Managing Operations

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Themes

- Operations is what firms and organizations do
- Improving operations means creating more value from inputs
- Reducing variation in processes and response times can create value
- Increasing product variety and customer choice can also create value (but increase variation and response time)
- Supply chain organization for increasing value requires a system perspective
Outline

• Basic operations strategy
• General operations areas
• Principles in variation reduction
• Principles in response time reduction
• Effects of variety and centralization
• Supply chain organization basics
Operations Strategy

• Create value in products and services to customers based on:
  – Time (responsiveness, convenience)
  – Price (cost)
  – Quality (reliability)
  – Variety (choice)

• Strategy generally focuses emphasis on one of these – examples?
Typical Ops Decisions

- Which products to develop? Markets to enter?
- What process to use (make/buy..)?
- Where to produce product?
- What suppliers to use?
- How much to integrate vertically (horizontally)?
- What strategic partners to invest in (acquire)?
- Parts to divest?
- How to distribute/reach consumers?
Operations Areas

- Product design and development
- Control and coordination (project/program)
- Product/service management (production (execution)/distribution/sales/service/return/coordination)
- Quality
- Inventory
- Purchasing/Supplier/Distribution Channel (Supply Chain)
- Logistics/Transportation
- Facilities
Operations Scope

- ~80% of employment in a firm
- Focus of capital equipment
- Disruptions often debilitating or catastrophic (long-term value impacts)
- All industries/organizations
Sources of Variation

- Fixed costs (often for ordering and setups)
- Setup times and lead-times
- Uncertainties in:
  - Suppliers: lead-times, quality, reliability
  - Production: process times, trans-shipment, available resources
  - Customers: demand (choice), reliability, location
Fixed Costs and Variation

• As fixed costs for setting up a product for production increase, how often is it produced?
• What is the difference in the quantity produced and the amount of inventory?
• What is impact of variable production costs?

• Note: Economic Order Quantity (EOQ)
  -Minimum average cost per production cycle
Setup Times and Variation

- Setup time creates variation in output that also creates need for inventory in particular at bottlenecks (constraints)

Questions:
- How to find bottlenecks?
- Suppose 2 machines: A produces 1/minute with 10 minute setup; B produces 2/minute with 20 minute setup

Which to buy?
Quality Variation

• Variability in quality of service or product reduces value to customer
• Variability in internal processes reduces value-added activity
• Reduction needs: visibility, measurement, assignability, feedback mechanisms

Q: Suppose minimum fill weight of box is 16 oz.; all shipped products pass with average 16.5 oz. and standard deviation of 0.5 oz. Cost is $0.10/oz.; How cost reduction by increasing packing precision?
Demand Variation

• How much to order (produce) to meet demand when it is uncertain
• Balance: Cost of understocking (shortage) versus cost of overstocking (overage)
• One more unit of production $\Rightarrow$ cost of overstocking $\uparrow$ & cost of understocking $\downarrow$

At best amount, costs for over and under balance
Production and Lead-time Uncertainty

• As uncertainty increases in production and lead-times, need for inventory to meet demand increases

• Inventory = Demand * Cycle time

Cycle time and inventory increase rapidly in variation of cycle time and in demand (for given capacity)
Popular Variation Reduction Mechanisms

- Customer-smoothing and vendor-management (VMI)
- Process improvement (Kaizen) – employee focus (Jidoka)
- Setup time reduction
- Lean manufacturing
- Pooling/centralization
Pooling and another Square Root Rule

• As you add N independent demands together, coefficient of variation (st. dev./mean) reduces by square root of N
• D1~\mu_1=10, \sigma_1=2;
• D2~\mu_2=10, \sigma_2=2
  \[ cv_1 = cv_2 = 20\% \]

But D1+D2 has mean: 20; \[ \sigma = (2^2 + 2^2)^{0.5} = 2 \times 2^{0.5} \]
\[ cv = 2 \times 2^{0.5} / 20 = 14\% = 20\% / 2^{0.5} \]
Pooling Exercise

Suppose two distribution centers with equal demands which require 98% fill rate (~2 st. dev.’s), how much inventory to carry if consolidated into one?

What about lead-time? (Usually increases at least by the square root of lead time)
Lean Concepts

• Switch from “push” to “pull”
• Push: make to meet anticipated demand
• Pull: let customers determine production
• Principles:
  – one-piece flow (or like water)
  – Eliminate waste and variability
  – Often: (Toyota): Fix inventory (kanban)
Also, referred to as Just-in-Time systems
Some Keys to Lean

• Have to know where value comes from
  – Identifying value-added is key
• Cannot reduce WIP without reducing variability
  – WIP/Cycle Time/Variability relation:
    
    ![Graph showing the relationship between WIP, Cycle Time, and Variability]

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GSB, January 15, 2008
Most Important Lean (JIT) Factors

• Management support*
• Reducing lot sizes
  – Must also reduce setup times
  – Remember focus on non-value-added
• Attention to differences from Toyota Production System
  – Environment matters with worker quality responsibility and standardized procedures
  – Consistency on metrics

*-Flynn, Sakakibara, Schroeder – Academy of Management Journal
Watching for Rocks
• High WIP

WIP
Problems
• Low WIP

WIP
Problems
Learning from the Rocks

• If your boat hits a rock, you have to learn from it
• Part of TPS is that everyone has responsibility for looking for rocks
• When anyone sees a rock in TPS, they are expected to suggest a solution
Historical Background for Lean (Auto Industry)

• Production Trends:
  Craft => Mass => Lean

• Next Steps:
  Agile/Flexible and Mass Customization
Additional Trends

• Globalization

• Consolidation
Effects: Inventory Turns (Sales/Inventory)

If Toyota is so lean, why inventory up?
Becoming Agile (after Lean)

• What does it mean to be agile?
• How important is that now?
• Key trends:
  – Mass customization
  – Delayed differentiation
  – Supplemental rapid response vendors
Agile in R&D

• Recent survey*
  – 45% increasing rate of new product innovation
  – 27% decreasing time to market
  – 30% project majority new product from outsider vendors

• Implications?
  – Faster and greater market changes
  – Relationships key

*NineSigma, Inc. 2004
Mass Customization

• Producing customer-specific products on a mass-production scale

• Requirements:
  – Modularity in design
  – Use of outsider vendors
  – Delayed product differentiation
Delayed Differentiation

• Advantages:
  – Pooling components decreases variability
  – Can position closer to customer
  – Rapid response to customer

• Examples
  – HP/Dell: Printer/computer assembly
  – LLBean: Long-lead time offshore and short lead-time local suppliers
Rapid Response Vendors

• Motivation
  – Respond to demand changes (especially for short seasons)
  – React to supply disruptions
• Building all on quick reactions, raw material, and peak capacity
  – Zara – fashion manufacturing and retail
Zara Model

- Small finished-goods inventory
- Constant product introductions
- Substantial material availability
- High peak capacity
- Local manufacturing
- Direct market measurement
- Results: 85% average full price (compared to industry 65%); 20% average annual sales growth
Supply Chain Concepts

• Goals: right amounts in right place at right time
• Determinants of supply chain design:
  - product characteristics (life cycle, demand variation, margin, variety, consumer responsiveness sensitivity)
  - cost of production, transportation, storage
  - supplier quality, availability
Additional Issues

- Bullwhip effect (escalating variation)
- Vendor management and ownership
- Collaborative planning and forecasting
- Shared shortage/overage costs (buyback/sharing)
Competitive Conclusions

- Lean is the base now if done in the right way
- Firms should aim for agility (and the culture that supports it)
- Need to know what they do best (and how to measure it)
- Need to prepare for disruptions
- Need to foster innovation
Reference on Ops/Supply Chains

• Articles:
  – M. Fisher, What is the right supply chain for your products?, HBR
  – H. Lee, et al., The bullwhip effect in supply chains, Sloan Mgmt Review

• Books:
  – Simchi-Levy et al., Managing the Supply Chain
  – Van Mieghem, Operations Strategy
Thank you!