


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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 2 

## Uncertainty from a changing world



23



## 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



24



## 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.”\*\*



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.....



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


27


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

The timeline shows the following events:

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

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/>



## 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....



30



## Effect of Supply Chain Problems

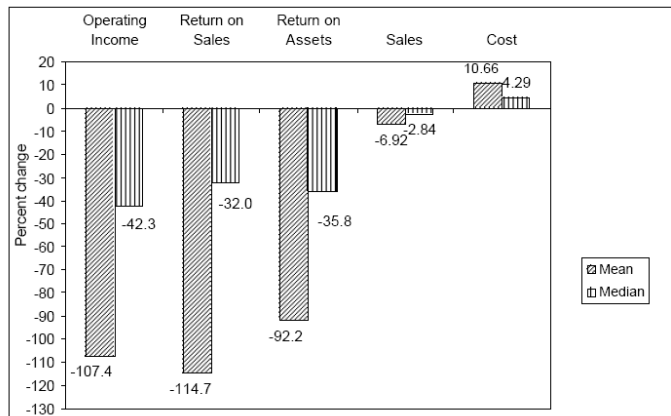


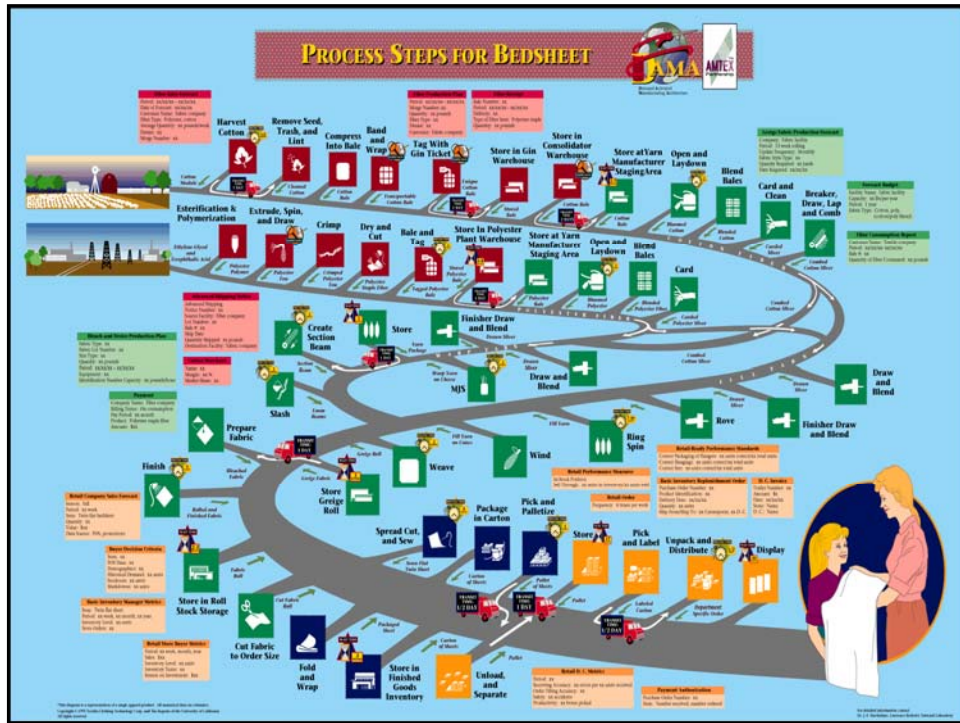
Figure 3: Change in control-adjusted operating performance of sample firms during the year before the announcement of glitches using the most-matched control sample.

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

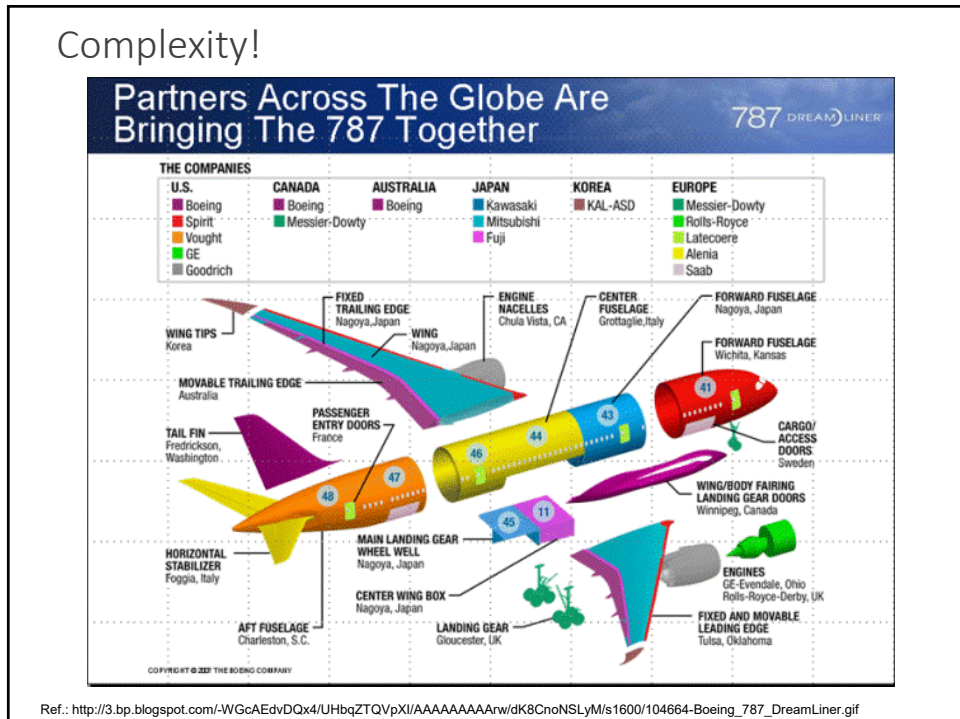
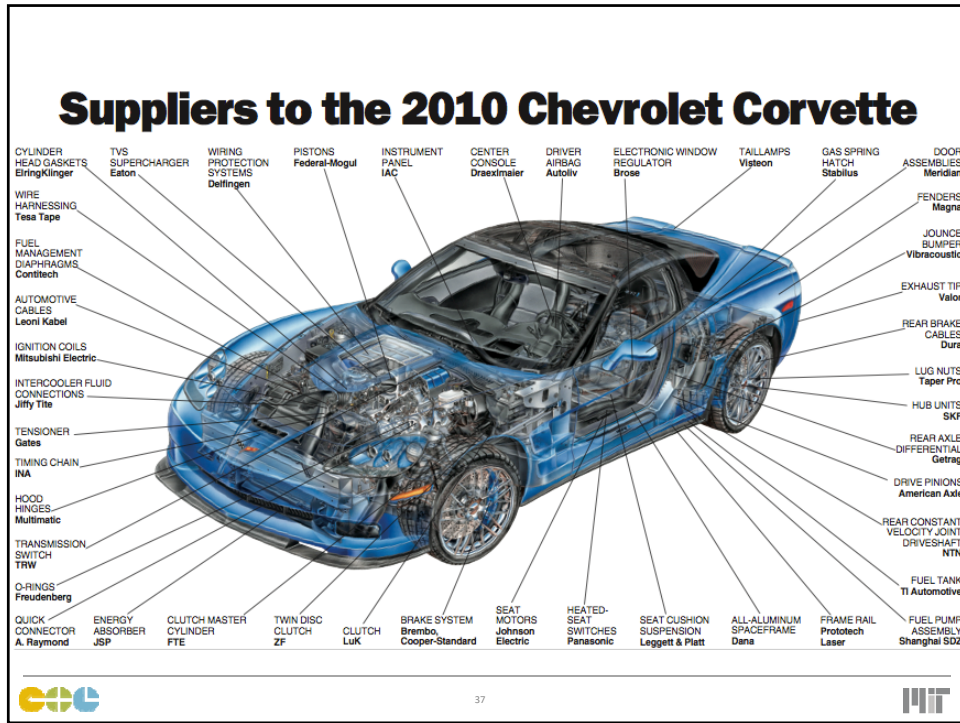
Source: Hendricks & Singhal, "Association Between Supply Chain Glitches and Operating Performance"

Complexity.....

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









## Dealing with Uncertainty (concepts)



40



### 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>

41



## 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



43



## 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?

### Matching Supply Chains with Products

	Functional Products	Innovative Products
Efficient Supply Chain	match	mismatch
Responsive Supply Chain	mismatch	match



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



45



## Supply Chain Risk Management

<http://ctl.mit.edu>

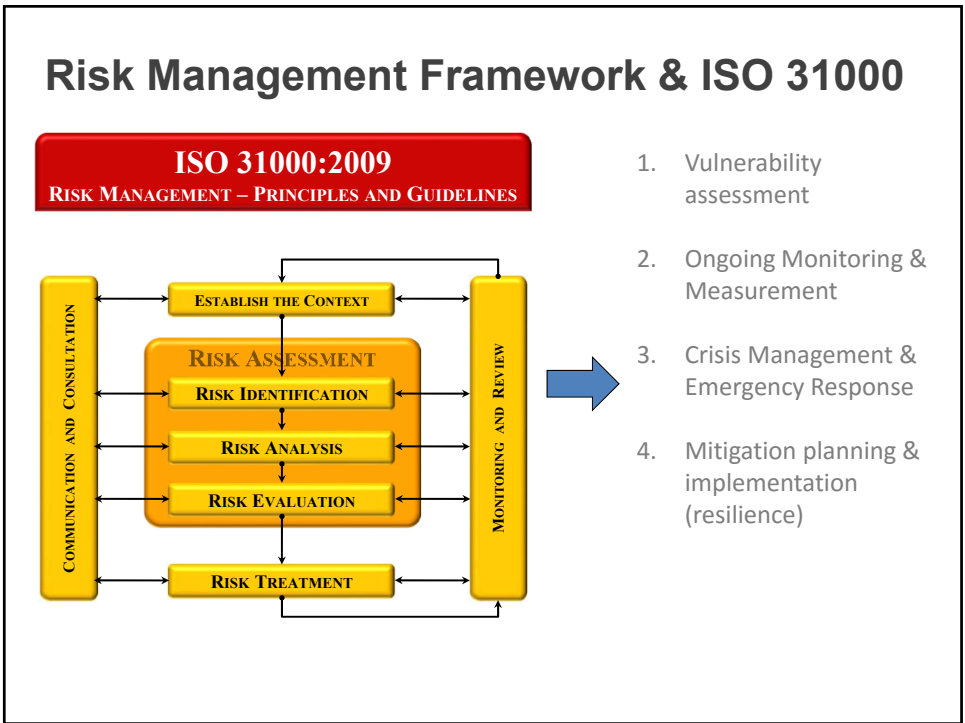
### Supply Chain Risk Leadership Council

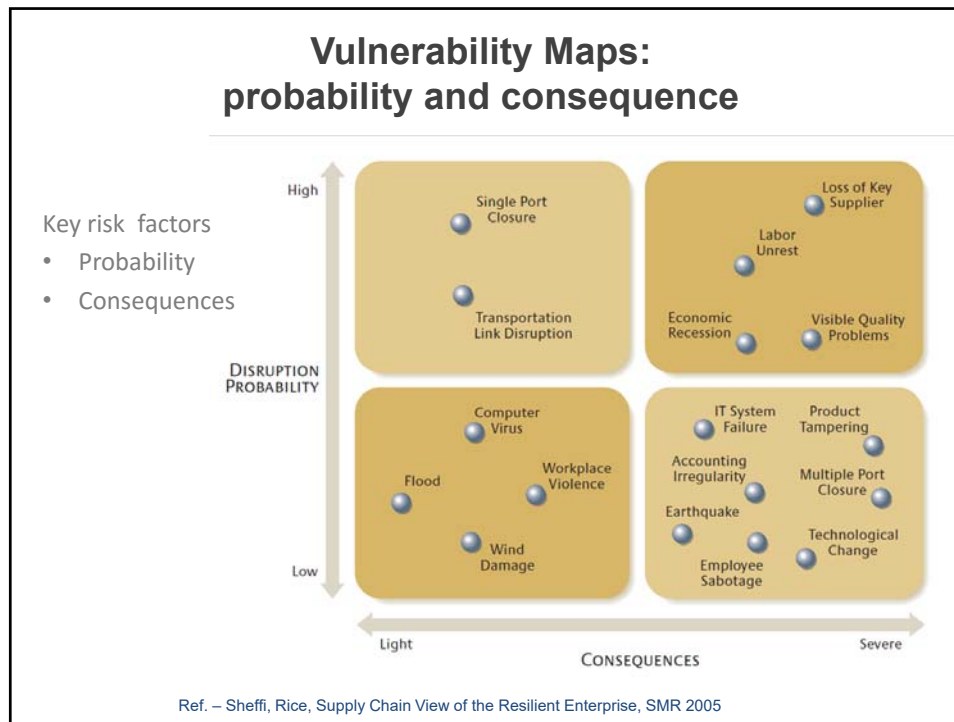
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SUPPLY CHAIN RISK LEADERSHIP COUNCIL

An industry council comprised of world class supply chain firms working together to develop and share supply chain risk management standards and best practices

www.scrlic.com



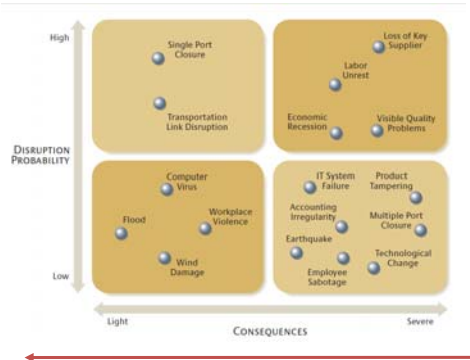


#### 4. Mitigation Planning & Implementation

- 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

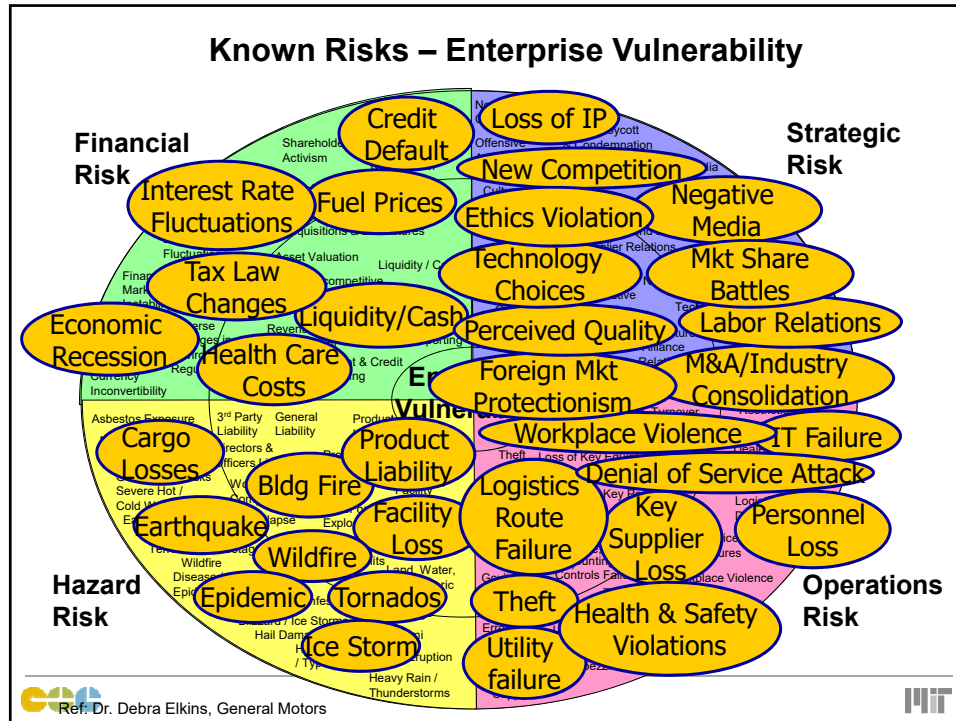
- Failure Mode Analysis – predictable outcomes
  - Plan for recovery from failure modes, not on risk source
  - Design to 'fail smartly' – plan to fail with limited impact
  - 'Options' thinking and planning
  
- Business Continuity Planning (BCP) for outcomes
  - Identify action plans to maintain & recreate business operations after disruption
    - Focus on responding to Failure Modes – outcomes
    - Prepare organization to response 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



74



## 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



75



## 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



76



## 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



77



## 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

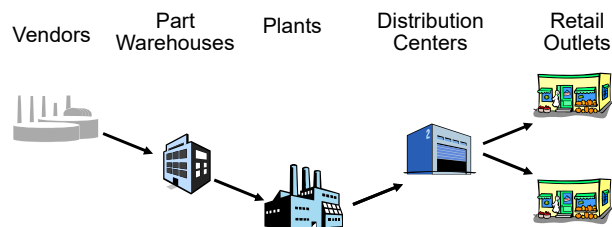
- Buffering
  - Inventory, capacity, time
- Capacity Segmentation
  - 80/20 rule,
  - ABC classification, customer profiles
- Diversify supply sources
- Flexible capacity
- Service level management
- Supply Contracts
- Outsourcing



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

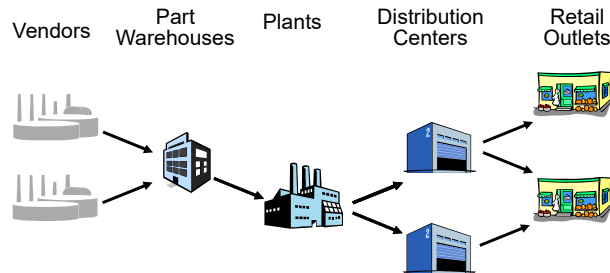


## Adding Resilience to a Supply Chain



**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