The Japan Disaster: Rebuilding Supply Chains

March 24, 2011

Bruce C. Arntzen, PhD
Senior Research Director

barntzen@mit.edu
W 617.252.6965

MIT Center for Transportation and Logistics (CTL)
Cambridge, MA

James B Rice, Jr.
Deputy Director, CTL

jrice@mit.edu
W 617.258.8584

Agenda

• What has happened?

• What will happen?

• What should companies do?
What has happened: business impacts?

- **Primary impacts** – earthquake and tsunami damaged facilities, personnel lost, destroyed communications systems in northern Japan
  - Automotive finished vehicles & parts (esp. engine air flow sensors & engines):
    - Honda, Toyota, Nissan, Mazda
  - High tech: semiconductors, technology (e.g. LCD, silicon wafers, rechargeable batteries, DRAM, NAND, digital cameras): Sony, Hitachi, Shin-Etsu, SUMCO, Toshiba, Nikon, Fujitsu
  - Pharmaceuticals (insulin, penicillin): Novo Nordisk, GSK, Roche
  - Others: Apparel (high tech fibers), Food (soy sauce): Kikoman
  - Some attempting to restart this week
- **Secondary impacts** – loss of supply from primary impacts causing shutdowns
  - Retailers and downstream customers of those industries currently working off of already lean inventories and starting to see cessation or slowdowns in supply
  - Factories in Japan shuttered to conserve power
  - Unreliable utilities (power, water) continue to impact operations
- **Discovery of critical dependence**
  - Hitachi engine air flow sensors
  - Renesas drive train microprocessors

### Business Impacts: Capacity Losses

<table>
<thead>
<tr>
<th>Company</th>
<th>Product</th>
<th>Core Capacity Loss (Failure mode)</th>
<th>Brief Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>iPad 2</td>
<td>Expected loss of supply</td>
<td>Key component suppliers shutdown (NAND flash memory, touch screens, iPad batteries)</td>
</tr>
<tr>
<td>Freescale</td>
<td>Accelerometers, pressure sensors and other chips</td>
<td>Loss of internal capacity</td>
<td>Plant in Sendai shutdown, drilling production to other facilities</td>
</tr>
<tr>
<td>iM</td>
<td>Automotive</td>
<td>Loss of supply</td>
<td>15 plants closed because lack of supply or engine air flow sensors</td>
</tr>
<tr>
<td>Hitachi</td>
<td>Engine air flow sensor</td>
<td>Loss of internal capacity</td>
<td>Plant damaged</td>
</tr>
<tr>
<td>Honda</td>
<td>Finished vehicles, auto components</td>
<td>Loss of supply</td>
<td>10 suppliers located in radiation zone; 10 component &amp; 2 assembly plants; expect to lose 16,000 units, lost contact with 44 of 113 suppliers</td>
</tr>
<tr>
<td>Kikoman</td>
<td>Soy sauce, seaweed, wasabi</td>
<td>Loss of internal capacity</td>
<td>Impacting buyers in Israel which purchases 85% of soy sauce supply from Kikoman</td>
</tr>
<tr>
<td>Mazda</td>
<td>Finished vehicles, auto components</td>
<td>Loss of supply</td>
<td>Plants closed, some to be closed until April</td>
</tr>
<tr>
<td>Nikon</td>
<td>SLR cameras</td>
<td>Loss of internal capacity</td>
<td>Plant closed; only plant making SLR cameras</td>
</tr>
<tr>
<td>Nissan</td>
<td>Finished vehicles, engines</td>
<td>Loss of internal capacity, loss of supply</td>
<td>Plant closed; lack water, electricity and gas to operate; considering sending engines from Tennessee plant to Japan</td>
</tr>
<tr>
<td>ON Semiconductor</td>
<td>Semiconductors</td>
<td>Partial loss of internal operations</td>
<td>Temporary shutdown expected at several facilities</td>
</tr>
<tr>
<td>Ports in Japan</td>
<td>Container</td>
<td>Loss of supply</td>
<td>4.4M containers, 30% of port closures</td>
</tr>
<tr>
<td>Toshiba</td>
<td>DRAM</td>
<td>Loss of supply</td>
<td>Redesigning product to use available supply</td>
</tr>
<tr>
<td>Hitachi</td>
<td>More than 2 million processors</td>
<td>Loss of internal capacity (flash memory)</td>
<td>Massively closed; many auto companies dependent on this product</td>
</tr>
<tr>
<td>Shin-Etsu Chemicals</td>
<td>Silicon wafers</td>
<td>Loss of internal capacity</td>
<td>World’s largest maker of silicon wafers disrupted; 57% of world’s silicon wafers come from Japan</td>
</tr>
<tr>
<td>Sony</td>
<td>Rechargeable batteries, DVD Blu- ray discs, lenses</td>
<td>Loss of internal capacity</td>
<td>Closed 10 factories</td>
</tr>
<tr>
<td>Toyota</td>
<td>Finished vehicles, Parts, Scion xD and Scion xD, Prius V</td>
<td>Loss of supply, Loss of internal capacity</td>
<td>Shutdowns across all 1MC plants. Expected loss of 140,000 units, Prius only made in Japan.</td>
</tr>
</tbody>
</table>

3/25/2011
What has happened: company response?

- Company response
  - Emergency Response Centers (ERC) activated
  - Business Continuity Plans (BCP) exercised
  - "Broken field running"
    - Day-by-day adjustments of plans dependent on facility, supply and utility availability
    - Shifting operations outside of affected area
    - Resupply from non-traditional sources (internal & external)
  - Those without ERCs and contingency plans (or enough contingency) are searching for back-up options
    - Searching after a disruption is not the best time to be setting up back-up options

Japan: contrast with recent disasters

New Zealand Earthquake Feb 2011
Haiti Earthquake Jan 2010
Gulf Oil Spill Summer 2010
Australian Floods Dec 2010
Iceland Volcano Mar-Apr 2010
Landslide in Peru Jan 2010
Chile Earthquake & Tsunami Feb 2010
Russian Wildfires Jul 2010
Hurricane Earl Aug 2010
Pakistan Floods July 2010
Hungary Toxic Spill Oct 2010
Haiti Cholera Outbreak Oct 2010
Indonesia Volcano & Tsunami Oct 2010
Guatemala Sinkhole may 2010
US East Coast Blizzard Feb 2010

Japan is a
- Major supplier region
- Major consumer region
Japan as a consumer of the world

Top 10 imports into Japan from the US*

1. Civilian aircraft including parts
2. Yellow corn
3. Soybeans
4. Artificial human body parts and related accessories
5. Fresh or chilled pork, unprocessed ...
6. Medications for retail sale
7. Frozen pork, unprocessed
8. Silicon
9. Wheat
10. Semiconductor manufacturing machines

Supply Chain Disruptions in the rest of the world:
- Lack of demand parts causes production to slow down or stop

Also - Japan is one of the world’s largest importers of Luxury goods (apparel, shoes, accessories, jewelry, etc.)

What has happened: indirect impacts?

Price of Oil – reduced demand by Japan lowers the price for the rest of the world (masked somewhat by the fighting in Libya)

Price of electricity -- likely immediate increase in Japan will make production costs higher for energy intensive products from basic industries. Long term big global impact as it will be much harder to re-license existing nuclear power plants, become much harder to build new ones, and costly to retrofit old ones based on the learning from Japan.

Toyota and Honda – there are intense capacity planning talks going on right now as they are both ramping up production at their US plants for export to other countries. They are beginning to promote the vehicles that they make outside of Japan for export to world markets. Both are activating suppliers in the US, asking US suppliers to resurrect recent quotes on parts that they bid on up to 4 years ago. They are asking “How fast can you get up and running on these parts?”

Currency Exchange rates – currency speculators drove up the price of the Yen in anticipation of Japanese businesses needing to sell of foreign assets to bring those funds home to pay for the reconstruction – this was thwarted by the intervention of the Group of Seven (sold off Yen to bring down the price)
What has happened: the Yen?

**AFTER THE DISASTER (As predicted by the currency speculators)**

- Sell Yuan, buy Yen
- Sell C$, buy Yen
- Sell $, buy Yen
- Sell £, buy Yen
- Sell E, buy Yen

Currency speculators believed that Japan will need 124 $Billion to rebuild. And that Japan would shortly begin selling their foreign assets to bring that money back to Japan to rebuild. And that they would have to convert those foreign funds into YEN.

So the price of YEN (exchange rate) on the currency markets shot upwards … but has now been brought back down through intervention by the Group of Seven central banks selling off Yen to counter this impact.

What will happen?

- Unanticipated disruptions in the coming weeks/months in downstream supply chains
  - Not limited to automotive & high tech industries
  - Likely material hoarding
- Expect some costs to increase (electricity)
- Growth opportunities
  - For those firms that fill the void left by lost capacity
- Resilience and risk management will matter to many
  - But only for a little while
  - Longer term only a subset will take action
  - Will your company take action now to prepare for the next disruption?
- Wisdom of JIT & Lean practices will be challenged
  - But the advantages are so high and downsides can be mitigated
What should companies do: now?

- Use your business continuity plans!
- Contact your suppliers
  - How are they being affected?
  - How are their suppliers being affected?
  - Understand the details of exposure: Trust but verify (material availability)
  - Specifically: look for dependence on suppliers of LCD materials, silicon wafers, and those who use those materials; check your suppliers’ suppliers
  - There will be surprises....
- Contact your customers
  - Do they expect their demand to fall off?
  - What is their dependency on demand from Japan?
  - What is their dependency on supply in Japan?
  - Grow! What material supply voids can your company fill?

What should companies do: near term?

- Seize the moment: get senior exec support for risk mgt action
- Develop back-up plans
  - ’Business continuity plans’ (BCP) focused on restoring lost capacities
  - Failure mode focus (the limited set of core capacities)
- Identify full supply chain network (Tier 1, 2, 3, etc.) & risks
  - Who are my suppliers?
  - Assess geographical risk (Are my suppliers all located in the same geo?)
  - Assess organizational risk (Are we sole sourced?)
  - Assess embedded risk (Are my various suppliers all dependent on a common material source?)
- What are the probabilities & consequences of loss
  - Reduce probability of disruption through preventative measures
  - Reduce consequences through mitigation measures: resilience
  - Choose balanced mix of redundancy & flexibility
Supply Chain Failure Modes/Core Capacities

All disruptions result in one or more of these capacity losses for a period of time:

- Capacity to acquire materials (supply)
- Capacity to ship/transport
- Capacity to communicate
- Capacity to convert (internal operations)
- Availability of human resources (personnel)
- Financial flows (e.g. demand)

Resilience Through Flexibility & Redundancy

- **Flexibility**
  - Requires prior investments in infrastructure & capabilities
  - E.g. contingent/reconfigurable capacity, multi-skilled workers
  - Flexibility through interchangeability
    - Standard facilities (Intel, GM), Standard parts (Dell, Lucent SCN, Southwest Airlines), Standard processes (Helix, UPS)
  - Flexibility through postponement (Benetton, H-P)
  - Flexibility through supply (Jabil, Lucent, Toyota)
  - Flexibility through distribution (Caterpillar, Dell)
  - Flexibility through flexible culture
    - Awareness of risks & tradeoffs, distributed decision-making (P&G, UPS), open and unconstrained communication (Dell)

- **Redundancy**
  - Requires prior investment in capacity that may not be used
  - E.g. Inventory & Excess capacity
What should companies do now?

Implement their Business Continuity Plan!

We have a Business Continuity Plan!

Use the crisis to further SC Risk Management in your company --- while you still have Management's attention.

MIT Project to show the Network Impacts of SC Disruptions

V = VENDOR, CM = CONTRACT MANUF., P = PLANT, W = WAREHOUSE, D = DISTRIBUTOR, R = RETAILER
Understand network dependencies

SourceMap.Org

References & Thank you

- MIT CTL Global Scale Risk Initiative
  - [http://ctl.mit.edu/research/global_scale_risk_initiative](http://ctl.mit.edu/research/global_scale_risk_initiative)
- MIT CTL Hi-Viz Research Project
  - [http://ctl.mit.edu/research/hi-viz](http://ctl.mit.edu/research/hi-viz)
- SC Resilience Publications
  - [http://ctl.mit.edu/research/supply_chain_resilience_publications](http://ctl.mit.edu/research/supply_chain_resilience_publications)
  - Sloan Management Review “A Supply Chain View of the Resilient Enterprise” article

- THANK YOU
  - Bruce Arntzen – barntzen@mit.edu, 617.252.6965
  - Jim Rice – jrice@mit.edu, 617.258.8584