Supply Chain Management
MGO 303

Supply Chain Integration
Supply Chain Integration – The Case of Dell Inc.

- Founded by Michael Dell in 1994
- Product offerings – consumer electronics: Workstations, servers, storage, monitors, printers, LCD TVs etc.

- Key strategy – sell direct to customers; build/assemble to order
- Manufactured by other companies but sold under the Dell brand

- Contract Manufacturing - $178 billion industry in 2001
- By 2005, almost all desktop PCs sold in the United States were contract manufactured
Critical Components of a Desktop PC & Major Component Manufacturers

**Chipset**
- AMD
- Intel

**Motherboard**
- ASUS
- Foxconn
- Intel
- MiTAC

**Printed Circuit Board**
- BTI Electronics
- Compeq
- GCE
- Plato Electronic

**LAN Chip**
- Broadcom
- Intel

**Desktop Chassis**
- ASUS
- Flextronics
- Foxconn
- MiTAC
- Lite-On

**Desktop PC**
- Acer
- Apple
- Dell
- Fujitsu Siemens
- Gateway
- HP
- Lenovo/IBM

Source: Fox
Figure 6-2 Levels 1–5 of desktop PC assembly.

- **Level I**: Parts manufacturing
  - Nonpointed stamping
  - Parts + Molding parts

- **Level II**: Parts assembly
  - Parts + cover pointed stamping

- **Level III**: Computer case

- **Level IV**: Computer case + SPS
  - and/or flat cable
  - and/or back plane

- **Level V**: PCB Level IV – FDD
  - Vaulted with heat sink and/or fan
  - Assembly
  - Floppy disk drive
  - and/or fan
  - Standby power supply

The diagram illustrates the hierarchical assembly process from parts manufacturing to the final assembly components, highlighting the integration of various parts and subassemblies at different levels.
Figure 6-3 Levels 6–10 of desktop PC assembly.

Source: Foxconn Company presentation.
Dell’s Supply Chain

L5

MB
Chassis

5 Weeks

China Integration

Supplier Logistics Center

Dell Manufacturing

Customer

3rd Party Integrator (managed by Equipment Manufacturers)

L5 additional cost

L6

MB
Chassis

5 Weeks

Supplier Logistics Center

Dell Manufacturing

Customer
## L6 vs. L5: Value Comparison

<table>
<thead>
<tr>
<th>L6</th>
<th>L5</th>
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<tbody>
<tr>
<td>• Integrated offshore &amp; outside a Dell facility</td>
<td>• Integrated inside a Dell facility</td>
</tr>
<tr>
<td>• Integrated motherboard-inside chassis shipped on water</td>
<td>• Chassis shipped on water</td>
</tr>
<tr>
<td>+ Labor savings</td>
<td>• Motherboards shipped by air</td>
</tr>
<tr>
<td>+ MB air-freighting costs are eliminated</td>
<td>+ Increased supply chain flexibility</td>
</tr>
<tr>
<td>+ Reduced motherboard packaging costs</td>
<td>- Increased motherboard air-freighting costs</td>
</tr>
<tr>
<td>- Reduced supply chain flexibility</td>
<td>- 3rd-party integration cost in US</td>
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<tr>
<td>- More motherboards need to be re-worked in the event of an MB ECN</td>
<td>- Separate logistical costs for chassis and motherboards</td>
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**L6 is more cost-effective than L5.**
Introduction

• Effective SCM implies:
  • Efficient integration of suppliers, manufacturers, warehouses, and stores.
  • Coordinate activities across the supply chain

• Improve performance: reduce cost, increase service level, reduce the bullwhip effect, better utilize resources, and effectively respond to changes in the market place.

• Challenges can be met by integrating:
  • the front-end, customer demand,
  • to the back-end, production and manufacturing portion of the supply chain.
  Recall how Dell managed to integrate the front-end and back-end of its supply chain

• Various supply chain integration strategies:
  • Push, pull, push–pull strategy.
  • Matching products and industries with supply chain strategies.
  • Demand-driven supply chain strategies.
  • The impact of the Internet on supply chain integration.
Push-Based Supply Chains

• Manufacturer demand forecasts based on orders received from the retailer’s warehouses.
Pros & Cons of Push-Based Supply Chains

+ Customer orders can be met from stock (less lead time)

+ Less risk in event of a supply disruption

+ Production batch sizes do not depend on Customer orders (large batches can reduce manufacturing cost); economies of scale in transportation

+ Machine & Labor utilization is high*

- Production is based on forecasts; always a margin of error

- Demand trends not reflected in production immediately => high production changeover costs

- High inventory levels; inventory can become obsolete due to regulation/customer trends

- Bullwhip effect – Demand forecasts becomes increasingly “bad” or inaccurate as you move up the supply chain
Bullwhip Effect in Push-Based Supply Chains

- Leads to inefficient resource utilization
- Planning and managing are much more difficult.
- Not clear how a manufacturer should determine production capacity? Transportation capacity?
  - Peak demand?
  - Average demand?
- Results:
  - Higher transportation costs
  - Higher inventory levels and/or higher manufacturing costs
  - more emergency production changeovers
Pull-Based Supply Chains

- Manufacturer production triggered due to customer order; no or limited reliance on demand forecasts
## Pros & Cons of Pull-Based Supply Chains

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>+ No or little inventory required at retailer &amp; manufacturer =&gt; less wastage due to obsolescence, lower inventory holding costs</td>
<td>- Long lead times to the customer</td>
</tr>
<tr>
<td>+ Greater product variety can be offered (custom-made products)</td>
<td>- Actual implementation may require the manufacturing lead times to be not too long</td>
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<tr>
<td>+ Manufacturing is synchronized with demand trends</td>
<td>- Reliance on Point-of-Sale systems; requires sharing customer demand info with channel partners</td>
</tr>
<tr>
<td>+ Labor and Machine (workforce) is utilized effectively</td>
<td>- Greater risk in event of a supply disruption</td>
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<tr>
<td>+ No or less Bullwhip effect; lower variability in the system</td>
<td>- Production batch sizes depend on customer orders; no economies of scale in transporation</td>
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Why are Pull-Based Supply Chains attractive?

Example: A major apparel manufacturer recently changed its supply chain strategy to pull-based system. Retailer orders from this manufacturer about once a month, but transfer POS (Point of Sale) data much more frequently, for example, daily or weekly. These data allow the manufacturer to continuously adjust production quantities according to true customer demand

• Lower lead times due to ability to better anticipate retailer orders
• Decrease in inventory at retailers due to lower lead times
• Decrease in variability faced by manufacturer
• Reduction in inventory at the manufacturer
Implementation of Pull-Based Systems

• Often difficult to implement
  • when lead times are long
  • more difficult to take advantage of economies of scale

• Advantages and disadvantages of push and pull supply chains:
  • new supply chain strategy that takes the best of both.
Push-Pull Strategy

- Some stages of the supply chain operate in a push-based manner
  - typically the initial stages
- Remaining stages employ a pull-based strategy.

- Interface between the push-based stages and the pull-based stages is the push-pull boundary
General Strategy

• Observe that, the manufacturer takes advantage of the fact that aggregate demand forecasts are much more accurate (Why?)

• Since demand for the generic product is an aggregation of demand for all its corresponding end-products, forecasts are more accurate and inventory levels are reduced.

• Dell has used this strategy very effectively and is an excellent example of push-pull strategy in practice
• Postponement or “delayed differentiation” is another example of the push-pull strategy
• The manufacturing process starts with a generic or “common” product
• Closer to end-product assembly, it is customized to a specific product as late as possible
• Product and manufacturing process can be delayed until after manufacturing is under way
Examples of postponement

- Benetton, Europe’s largest clothing manufacturer supplying wool sweaters
- Rapidly changing consumer preferences
- Long manufacturing lead time
- Push-supply chain; little flexibility to changing customer taste

Supply Chain Timeline

7 months from start to finish

Customer order

<table>
<thead>
<tr>
<th>Acquire yarn</th>
<th>Dyeing &amp; finishing yarn</th>
<th>Assembly</th>
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Examples of postponement

- Benetton revised its production process to a push-pull supply chain.
- Postponed dyeing of garments until after sweater assembly.
- Color choices can be delayed until closer to the selling season.

Supply Chain Timeline:

- <<7 months from customer order to delivery

Push

Acquire yarn

Part manufacturing and assembly of “generic” product

Pull

Dyeing & Finishing

Dyeing & Finishing

Dyeing & Finishing
Summary

- In postponement, make a part of the product to stock – generic product
- The point where differentiation has to be introduced is the push-pull boundary
- Observe that portion of the supply chain starting from the point of differentiation is pull-based
- Based on extent of customization, the position of the boundary on the timeline is decided
- The customer order receipt is synchronized with the location of the push-pull boundary
Identifying the Appropriate Supply Chain Strategy

- A framework for identifying the appropriate supply chain (push/pull/hybrid) is in looking at
  - Extent of variability in customer demand
  - Economies of Scale in manufacturing/storage/distribution
- Higher demand variability leads to a preference for managing the supply chain based on the pull strategy
- Smaller demand uncertainty leads to interest in managing according to a long-term forecast, a push strategy
Identifying the Appropriate Supply Chain Strategy

• If economies of scale are important, there is a preference for managing the supply chain based on the **push** strategy
  • The greater the value of aggregating demand
  • The greater the importance of managing the supply chain based on long-term forecast

• If economies of scale are unimportant i.e., aggregation does not significantly reduce cost, there is a preference for managing the supply chain based on the **pull** strategy
Economies of Scale

Demand Uncertainty

Low

High

PULL

PUSH-PULL

I
Computers

II
Furniture

III
Books & CDs

IV
Grocery

PUSH-PULL

PUSH
Some more thoughts

• It is relatively easy to identify the best strategy in boxes I and III

• In the others, uncertainty “pulls” the supply chain towards one strategy, while economies of scale “push” towards another

• Need to distinguish between production and distribution strategies
  • Production has to follow a pull-based strategy to avoid depending on long-term forecasts
  • Distribution should follow “push” to take advantage of economies of scale in transportation

• Example: Furniture industry
  • Make-to-order production (pull)
  • Fixed delivery schedule; LTL carriers (push)
Implementing a Push–Pull Strategy

• Achieving the appropriate design depends on many factors:
  • product complexity
  • manufacturing lead times
  • supplier–manufacturer relationships.

• Many ways to implement a push–pull strategy
  • location of the push–pull boundary.
    • Dell locates the boundary at the assembly point
    • Furniture manufacturers locate the boundary at the production point
Implementing a Push–Pull Strategy

• Story of GM’s Cadillac

• Why did this strategy fail?
## Characteristics of the Push and Pull Portions of the Supply Chain

<table>
<thead>
<tr>
<th>Portion</th>
<th>Push</th>
<th>Pull</th>
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<tbody>
<tr>
<td>Objective</td>
<td>Minimize Cost</td>
<td>Maximize Service Level</td>
</tr>
<tr>
<td>Complexity</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Focus</td>
<td>Resource Allocation</td>
<td>Responsiveness</td>
</tr>
<tr>
<td>Lead time</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>Processes</td>
<td>Supply Chain Planning</td>
<td>Order Fulfillment</td>
</tr>
</tbody>
</table>
Impact of the Push-Pull Strategy

• Push portion
  • Low uncertainty
  • Service level not an issue
  • **Focus on cost minimization.**
  • Long lead times
  • Complex supply chain structures
  • Cost minimization achieved by:
    • better utilizing resources such as production and distribution capacities
    • minimizing inventory, transportation, and production costs.
  • Supply Chain Planning processes are applied.
Impact of the Push-Pull Strategy

• Pull portion
  • High uncertainty
  • Simple supply chain structure
  • Short cycle time
  • Focus on service level.
  • Achieved by deploying a flexible and responsive supply chain
  • Order-fulfillment processes are applied
The Impact of Lead Time

• What is the impact of lead time on supply chain strategy?

• Longer the lead time, more important it is to implement a push based strategy.

• Typically difficult to implement a pull strategy when lead times are so long that it is hard to react to demand information.
Matching supply chain strategies with products: the impact of lead time and demand uncertainty.
Impact of Lead Time

• Box A
  • Items with short lead time and high demand uncertainty
  • Pull strategy should be applied as much as possible.

• Box B
  • Items with long supply lead time and low demand uncertainty.
  • Appropriate supply chain strategy is push.
Impact of Lead Time

• **Box C**
  - Items with short supply lead time and highly predictable demand.
  - Continuous replenishment strategy
    - Suppliers receive POS data
    - They use these data to prepare shipments at previously agreed-upon intervals
    - A pull strategy at the production and distribution stages and push at the retail outlets.

• **Box D**
  - Items with long lead times are long and unpredictable demand
    - Inventory is critical in this type of environment
    - Requires positioning inventory strategically in the supply chain