Managing Manufacturing & Supply Chain Risks in Global Automotive Operations

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Quick Facts About General Motors Corp.

Mfg Operations in 32 countries
Vehicle sales in 200 countries
Sold almost 9 million vehicles in 2004

GMAC (financing operations, mortgage, insurance, etc.) reported 10th consecutive year of annual earnings growth, posting a record profit of $2.9 billion.

$193 Billion in Revenue for 2004
Earnings of $3.6 Billion for 2004
Vehicles Then...
Vehicles Now!!!
Outline of Presentation

- New Perspectives on Manufacturing & Supply Chain Risks
- Why Should CEOs & CFOs Care About Operational Risks?
- Getting Started With Identifying & Assessing Operational Risks
- Value Proposition for Better Operational Risk Management
- Key Takeaways
Two Observations:
1. Global Risk Events Overlap and Impacts Compound
2. Dealing with Risks is the Normal Operating State

More Corporate Sensitivity to Operational Risks
(supply chain problems, loss of key facilities, business interruptions)
Why CEOs and CFOs Should Also Pay Attention To Operational Risks

Shareholder Value Impact Is About the Same Magnitude & Duration for Mfg. & Supply Chain Risk Events and Traditional Crises

• **Cost of supply chain “glitches”** – average of 10.28% decrease in shareholder value at time of announcement, with share price recovery (if firm does recover…) in roughly 60 trading days.¹

• **Cost of crises** – sharp initial decrease of almost 8%, with full share price recovery (if firm does recover…) in roughly 50 trading days. ²

• 69% of CFOs, Treasurers & Risk Managers at Global 1000 companies in North America & Europe view fires/explosions and supply chain disruptions as leading threats to top revenue sources.³

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Changing nature of supply chain operations

• Lean / Just-In-Time operations
  - less inventory
  - less unutilized capacity

• Single sourcing

• Global sourcing

• More responsive to real-time customer demands

Observation: Significant cost savings and production efficiencies achieved, but supply chains are more vulnerable to disruptions.
Selection of External Risk Events Impacting Global Operations

Regular Pattern of Severe Business Interruption Events

- Toyota Brake Plant Fire
- UPS Labor Strike
- GM Labor Strike
- Nokia - Ericsson Supplier Fire
- Ford-Firestone Tire Recall
- Sarbanes-Oxley Act
- Iraq War
- Canadian Nat’l Rail Strike
- Hyundai India Paint Shop Fire

- Asian Economic Crisis
- GM Economic Downturn
- Sept 11 Terrorist Attacks & U.S.-Canada Border Closures
- Economic Downturn
- Hyundai India Paint Shop Fire
- SARS Outbreak

- Business Failures: Enron, Arthur Andersen, Worldcom, Global Crossing, Quest Communications, K-Mart, etc.
- Longshoreman Strike & West Coast Ports Lockout
- Mazda Japan Paint Shop Fire

- Ford-Firestone Tire Recall
- SARS Outbreak
- Mazda Japan Paint Shop Fire

- Taiwan Earthquake
Risk Map: Acceptable & Unacceptable Risk Levels

Acceptable Risks / Usually Insured

Supply Chain Risk Has Grown Over Time Into Unacceptable Realm!

Acceptable Risks – Cost of Doing Business

Aggregate Loss Severity

Low

High

Low

High

Low Probability / Frequency of Occurrence

10
Getting Started With Identifying and Assessing Mfg & Supply Chain Risks…

Step 1 – Form a Cross-Functional Team

Step 2 – Identify Portfolio of Risks

Step 3 – Filter, Assess and Prioritize Risks

Step 4 – Develop Op Risk Analysis Models

Step 5 – Work on “Actionable” Risks and “Integrate Learnings” into Business Processes
Step 1: Form a Team To Identify Operational Risks in Key Business Processes

Enable cross-functional collaboration to manage risks!

GLOBAL MFG Operations

Supply chain and logistics risk mgmt.

- Supply Chain Operations
- Procurement
- Facilities Management
- Security
- IT Systems
- Audit
- Sales & Marketing
- Insurance Risk Mgmt

- Supply base risk mgmt.
- Asset maintenance, risk mgmt. inside the plants
- External risks & threats monitoring
- IT risks, disaster recovery planning
- Business continuity planning, business process risk mgmt., crisis mgmt.
- Property insurance, risk financing

Enable cross-functional collaboration to manage risks!
Step 2: Enterprise Portfolio of Risks

Financial Risks
- Interest Rate Fluctuations
- Currency & Foreign Exchange Rate Fluctuations
- Financial Markets Instability
- Economic Recession
- Currency Inconvertibility

Risk Interactions
- Restriction of Access / Egress
- Logistics Provider Failures
- Dealer Distribution Network Failures
- Computer Virus / Denial of Service Attacks
- IT System Failures (Hardware, Software, LAN, WAN)
- Service Provider Failures
- Harassment & Discrimination
- Loss of Key Equipment
- Tier 1, 2, 3, …n Supplier Problems: Financial Trouble, Quality “Spills”, Failure to Deliver Materials, etc.
- Warranty / Product Recall Campaigns
- Logistics Route or Mode Disruptions
- Kidnapping
- Extortion
- Vandalism
- Arson
- HR Risks – Key Skill Shortage, Personnel Turnover
- Inadequate Mgmt. Oversight
- Inaccurate Financial Controls & Reporting
- Health Care & Pension Costs
- Debt & Credit Rating
- New or Foreign Competitors
- Public Boycott & Condemnation

Strategic Risks
- Operational Risks
- Supplier Bus. Interruption
- Joint Venture / Alliance Relations
- Product Development Process
- Perceived Quality
- Product Design & Engineering
- Health & Safety Violations
- Unplanned Expenses
- Asbestos Exposure
- Mold Exposure
- Cargo Losses
- Geopolitical Risks
- Severe Hot / Cold Weather
- Earthquake
- Flooding
- Terrorism / Sabotage
- Animal / Insect Infestation
- Weather / Ice Storms
- Tornadoes
- Building Collapse
- Building Subsidence & Settling
- Bldg. or Equip. Fire
- Equipment Failure
- Product Liability
- Property Damage
- Loss of Key Facility
- Expensive Exposures
- High Net Worth
- Atmospheric Pollution
- Wind Damage
- Tsunami
- Volcano Eruption
- Heavy Rain / Thunderstorms
- Second Party Liability
- Directors & Officers Liability
- General Liability
- Environmental Liability
- Product-Market Alignment
- "Gotta Have Products"
- Attacks on Brand Loyalty
- “Gotta Have Products” Program Launch
- Ineffective Planning
- Perception of Poor Customer Service
- Inadequate Mgmt. Oversight
- Inflated Revenue Management
- High Debt & Credit Ratings
- Inaccurate Financial Reporting
- Audit Failures
- Financial Markets Instability
- Foreign Exchange Rate Fluctuations
- Inventory
- Hedging, Derivatives
- Adverse Changes in Industry Regulations
- Adverse Changes in Environmental Regulations
- Inadequate Mgmt. Oversight
- Inaccurate Financial Controls & Reporting
- Health Care & Pension Costs
- Debt & Credit Rating
- New or Foreign Competitors
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Business Interruption Risks = events that disrupt production operations

Op. Risks
- Mergers & Industry Consolidation
- Shipments over Rail, Road
- Mergers & Industry Consolidation
- Tier 1, 2, 3, …n Supplier Problems: Financial Trouble, Quality “Spills”, Failure to Deliver Materials, etc.
- Supplier Bus. Interruption
- Joint Venture / Alliance Relations
- Product Development Process
- Perceived Quality
- Product Design & Engineering
- Water Damage
- Tsunami
- Earthquake
- Volcano Eruption
- Wind Damage
- Building Subsidence & Settling
- Heavy Rain
- Thunderstorms
- Product-Market Alignment
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Enterprises
- HR Risks – Key Skill Shortage, Personnel Turnover
- Inadequate Mgmt. Oversight
- Inflated Revenue Management
- High Debt & Credit Ratings
- Inaccurate Financial Reporting
- Audit Failures
- Financial Markets Instability
- Foreign Exchange Rate Fluctuations
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- Hedging, Derivatives
- Adverse Changes in Industry Regulations
- Adverse Changes in Environmental Regulations
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- Inaccurate Financial Controls & Reporting
- Health Care & Pension Costs
- Debt & Credit Rating
- New or Foreign Competitors
- Public Boycott & Condemnation

GM
Notes on Risk Portfolios

1. Portfolio documents and demonstrates that we’ve been as thorough as possible in identifying manufacturing and supply chain risks.

2. Categorizing risks helps with identifying risk owners and getting owners to take responsibility for risk management.

3. Portfolio is also a key “tool” for getting groups to talk openly about risks they can control, manage, or mitigate, and those risks that are outside their spheres of influence.
Step 3: Draft a Subjective Risk Map

Expert Opinion Only, Not Based on Any Statistical Analysis

<table>
<thead>
<tr>
<th>Probability / Frequency of Occurrence</th>
<th>Aggregate Loss Severity $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

- **Low Probability / Frequency of Occurrence**
  - Terrorism / Sabotage
  - Earthquake
  - Land, Water, Atmospheric Pollution
  - Flooding
  - Volcano Eruption
  - Tornadoes
  - New or Foreign Competitors
  - Technology Decisions
  - Building Collapse
  - 3rd Party Liability
  - Gov’t Agency Inquiries
  - Workplace Violence
  - Directors & Officers Liability
- **High Probability / Frequency of Occurrence**
  - Perceived Quality
  - Economic Recession
  - Negative Media Coverage
  - Financial Markets Instability
  - Share Battles
  - Attacks on Brand Loyalty
  - Union Relations, Labor Disagreements & Contract Frustrations
  - Pricing & Incentive Wars
  - Product Liability
  - Warranty / Product Recall Campaigns
  - Loss of Key Personnel
  - Tier 1, 2, 3, …n Supplier Problems: Financial Trouble, Quality “Spills”, Failure to Deliver Materials, etc.
  - Timing of Business Decisions & Moves
  - Poor Supplier
  - Poor Customer
  - Relations
  - Property Damage
  - Budget Overruns or Unplanned Expenses
  - Bldg or Equip. Fire
  - Operator Errors / Accidental Damage
  - Program Launch Delays
  - Currency & Foreign Exchange Rate Fluctuations
  - Interest Rate Fluctuations
  - Loss of Key Personnel
  - Heavy Rain / Thunderstorms
  - Logistics Provider Failures
  - Logistics Route or Mode Disruptions
  - Cargo Losses
  - Restriction of Access / Egress

**Note:**
- Expert Opinion Only, Not Based on Any Statistical Analysis
- GM
- R&D CENTER
Update Risk Map Periodically

Dynamic Risk Maps can show how the corporate risk profile is evolving over time as the operating environment changes and as risk management efforts are undertaken to address specific risks.
Notes on Risk Maps

1. Developing such a map is a quick way to focus a team to critical risks in the “red zone.”

2. Using a risk map to generate a Top 10 List of Risks forces subject matter experts to make some risk comparisons and adjust/refine their assessments.

3. Any method of “Quick & Dirty Subjective Risk Assessment” (e.g., risk mapping or risk scoring) yields a priority ranking of risks, so resources (people, time, and money) can be allocated to manage risks most effectively.

4. Recognize that a risk map is a 1-time snapshot of risk event likelihood and severity, and require periodic updating.
Step 3: Develop Op Risk Analysis Models


Treat risks as “shocks” that impact inter-dependent operations.

- Evaluate options that change frequency / severity of risk events.
- Evaluate options that change structure of operations.

Data Acquisition and Analysis

Probability & Statistics Models

Operations Inter-Dependency Models

Measure Risk

Risk Reduction and Control Efforts

Obtain Probability Density Functions for Chosen Risk Measures via Monte Carlo Simulation
Model Business Operations Process Flows to Capture Key Inter-Dependencies

- Cash
- Information
- Knowledge
- Material
- Logistics
- Other

Map Key Processes & Interactions
- Manufacturing Processes / Locations
- Supply Chain Material Flows
Op Risk Model Application: Fire Risk

Include plant dependent statistics data
(1) likelihood of fire event occurrence
(2) property damage severity
(3) production disruption duration

For each fire, evaluate direct and indirect impacts

Use Monte Carlo Analysis to simulate lots of fires “shocking” the mfg. network per 90-day quarter

(1) $ Total Cost Loss Exceedance Probability
(2) # Vehicles Loss Exceedance Probability
(3) Other statistical reports that help focus fire protection efforts
Example Model Outputs: Enterprise Risk Profile

Enterprise Level
Aggregate Loss Probabilities

Loss Exceedance Probability for Total Cost

Cost in $M

Loss Exceedance Probability
Total Production Lost per 90-Day Quarter

# of vehicles not produced

Statistical Reports to Focus
Fire Protection Efforts

Mean Down Time per Plant Type (%)

Overall (82) Assembly (37) Engine (11) Transmission (8) Metal Fab. (15) Components (11)

Engine Plants

Romulus Engine – more fires than expected
– update fire protection & loss control?
Example Results: Total Cost of Risk


Example: Can I tolerate a 10% chance that our total losses exceed $800M per Qtr?

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Total Cost in $M per Qtr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>213.97</td>
</tr>
<tr>
<td>Std Dev</td>
<td>283.24</td>
</tr>
<tr>
<td>Min</td>
<td>0</td>
</tr>
<tr>
<td>25%</td>
<td>25.66</td>
</tr>
<tr>
<td>50%</td>
<td>105.65</td>
</tr>
<tr>
<td>75%</td>
<td>173.03</td>
</tr>
<tr>
<td>Max</td>
<td>1,103.06</td>
</tr>
</tbody>
</table>

Loss Exceedance Probability (Risk Curve) for Total Cost

Pr\{TC > \$x\}

Numerical values are for illustration purposes only.
Example Results: Lost Production Risk

Alternate Risk Profile Characterization

Example: Can I tolerate a 10% chance that losses exceed 450,000 units per Qtr?

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Lost Production Units per Qtr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>267,500</td>
</tr>
<tr>
<td>Std Dev</td>
<td>162,790</td>
</tr>
<tr>
<td>Min</td>
<td>0</td>
</tr>
<tr>
<td>25%</td>
<td>100,000</td>
</tr>
<tr>
<td>50%</td>
<td>290,000</td>
</tr>
<tr>
<td>75%</td>
<td>430,000</td>
</tr>
<tr>
<td>Max</td>
<td>500,000</td>
</tr>
</tbody>
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Op Risk Modeling Comments

1. Start with simple business process inter-dependency models and add details as necessary.

2. Start with basic probability models to gain confidence in output results.

3. Can implement models in MS Excel with Monte Carlo Simulation Add-Ins
   - Palisade Decision Tools @Risk
   - Decisioneering’s CrystalBall

4. Simple modeling approach permits comparison of a wide variety of risks and risk management options in a common framework.
Step 5: Integrate Learnings
Deploying Risk Mgmt. Across The Supply Chain

• Work on “actionable risks” – risks we can change.
• Build upon successes - business unit by business unit
• Get senior management attention and support
• Report back regularly to top executives
• Recognize organizational change management battle - moving from risk-averse reactive culture to risk-aware proactive culture
Where Are The Savings To Be Gained?

1. Enhanced coordination of different business units managing risks.
2. Faster risk detection, assessment, mitigation, & business resumption.
3. Improved supply chain resiliency / robustness.

*Some reduction in insurance costs & improved coverage limits.*

Reduce time and cost of responding to unplanned events.

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**Probability / Frequency of Occurrence**

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**Aggregate Loss Severity**

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Low Probability / Frequency of Occurrence → High
Prediction on Future Industry Trends:

“Industry moves past lean and Just-In-Time manufacturing to risk-informed operations management.”

- Supply Chain Redesign to Achieve Resiliency & Robustness
- Product Design Issues – Modularity
- Dynamic Pricing and Revenue Management to Respond to Risks
Final Takeaways & Comments

Implementation Cost is Low – Use internal cross-functional team.

Value to Enterprise is High – Efforts can significantly reduce risk detection and mitigation response times. *And time is money...*

- Be thorough in identifying enterprise risks.
- Don’t get lost in too much data collection to assess probability & severity of risks.
- Use simple op risk models to tell the story and provide quantitative metrics of risks
- Prioritize focus to the top risks identified.
- Empower business units to take ownership of managing risks.
- Integrate learnings into operational business units.
Questions?