Real Options in
Supply Chain Management

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Objectives of this presentation

- To stress the role of flexibility in design and management of supply chains
  - It provides the means to adjust to the consequences of inevitable risks

- To define Options, as means to create flexibility
  - Build upon their use in financial context
  - Focus is on application to the design and then effective management of the system over time

- Take-away: “options thinking” is crucial
Outline

Managers need flexibility to respond to unexpected

- This concept implies a deep change in way we think about design of supply chain systems
  - From: designing to specified circumstances
  - To: planning for a range of possibilities

- Options analysis is way to value flexibility
  - Builds upon options analysis as used in finance

- Example from current work on disruptions
Managers need flexibility

- Both suppliers and customers need flexibility to deal with unexpected changes

- Aircraft industry has been selling options for years, to benefit of airlines and manufacturers

- Product modularity and platforms enhance ability to adjust products to market demands

- Short life cycles provide flexibility to recognize manufacturing issues, to respond to design changes requested by marketplace
Flexibility for Disruptions

- Managers frequently encounter disruptive situations that demand, or would benefit from, out-of-ordinary responses

- Recent Examples:
  - Key supplier cannot deliver (fire in a chip plant)
  - Normal links broken (West Coast shipping strike)
  - Product demand surges (hit fashion or holiday item)

- Ability to respond quickly can be critical
  - Nokia responded fast to chip plant fire, Ericsson couldn’t => Nokia was able to expand market share significantly
Flexibility => Insurance, Opportunity

- One way to view flexibility is as “insurance”, the capability to avoid bad outcomes

- Another: readiness to capitalize on opportunities

- [these are like ‘puts’ and ‘calls’ – see later]

- Either way, flexibility requires prior preparation
  - Backup suppliers or alternative designs
  - Commitments by manufacturers for extra capacity
  - Capacity to re-deploy supply chain
Flexibility thinking => Mental Shift

- Building flexibility into system requires a mental shift in framing of supply chain

- Problem viewed as
  - managing risk over time (time varying practices)
  - … and over range of circumstances
  - not traditional optimization of performance for given specifications

- Need to face a more complex problem, building on our capability to optimize for particular situations
Traditional Practice

- Typically focuses on design to specifications
- This is a complex optimization process
- These specs decided outside the optimization process (for example, by market analyses)

![Diagram showing the best design to specification on a Cost vs. Capacity graph]
Actual System Performance is Risky

- Why is this?

- Because market and other conditions uncertain

- Example: Profitability depends on market size

![Diagram](attachment:image.png)
Design involves a distribution of risk

- Outcomes vary in probability

- Results of outcomes times probability => pdf (probability distribution function)
Design Opportunity

- To vary the distribution of probability distribution to increase, maximize value

- Key means of doing this: flexibility that permits adaptation of design to circumstances
Consequences of Flexibility (1)

- Accentuate the positive -- take advantage of opportunities (also known as “call options”)

![Diagram showing original and new probability density functions (pdfs) for loss and profit.](image-url)
Consequences of Flexibility (2)

- Minimize the negative -- avoid big losses (as with insurance) (also known as “put” options)
Stress on Flexibility

- Represents a real change in concept of design and management of systems over time
- Why is this?
- Because: instead of designing to a specification, design for range of possible levels of performance

![Diagram showing the relationship between cost, performance, design to specification, and design for expansion.]
Flexibility Adds Value

• Flexible systems allow managers to
  – Recover from bad events, such as disruptions
  – Take advantage of opportunities

• Flexibility can reduce total costs
  – Costs less to adapt to variability and change

• Example: Fire in chip plant
  – Ability to redesign product with alternative chips permitted Nokia to reduce cost of interruption and, in this case, to take advantage of weakness of competitor
Flexibility Costs

- **Money**
  - Inventories, investment in design, computer systems
  - Extra Space for Expansion

- **Complexity**
  - Management systems more complex

- **Time**
  - Design and Planning Efforts take time
Central Issue

- What Flexibility should we incorporate in System?
- The question is in effect: “What elements of flexibility are more valuable than their cost?”
- How do we value flexibility?
- This is the central topic of options analysis
"Options" = Formal Notion of Flexibility

- An Option is a formal way of defining flexibility
- Options valuation well developed for finance markets
- Field of "real" options applies theory to real projects
  - Future decisions have features similar to financial options
  - Financial options valuation can be extended to projects
- However, adaptation not simple:
  - We do not have statistics on future events
  - Developments unlikely to be random
What is an Option?

- A right, but not an obligation...
  - Asymmetric returns; exercise only if advantageous
  - Acquired at some cost

- to take some action...
  - to switch fuels, drop project, buy or sell something, etc, etc,

- now, or in the future...
  - May be indefinite, as for dual fuel burner
  - Often for a limited time after which option expires

- for a pre-determined price.
  - Cost of action separate from cost of option (down time for switching burners different from cost of dual fuel burner)
Example Financial Option

- Example: An Option to buy 100 shares of ATT at 20 through Oct. 3, 2003

- Option is a right. It allows, doesn’t force owner to ...
  - … buy shares at a specified price
  - … for a specific time (up to October 3, 2003)
  - “Strike” price is set in advance (at $20 in this case)

- Note: on May 23, 2003, quoted prices were:
  - 1 share of ATT = $ 19.25
  - option on 1 share = $ 1.95

(Source: finance.yahoo.com)
Asymmetry of Option

- Owner of Option Likely to exercise right to buy stock if its price > strike price or $S > $20
  - owner then makes profit = $(S - 20)
  - these profits may be unlimited

- Owner not required to exercise option
  - Loss limited to cost of buying option (example: $1.95/share)
  - losses are limited

- Once you own this option, Value is not symmetric
  - In this case: All gain, No pain

- Note: Other options might be all pain, no gain...
Example: “Real” Option

- “Real” Options concerns things, as distinct from “financial” options embodied in contracts

- Example: The spare tire on your car is an option that gives you the right
  - ... to change the tire
  - ... the right in this case has unlimited time
  - ... “cost” of exercising option = effort to change tire

- Note Similarity to Financial Option
  - You will change tire only if you need to
  - You do not have to do a thing about it
Supply Chain “Real” Options

“Real” Options for Supply Chain Management can come in many shapes

Examples:

- Maintenance of alternative supplier, perhaps at higher cost, to enable use as needed
- Inventories motivated by disruptive events
- Investment in platforms for products to reduce vulnerability to specific components
- Contracts with manufacturers to insure priority supply
- Cutting cycle-time of product, to make faster response to market and production issues
Recent Results (Pochard)

- Research on supply chain disruptions

- What circumstances justify a Second Supplier?

- We developed a model to estimate cost, benefits
  - set up of relationship, part costs, frequency of disruption
  - gain or loss of market share

- Model investigates option of delaying decision
  - This can be worth a lot

- A time-varying dynamic strategic is best!
Best Policy for Second Supplier

Best policy depends on Set-up Cost, I:
- If $I < A$, take 2 suppliers from start.
- If $A < I < C$, delay decision: start with 1 supplier, take 2 if circumstances warrant.
- If $C < I$, take 1 supplier.
T = 0
Delay investment decision. Value of 2nd supplier not yet clear.

Path 1: Demand keeps increasing.
  – Take 2 suppliers at t = 3

Path 2: Demand keeps decreasing.
  – Stick to one supplier

Demand Evolution

T = 0  1  2  3  4

Delaying decision to invest in dual-sourcing lets firm observe demand changes over time and make right decision at right time.
Results Sensitive to Circumstances

Illustration of the evolution when
- disruption probability increases
- disruption induced loss of market share increases
Summary

- Flexibility has value, because of risk
- Supply chain design should incorporate flexibility
- Issue is: How do we value flexibility?
- Options embody formal concept of flexibility
- "Options Thinking" key
- Topic of current research