


MIT MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MIT Center for Transportation & Logistics



How Supply Chains Can Deal with Uncertainty and Risk


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Agenda


- Introduction
- **How Supply Chains Can Deal with Uncertainty**
- Uncertainty from a changing world
- Dealing with Uncertainty (concepts)
- Dealing with Uncertainty (examples)

SCREAM

Access xlsx file at
<http://ctl.mit.edu/jim>



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Uncertainty from a changing world



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Supply Chains Today → Uncertainty and Vulnerability

- Global sources of supply & customer destinations
 - Increasing distances → longer lead times
 - Many transborder imports & exports
 - Added security constrains flow, raises costs (C-TPAT, AEO)
- Product dynamics:
 - Fast NPI, product proliferation, increasing variety (margin*), shorter life cycle
 - How many variations of toothpaste are there on the shelf?
- Complexity! More parties in the supply chain
 - More outsourcing
 - More dependence on others in supply network
- Lean supply chains
 - Reduced inventories → Fragile supply chains
- Result → uncertainty and high vulnerability
 - Our vulnerability is a function of the supply network
 - Ex. Pan Am over Lockerbie; Williams Pipeline



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How do you predict the demand for new products?



“Why would you want to buy an Apple Watch? I’m still trying to figure that out.”**



iPad 2
Thinner. Lighter. Faster. FaceTime. Smart Covers. 10-hour battery.

Announced 3-2-11, for sale 3-11-11, 5 week delay by 3-15-11...then the tsunami impact hit



“It would have been nice if I'd made sure the product tasted good.”*



* Yum Brands Chairman David Novak, December 2007
** WSJ 3-10-15, “With Apple Watch, Fewer Distractions” by Geoffrey A. Fowler



Cases of NPI Sales Forecasting Optimism

Before their time.....

A new concept in personal transport



It was never their time.....



Adapted from Y. Sheffi, Jan '12 MIT Executive Education Program



A Few Cases of Sunset Sales Forecasting Surprise




Despite their initial death....they're back


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A Ten-Year Look at High Consequence-Low Probability Disruptions

The timeline illustrates the following events:

- 1997:** Toyota Brake Plant Fire
- 1998:** UPS Labor Strike
- 1999:** GM Labor Strike, Quebec Ice Storm
- 2000:** Taiwan Earthquake
- 2001:** Firestone-Ford Tire Recall, Philips Plant Fire, Scandals: Enron, Andersen, Worldcom
- 2002:** Sept. 11 Terrorist Attacks, FMD in UK
- 2003:** West Coast Ports Lockout, GM-Ok. tornado
- 2004:** Iraq War, Blackouts US - EU, SARS
- 2005:** Katrina
- 2006:** London Madrid Attacks, Nor'Easter
- 2007-2008:** Global Financial Crisis, Tornadoes, Pirates, Wash. storms, bridge collapse

Ref: Adapted from Dr. Debra Elkins, General Motors

Some Recent Disruptions...

- Avian Bird Flu Outbreak (US), April 2015
- GE Appliance Whse Fire, April 2015
- West Coast US Port Congestion & Labor Action, 2014-2015
- Typhoon Halong, SE Asia, Aug 2014 (\$10B revenue & 41 week impact)
- Severe flooding, NY USA, 2014 (\$4B revenue & 38 week impact)
- Typhoon Rammsun, SE Asia, July 2014, (\$1.5B rev & 38 week impact)
- Gas explosions, Kaoshing, Taiwan, 2014 (\$900M rev & 26 week impact)
- Hazmat spill, Arizona US, 2014 (\$900M revenue & 10 week impact)
- Building Collapse, Rana Plaza Bangladesh, 2013
- Thai Floods 2013
- Hurricane Sandy 2012
- Europe Financial Crisis 2012
- Thai Floods 2011
- Japan Quake/Tsunami 2011
- Haiti Earthquake 2010
- Gulf Oil Spill 2010
- Iceland Volcano 2010
- Russian Wildfires 2010
- Global Financial Crisis 2008+
- Beijing Olympics Summer 2008

How did these affect your supply chain?



Ref: Source material from "The Japan Disaster: Rebuilding Supply Chains" webinar for Journal of Commerce, by B. Artzen and J. Rice, March 24, 2011; and Resilinc Event Watch Annual Report 2014, March 2015 available at <https://www.resilinc.com/products/eventwatch-2014-annual-report/>

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High Impact of Supply Chain Failures

- Japan Earthquake/Tsunami/Nuclear Meltdown 2011: \$Bs+
- Philips Fire 2000– Nokia vs Ericsson, Ericsson loses \$400m
- West Coast Lockout 2002, \$~20B economic loss
- Boeing 787 Outsourced SC 2007-8, 2-yr delay, \$2B charges
- Mattel Product Quality Recall, 2007, 50% stock price drop
- Hershey Halloween Miss (IT), 1999, \$150M loss, -30% stock
- Nike IT system failure, \$100M revenue drop, -20% stock
- P&G Folgers (Hurricane Katrina)
- GM (tornado at Oklahoma City)
- Land Rover/UPF Thompson frame supplier bankruptcy
- Toyota (Aisin) brake plant fire 1997
- Toyota defective gas pedals, \$1.2B settlement and equity/share loss
- And many others.....LA/LB port disruption/congestion 2014-2015, Hurricane Rita, London-Madrid-Bombay terrorist attacks, labor actions/strikes, SARS, H1NI, HiN5, Somali pirates....



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Effect of Supply Chain Problems

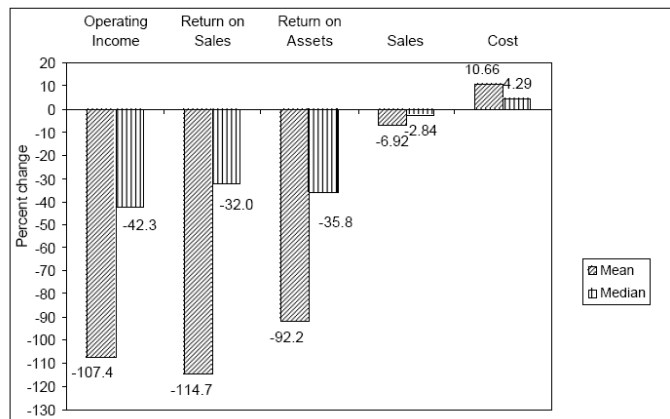


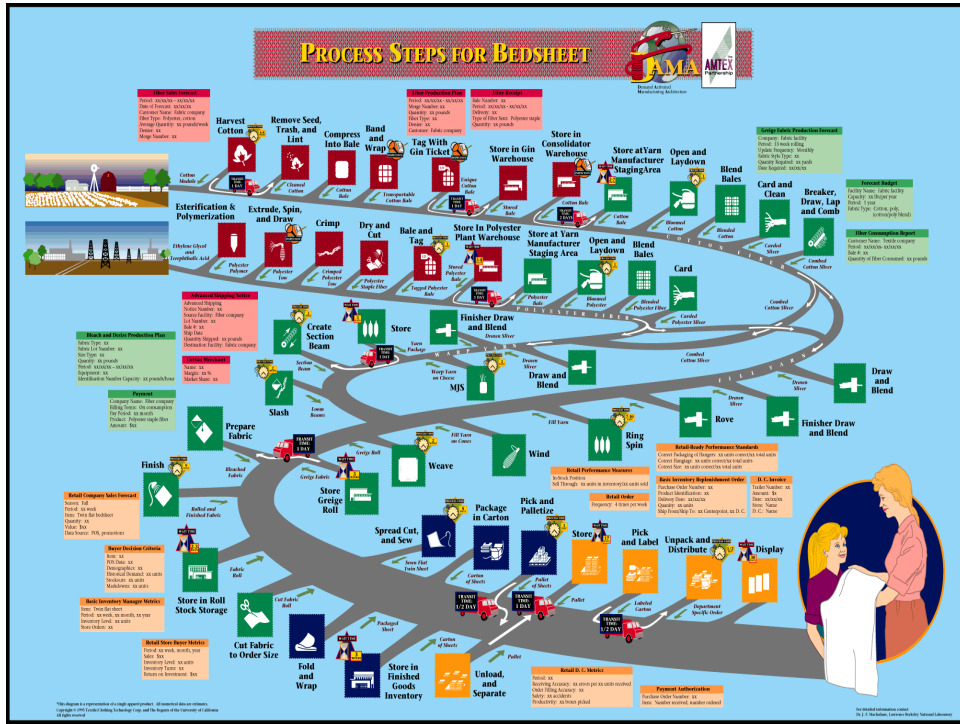
Figure 3: Change in control-adjusted operating performance of sample firms during the year before the announcement of glitches using the most-matched control sample.

Adapted from Y. Sheffi, June '10 MIT Executive Education Program

Source: Hendricks & Singhal, "Association Between Supply Chain Glitches and Operating Performance"

Complexity.....

How complicated is it to make a bedsheet?
(or other products...)



Dealing with Uncertainty (concepts)



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Some Observations about Forecasting or “we often depend on forecasts and are disappointed”

- “The only function of economic forecasting is to make astrology look respectable”
John Kenneth Galbraith
- “Wall Street indices predicted nine out of the last five recessions!” – Paul A. Samuelson in Newsweek, Science and Stocks, 19 Sep. 1966.
- “Prediction is very difficult, especially if it’s about the future.” – Nils Bohr, Nobel laureate in Physics
- “If you have to forecast, forecast often.” – Edgar R. Fiedler in The Three Rs of Economic Forecasting-Irrational, Irrelevant and Irreverent, June 1977.
- “An economist is an expert who will know tomorrow why the things he predicted yesterday didn’t happen today.” – Evan Esar

Ref.: E. Belasco, <http://www.montana.edu/ebelasco/agec421/Forecasting.pdf>

Forecasting reality

- A point forecast is always wrong – high or low
- How to make the forecast more accurate?
 - A range forecast can be right and encompass the actual demand
 - Forecasts for near-horizons can be more accurate (there is less uncertainty)
 - Collaborate with upstream and downstream partners, sharing promotion/demand/supply plans
 - Learn from past patterns – but don't be slave to them if the conditions vary
 - Share risks with partners
 - Scenario planning for multiple options
- But there is always uncertainty about the outcome until occurs
- Consider other actions that can help address uncertainty
 - Supply chain design
 - Managing uncertainty



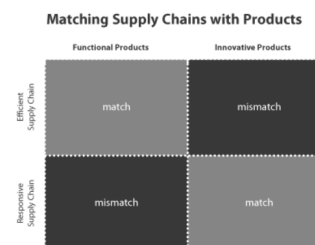
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Supply Chain Design Key Success Factors

- Design the supply chain as a System
 - Dell, Zara, Caterpillar, P&G, Walmart, Flextronics, Cisco
- Develop a portfolio of supply chains
 - Fast, responsive – low volume, high cost, near point of demand
 - Slow, efficient – high volume, low cost operation
- Right supply chain for product
- Design for Flexibility & Robustness

What is the Right Supply Chain for Your Product?



Ref.: HBR "What is the right supply chain for your product?" Marshall Fisher, March 1997



Design for Flexibility and Robustness

- **Flexibility:** prior investments in capabilities & options
 - Workforce trained to perform multiple tasks
 - Products designed to be easily reconfigured based on material and supplier selection
 - Production assets designed to be reconfigured to accommodate variability in demand
 - Provides benefit dealing with daily variations
- **Robustness/Redundancy:** prior investments in assets
 - Inventory maintained throughout the supply chain, at suppliers, internally, finished goods inventory
 - Additional production capacity maintained beyond needs to serve known customer needs
 - Only provides benefit when assets are used



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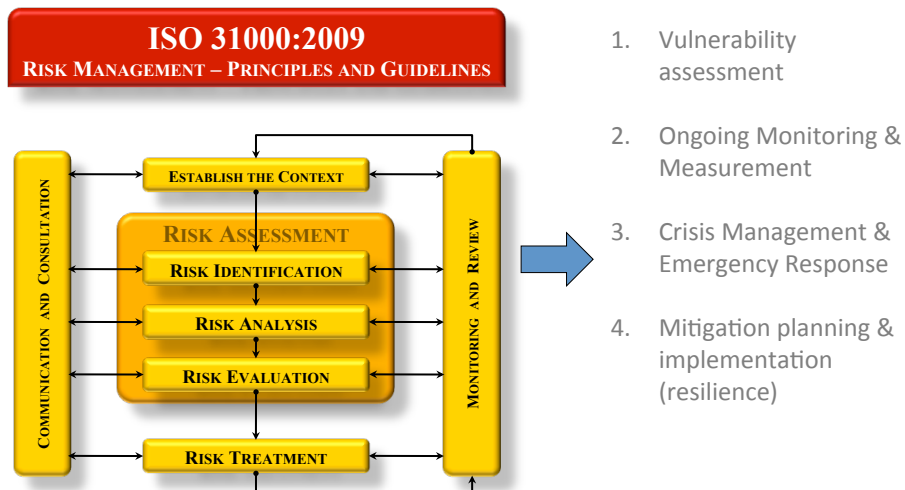
Supply Chain Risk Management

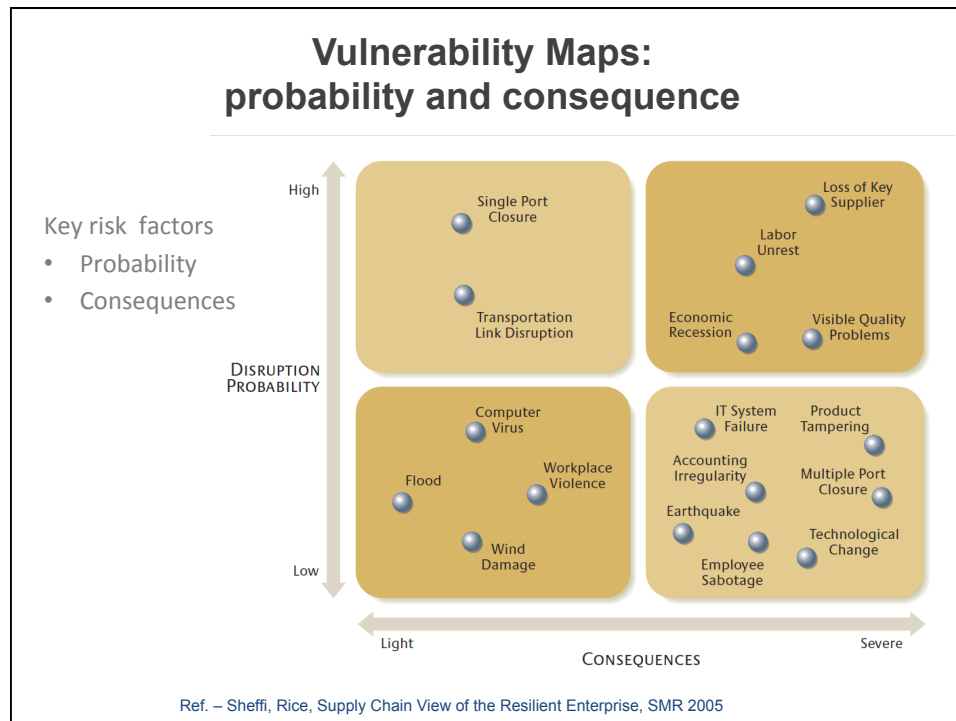
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Supply Chain Risk Leadership Council



Risk Management Framework & ISO 31000



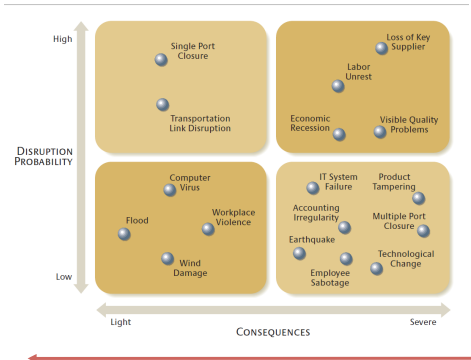


4. Mitigation Planning & Implementation

- Identify options for reducing probabilities & consequences
 - Identify company risk profile
 - Choose right mix of each for the business
 - Prevention or Response? How much of each?
- Reduce Probability → Security and Prevention
- Reduce Consequences → Response and Resilience

Reduce Vulnerability to Disruption

1. Reduce probability of disruption: increase security, prevention



2. Reduce consequences of disruption: increase resilience

Ref. – Sheffi, Rice & SC Response Project

Supply Chain Resilience

- Supply Chain Resilience:
 - In material science, resilience is the physical property of a material that can return to its original shape or position after a deformation that does not exceed its elastic limit.
 - In today's business environment, resilience is widely used to characterize an organization's ability to react to an unexpected disruption, such as one caused by a terrorist attack or natural disaster, and restore normal operations.
 - It's the ability to recreate supply chain capabilities, to 'bounce back' from variations and disruptions
- Examples of supply chain resilience?

Source: "Building a Secure and Resilient Supply Network" by J. Rice, F. Caniato, SCMR Sept-Oct 2003

SC Resilience Principles

- Failure Mode Analysis – predictable outcomes
 - Plan for recovery from failure modes, not on risk source
 - Design to 'fail smartly' – plan to fail with limited impact
 - 'Options' thinking and planning

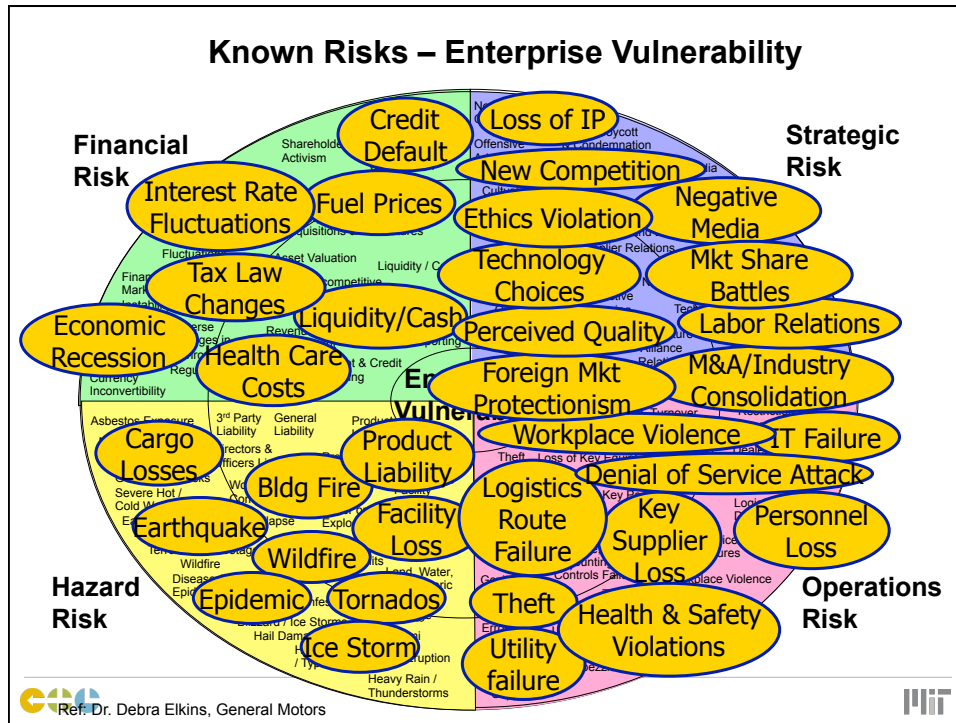
- Business Continuity Planning (BCP) for outcomes
 - Identify action plans to maintain & recreate business operations after disruption
 - Focus on responding to Failure Modes – outcomes
 - Prepare organization to respond and recover
 - Choose mix of flexibility & redundancy
 - Design supply chain network for resilience
 - From upstream suppliers, internal operations and downstream to customer, plan for backup

Sources: "SC Response Project Interim Report" by J. Rice, F. Caniato, Aug 8, 2003; Draft of SC Response Book project, Oct. 2004

Supply Chain Failure Modes

All disruptions result in a loss of one or more of these capacities:

- Capacity to acquire materials (supply)
- Capacity to ship/transport
- Capacity to communicate
- Capacity to convert (internal operations)
- Human resources (personnel)
- Financial flows



Many Paths to Flexibility Through...

- Interchangeability
- Postponement
- Supply
- Distribution
- Flexibility culture

Sources: "SC Response Project Interim Report" by J. Rice, F. Caniato, Aug 8, 2003; Draft of SC Response Book project, Oct. 2004, later pub as "The Resilient Enterprise" by Y. Sheffi

Many Paths to Flexibility

- **Interchangeability**
 - Use standardized facilities
 - Intel 'Copy Exact' – same orientation to the sun....
 - Use standard parts
 - Common parts and platforms used at tech companies (Dell, Lucent), Lucent reduced platforms from 85→5
 - Single interface used by Southwest for pilots
 - Use standard processes
 - Helix Technologies reduced production process into many small steps that can be taught and performed quickly
 - Standard processes enable rapid response to disasters (UPS)
- **Postponement**
 - Delay customization of product
 - Benetton make greige sweaters, batch colors the final product
 - H-P makes std printer & tailors for EU markets once demand surfaces
 - Sherwin-Williams paint mixed at store for custom color



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Many Paths to Flexibility (continued)

- **Supply**
 - Contract with suppliers for different response rates (Jabil, Lucent)
 - Favorable relationship supports supplier collaboration in response to disaster (Toyota – Aisin fire)
- **Distribution**
 - Use distribution system to provide broad access to parts across entire network (Caterpillar)
 - Use make-to-order and direct distribution system to enable tailoring product sales to materials on hand (Dell)
- **Flexibility culture**
 - Make employees aware of risks & tradeoffs in decisions
 - Install early warning systems (Nokia)
 - Educate for awareness & train for response (Intel)
 - Distribute decision-making, open communications



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A few examples of flexibility....

- Auto part supplier: Fire burned facilities, data
 - [Standard production process, suppliers](#) provide 'lost' info
- Cantor Fitzgerald: Lost traders, customer info
 - Recaptured 50% of trades using CRM for info
- Intel
 - [Interchangeable plants](#) via "Copy Exact!", Earthquakes BCP
- UPS
 - [Standardized processes](#) enable work force flexibility
- Lucent Technologies
 - [Interchangeable parts](#), standard models, [concurrent SC](#)
- Reebok
 - [Postpone](#) customization of NFL jerseys
- Helix Technology
 - Simplified production so supplier produces in emergency
- Jabil Circuits
 - Builds flexibility into standard contracts, 100% in 4 weeks



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A few examples of robustness....

- Morgan Stanley
 - [Redundant IT system](#), restarted 9-12-01
 - Redundancy added after '93 attack on World Trade Center
- USPS: Anthrax
 - Used [excess capacity](#) to shift processing to other sites
- Boston Scientific
 - Financial analysis indicated cash flow crunch
 - Set up [redundant production facility, staff](#) – ready & waiting
- US Government & J&J
 - [Maintain stock](#) of medical supplies, rolling inventory



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Managing Uncertainty

Uncertainty Reduction

- Risk Pooling
 - Aggregation
 - Platform strategy, product modularization
 - Standardization
 - Inventory centralization
- Time compression
 - Cycle time reduction
 - Postponement
- Information Management:
 - Focus groups, expert opinions IT tools (ERP, cloud, SaaS)
 - CPFR, VMI
 - Demand shaping
 - POS data

Risk Management

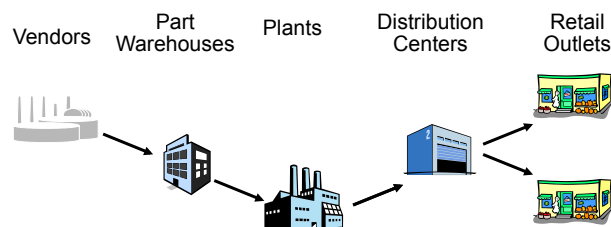
- Buffering
 - Inventory, capacity, time
- Capacity Segmentation
 - 80/20 rule,
 - ABC classification, customer profiles
- Diversify supply sources
- Flexible capacity
- Service level management
- Supply Contracts
- Outsourcing



Ref.: "Supply Chain Principle # 2; Topic: Uncertainty" MIT Supply Chain 2020 Working Paper, M. Singh July 24, 2006

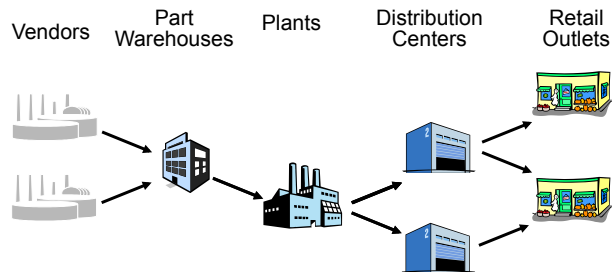


Adding Resilience to a Supply Chain



How would you add resilience to this supply chain?

Adding Resilience to a Supply Chain



Options include.....

- Redesign entire SC for resilience (streamline)
- Adding back up supplier
- Adding additional inventory
- Add additional facility
- Choices on response time
- Buying options for additional capacity in your network....

Break