Adapting To Supply Network Change

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Existing manufacturing supply networks lack sense-and-respond capabilities. Over the next decade, winners will use X Internet, Web services, and agent-based software to help these networks continually adapt to change.

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MARKET OVERVIEW

Unplanned Exceptions Cripple Manufacturers

Despite millions of dollars of investments in supply chain apps like those from i2 and Manugistics, manufacturers are still caught off-guard by supply hiccups. These exceptions are disruptive and expensive because manufacturers lack a systematic approach to resolve operational snafus.

SUPPLY NET EXCEPTIONS: A MESS FOR MANUFACTURERS

In the last decade, increased reliance on outsourcing and partnering has heightened interdependency among different nodes of global supply networks -- amplifying the nonlinear effects of supply net exceptions, which we define as (see Figure 1-1):

> *The lack of a rule-based resolution to the difference between the expectation and result of a supply chain process step.*

Supply net exceptions are a nightmare for manufacturers because they produce three negative outcomes:

1) Short-term financial impact.

2) High cost of corrective measures.
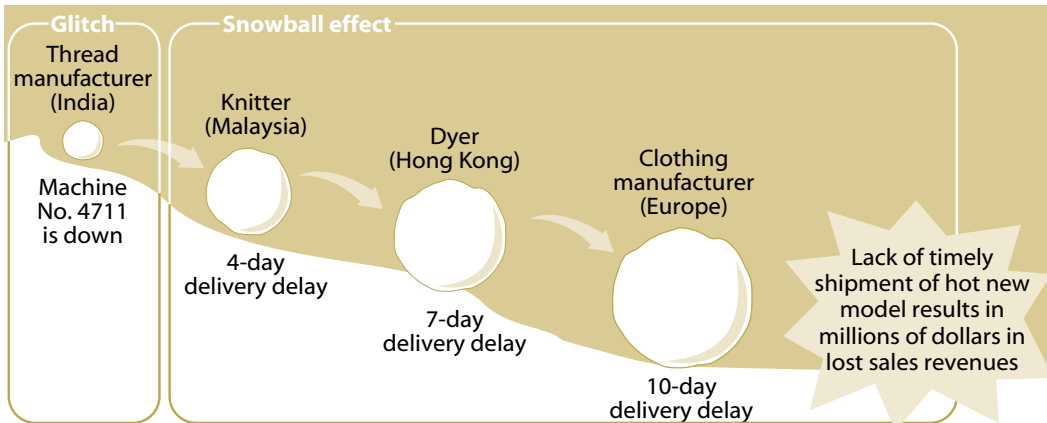
3) Undesirable side effects.

1) Short-Term Financial Impact

Whatever their root causes, supply net exceptions severely hamper manufacturers' ability to balance supply and demand. Whenever they fail to promptly deal with supply network glitches, manufacturers suffer from:

- **Opportunity costs -- when supply fails to ramp up fast enough.** Boeing in 1997 and Sony in 2000 are among the many firms that suffered billions of dollars in lost revenues as operational hiccups crippled their supply networks' ability to promptly fulfill demand for their popular products (see Figure 1-2).

- **Economic costs -- when supply fails to ramp down fast enough.** When manufacturers fail to ramp down production and supply deliveries in the face of unanticipated demand decreases, firms like Cisco Systems end up writing off billions of dollars in inventory and purchase commitments.

Figure 1 Supply Network Exceptions Cramp Manufacturers' Performance

1-1 **Glitches are amplified throughout the supply network**

Glitch

Thread manufacturer (India)

Machine No. 4711 is down

Snowball effect

Knitter (Malaysia)

4-day delivery delay

Dyer (Hong Kong)

7-day delivery delay

Clothing manufacturer (Europe)

10-day delivery delay

Lack of timely shipment of hot new model results in millions of dollars in lost sales revenues

1-2 **Opportunity costs associated with supply network exceptions**

Company	Supply net exception	Opportunity costs
General Motors	In 1996, an 18-day labor strike at a brake supplier factory idled workers at 26 assembly plants	Quarterly earnings were reduced by $900 million
Boeing	In 1997, two key suppliers failed to deliver critical parts on time	Deals lost were worth $2.6 billion
Sony	Shortage of PlayStation 2 graphic chips in 2000	Sony console shipment in US was 50% less than planned
Ericsson	A fire in Philips Electronics' plant in New Mexico disrupted chip supplies for key new handset	Lost three market share points against Nokia in 2000 and was forced to exit handset market

Source: Forrester Research, Inc.

2) High Cost Of Corrective Measures

Devoid of an institutionalized mechanism to deal with such exceptions, most manufacturers switch to firefighting -- costly because it:

- **Diverts valuable time and resources.** Because manufacturers view supply net exceptions as a potential threat to customer satisfaction, they will go the extra mile to fix them, even if that means incurring high expenses -- like expedited shipments -- and diverting valuable time and resources from day-to-day operations (see the July 2000 Forrester Report "Manufacturing Deconstructed").[1]

- **Leads to costly inventory build-up.** To better defend themselves against unanticipated supply chain misalignments, manufacturers are willing to pay an expensive insurance premium by stockpiling inventory. But this "protective shield" -- which in the US consumer goods industry translates to $250 billion worth of excess inventory -- can't always solve customer service problems.[2]

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3) Undesirable Side Effects

If a supply net exception can be compared to an illness, the cure is sometimes worse than the disease. That's because firefighting manufacturers:

- **Tackle only the symptoms -- not the root cause -- of the exception.** Facing an upward demand swing, a PC maker may lack the time to do a root-cause analysis on what actually caused that demand increase. Instead, its reflex may be to tackle the symptoms -- inventory shortfall -- by ramping up capacity and expediting shipments to its retailers. But these quick-hit solutions ease pain only temporarily. A root-cause analysis would have revealed that marketing doesn't communicate promotion plans in advance to production managers.

- **Are oblivious to their corrective actions' negative side effects.** In some cases, the cumulative effects of a manufacturer's short-term fixes can cause havoc to operational performance -- further hampering the manufacturer's ability to cope with supply net exceptions. For instance, if the PC maker overreacts to every single order increase by pushing all assembly lines to operate at 100% capacity, its plants' shop-floor equipment could break down -- just when its demand ratchets to an all-time high.

PREVAILING SUPPLY CHAIN HABITS AND TOOLS DON'T HELP

Of the senior executives surveyed by the MIT Center for Transportation Studies, 70% agree that future competition will be between supply chains -- not corporations.[3] But today's supply chain practices are hurdles because manufacturers continue to:

- **Insulate plans from execution reality.** Large manufacturers like PepsiCo dedicate departments to long-term demand, purchasing, and production plans -- all aligned with the firm's strategic goals. Once crafted, these idealistic plans and forecasts are tossed over the wall for operations execs to execute. These execs make adjustments to reflect what they perceive as operational reality. Over time the number of these adjustments grows -- but are seldom fed back into the planning system.

- **Optimize in a linear, deterministic fashion.** Each member in a supply network today attempts to optimize its end based on individual goals and constraints. The result? Islands of optimization and pockets of efficiency, which fail to maximize networkwide performance. Worse: As manufacturers outsource, one partner's locally optimized decisions cramp another partner's performance -- leading to more supply net exceptions.

Supply Chain Apps' Centralized Data Architecture Is Oblivious To The Real World

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Current supply chain apps' client-server heritage hampers manufacturers' ability to swiftly sense and respond to changes in their environment because these apps:

- **Rely on a "smart-hub/dumb-spoke" data architecture.** Using platforms from vendors like Manugistics, giants like Cisco are building private hubs that aim to tightly integrate their supply networks. But these apps' hub-and-spoke data architecture hoards all processing intelligence at the hub (Cisco) level -- leaving the spokes (suppliers) "dumb" and uninformed. The outcome? Decision-making paralysis, while the hub software collects and synthesizes information from multiple sources to solve every single *node-level* exception.[4]

- **Ignore the physical environment in which manufacturers operate.** Apps from vendors like i2 and Oracle can manage the flow of supply chain information -- but don't tie that data to the billions of physical assets like machine tools and trucks that constitute a real-word supply network. So while Oracle's sourcing app can let Compaq negotiate a better contract with Pentair, it can't help Compaq react when the truck carrying Pentair's enclosures for the day's PC assembly is delayed.

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ANALYSIS

Manufacturers Must Embrace Uncertainty

To deal with emerging risks and opportunities proactively, manufacturers must cultivate a portfolio comprising coping strategies that boost operational flexibility. Firms will exploit three emerging technologies -- Web services, X Internet, and agent software -- to make supply networks more adaptive.

FIRMS WILL LEARN TO TURN UNPLANNED EVENTS INTO INSIGHT

Manufacturers' static and linear supply chains prevent them from quickly responding to supply net exceptions -- or seizing unexpected business opportunities. Transmission networks in energy and telecom today can self-regulate -- instantly turning exceptions into fixes before users experience a service disruption. In the same way, Forrester expects these sense-and-respond capabilities to extend to physical goods supply chains over the next decade -- paving the way for adaptive supply networks (see the February 22, 2002 Forrester Brief "Executive Overview: Adaptive Supply Networks").[5]

To make adaptive supply networks a reality, manufacturers will create a technology-enabled cycle to help them (see Figure 2):
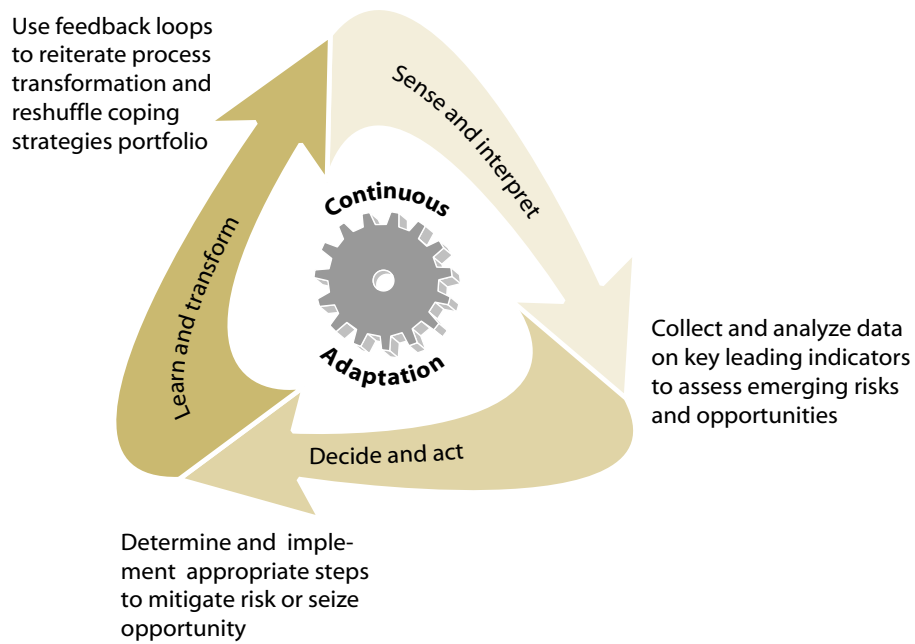
1) **Sense and interpret.** To predict future risks and opportunities, manufacturers will identify, assemble, and continually track directional indicators that measure operational performance -- and alert partners when a major deviation is detected.

2) **Decide and act.** Upon notification, partners will decide which action plan is most appropriate under current conditions and then rally shared resources.

3) **Learn and transform.** Partners will turn exceptions into insights into change -- altering their organizations' underlying processes and objectives, and reshuffling their coping strategies portfolio to better handle similar situations in the future.

1) Sense And Interpret: To Proactively Detect Emerging Risks And Opportunities

Instead of relying on performance measurements, firms will probe leading indicators to detect possible changes of supply, demand, and customer satisfaction (see the September 2000 Forrester Report "Managing Business Velocity").[6] They will gather and interpret real-time data to:

Figure 2 Manufacturers Will Learn To Turn Unexpected Events Into Insight

2-1   To gain flexibility, manufacturers need a continuous process adaptation strategy

Use feedback loops
to reiterate process
transformation and
reshuffle coping
strategies portfolio

Sense and interpret

Learn and transform

Continuous

Adaptation

Collect and analyze data
on key leading indicators
to assess emerging risks
and opportunities

Decide and act

Determine and imple-
ment appropriate steps
to mitigate risk or seize
opportunity

2-2   Traditional sense-and-respond reflexes won't work in adaptive supply networks

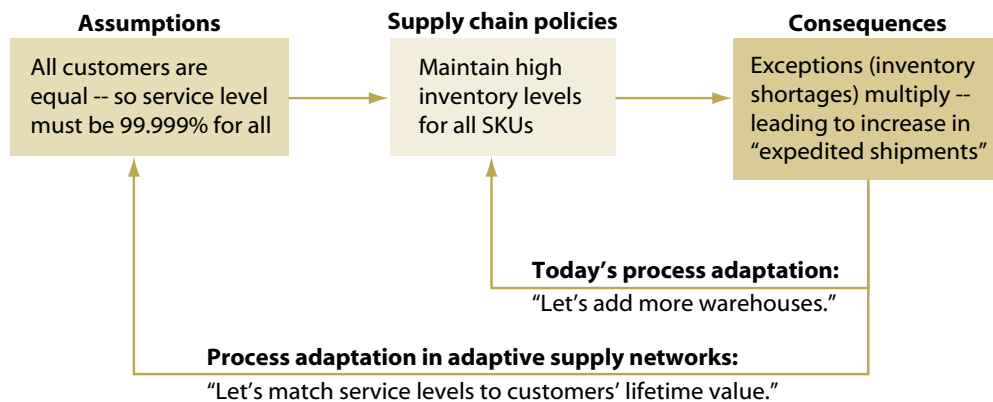| Traditional supply chains	Adaptive supply networks
Sense and interpret • Collect data with historical value • Model past performance • Interpret batched data	**Sense and interpret** • Collect data on future performance • Interpret filtered data in real time
Decide and act • Firefighting and replanning • Centralized problem solving	**Decide and act** • Well-delineated exception management roles and accountabilities • Distributed decision-making
Learn and transform • No learning • 80% of time spent tackling noncritical exceptions • One-off contingency plan	**Learn and transform** • Continuous learning • Automated decisions enable focus on evaluative decisions • Dynamic portfolio of coping strategies

Source: Forrester Research, Inc.

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- **Understand current customer needs.** As they become disillusioned with voodoo rites of forecasting demand from historical data, manufacturers will start capturing demand signals at the point of consumption -- whether it's the retail store or the industrial customer's factory floor. For instance, Spanish apparel maker Zara gets real-time sales data from all its Net-enabled point-of-sale systems.

- **Monitor supply availability.** Many factors -- from equipment failure to capacity reallocation -- can thwart a supplier's delivery commitment. Rather than crossing fingers hoping that ordered parts arrive, manufacturers will track their multitier suppliers' capacity and inventory levels -- watching for "butterfly effects," in which a minor upstream supply variation can produce a huge disturbance down the road.[7] For example, HP tracks all its supply availability down to the resins to avoid shipping printers without resin-dependent logos.

- **Manage partner performance.** OEMs that outsource supply chain activities must realize that they give up the authority over their execution -- but not the responsibility for the outcome. OEMs will take a cue from Honeywell, which uses Apexon's quality management tool to verify each ordered part's compliance with its Six Sigma quality requirements -- *before* the part leaves the supplier's plant.

- **Acknowledge market conditions.** Manufacturers will also track macroeconomic indicators like commodity price fluctuation, weather predictions, and capital availability. For instance, Deere & Company uses Planalytics' weather-condition-tracking tool to learn of a potentially warm winter in Europe that would impact the promotions and product fulfillment for its lawn and garden tractors in the UK.

2) Decide And Act: To Expedite Exception Resolution And Opportunity Capture
Detecting a supply shortfall or a demand change has no value unless partners can rally to prevent its escalation. To raise their supply nets' decision-making velocity, firms will:

- **Trust but verify.** To prevent exceptions from being "broadcast" to entire supply networks or passed along as hot potatoes, manufacturers and partners will adhere to policies that clearly delineate each other's exception management roles and accountabilities. Firms will also instrument an exception management protocol to ensure that exceptions by entrusted partners are handled effectively. For instance, Juniper Networks uses Valdero's app to check whether Celestica has rightly responded to a demand boost for Juniper's routers by placing necessary POs.

- **Avoid replanning.** When facing an exceptional event, partners will foremost try to contain it within their *existing* plans' limits. Without propagating variability by re-running i2's Factory Planner or Manugistics' Master Planning app, firms will tap adaptive planning solutions that provide the intelligence to contain the event

Figure 3 Firms Can Improve Learning By Focusing On Exceptions' Root Causes

Assumptions	Supply chain policies	Consequences
All customers are equal -- so service level must be 99.999% for all	Maintain high inventory levels for all SKUs	Exceptions (inventory shortages) multiply -- leading to increase in "expedited shipments"

Today's process adaptation:
"Let's add more warehouses."

Process adaptation in adaptive supply networks:
"Let's match service levels to customers' lifetime value."

Source: Forrester Research, Inc.

and its perturbation to the supply network (see the March 22, 2001 Forrester Brief "Optimization Is Dead. Long Live Adaptive Planning!").[8] STMicroelectronics, for instance, uses i2's Supply Chain Planner to create master and factory plans -- but relies on Saltare's exception-handling app to tackle deviations to those plans.

- **Decentralize problem solving.** OEMs can't swiftly resolve operational snafus if they resist delegating exception management authority to partners. To make distributed problem solving fail-safe, firms will institute an escalation mechanism for unresolved local exceptions -- and use policies to ensure that corrective actions taken by individual nodes don't compromise the entire network's equilibrium.[9]

- **Collect constant feedback from fixes.** After enacting their corrective actions, firms will track their effectiveness by using feedback loops to redesign existing processes if necessary. By continuously analyzing the amplifying (positive) and damping (negative) feedback of their process changes, manufacturers will learn to fine-tune appropriate response strategies to emerging risks and opportunities.

3) Learn And Transform: To Drive Supply Network Excellence

Accelerating reaction time to exceptions *without* process changes will make long-term improvement accidental. To improve learning and transformational skills, firms will:

- **Tune the organization.** When a supply network error is detected and corrected as an anomaly, organizations are doomed to confront it repeatedly. Only when the exception is detected and corrected in ways that involve modifying an organization's underlying processes, policies, and objectives can firms like Kraft eliminate their inventory shortages -- by tackling their root causes (see Figure 3).

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- **Automate the mundane.** Firms will use their learning to automate the resolution of the more mundane exceptions -- so they dedicate more time dealing with ill-defined exceptions that require human intervention. So DuPont's SCM execs will program a tool like iSpheres' to tender container loads through logistics.com as soon as the odds of its regular carrier being delayed top 66%. That way, execs could focus on contingency plans to protect their $1.6 billion logistics operations against major disruptions caused by cataclysmic events like September 11.[10]

- **Employ analytical frameworks that increase strategic flexibility.** Manufacturers can't rely on a single course of action when facing an exception or opportunity. To boost their decision-making velocity and increase alternatives, manufacturers will cultivate a portfolio of coping strategies that exploits various analytical techniques (see Figure 4-1). They will emulate HP, which protects itself against disruptive supply network changes by exploiting a portfolio of real options to make its design, sourcing, and production processes flexible (see Figure 4-2).[11]

EMERGING TECHNOLOGIES WILL HELP SUPPLY NETWORKS ADAPT

Manufacturers will be able to exploit three key emerging technologies to sharpen their sense-and-respond faculties (see Figure 5).
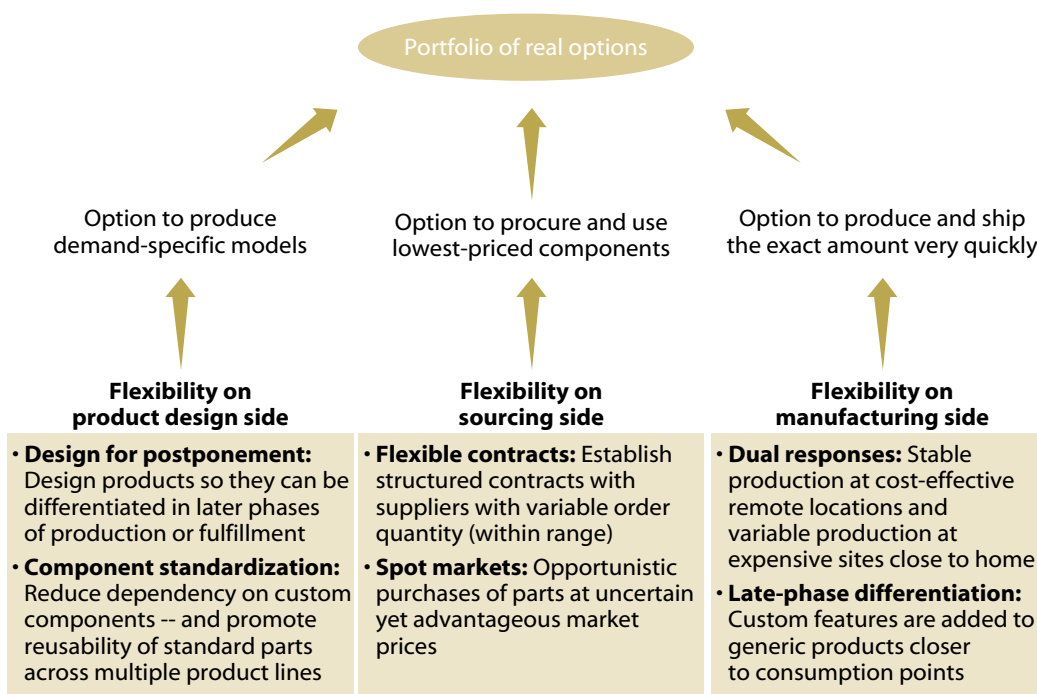
1) **Web services strengthen a supply network's weakest links.** Given the nonlinear impact of supply chain exceptions, OEMs have to monitor events occurring across their entire trading network. But B2B integration issues have hampered collecting operational data from partners beyond the tier-one level. So manufacturers like Eastman Chemical Company have begun to use Web services to connect cost-effectively to even their fourth-tier suppliers (see the February 2002 Forrester Report "Web Services Boost B2B Collaboration").[12]

2) **Extended Internet raises networked processes' real-world awareness.** Without visibility into the physical assets used to produce and transport their goods, manufacturers can't proactively detect exceptions like shop-floor yield drop or delivery delays. But extended Net technologies like sensors and RFID tags will let firms detect a looming device failure on their contract manufacturers' shop floor or an engine malfunction in their suppliers' delivery trucks (see the October 2002 Forrester Report "The X Internet Invigorates B2B Apps").[13]

3) **Intelligent agents find ways to learn.** Experimenting with process changes can be a costly affair. But emerging agent-based modeling techniques will let manufacturers conduct nonlinear simulations and learn how planned process changes will impact their supply network's performance. These adaptive agents will also provide constant feedback on the *post*-implementation effectiveness of

Figure 4 Firms Must Tap New Analytical Tools To Boost Operational Flexibility

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4-1   **Manufacturers must use analytical tools to achieve best practice**

Analytic technique	What is it?	Global 3,500 firms that use it
Game theory	Studies strategic interactions among supply network members to predict outcome of these interactions.	• **Ford Germany:** To shape build-to-order partner interactions • **Nucor:** To anticipate rivals' reactions to new manufacturing processes
System dynamics	Improves understanding of nonlinear behavior of complex systems -- like supply networks -- by studying their internal feedback loops.	• **Intel:** To learn how to reconfigure its supply network processes on the fly • **Syngenta:** To adapt sourcing and production plans to demand swings
Agent-based modeling	By modeling supply network nodes and assets as agents, firms can simulate how the agents' collective behaviors will govern the entire network's performance	• **CEMEX:** For efficient rerouting of cement trucks through traffic jams • **Unilever:** To optimize shop-floor scheduling and inventory handling • **Procter & Gamble:** To reduce order fulfillment cost
Real options	By valuing future supply chain decisions as "real-options" (the rights -- not the obligations -- to do something) firms can quantify the costs and value of flexibility	• **Acer:** To minimize supply network risks when entering new markets • **HP:** To make design, sourcing, and production processes more flexible

4-2   **How HP uses real options to increase its supply network flexibility**

Portfolio of real options

Option to produce demand-specific models

Option to procure and use lowest-priced components

Option to produce and ship the exact amount very quickly

Flexibility on product design side

• **Design for postponement:** Design products so they can be differentiated in later phases of production or fulfillment
• **Component standardization:** Reduce dependency on custom components -- and promote reusability of standard parts across multiple product lines

Flexibility on sourcing side

• **Flexible contracts:** Establish structured contracts with suppliers with variable order quantity (within range)
• **Spot markets:** Opportunistic purchases of parts at uncertain yet advantageous market prices

Flexibility on manufacturing side

• **Dual responses:** Stable production at cost-effective remote locations and variable production at expensive sites close to home
• **Late-phase differentiation:** Custom features are added to generic products closer to consumption points

Source: Hewlett-Packard, Forrester Research, Inc.

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Figure 5 Emerging Technologies Will Improve Firms' Supply Network Flexibility

Emerging technology (hypergrowth year)	How it increases the supply network's capabilities to:		
	Sense and interpret	**Decide and act**	**Learn and transform**
Web services (2003)	By staging and exposing enterprise data from legacy systems and business apps, paves the way for real-time requests and notifications	Enables closed-loop exception manage-ment -- by tying back into partners' apps to improve their existing operational processes	Business analysts can exploit simple interfaces to extend processes with few developers
Extended Internet (2004)	Sensors and RFID tags let firms track in real time the identity, location, and status of all globally distributed physical assets	"Actuators" (a.k.a. microelectro-mechanical systems), will let firms act on physical environment	Net-aware physical assets can be added to, dropped from, or transferred to any virtual supply network on the fly
Intelligent agent technology (2006)	Agents analyze real-time data collected from Web-service-enabled apps and sensor-embedded objects to find meaningful patterns and exceptions	Agents recommend corrective actions to exceptions -- and redirect resources to maximize network-wide performance	Allows firms to simulate multiple supply network improvement scenarios -- before they commit resources to any one of them

Source: Forrester Research, Inc.

process changes (see the March 11, 2002 Forrester Brief "Adaptive Agents Boost Supply Network Flexibility").[14]

App Vendors Will Rise To The Challenge Of Adaptive Supply Networks

Manufacturers will expect software vendors to help them achieve much needed supply network flexibility. In particular (see Figure 6):

- **SAP will migrate its process sector clients to adaptive supply networks.** In partnership with BiosGroup and the Auto-ID Center, SAP is developing a collection of real-world-aware adaptive agents that will help trading partners proactively resolve supply network glitches (see the June 22, 2001 Forrester Brief "SAP Leads Race To Build Adaptive Supply Nets").[15] Which industry will be the initial target of SAP's new breed of interenterprise software that will hit the market later in 2002? Energy and chemicals -- whose larger players have all standardized on SAP's ERP backbone and where 70% of trade occurs *within* the industry.

- **IBM will promote standards-based agent tools.** IBM isn't a supply network newbie: Its homegrown Supply Chain Analyzer (SCA) technology helped IBM save $750 million in inventory costs in 1998. IBM's SCA was sold to i2 in 1999.

Figure 6 Key Solution Providers For Building Adaptive Supply Networks   13

	Strengths and offerings	Forrester's take
Infrastructure		
IBM	• Autonomic Computing vision is built around Web services and agent software • Key promoter of distributed computing	• Can sell agent-based distributed optimization engines • Grid computing is fit for simulations
Microsoft	• .NET as Web service deployment platform • Its DTAS research team is building tools that enable time-critical decision-making	• Will offer agent-based supply chain services to small, medium companies • Will appeal only to Microsoft shops
Others of note	• Sun: Can rally agent-app developers around Java; hardware mindset is a barrier • Asera: Its Web-service-enhanced platform can be used to deploy adaptive agents	
Business apps		
SAP/ BiosGroup	• Will release in Q2 2002 adaptive agents that augment capabilities of mySAP SCM • Founding member of Auto-ID Center	• Will corner R/3-heavy process sector • Must target Japan and Scandinavia -- with cooperative business cultures
Vigilance	• Its closed-loop exception management app is used by 13 Global 3,500 firms	• Will be bought by Oracle or PeopleSoft
living systems	• Agent-app pioneer has sold its sourcing and logistics apps to 30 clients worldwide	• Must drop "agent platform" provider ambitions and focus on business apps
Others of note	• WorldChain: Dell uses its app to manage supply network exceptions proactively • Wellspring Solutions: Big utilities use its app to make processes exception-proof	
Integrators		
Cap Gemini Ernst & Young	• Co-founded agent pioneer BiosGroup • Boasts an "adaptive supply chain" practice	• Definitely a thought leader; must now deliver on execution
PwC	• Acquisition of Applied Decision Analysis brings in topnotch decision-support tools	• Will help build marketplaces that trade options on production capacity
Others of note	• GE Cisco Industrial Networks: Helps clients link shop floor to enterprise backbone • Sapient: Built sense-and-respond supply nets for Union Gas and US Marine Corps	

Source: Forrester Research, Inc.

IBM's ongoing supply chain optimization research exploits agent-based technology and Web services to make firms' supply networks more adaptive.16 Expect IBM to release in 2004 "VisualAge for Agents" -- a development platform for building agent-based multifirm apps using FIPA's interoperability standards.[17]

• **Military spinoffs will commercialize extended Net apps.** Extended Net technologies from vendors like Savi Technology and WhereNet that have been used by the US Army for years now are finally making a foray into the commercial realm. We expect these extended Net pioneers to link up with agent-based simulation startups like MAYA Viz -- used in the Pentagon's war rooms to coordinate attack strategies with globally distributed military allies -- to inject sense-and-respond capabilities into manufacturers' logistics processes.

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- **Distributed computing pioneers will partner with simulation app vendors.** To support the need for distributed decision-making in adaptive supply networks, peer-to-peer computing platform providers like Parabon Computation and United Devices will partner with financial simulation wizards like Lostwax and Icosystem -- and create a distributed computing platform that manufacturers can use to perform complex game-theoretical simulations and get results within seconds.

- **CGE&Y and PwC will help firms craft adaptive supply networks.** CGE&Y cofounded the agent-based software pioneer BiosGroup -- which counts Unilever, P&G, and Ford as clients -- and has partnered with GE Cisco Industrial Networks, a provider of extended Net services. As for PwC, expect it to use its acquisition of Applied Decision Analysis to create decision-support tools that help buyers handle supply uncertainty by acquiring options on future capacity (see the February 25, 2002 Forrester Brief "Use Sell-Side B2B Auctions To Boost Asset Value").[18]

A C T I O N

☑ Firms must create network metrics that drive collaboration.

Firms often struggle with production crunches from overzealous marketing -- which fails to heed supply constraints when planning promotions. How can that change? By tying marketing's bonuses to supply network performance metrics like cost per shipment and cash-to-cash cycle.[19] For instance, Toyota and Nissan boast tight links between their shop floor and sales/marketing -- which they consider as a prerequisite for building an adaptive supply network.

☑ Users must increase supply net flexibility one step at a time.

Global 3,500 firms now shun big bang business app implementations: Only 23% are even considering buying a supply chain app this year (see the March 2002 Forrester Report "Benchmark North America: Business Technographics® Data Overview").[20] To sustain CXO's support for supply network improvement efforts, SCM execs must deploy bite-sized projects with quick ROI that will fund their next initiatives (see the March 2002 Forrester Report "Bite-Sized SCM Projects").[21] For instance, P&G's initial rollout of BiosGroup's agent app only included noncritical product lines and was limited to a few trusted partners. But its success led top management to extend the app's use across all product lines.

☑ Enterprise vendors must publish data dictionaries in RDF.

App vendors like SAP and Oracle have all joined the Web services bandwagon -- and agreed on how their proprietary apps will swap messages over the Net using SOAP and WSDL. But having a standard envelope doesn't make the message inside comprehensible -- key for letting software agents handle interfirm process exceptions. To avoid non-SAP agents misinterpreting data extracted from an R/3 system, SAP must lead app vendors by publishing its proprietary data dictionary in a machine-understandable format like RDF.[22]

☑ Systems integrators (SIs) should emulate PwC and CGE&Y.

A Deloitte partner prided himself for having the largest pool of i2-certified consultants among all SIs. But to attain supply network flexibility, firms like Dell need more than i2's planning app: They need solutions that preserve their plans' integrity by proactively resolving operational snafus. SIs should take a cue from PwC and CGE&Y, which provide clients with tools and frameworks to mitigate supply network risks. For instance, rather than waiting for i2 to link plans to execution, Deloitte should partner with agent app vendor living systems.

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W H A T   I T   M E A N S

! **The SEC hastens migration to adaptive supply networks.**
In the wake of the Enron and Global Crossing debacles, the Securities and Exchange Commission (SEC) has encouraged publicly traded manufacturers to make data about supply network performance public in a timely fashion.[23] For instance, the SEC wants to see firms report unplanned events like supply net exceptions within 24 hours of their occurrence. We expect that the SEC's new disclosure rules will lead to increased supply network transparency -- the first inroad in the route to adaptive supply networks.

! **Planning apps join the ranks of legacy systems by 2006.**
Given their centralized data architecture and top-down optimization frameworks, planning tools like Oracle's Advanced Planning and Scheduling are unfit to recast themselves as the power engines of event-driven adaptive supply networks. By 2006, planning apps will become a "last recourse" tool whose use is solicited only to reestablish network equilibrium when node-level agent-assisted exception management fails. But as agents become smarter in proactively responding to supply network changes, the need for global replanning will further diminish.

! **Exit availability to promise. Enter profitability to promise.**
Suppliers view demand as sacrosanct -- they bend backward to meet it. As a result, suppliers' exception-handling tactics rely on brute force -- using express shipments and expediters -- to align constrained supply with fickle demand. But as suppliers improve their sense-and-interpret capabilities over the next decade, they will gain better insight into supply and demand variability. The result? Capacity-constrained commodity suppliers will learn to allocate assets and resources more profitably by using yield management techniques and tools (see the October 2001 Forrester Report "Power Tools For Supplier Profit").[24]

! **Firms' obsession shifts from efficiency gains to greater flexibility.**
Post-September 11, Ford learned the hard way that techniques like just-in-time manufacturing make supply networks more efficient -- but not more flexible. In contrast, flexibility-seeking IBM had long ago instituted a "mission relocations" process, which supports the shift of manufacturing operations around the globe within 90 days.[25] The result? Following 9/11, IBM managed to swiftly move production of chips used by its defense customers from Germany to the US.

RELATED MATERIAL

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Companies Interviewed For This Report

Aspen Technology
www.aspentech.com

BiosGroup
www.biosgroup.com

BTexact Technologies
www.btexact.com

Cap Gemini Ernst &
Young
www.cgey.com

Categoric
www.categoric.com

Foundation for Intelligent
Physical Agents
www.fipa.org

GE Cisco
www.gecisco.com

i2 Technologies
www.i2.com

IBM Research
www.research.ibm.com

iSpheres
www.ispheres.com

Juniper Networks
www.juniper.net

KnowNow
www.knownow.com

living systems
www.living-systems.com

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MIT Media Lab
www.media.mit.edu

nthOrbit
www.nthorbit.com

Open Services Gateway
Initiative
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Saltare
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SAP
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Savi Technology
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STMicroelectronics
www.stmicroelectronics.com

Valdero
www.valdero.com

Vigilance
www.vigilance.com

WorldChain
www.worldchain.com

Experts Interviewed For This Report

Dr. Pattie Maes, founder of the MIT Media Laboratory Software Agents Group

Related Research

March 11, 2002 Forrester Brief "Adaptive Agents Boost Supply Network Flexibility"

February 22, 2002 Forrester Brief "Executive Overview: Adaptive Supply Networks"

February 2002 Forrester Report "Web Services Boost B2B Collaboration"

October 2001 Forrester Report "The X Internet Invigorates B2B Apps"

March 22, 2001 Forrester Brief "Optimization Is Dead. Long Live Adaptive Planning!"

September 2000 Forrester Report "Managing Business Velocity"

January 24, 2000 Forrester Brief "Hands-Free: A New Trajectory For Business Apps"

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GRAPEVINE

Metaphysics and the meaning of (agent) life.
We knew that agent software developers were frustrated by the lack of shared data dictionaries -- ontologies -- that agents can use to interpret data exchanged between trading partners. But when talking with IBM researchers, we found agent software developers also have other "ontological" questions to tackle, such as: "Can an agent beget other agents?" and "When should an agent die?" We understand their concerns: No IT developer would like to be known as the Dr. Kevorkian for agents.

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CEOs: How does your SCM garden grow?
CGE&Y's John Jordan explained that instead of crafting multiyear strategic plans, CEOs should focus on building adaptive organizations that can opportunistically respond to change in their adaptive supply networks. Execs must behave less like micro-managing puppeteers and more like gardeners, planting the seeds of growth and letting one thousand flowers bloom. We agree: Monolithic organizations with hierarchical decision-making structures won't survive in adaptive supply networks where winners will foster bottom-up control. SCM VPs of shouldn't create a strategy: Rather, they should cultivate the right set of preconditions and let supply chain strategies bloom.

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Need a date? Tell your agent.
Software agent company Tryllian gave us a peek at what it's doing with agent technology. Tryllian created Frog, a dating application that lets users look for dates by registering themselves with a matchmaking service through SMS or the Web. Agents then filter out messages from unwanted suitors based on preferences determined by the user. Your mother doesn't need to play matchmaker anymore -- leave it to your agent.

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Generals of the supply chain war.
Major integrators like IBM and PwC are aggressively posturing as supply chain gurus. But they will have to compete with US Army generals like William (Gus) Pagonis. During the Gulf War, Pagonis handled the highly complex logistics needed to support 60,000 GIs. Now an executive vice president at Sears, he used his adaptive planning techniques to keep the 2,000 Sears outlets fully stocked and loaded after September 11. Expect hierarchically organized corporate giants like GM and Siemens to rope in their own General Pagonis for a post-military commercial career -- and a new "army" of consultants to appear at your door.

ENDNOTES

1 For instance, two-thirds of manufacturers that Forrester surveyed handle capacity crunches by working overtime or reallocating production among other plants -- inducing constraints elsewhere in their supply networks.

2 Source: Voluntary Interindustry Commerce Standards (VICS) Association

3 Source: http://web.mit.edu/jrice/www/resource/scvsc.pdf

4 In *Supply Chain Management Review*'s August 2001 issue, Franklin Grosvenor, Cisco's director of supply chain, and Terry Austin, Manugistics' VP of communication, describe Cisco's eHub as "*a central* point for planning and executing tasks across the company's extended manufacturing supply chain."

5 Forrester defines adaptive supply networks as "business networks of supply chain partners that use technology to sense and respond in a coordinated fashion to changes in their environment."

6 Measurements based solely on historical results prevent executives from seeing the future in time to get ready. Firms must deploy business velocity management, enabling them to detect meaningful changes in leading indicators of supply, demand, and customer satisfaction. Acting on these indicators will help firms to adapt quickly to changing business conditions.

7 In complexity theory, a butterfly effect is formally known as "path dependence" -- a butterfly flapping its wings in China can create a tornado in the US.

8 Adaptive planning apps help preserve the integrity of existing supply chain plans -- by enabling event-driven, continuous, and distributed control of supply network operations.

9 Firms can take a cue from Unilever and Heineken -- which push exception-solving rights down to regional units and strategic partners.

10 DuPont -- which receives feedstock supplies by rail -- was close to shutting down its plants after October 2, 2001, the day the US government prohibited shipment of hazardous chemicals by rail. Source: Anna Bernasek, "The Friction Economy," *Fortune*, February 18, 2002.

11 Source: www.hp.com/solutions1/supplychain/resources/index.html#strategy

12 Web services mitigate integration headaches that thwart intercompany collaboration by enabling loosely coupled links. As Web services adoption spreads, firms will overhaul their supply management practices.

13 In the next decade, Forrester expects new tagging technologies and standards to improve device-to-device interoperability -- making it easier for manufacturers to identify and track the location and performance of all physical assets in their supply networks.

14 Adaptive agents are configurable, lightweight software components that increase a supply network's adaptability by continually aligning its members' diverging goals and processes.

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15 SAP plans to combine its portal and private hub offerings with new agent-based technology to help users evolve clunky supply chains into adaptive supply networks.

16 For more info on IBM's supply chain research named Continuous Optimization, please visit: http://www.research.ibm.com/autonomic/business/projects.html

17 While OMG and W3C are working on agent-interoperability standards, FIPA's interagent communication standards have been gaining the most traction among vendors and the user community. For more info on FIPA, visit: http://www.fipa.org

18 @TheMoment is providing its auction software to Reliant and TXU -- enabling the two energy companies to sell options on generation capacity at the best prices. Other manufacturers will turn to sell-side auctions to improve earnings.

19 For a list of supply network performance metrics, please visit the Supply-Chain Council at http://www.supply-chain.org

20 A survey of more than 650 senior executives at Global 3,500 firms built this report.

21 Users complain that traditional SCM app implementations are time-consuming and costly. A better alternative is to roll out small scope projects with quick ROI that fund firms' next initiatives.

22 RDF (Resource Description Framework) is a lightweight way of modeling knowledge so that it can be processed simply by a software system. It's designed to avoid the need for centralized control of the vocabularies that messages use and of the knowledge that they convey. For more info on RDF, please visit: www.w3.org/RDF/

23 Source: http://www.sec.gov/news/headlines/corpdiscrules.htm

24 Suppliers must strike back -- responding quickly to buyer demands with bids that are good for business. But to do so, they need product-revenue management practices that reduce demand variability and suggest appropriate responses. To succeed, firms will use technology to link profit strategies with optimized yield management and effective deal execution.

25 Source: Ralph W. Shrader and Mike McConnell, "Security and Strategy in the Age of Discontinuity," *strategy+business*, Issue 26, First Quarter 2002.