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INTEGRATING SUPPLIERS AND S&OP: DECIDING WHICH SUPPLIERS SHOULD BE  
INCORPORATED

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## **Abstract**

This purpose of this thesis is to investigate existing frameworks for supplier segmentation and the Sales & Operations Planning (S&OP) Process. Given the shift toward outsourced production, supplier relationship management is critical to manage risk in a supply chain. While supplier capacity is traditionally considered during the supply review, most companies have not fully integrated suppliers into their S&OP process. Since all suppliers are not created equally, Caterpillar wanted to know how to determine which suppliers were worth extra attention within the S&OP supply review and what other companies were doing. In order to supply this information, a literature review and interviews were conducted. Through these methods, a recommendation for a framework to segment suppliers for Caterpillar was developed based on the lessons learned and best practices in other industries.

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## **I. Introduction**

### **A. Introduction**

This purpose of this thesis is to develop recommendations for supplier segmentation within the Sales & Operations Planning (S&OP) Process for machinery companies such as Caterpillar, Inc. First, this thesis will elaborate upon the role of S&OP within a business and the value that it creates. Second, a series of interviews will be conducted to gather information regarding current practices for supplier segmentation and S&OP. Third, this thesis will explore the existing frameworks for supplier segmentation. Fourth, this thesis will provide a breakdown of suppliers by industry. Finally, this thesis will make recommendations for the best method of supplier segmentation for the S&OP Process for Caterpillar.

### **B. Methodology**

In writing this thesis, secondary sources were used to establish a background of Sales & Operations Planning, supplier segmentation, and supplier risk. Existing published research was readily available from library databases and Supply Chain publications, like the Supply Chain Management Review and Supply Chain Brain. In addition, resources from APICS, the Association for Operations Management, which is a non-profit knowledge community for supply chain and operations management, were utilized as background sources.

Primary sources that are used in this thesis are telephone interviews conducted to gather information on how supplier segmentation is conducted in various industries. Interviews were conducted with Tom Wallace, a writer and educator who specializes in Sales & Operations Planning, and supply chain professionals from Church & Dwight, Johnson & Johnson and The Hershey Company.

## **II. Background of S&OP**

### **A. Definition of S&OP**

According to The Association for Operations Management, or APICS, Sales & Operations Planning is defined as “a process to develop tactical plans that provide management the ability to strategically direct its businesses to achieve competitive advantage on a continuous basis by integrating customer-focused marketing plans for new and existing products with the management of the supply chain” (APICS, 2012). It is important to note that this process was first developed as a strictly internal process. However, any decision made in a company’s S&OP process will have a direct impact on the company’s suppliers. This process combines the company’s plans for sales, marketing, development, manufacturing, sourcing, logistics, and finance into an integrated plan that all functional areas can realistically execute.

Additionally, APICS goes on to describe the S&OP process as one that must “reconcile all supply, demand, and new-product plans at both the detail and aggregate levels and tie to the business plan” (APICS, 2012). Because S&OP is based on the fundamentals of balancing supply and demand in terms of both mix and volume, S&OP not only supports the company’s annual business plan and strategic plan, but also is used to link these aggregate plans with tactical execution in the short-term. In summary, S&OP is an internal business process that aligns supply chain execution with business strategy (APICS, 2012).

### **B. Business Planning**

Today, integration of functional areas is the key to enterprise success. Large improvements in business planning have been made since the 1960s and 1970s, when functional silo management was not viewed negatively. It is now commonly accepted that functional silo

management may optimize a single functional area, but optimization of individual silos does not optimize the entire business because tradeoffs are made. For optimization of the entire business, all functional area plans need to be compared, reconciled and rectified with each other to ensure that the final plan is attainable by all business functions.

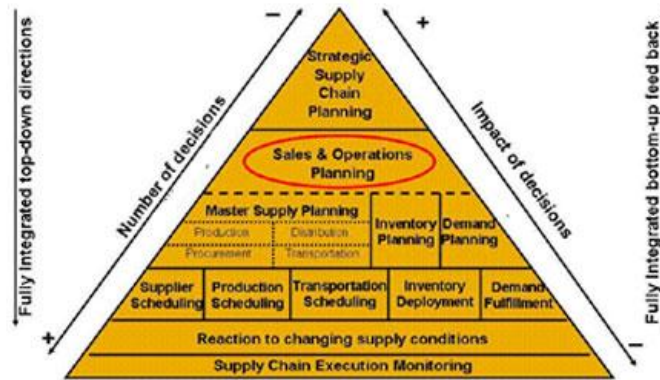
Consequently, business planning exists at all levels – ranging from long-term strategic planning all the way to detailed operations planning. These plans differ in both timeframe and scope. The strategic plan is an overarching three to five year plan that establishes the long-term goals for a company. The strategic plan is aligned with trends observed and forecasted in the macro-environment. It cannot dictate operational decisions because the environment in which operational decisions are made is constantly changing. For example, the business strategy most likely will not dictate the labor scheduling because the company's demand for labor is likely to shift depending on the demand from end-consumers. Any small change in demand from the end-customer, even in the medium-term, can mean a large shift in the short-term.

In order to better align a company's production and sales with the strategic business plan, medium-term planning is needed looking at a rolling eighteen to twenty-four month planning horizon. Without planning in the medium-term, there is not adequate planning to align the short-term with overarching business trends. The lack of medium-term planning often results in poor capacity planning, expediting, and heightened levels of safety stock held in order to buffer against shifts in demand. This in turn increases costs and decreases service to the customer.

### **C. Planning in the Medium-Term: Sales & Operations Planning**

Sales & Operations Planning (S&OP) is a medium-term cross-functional and collaborative planning tool which aligns strategic planning with operational plans on an aggregate level (See

Exhibit 1). In the absence of S&OP, functional areas are inclined to make unrealistic plans that do not consider capacity constraints. In addition, S&OP achieves balance in terms of both aggregate volume and product mix, which makes it the input to master scheduling and inventory planning (See Exhibit 1).



**Exhibit 1: Levels of Supply Chain Planning (Enchange Ltd., 2012)**

Structured as a monthly internal decision making process, S&OP involves a series of meetings which engage functional areas of the business to create a single plan that balances supply and demand. Through this process, all parties on the supply side and demand side – logistics, sales, marketing, finance, supply chain, procurement, and operations -- are committed to support and execute this single plan. S&OP is used to ensure that business objectives, customer requirements, and operating goals are both aligned and reconciled into a single company game plan that is achievable given business constraints. S&OP also functions as a performance review process that fosters root cause analysis of variation from the agreed upon plan, which therefore ensures that the plan is realistic month after month.

Sales & Operations Planning is needed because all markets are subject to change, which means that businesses must react. Overall sales volume, product mix, or demand on specific



resources and supply are all likely to change within the timeframe of a company's strategic plan. While it is difficult for a business to react to these shifts in the short-term, medium-term planning allows for better visibility of these changes. S&OP could even be considered more important for companies who outsource their manufacturing, because they have sacrificed direct control over manufacturing and require S&OP to provide visibility of supply and demand (Wallace, 2012).

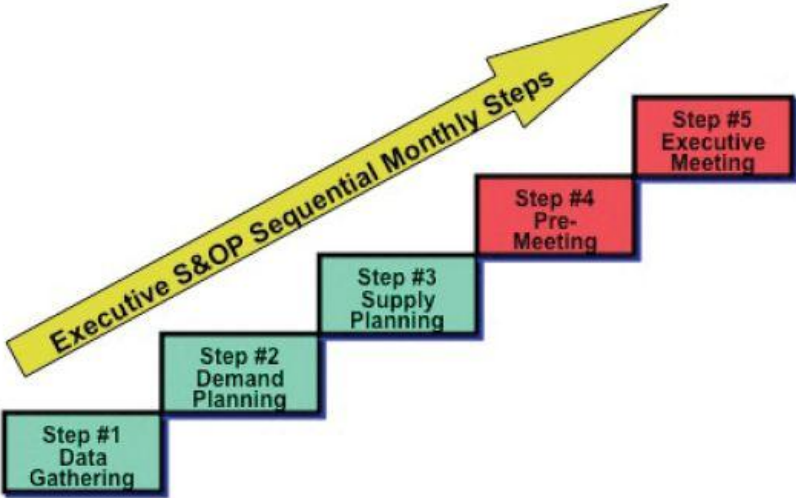
#### **D. S&OP Steps**

The S&OP process is traditionally composed of five steps, which occur sequentially every S&OP period. The first three steps (data gathering, demand planning, supply planning) are used as preparatory steps for the pre-meeting (step 4) and executive meeting (step 5) (See Exhibit 2).

Once data is gathered, a collaborative demand forecast needs to be created (step 2). This process will review past performance and reconcile the views of sales, customers, and historic demand. The demand review will also review inventory targets. Once this collaborative demand forecast is made through a preliminary S&OP run, which balances supply and demand, the plan is passed on to the supply planners. Supply side meetings (step 3) balance the interests of manufacturing, logistics, warehousing, procurement, and outsourcing – the parties involved with execution of the demand plan. An important part of the supply side meeting is that these plans are tested for feasibility using rough-cut capacity and material planning, facility capacity, and labor availability (Stahl, 2010). A second preliminary S&OP is run after the supply planning process has developed a collaborative production plan.

The final two steps are the pre-meeting (step 4), or partnership meeting, and the executive meeting (step 5). In the partnership meeting, mid-level managers from cross-functional groups come together to review the supply and demand plans established in steps 2 and 3. These parties

recommend changes and work toward a consensus when able or propose alternative solutions. If necessary, a third preliminary S&OP will be run in order to rebalance supply and demand. This meeting develops the agenda for the executive meeting. The executive meeting (step 5) reviews the decisions and then selects among alternatives developed in the partnership meeting. Finally, the final S&OP is run, to which all cross-functional parties are held accountable (Dougherty, 2007). This process is conducted monthly so that there is a rolling planning horizon of eighteen to twenty-four months. Suppliers are then tasked to meet production plans that are broken down from the S&OP plan.



**Exhibit 2: S&OP Steps (Stahl, 2010)**

## **E. Business case for S&OP**

According to an article in the Journal of Business Forecasting, the S&OP Process creates value (Bower, 2006). Bower defines value as “an improvement in revenue, profit, efficiency, reduction of waste, obsolescence or working capital” in the supply chain within five key areas, which include:

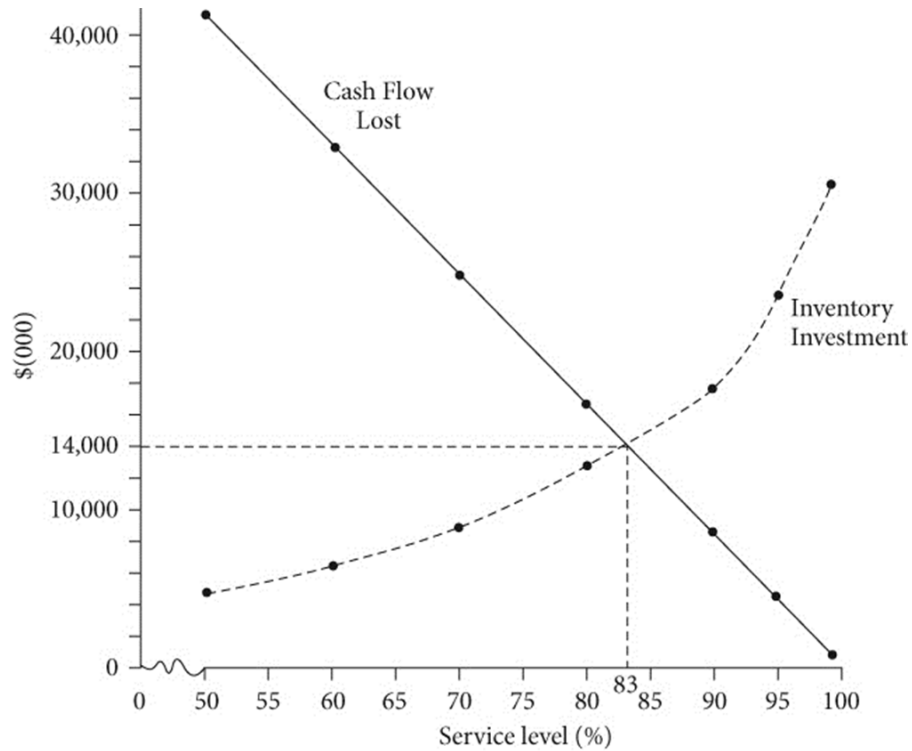
1. Improved Forecast Accuracy
2. Reduced Inventory
3. Reduced Obsolescence
4. Improved Customer Service/Revenue Generation
5. Improved Portfolio Management/New Product Introductions

Improvements in last four key areas cascade from the improvements in forecast accuracy. The demand forecast drives planning for suppliers, materials, levels of cycle and safety stock, and production planning, all of which need to balance with the business’ financial plan. Forecast accuracy, which is commonly measured with the mean absolute percent error (MAPE), therefore has a significant impact on planning decisions. Further, there is a direct correlation between Demand Forecast Accuracy (MAPE) and Perfect Order fulfillment (Hofman, 2004). In general, good demand visibility correlates with better perfect order performance, as it facilitates lower costs and improved responsiveness to the end customer (Hofman, 2004). S&OP enables better demand forecast accuracy because it facilitates a collaborative forecasting process utilizing inputs from supply-side and demand-side functions. According to Bower’s research, companies who have implemented S&OP have reduced forecast error from 12% to 0.69%, an improvement of 11.31% (See Exhibit 3).

<b>TABLE 3 BENEFITS OF S&amp;OP PROCESS</b>		
<b>Measure</b>	<b>Before S&amp;OP</b>	<b>After S&amp;OP</b>
New Product Forecast Error	1.2 million cases	300,000 cases
Obsolete Inventory	\$3 million per year	\$800,000 per year
Transshipments	5% of shipment volume	A little more than 1% of shipment volume
Mis-sourced Demand	25% diversions from "optimal" source site	5% diversions from optimal source site
Forecast Error (Measured at SKU, National Level)	12%	0.69%
Order Fill	95%	99.7%
Inventory expressed as days of supply (DOS)	45 DOS	27 DOS

**Exhibit 3: Benefits of S&OP (Bower, 2006)**

Another benefit of improvement in forecast accuracy is inventory reduction. On average, Bower’s experience has demonstrated a trend that for every improvement of one-percent in forecast accuracy, a similar one-percent decline in inventory levels results (Bower, 2006). The S&OP process leads to inventory reduction by addressing the three main factors that determine safety stock and cycle stock—lead time variability, demand variability and supply variability. The demand review assists in decreasing demand variability by creating a single forecast, while the supply review meeting addresses supply variability and lead time variability from suppliers on an aggregate level. By managing overall variability with the S&OP process, it is possible to decrease inventories held. In turn, reductions in inventories create the additional benefit of increased cash flow for the enterprise (See Exhibit 4).



**Exhibit 4: Cash Flow Lost/Inventory Investment Tradeoff (Novack, 2008)**

Together the demand and supply reviews work to control the sources of obsolete inventory, or inventory that result from over-production, for which no end customer demand yet exists. Given the fast pace of today's business environment, slow-moving inventory can often become obsolete if it is not sold early on, especially for products that are perishable or have short life cycles. Obsolete inventories tie up cash, and are either sold at a lower margin or are disposed of. Liquidation is common for industries like consumer packaged goods or retail, whose product life cycles are often short. For industrial equipment manufacturers, an overage in production often will result in inventory sitting at a dealership or in storage for extended periods of time, tying up thousands of dollars in an unsold machine. Because both the demand and supply meetings look to see if hedging behavior from any one functional group is creating a bias in the forecast, these

reviews work in tandem to establish a reconciled plan for the medium-term. With greater forecast accuracy from these reconciled plans comes a greater chance that production will not over-produce, resulting in obsolete inventory.

Another value that comes from the S&OP process is improvements in customer service. While the service level itself might not change, as it is driven by the end-customer's demands, the amount of inventory and cash dedicated to achieving this service level will decrease due to the S&OP process because S&OP decreases variability by reconciling supply and demand. As previously noted, the S&OP process leads to improvements in demand forecast accuracy which correlate to a higher perfect order. The perfect order metric is customer facing, meaning that as perfect order increases, so does customer service. As perfect order rates improve, revenue tends to improve because less cash is tied up in excess buffer stock inventory and additional costs due to variability are minimized as planning improves.

The final benefit discussed in Bower's article is the improvement in portfolio management and new product introduction. Portfolio management is a separate step in the S&OP process, as defined by Bower, during which topics such as new product forecasts, promotional plans, SKU rationalization or discontinuation, and shifts in strategy for products undergoing lifecycle changes are discussed (Bower, 2006). By aligning all parties, supply side and demand side, on the plans for these issues, the portfolio management step for S&OP allows organizational silos to balance their interests.

### III. **Suppliers by Industry**

While supplier relationship management is important for all industries, suppliers are inherently different due to their industry. There are four major industry segments: discrete, consumer, process, and high-tech/electronics (Viswanathan, 2011).

These four industry segments are described in more detail below.

#### **Discrete**

- Industries and Company Examples:
  - Aerospace and Defense
  - Automotive
  - Industrial Equipment Manufacturing
  - Industrial Product Manufacturing
  - *Examples:* Caterpillar, Inc., John Deere, Boeing, Toyota, General Electric, Navistar

#### **Consumer**

- Industries and Company Examples:
  - Apparel
  - Consumer Durable Goods
  - Consumer Packaged Goods
  - Consumer Electronics
  - Wholesale/Distribution
  - Food/Beverage
  - Retail

- *Examples:* Zara, Proctor & Gamble, Church & Dwight, Unilever, Hershey's, Whirlpool, Johnson & Johnson, Wal-Mart, General Electric

## **Process**

- Industries and Company Examples:
  - Chemicals
  - Metals and metal products
  - Mining, Oil, Gas and Utilities
  - Paper/lumber/timber
  - Pharmaceutical manufacturing
  - *Examples:* General Electric, Pfizer, Dow Chemical, BASF, US Steel, Alcoa, Johnson & Johnson

## **High-tech/electronics**

- Industries and Company Examples:
  - Computer equipment and peripherals
  - Health/medical/dental or services
  - High-technology
  - Telecommunication equipment/services
  - *Examples:* General Electric, Cisco, HTC, Apple, Dell, HP, Siemens

Some companies can fit into multiple segments depending on company diversification, like General Electric, which fits into all four segments.



Given these four industry segments, suppliers are very different. Most literature available about supplier segmentation focuses on the consumer, high-tech/electronics and sub-industries within the process and discrete segments like chemicals which are used frequently in consumer goods and passenger vehicles. Based on the limited amount of information about supplier relationship management within the discrete segment, there is an opportunity for more research in this area particularly for industrial equipment manufacturers.

Suppliers to industrial equipment manufacturers are inherently different than suppliers to consumer goods and high-tech companies. First, the customers for industrial equipment manufacturers are generally not individual consumers, but rather governments, construction companies, builders, land developers, and mining companies. Consequently, consumers of industrial equipment try to maximize the amount of use attainable from one machine while purchasing at the lowest lifecycle cost. Lifecycle costs are important to consider because industrial equipment can last for decades depending upon its intended use. This is inherently different than consumer goods and high-tech goods, which typically follow a more stable, faster-moving demand pattern like that of a household staple good like detergent or a cell phone, which may have life cycles of 3 months to 1 year (Fisher, 1997).

Second, consumer and high-tech/electronics companies are numerous, whereas fewer industrial equipment manufacturers exist. Because there are so many consumer goods companies, there is an opportunity for many more suppliers to compete to provide components and materials than there would be for a supplier of specialized components. This means that for consumer goods and often for high tech companies, many components for their products have a diverse supply base to select from. If one supplier were to go out of business, another could take over without much delay. The consumer goods industry also protects itself from supplier risk by

diversifying its supply base. The Hershey Company is able to maintain flexibility and manage supplier risk using seven or eight different suppliers for corrugate, so that order volume can be allocated according to supplier capacity to meet demand (Teets, 2012). However, if a casting supplier or gear manufacturer for an industrial equipment manufacturer went out of business, it would likely take months to find, qualify, and scale up another supplier who could replace the other. For industrial equipment manufacturers, almost all components must achieve specialized tolerances to meet engineering and quality standards, which makes the cost of switching suppliers and qualifying new suppliers very high.

Finally, another inherent difference between consumer goods and high-tech goods is that they tend to be physically smaller. While there are obvious exceptions like bolts and fasteners, many components and subassemblies for industrial equipment take up not only a lot of space in a warehouse, but also working capital. Many of these large components are long lead time items that must be ordered months to years in advance. The visibility from S&OP at the aggregate level is especially important to improve visibility into these components with long lead times, high amounts of capital, and limited numbers of suppliers.

#### **IV. Voice of Industry: Interviews and Lessons Learned**

##### **A. Interviews: What is being done now in industry with S&OP and suppliers?**

###### **1. Church & Dwight Co., Inc.**

Church & Dwight is a consumer products company that manufactures household products like Arm & Hammer® and personal care products like Nair®. Sales & Operations Planning at Church & Dwight began in the mid-2000s and was mainly led by the sales and marketing groups. In the past few years, forecast ownership was moved into the supply chain group so that their S&OP process was able to more efficiently balance supply and demand. The output of S&OP is a consensus plan at the aggregate level which then is translated by master planners into production plans. Production plans are given to suppliers who must then make their own production plans. In this interview, Church & Dwight said that if the supplier does not have enough capacity or cannot meet the production plan, they will work with the supplier to add an additional line for production or they consider additional suppliers. The purchasing department hedges against risk by pre-qualifying suppliers who provide basic material inputs. However, when suppliers are providing proprietary products, the cost of switching or adding additional suppliers is greater. For this reason, chemical suppliers can take several years to qualify (Mahoney and Yeager, 2012).

Furthermore, Church & Dwight splits its suppliers into two categories: material suppliers and contract manufacturers. Within the first category, Church & Dwight focuses on two suppliers who are important to most of their value streams and have historically been supply constraints. Within this first category, there are purchasing managers for commodities like bottles, corrugate, and chemicals. The second category of contract manufacturers provides about

twenty percent of Church & Dwight's manufacturing capacity. These contract manufacturers do their own sourcing and receive an eighteen month rolling forecast from Church & Dwight as a result of S&OP (Mahoney and Yeager, 2012). While suppliers do receive outputs of S&OP, none of their suppliers are integrated into their S&OP process.

## **2. The Hershey Company**

The primary suppliers to The Hershey Company are flexible packaging, cardboard, and ingredients. Hershey's builds flexibility into its supply base by diversifying. For corrugate, Hershey's maintains seven or eight corrugate suppliers in various regions (Teets, 2012). Hershey's also utilizes forward buying to lock in prices and quantities for packaging and commodities like dairy and cocoa. From the interview with Hershey's, though suppliers were segmented by commodity, Hershey's also follows the 80-20 rule that says eighty percent of Hershey's spend will go to twenty percent of its suppliers. These twenty percent of suppliers are Hershey's strategic suppliers (Teets, 2012).

Another planning initiative for Hershey's is its long-term planning for product line utilization. Hershey's projects out demand for production lines three to five years in advance. These projections are done three times per year based on sales and marketing's five year strategic plan. This strategic plan involves growth rates by brand so that Hershey master planners are able to calculate product line utilization by brand. Rolling updates to this capacity plan allow time for manufacturers to upgrade and purchase new equipment as needed, since the lead time for adding a new line can be a year to a year and a half (Teets, 2012).

### **3. Johnson & Johnson**

For the Johnson & Johnson Consumer Products North America division there are three main supplier types: chemical suppliers for raw materials, packaging suppliers of tubes, bottles, pumps, and cartons, and external manufacturers who control about fifty percent of their consumer product manufacturing (Lawse, 2012). Within these three groups, there are strategic suppliers. For example, of Johnson & Johnson's approximately forty external manufacturers, nine are strategic suppliers. Instead of using the quadrant model (See Exhibit 5), suppliers are determined to be strategic based on the volume and level of spend. The volume and level of spend for a given supplier is also correlated with the end product sales volume. This allows more resources to be allocated toward internal improvements for products that generate higher profits for Johnson & Johnson (Lawse, 2012).

## **V. Existing Frameworks**

Many frameworks have been created and applied in order to decide the optimal allocation of limited time and resources among a supply base. The primary frameworks elaborated on below are the quadrant model and Dyer's Strategic Supplier Segmentation Model.

### **A. Quadrant Model**

The quadrant model is a two-by-two grid based on the value and risk that is typically applied to inventory (See Exhibit 5). The horizontal axis of the Quadrant Model is value, or profit potential. The vertical axis of the Quadrant Model is relative risk, which refers to the probability of the item not being available when it is needed (Center for Logistics Research, 2001). The four quadrants in the matrix—generics, commodities, distinctives, and criticals—represent the extremes.

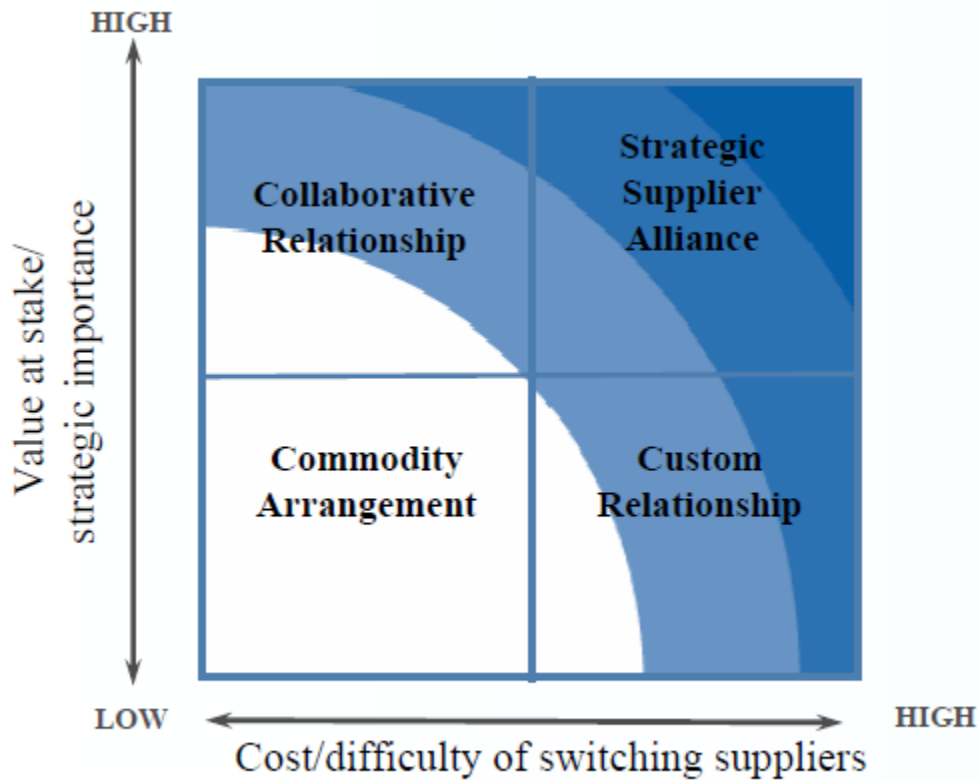
Risk	High	<b>Distinctives</b> <ul style="list-style-type: none"> <li>• High safety stocks</li> <li>• More than one stocking location</li> <li>• Produce to inventory</li> </ul>	<b>Criticals</b> <ul style="list-style-type: none"> <li>• High safety stocks</li> <li>• Multiple stocking location</li> <li>• Produce to inventory</li> </ul>
	Low	<b>Generics</b> <ul style="list-style-type: none"> <li>• Low/no safety stock</li> <li>• Single stocking location</li> <li>• Produce to order</li> </ul>	<b>Commodities</b> <ul style="list-style-type: none"> <li>• Adequate safety stocks</li> <li>• More than one stocking location</li> <li>• Produce to inventory/produce to order</li> </ul>
		Low	High
		Value	

**Exhibit 5: Quadrant Model (Novack, 2008)**

A further distinction can be made from the quadrant model into the relationships that might be derived from this value versus risk segmentation. Joseph Black discussed segmentation based on value and risk in a presentation about supplier relationship management<sup>1</sup>. Black's segmentation model is based on the assumption that suppliers with different levels of value and risk should be managed through different types of relationships.

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<sup>1</sup> The axes for Exhibit 5 and Exhibit 6 are opposite



**Exhibit 6: Supplier Relationship Segmentation Model (Black, 2005)**

**1. Synthesizing Quadrant Model with Supplier Segmentation Model**

**Commodity Relationship: Generics**

Inputs classified as generics in the quadrant model (See Exhibit 5) are low value and low risk. Cost is the major driver when sourcing these products and Black would argue that generics are best fit for a commodity relationship in which planning is done annually and with narrow scope. Companies generally divert the fewest resources to these suppliers, since relationships generally last for a short to medium time period and are driven by cost efficiency. Generic inputs are low value and switching suppliers is easier and less expensive.

### **Custom Relationship: Distinctives**

Distinctive inputs often provide for the company's competitive advantage. Because of this, they are often managed in a custom relationship (Black, 2005). Often, these inputs are related to new technologies and thus there often is only one source. Consequently, sole sourcing is not uncommon for distinctive inputs. While custom supplier relationships often have dedicated resources, the relationship is dependent on the market environment. As technologies evolve, what was once a distinctive input might no longer be distinctive a few months later, meaning that as long as the technology or benefit derived from a distinctive input still contributes to the company's competitive advantage, the custom relationship will survive. Even though distinctive inputs are low value, switching suppliers tends to be both expensive and difficult.

### **Collaborative Relationships: Commodities**

Commodities are high value and often represent large volumes of spend. However, given the large number of suppliers the cost to switch suppliers is relatively low and simple. Commodities are managed through collaborative relationships that are driven by the goal of maximizing value while achieving the lowest total cost. Collaborative relationships leverage the number of suppliers and the volume of business that is awarded to each. As a collaborative relationship, there is robust and frequent communication. It is important to for the buyer understand and monitor the supplier's financial viability to see if an alternative source should be selected.

### **Strategic Supplier Alliances: Criticals**

Critical inputs are high value, and thus should be managed through a strategic supplier advantage. Suppliers of critical inputs are expensive to replace, and there are limited numbers of



suppliers who can provide these critical inputs. As these inputs are a critical need, strong supplier alliances are built so that joint benefits can be realized. In a strategic supplier alliance, communication is robust and there is often an equal investment in the supplier's development. Not only does the buyer hope to make the supplier more efficient in this relationship, but the buyer also has an interest in the company's financial viability. By guaranteeing the supplier's success and financial viability by maximizing joint gain, the buyer can promote a long-term supplier alliance.

### **Quadrant Model to integrate suppliers into S&OP Process**

By segmenting suppliers into quadrants, it is apparent that criticals (high value, high risk) and distinctives (low value, high risk) are inputs that would benefit from further demand visibility and incorporation into the S&OP process. By integrating these suppliers into the S&OP supply review process, capacity constraints or other issues can be revealed and addressed. The importance of including suppliers of distinctives in the aggregate planning stage is driven by the high cost of switching suppliers. Many times in the high-technology industry, there is only one supplier for a new technology that will set a company apart. Mutual understanding of demand trends and the supplier's capabilities are essential for the buyer-supplier relationship to succeed. More visibility of downstream demand provided by the rolling S&OP plan allows the supplier to adjust production capacity proactively. On the other hand, more buyer visibility upstream allows the buyer to develop a plan to manage the risk of disruption of product flow.

Companies with S&OP processes deemed best-in-class by the Aberdeen Group in 2009 were already implementing rapid response management capabilities and monitoring performance against the S&OP plan daily (Viswanathan, 2009). Best-in-class S&OP companies

were twice as likely to have the ability to respond quickly to unplanned events compared to other companies (Viswanathan, 2009), which is a growing trend as many companies are outsourcing manufacturing to contract manufacturers and external providers. With this loss of direct control, companies like Cisco who has outsourced ninety-five percent of its component production to global manufacturing partners are building foundations to respond to disruptions in supply (Harrington and O'Connor, 2009).

Companies who outsource control of manufacturing realize that any supplier has the ability to shut down a production line. Cisco, which is a company with a best-in-class S&OP program (Wallace, 2012), realized that it needed to take a proactive approach to respond to unplanned events quickly. Cisco's Supply Chain Risk Management (SCRM) program is supported by its Global Supplier Management team, Product Operations group, and Global Manufacturing Operations Group. Together these three groups manage everything from supplier relationships and procurement to engineering, global manufacturing, transportation, and logistics. The SCRM program uses Cisco's Business Continuity program which collects key information to assess supply chain risk (Harrington and O'Connor, 2009). Data collected through this program about suppliers, manufacturers, and logistics providers regarding their recovery times and plan enables Cisco to respond quickly to unplanned events. These foundations allow Cisco take a proactive approach at managing their supply chain from end to end.

## **B. Dyer's Strategic Supplier Segmentation Model**

Jeffrey Dyer, Dong Sung Cho, and Wujin Chu developed their strategic supplier segmentation model in 1998. They studied supplier relationships across three different cultures: the United States, Japan, and Korea to determine if the traditional arm's length model or the

Japanese-style partnership model is more effective (Dyer, Cho and Chu, 1998). Through their research, the authors determined that the best way to achieve the benefits of arm's-length and partner models is to segment suppliers into two groups: necessary, but non-strategic inputs and strategic inputs (Dyer, Cho, and Chu, 1998). Strategic inputs like engines and transmissions, used to differentiate from competing firms, are high-value and related to the buyer's core competence. The necessary, but non-strategic inputs like tires would be provided by independent suppliers through what the authors term durable arm's-length relationships, whereas the strategic inputs would be managed as a strategic partnership (Dyer, Cho, and Chu, 1998). Exhibit 7 contrasts the differences between these two types of buyer-supplier relationships.

Given the degree of interaction in the strategic partnership category within this framework, demonstrated through multiple functional interfaces and the level of investment in these suppliers, it logically follows that incorporating these suppliers into the buyer's S&OP process would provide beneficial visibility into demand. Added visibility for the supplier means that appropriate investments in capital equipment and raw materials can be made, which is important for long lead time items.

	<b>Durable Arm's-Length Relationships (Quasi Markets)</b>	<b>Strategic Partnerships (Quasi Hierarchies)</b>
<b>Product/Input Characteristics</b>	<ul style="list-style-type: none"> <li>• Commodity/standardized products</li> <li>• Open architecture products</li> <li>• Stand alone (no or few interaction effects with other inputs)</li> <li>• Low degree of supplier-buyer interdependence (sequential interdependence)</li> <li>• Low value inputs</li> </ul>	<ul style="list-style-type: none"> <li>• Customized, non-standard products</li> <li>• Closed architecture products</li> <li>• Multiple interaction effects with other inputs</li> <li>• High degree of supplier-buyer interdependence (reciprocal interdependence)</li> <li>• High value inputs</li> </ul>
<b>Supplier Management Practices</b>	<ul style="list-style-type: none"> <li>• Single functional interface (i.e., sales to purchasing)</li> <li>• Price benchmarking</li> <li>• Minimal assistance (minimal investment in interfirm knowledge-sharing routines)</li> <li>• Supplier performance can be easily contracted for ex ante</li> <li>• Contractual safeguards are sufficient to enforce agreements</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple functional interfaces (e.g., engineering-to-engineering, manufacturing-to-manufacturing)</li> <li>• Capabilities benchmarking</li> <li>• Substantial assistance (substantial investments in interfirm knowledge-sharing routines)</li> <li>• Supplier performance on non-contractibles (e.g., innovation, quality, responsiveness) is important</li> <li>• Self-enforcing agreements are necessary for optimal performance (e.g., trust, stock ownership, etc.)</li> </ul>

**Exhibit 7: Contrasting Durable Arm's-Length Relationships with Strategic Partnerships (Dyer, Cho, and Chu, 1998)**

## **VI. Suppliers**

### **A. Supplier Relationship Management**

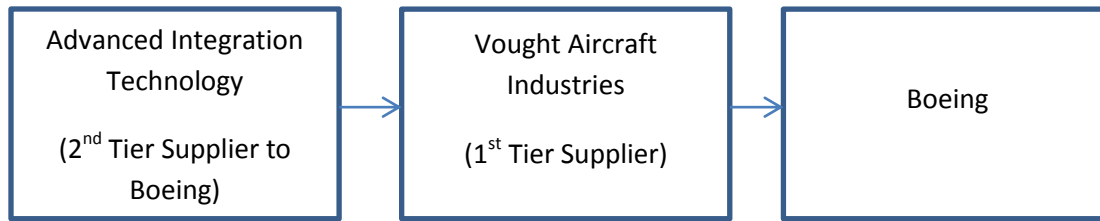
While supplier capacity is traditionally considered during the supply review (See Exhibit 2), many companies have not yet integrated direct supplier input into their S&OP process. In the past, businesses have interacted with suppliers by sending purchase orders with metrics for quality, quantity, timing of delivery, and other specifications. However, today supplier relationship management is critical to success as seventy to eighty percent of a product's components are no longer made in house, but rather sourced externally (Rizza, 2010). Not only are components sourced externally, but also are sourced globally as expertise grows in lower cost sourcing areas. This means that even as companies are trying to rationalize their supply base, their supply network is likely to be growing, not shrinking, as tiers of secondary suppliers are growing.

Outsourcing is often motivated by a company's desire to cut costs and focus internal efforts on core competencies (Lynch, 2004). However by acting as the integrator of outsourced parts and assemblies, risk is pushed upstream and companies often lose direct control over outsourced activities. Resources must be dedicated to mitigate the risk that suppliers now pose to manufacturers. Industry trends show that more company resources are being dedicated to supplier relationship management and supplier risk management. One reason for this is that companies are learning that they need to proactively manage supplier risk, such as delays or disruptions from one supplier that can result in entire production lines being shut down. However not all supplier relationships will require the same level of buyer resources.

The following three sections are examples of how several companies are managing suppliers. The example of the Boeing 787 Dreamliner is an example of poor supplier relationship management; meanwhile Proctor & Gamble and John Deere are best-in-class examples.

### 1. **Boeing 787 Dreamliner**

In order to manufacture the Dreamliner 787, Boeing decided to outsource over half of production to a global supply base. The outsourced material would be flown in from suppliers and assembled by Boeing within a three day period (Greising, 2007). While there are many benefits that could be gained by Boeing pushing the both component development and financial risk upstream, this sourcing decision made Boeing more dependent on its suppliers. Given this dependence, communication and monitoring of supplier and second tier supplier progress was insufficient. Consequently, Boeing's first delivery delay was characterized by shortages of fasteners from a second tier supplier (See Exhibit 8). Boeing's second tier supplier Advanced Integration Technology (AIT) was struggling to produce both the fasteners and equipment that were essential to the assembly of the 787's fuselage. In turn, this meant that Boeing's first tier supplier, Vought Aircraft Industries, which already was the 787's "most troubled supplier" (Greising, 2007), experienced more difficulty in delivering the fabrications to Boeing due to AIT's delays. This is a clear example of how a small supplier can have a domino effect in a supply chain, ultimately delaying delivery to the customer. It also shows that without flexible suppliers, delivering innovation becomes more risky.



**Exhibit 8: Boeing 787 Dreamliner Suppliers**

## **2. Proctor & Gamble**

As the largest consumer-products company in the world, Proctor & Gamble (P&G) has over 90,000 suppliers, 400 of which are key partners (Teague, 2008). P&G is able to manage this vast base of suppliers through its centralized Global Purchases organization, which is tightly integrated with all company business units. This tight integration allows for suppliers to contribute directly to product innovation. The centralized structure also allows for P&G to use its global leverage, which is a strategic benefit since one supplier will often supply several business units. By pooling its spend by category, P&G is better able to leverage its volume.

Supplier relationship management is of strategic importance to P&G because of the company's strategic goals to have half of P&G's total innovation originate from external sources; the Vice President for Global Purchases intends for fifty percent of that innovation to come from suppliers (Teague, 2008). For example, thirty suppliers worked together with P&G Global Purchases to launch a concentrated formula and packaging of the company's liquid laundry detergents (Teague, 2008), which made the product more sustainable and improved supply chain operational efficiency by improving warehouse and truck-space utilization and reducing fuel consumption. P&G has reaped benefits from partnering with suppliers; however external collaboration is inefficient if the relationship is not managed and risk is not monitored

and managed. While selecting suppliers, P&G looks globally for the best suppliers and begins its consideration with the following ten factors:

- Financial stability
- Legal structure
- Sources of supply and financing
- Cost competitiveness relative to competition
- Operational practices
- Track record for innovation
- Agility/flexibility
- Responsiveness to quality of products and services
- Strategic alignment with P&G

In order to manage supplier risk once suppliers are selected, P&G Global Purchases is careful to look at the risks that tier two and tier three suppliers may present (Teague, 2008). By drilling down into the supply base, P&G ensures the continuity and quality of supply further upstream. P&G also involves their suppliers at regular supplier summits by region and category so that the participants are able to address existing and anticipated needs by developing joint business plans (Teague, 2008). Finally, P&G drives continual improvement not only by monitoring the performance of suppliers with a scorecard performance management system, but also by employing a reverse score-carding system which rates P&G as a customer.

### **3. John Deere**

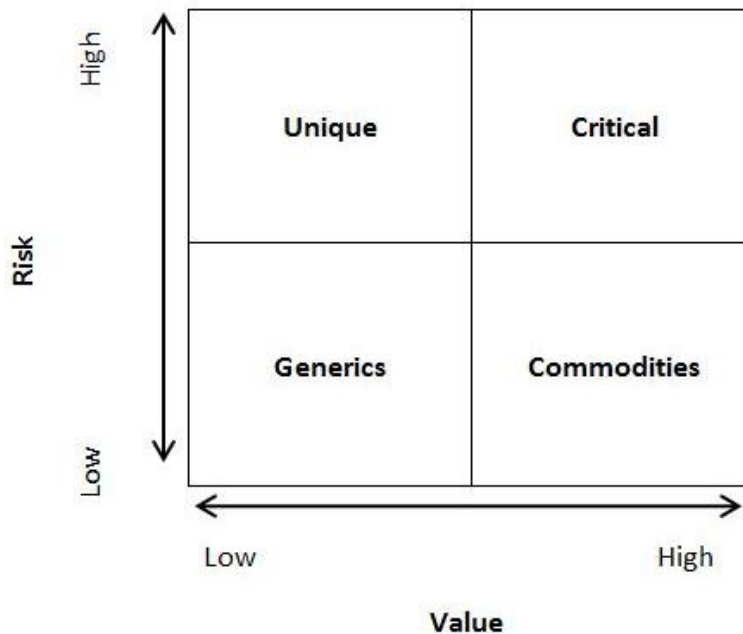
John Deere was awarded Purchasing Magazine's Medal of Professional Excellence in 2001. In the late 1990s, Deere was purchasing from 14,000 active suppliers and had over 80,000



suppliers in their database (Smock, 2001). This massive supply base was due to an outsourcing trend in the 1980s where each business unit was given free rein to manage procurement. To optimize their supply base, Deere's Worldwide Supply Management group was given executive support to cut costs and implement strategic sourcing. This group developed strategies for four material classifications with the quadrant model (See Exhibit 9):

- Unique
- Critical Products
- Generics
- Commodities

By segmenting their supply base, Deere was able to better allocate resources toward the suppliers that were critical and unique, and better manage the company's cost structure.



**Exhibit 9: John Deere's Application of the Quadrant Model (Smock, 2001)**

In addition, Deere centralized procurement except for major components that were used only at one production location. By centralizing procurement, Deere was able to optimize its supply base and leverage worldwide spend categories to obtain better pricing.

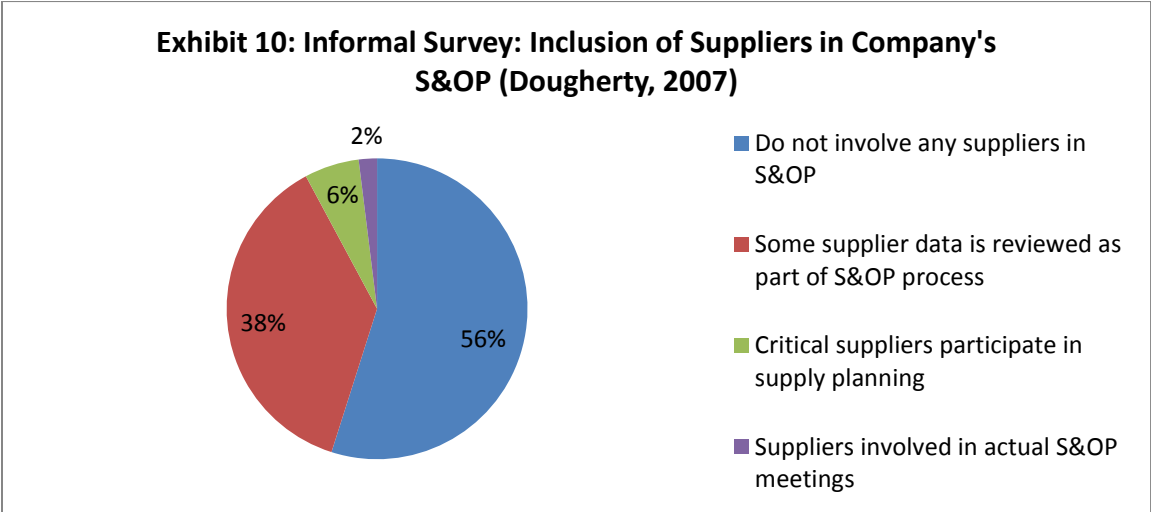
### **B. Role of suppliers in S&OP – Looking Forward**

While S&OP allows for top-to-bottom integration within the business of overarching business plans with operational plans, S&OP at the basic level does not integrate the business plans of multi-enterprise trading partners. These multi-enterprise partners could be customers, suppliers, service providers, and 3PLs ("SupplyChainBrain," 2012). When key suppliers are involved, the benefits of S&OP can be maximized ("SupplyChainBrain", 2012). For companies to mature within S&OP, “companies will begin to collaborate with customers and suppliers outside of the four walls” ("SupplyChainBrain", 2012 ).

However, all suppliers are not created equally. Consequently, there is a need to decide which suppliers should be incorporated into S&OP. This framework will help businesses determine optimal allocation of resources to suppliers.

**VII. Supplier S&OP**

There are several different levels to which a supplier can be integrated into a company’s S&OP process, but in a 2007 informal survey it was concluded that more than half of the companies surveyed were not involving suppliers in S&OP (See Exhibit 10). Suppliers are often viewed as an added capacity constraint. However, by linking critical suppliers into S&OP, internal benefits of S&OP can transcend company boundaries. The critical question is how to determine which suppliers should be integrated.



**A. Supplier S&OP at Motorola**

Companies are operating in an environment where the supply base is constrained and often represents high-risk potential. Consequently, companies are beginning to partner with key customers and suppliers and involving purchasing in the company’s Sales & Operations Planning process. Praised in an interview with Tom Wallace, Motorola is a company that integrated suppliers into its S&OP program after struggling with component shortages (Wallace, 2012). According to Grant Hoffman, director of global business operations for the mobile devices

business unit of Motorola Mobility, “Supplier S&OP is an innovative, world-class collaborative-planning process that Motorola Mobility developed to align our forecast ranges with our suppliers’ capabilities of fulfilling the demand. By implementing supplier S&OP, we improved gross margin and on-time delivery to customers, reduced E&O exposure and inventory, and forged stronger supplier relationships” (CSCMP, 2011).

The ultimate goal of the Supplier S&OP program was to improve the link between supply and demand, which would ultimately improve demand visibility to the supplier and supplier visibility to Motorola. Motorola’s Supplier S&OP process meant that critical suppliers received ranges as their forecast. By allowing the supplier to plan within the forecast range, Motorola could lock in the final forecast closer to when the end product demand was locked in. Despite challenges, range forecasting allowed suppliers for Motorola to see improvements in their own inventory levels (“SupplyChainBrain”, 2011). Once suppliers were selected, decisions were made with direct communication between Motorola and the supplier. By having decision makers on both sides, Motorola connected supply and demand between companies through procurement.

An important decision for Motorola was selecting those suppliers with which to execute this process. The first suppliers targeted were high value, long lead time items since they represented the greatest amount of excess and obsolete inventory. Its next targets were suppliers who recurrently appeared on shortage lists, required long lead times, suffered from capacity constraints or parts that were single sourced (“SupplyChainBrain”, 2011).

## **B. Lessons Learned**

Based upon research into existing supplier segmentation models and supplier relationship management, several key criteria must be considered in order to determine which suppliers

should be integrated into a company's S&OP process. Through data analysis, suppliers should be tied to the most profitable value streams. Suppliers who provide products for the most profitable value streams should be examined first when selecting suppliers to integrate into the company's S&OP. Within these profitable value streams, segment the suppliers by the amount of revenue they enable and the risk that the supplier presents if there are delays or not enough capacity. An additional consideration to be weighed is the cost or ability for the company to qualify an additional source of supply and the revenue that would be lost to do so. Suppliers whose components generate the most revenue and present the most risk should receive the primary allocation of resources.

The most robust way to incorporate suppliers into S&OP is to look at what Motorola is doing with its Supplier S&OP program. Motorola segmented its supply base so that it could determine which suppliers were long lead time suppliers, constrained industries, and single sourced components. By adding suppliers based on careful analysis of their fitness with its program, Motorola was able to show steady improvement in its supplier base.

## **VIII. Conclusion**

As companies continue to outsource manufacturing and become assemblers rather than manufacturers, they must work to improve the link between end-customer demand and their supply base. By integrating suppliers into Sales & Operations Planning, demand visibility improves for suppliers and visibility into supply improves for buyers. Companies like Motorola are at the forefront now with their Supplier S&OP process, which utilizes range forecasting for suppliers.

Not all suppliers should be the first choice to integrate into S&OP. Risk and value, the two criteria that form the quadrant model, form a simple framework to decide which suppliers to integrate first. The most risky and high value suppliers operate in constrained industries, have long lead times and are sourced from only one supplier. For industrial equipment manufacturers, integration of these three types of suppliers would provide a simple starting point.

Furthermore, integrating suppliers into S&OP should follow a phased implementation. By starting with one product family, a company can slowly begin to integrate suppliers who enable the most profitable value chains. Once the process is running smoothly, more suppliers can be involved.

### **A. Limitations**

This thesis has some limitations. The primary limitation was that interviews were not conducted early on during the research process. Consequently, follow up interviews were not possible. In the future, more research could be done directly with Motorola on the development and implementation of their Supplier S&OP process.

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## **IX. Appendices**

### **A. Interview Questions**

The following questions were a framework for interviews conducted with companies regarding S&OP and Supplier Segmentations.

1. Brief background of S&OP at your company.
2. Does your company focus heavily on supplier capability during the S&OP process?
3. How does your company measure and manage supplier risk when developing the S&OP plan?
4. Brief background of who contributes to the supply review in your company's S&OP process.
  - a. Is your company's purchasing organization involved directly in the S&OP process?
5. How much direct input do suppliers give during the supply review of S&OP at your company? Does this input level differ depending on the strategic importance of the supplier?
6. Do you think that including suppliers directly in S&OP would better manage supplier risk?
  - a. Would this answer change depending on the volume of production that has been outsourced to this supplier?
7. In order to select suppliers that should be more involved in your company's S&OP, how would you recommend segmenting suppliers? Does your company already practice this?
8. What factors are critical to determining the strategic importance of a supplier to your business? Are these factors weighted differently?

9. How many tiers of suppliers are investigated when determining a given supplier's capabilities? Does this vary depending on strategic importance of the supplier?

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- Sam Wherry Honors Scholarship 2008 -2012
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**Computer:** Proficient in the use of Microsoft Excel, Word and PowerPoint

**Other:** 6 Sigma Green Belt Certified

**WORK EXPERIENCE:**

**Caterpillar, Inc.,** Advanced Components Systems  
*Demand and Orders Analyst*, Material Planning

**East Peoria, IL**  
**May – August 2011**

- Intercepted and analyzed daily customer releases that violated 90 day freeze parameters for all purchased finished parts
- Collaborated with material planners to analyze available capacity to meet demand variations, performing Release Collaboration Flag process when customer orders could not be met to ensure visibility to supplier and customer
- Resolved mismatched schedules with Morton, targeting 95% accuracy and achieving an average of 96.8% accuracy
- Drove common processes for team by collaborating with Master Schedulers to create standard work and reference guides for 12 processes

**Caterpillar, Inc.,** Integrated Manufacturing Operations Division  
*Logistics Planning Analyst*, Material Requirements

**Decatur, IL**  
**May – August 2010**

- Responsible for managing daily shipping performance of Caterpillar Mexico to Decatur
- Analyzed and made decisions for hot part issues, keeping point of use and management informed using the Critical Part Tracker
- Coordinated air shipment from Mexico to avoid shutting down Wheel Tractor Scraper production line after June hurricane in Mexico
- Developed the Root Cause Corrective Action process flow for supplier caused issues and presented this process to the Supply Chain Department Managers and logistics planning analysts
- Contributed inventory and capacity information from Caterpillar Mexico to Wheel Tractor Scraper Planning and Build Schedule meetings
- Assisted team members with other Mexican suppliers in Spanish for efficient communication, adding cultural awareness to my team

**The Pennsylvania State University,** Digital Library Technologies  
*Help Desk Coordinator*

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**May 2008- Present**

- Conducted an audit of department's WikiSpace, proposing and implementing changes to align with management's transparency initiatives
- Managed and audited front-end process for establishing and updating all PSU Library employee accounts, advising changes that reduce our paper usage by approximately 50% while ensuring user confidentiality
- Responsible for coordinating department's telephones, mail distribution, and aligning help desk requests with appropriate technicians

**PROFESSIONAL REFERENCES:** Available upon request