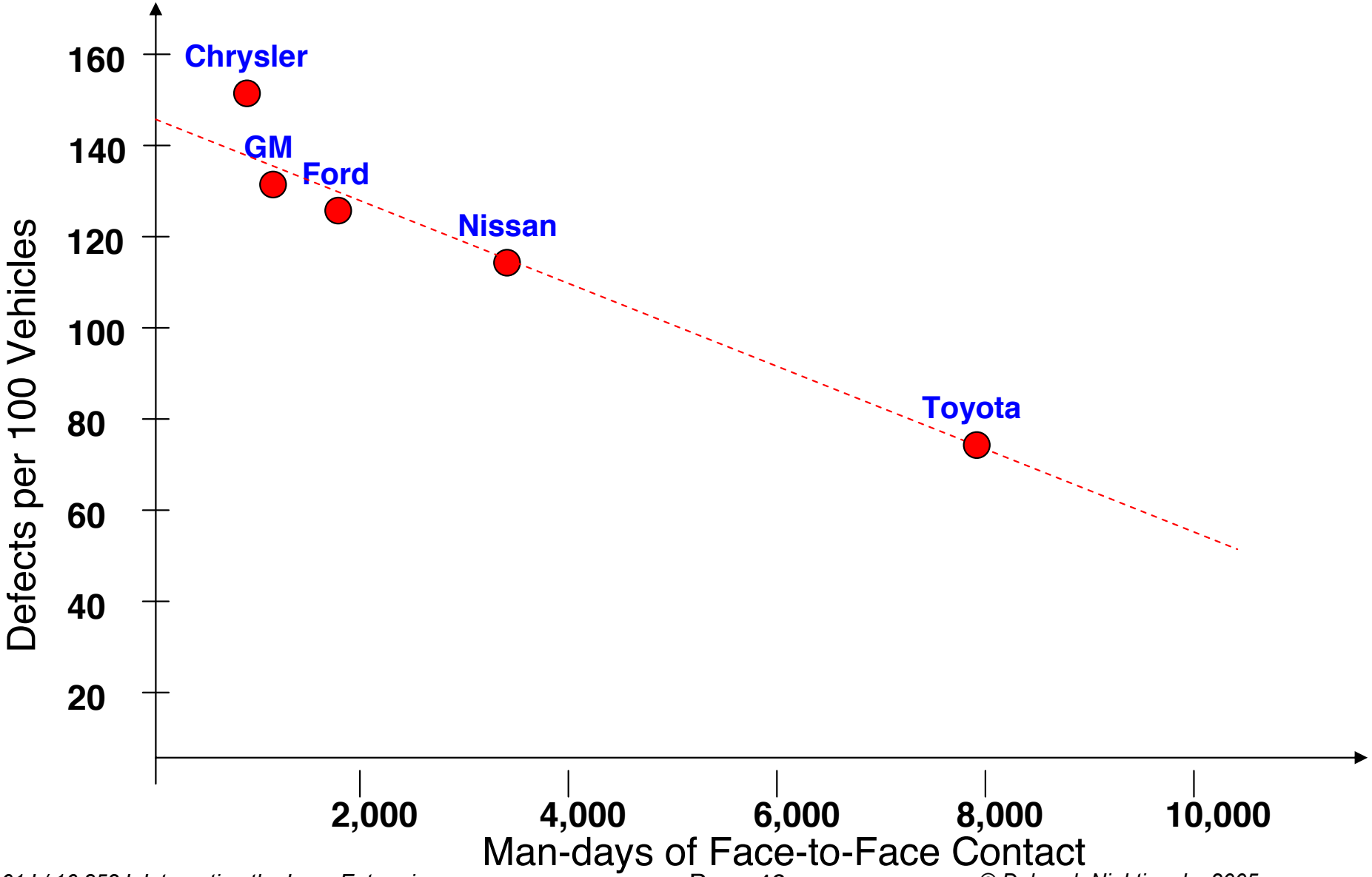
Site Specialization



[1]*Source: "Collaborative Advantage" by Jeff Dyer*

Collaborative Advantage[1]

Human Specialization



[1]Source: "Collaborative Advantage" by Jeff Dyer

Collaborative Advantage[1]

Physical Asset Specialization

- 22% **of *Toyota's* supplier's capital investment were so dedicated to their primary customer, that they could not be redeployed if *Toyota* walked away.**

- 15% **of *US firms* supplier's capital investment were so dedicated to their primary customer, that they could not be redeployed if the *US firm* walked away.**

[1]*Source: "Collaborative Advantage" by Jeff Dyer*

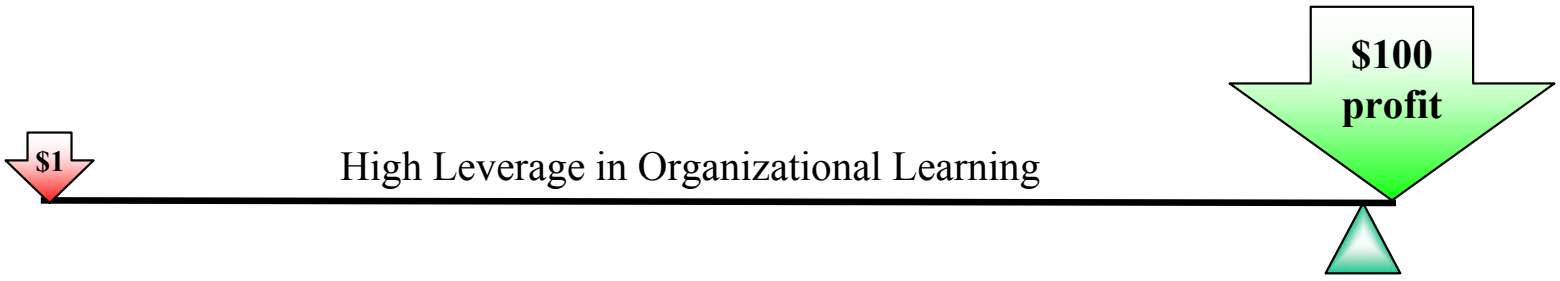
Collaborative Advantage[1]

Toyota's Consulting Teams

- **OMCD (*Operations Management Consulting Division*)**
  - **6 senior executives**
  - **50 consultants**
    - **15-20 permanent consultants**
    - **25-30 "fast-track" younger consultants**

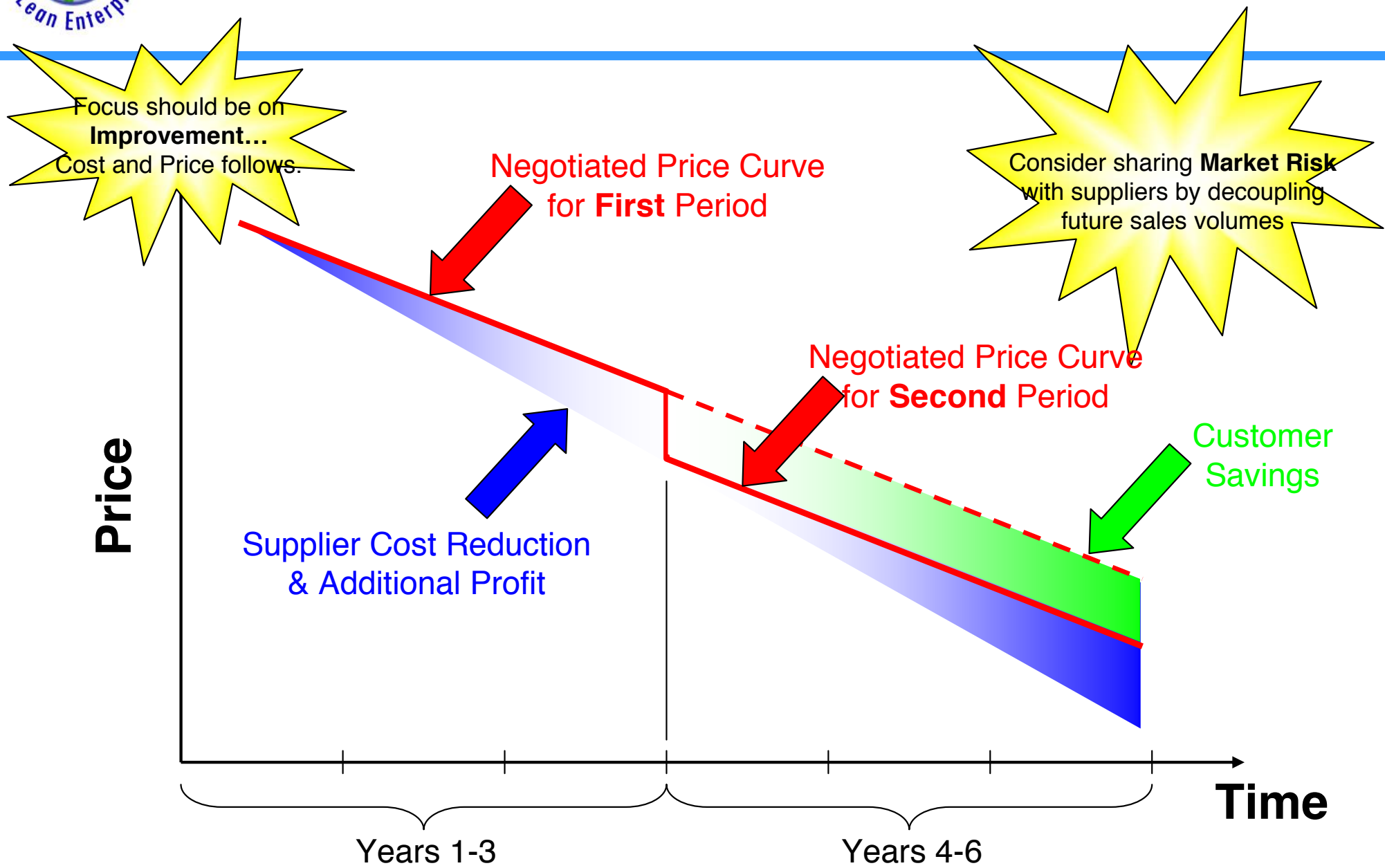
- **TSSC (*Toyota Supplier Support Center*)**
  - **US version of the OMCD**

- **Toyota invests $50 million annually on Supplier Training**
  - **This is only 0.03% on annual revenues of $150 billion**
  - **$50 million invested to achieve 3.3% spread on profits for themselves** (& their suppliers**) = $5 billion**
  - **For every $1 spent on Supplier Training, $100 comes back in profit.**



[1]*Source: "Collaborative Advantage" by Jeff Dyer*

Long Term Contracts and Pricing[1]



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