Getting Ahead in Sourcing Through Benchmarking and System Dynamics Analysis: An Aerospace Industry Perspective

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Master of Science in Engineering Systems

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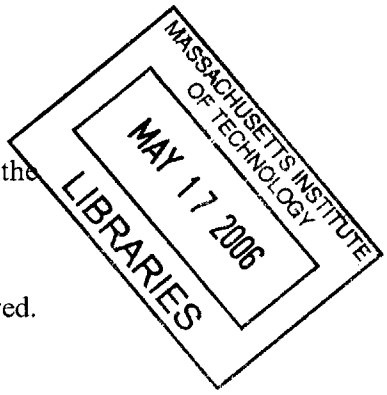

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Abstract

Sourcing and purchasing have received renewed attention recently as many supply chains challenge themselves to meet cost reduction goals. These challenges are especially apparent in the high-mix, low volume, and often considered cyclical aerospace industry where customer purchase decision emphasis is shifting from technology-centric to cost-centric.

This study identifies three sourcing frontiers by time, and develops a Benchmarking-Internal data analysis-System dynamics model (BIS model) to recommend sourcing strategies to aid Honeywell Aerospace in advancing to the highest sourcing frontier. The thesis details the BIS model as a framework and a set of methodologies to aid aerospace incumbents in understanding their competitiveness and in formulating a balance of short-term and long-term sourcing strategies. This model applies not only to the aerospace industry but also to other industries in identifying cost reduction strategies and in constructing a competitive sourcing foundation for the next generation sourcing frontier.

This research was conducted jointly between the MIT Leaders for Manufacturing Program and Honeywell International within the Honeywell Aerospace Strategic Business Group and considered the historical evolvement of sourcing frontiers and key challenges of aerospace sourcing: airline deregulation, exponential increase in strategic sourcing, rise of precious metals prices, diverse products and supplier base, and stringent regulations.

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On the personal side:

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To my sister, Ann, I wish I could borrow your deep concentration when reading and writing (it would have been really useful during the course of writing this thesis)

And finally, to my husband, Jike Chong: thank you for your loving support for me to pursue my dreams on "the other" coast. The journey has not been easy, but is definitely worthwhile.

NOTE ON PROPRIETARY INFORMATION

In order to protect proprietary Honeywell information, the data presented throughout this thesis has been modified, scaled, or minimized and does not represent actual values used by Honeywell.

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1 Introduction

"Nowhere in business is there greater potential for benefiting from ... interdependence than between customer firms and their suppliers. This is the largest remaining frontier for gaining competitive advantage."[1]

Peter F. Drucker (b.1909), writer, management consultant and university professor

1.1 Evolution of Sourcing Methods and Success Measures

Sourcing[2], the process of identifying, conducting negotiations with, and forming supply agreements with vendors of goods and services, has undergone tremendous changes in the past few decades. It is often used synonymously with Supply management, purchasing, and procurement, and will be used in this fashion here. Although the top focus remains on cost, safety, quality and on-time delivery, cost has increasingly become the metric that matters the most. Cost of sourcing may include cost of direct materials - materials used to manufacture finished goods, cost of indirect materials - materials not used in the making finished goods such as office supplies, and other indirect costs such as personnel travel expenses. Virtually all industries have seen "rising direct and indirect material costs," which are leaving many engineering and manufacturing companies with less profit. Traditional sourcing practices of squeezing suppliers seem only to add fuel to the fire resulting in further price rises and quality deterioration[3]. With communication and transportation systems drastically improved, many are embracing globalization and lower-cost sourcing practices.

Outsourcing, the practice of paying an outside firm to handle internal functions, had been well known and studied since the 1960s. Outsourcing is illustrated by industry experts to benefit higher cost regions such as the United States by saving money, improving quality, or freeing resources for other activities.[4] In the 1990s, business outsourcing, or often referred to as strategic sourcing, increased. Strategic sourcing is synonymous with outsourcing in the purchasing world as much of the activities involved are shifting internal functions to the outside.

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[1] Laseter, Timothy M., *Balanced Sourcing*, San Francisco: Jossey-Bass Publishers, 1998
[2] Bridgefield Group., "Bridgefield Group ERP/Supply chain Glossary", www.bridgefieldgroup.com/glos8.htm
[3] "Telling the Story of Strategic Sourcing," Supply Chain Management Review, Nov2005, Vol.9 Issue 8, p62, 3/4p
[4] "AnswerStat," www.answerstat.com/articles/glossary.html

As strategic sourcing gains popularity, global sourcing,[5] or "integrating and coordinating common items, materials, processes, technologies, designs and suppliers across worldwide buying, design and operating locations" came into style. Outsourcing, strategic sourcing, and/or global sourcing, often used interchangeably to some degree, are believed to be the wave of the future.

These changes in sourcing were in part driven by the customers as they demand and expect lower prices for end products, and in part by buyers who want to reduce cost and increase their competitiveness. When the most important factors for sourcing were technology and quality, sourcing was a profession which had limited visibility and often worked separately from the rest of the organization. With changes in described customer behavior, sourcing is increasingly becoming cost focused and driven. Many of the practices and initiatives taken as part of leaning the companies are cost-centric. There has been an exponential increase in journal articles and consulting projects targeting taking costs out of sourcing. This cost takeout is also referred to as year-over-year price reductions, or tighter integration to improve material productivity and material cost productivity. Material productivity means the efficiency of transforming material inputs into product outputs (usually over a year)[6], while material cost productivity means the efficiency of purchasing materials inputs that transform into product outputs. Cost reduction has become the only metric that matters in judging sourcing success in most cases.

1.2 Industry Driven Sourcing Initiatives

In addition to customer behavior driven changes in sourcing, there are supply chain changes in specific industries that accelerate the cost-centric progression in sourcing. Two representative types of changes driving supply chain transformation are discussed: one involving customer base fragmentation where OEMs' customer base change significantly; the other involving supply chain disintermediation where suppliers bypass OEMs to conduct business with their customers.

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[5] Trent, Robert J. and Robert M. Monczka, "Achieving Excellence in Global Sourcing," Topic: International Business Reprint 47108; Fall 2005, Vol. 47, No. 1, pp. 24-32

[6] Van Mieghem, Jan A. *Operations Strategy: Principles and Practice*, to be published

1.2.1 Customer Base Fragmentation

Customer base fragmentation exists in many industries and is most apparent in the electronics industry. Electronic suppliers such as Fairchild have seen increased division in its customer base. In the 1980s there were only Original Equipment Manufacturer (OEM) and Distribution, then Contract Manufacturing and Original Design Manufacturer (ODM) came into play in the 1990s, and more recently, more echelons have appeared between ODM and Distributors. Although this series of changes introduces more focused companies and may thus improve the overall cost and quality of the end product, the same series of changes causes additional competitiveness and cost pressure for each segment and the overall supply chain to be more fragmented. Indirectly, the sourcing needs of OEMs adjust due to changes in their customer base.

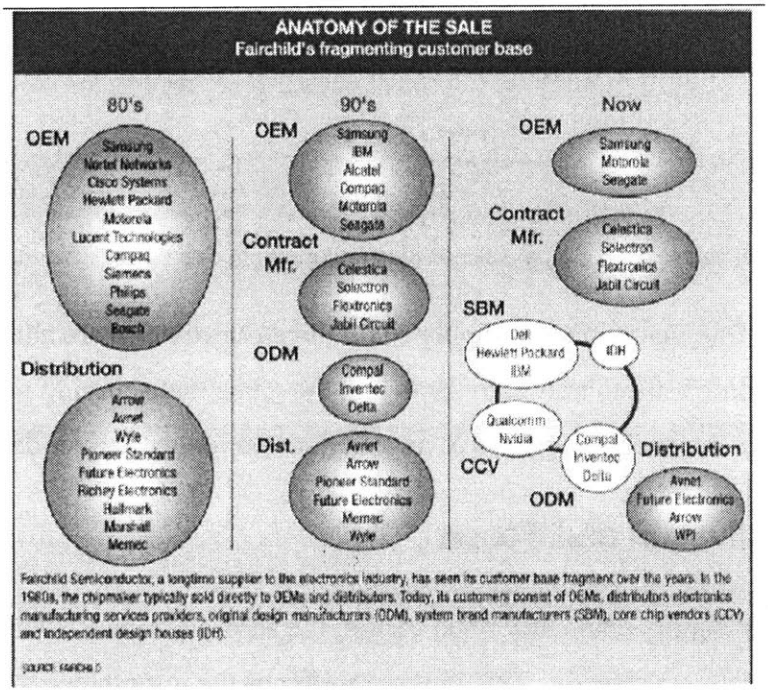

Figure 1. Customer base fragmentation at Fairchild

1.2.2 Supply Chain Disintermediation

The aerospace industry (with the exception of aircraft electronics segment) is different from the electronics industry in the sense that the customer base of OEMs remained stable throughout this time; however, as OEMs continually evaluate their core and non-core businesses and outsource

much of their manufacturing to suppliers, the suppliers are increasingly serving an expanding customer base. Even though OEM is still a key supply chain segment, cost pressures promote its customers and its suppliers to reach out to each other while bypassing OEM in an effort to save costs. This occurrence undermines OEM's profits in their high-margin aftermarket businesses, and threatens their business strategies of selling engines at or below cost as they expect to make up that profit in aftermarket parts orders. This phenomenon has been referred to as supply chain disintermediation.[7]

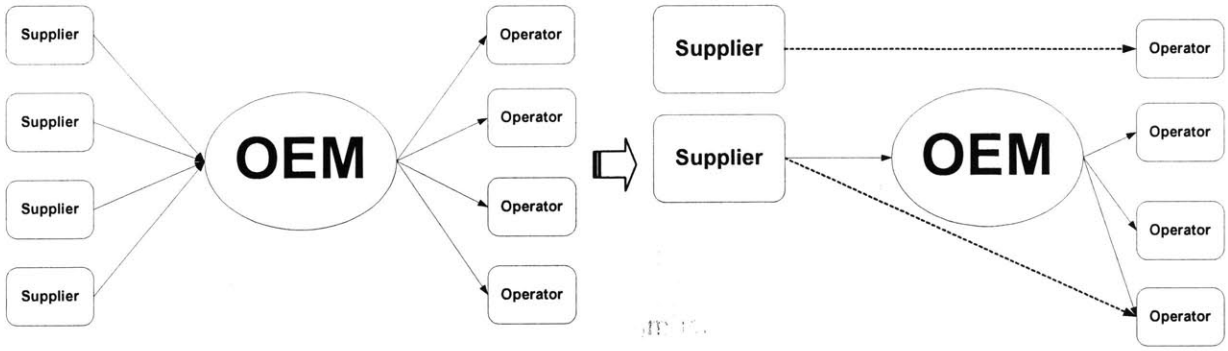

Figure 2. Historical and emerging supply chains illustrating supply chain disintermediation in Aerospace

Both customer base fragmentation and supply chain disintermediation are adding cost pressures to the OEMs. In addition, these trends are changing the game that sourcing professionals play when the old cost drivers such as aggressive negotiations no longer deliver desired results.

1.3 Thesis Motivation and Scope

In light of changes in supply chain described earlier, the aerospace industry in the United States has been showing promising trends. This in turn reinforces the importance to sourcing in this industry: increased air traffic, soaring sales growth, high profits, and amplified system orders, backlog, and shipments.

Recent FAA studies and forecasts show that the number of passenger enplanement[8], a person boarding in the United States in scheduled or nonscheduled service on aircraft in intrastate,

[7] Rossetti, Christian and Thomas Y Choi. "On the Dark Side of Strategic Sourcing: Experiences from the Aerospace Industry," Academy of Management Executive, Feb2005, Vol. 19 Issue 1, p46-60
[8] "Passenger Civil Aviation..."http://www.washingtonwatchdog.org/documents/cfr/title49/part1510.html

interstate, or foreign air transportation, not only returned to pre-2001 level of 600+ million by 2006, but will exceed one billion by 2015. This means that Aerospace sales will continue to grow (expected to be >$180B in 2006). The U.S. aerospace industry profits have gone up 73% since 2001 (from $6.6B to $11.4B) and profit margins increased from 3.9% to 6.2%. System backlog, shipments and orders are up 20%, 13% and 44%, respectively. [9] With these trends in the commercial and business jet space and the increases in defense aero needs, the volume of purchased materials is expected to increase, elevating the importance of sourcing in the coming years.

Material cost reduction has been an important initiative at many manufacturing and engineering firms, and much has been written about year-over-year cost reduction methods and better practices of all aspects of strategic sourcing. As material cost reductions become meager and disappear, sourcing professionals' desires to obtain drastic cost reductions grow stronger. This thesis first identifies material cost reduction opportunities and challenges and then makes recommendations for the Global Sourcing (GS) team in Honeywell's Aerospace Strategic Business Unit (SBU) based on benchmarking of competitors and other selected industries, examining internal practices, and researching industry trends. In addition, this thesis will sourcing frontiers evolution is At the same time, suggest a process framework for opportunity identification, analysis, and prioritization, offer tools for cost savings forecasting and sourcing allocation decisions, and present a vision for the next sourcing frontier and suggestions for Honeywell GS to approach this frontier. This research work focused on Define, Measure, and Analyze stages of six-sigma DMAIC, with some ongoing work in Improve and Control.

1.4 Aerospace/Aircraft Sourcing Challenges

The content, strategies, and importance of sourcing continue to evolve, and the aerospace industry is searching for the next competitive edge. The following diagram shows how sourcing has progressed over time, adapting to changes in customer behavior, industry driven sourcing initiatives and sourcing regulations.

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[9] Douglass, John W. Aerospace Industries Association (AIA) 41st Annual Year End Review & Forecast, http://www.aia-aerospace.org/stats/yr_ender/2005yrendr.pps
http://www.faa.gov/data_statistics/aviation/aerospace_forecasts/2005-2016/
http://www.aia-aerospace.org/aianews/speeches/speeches.cfm

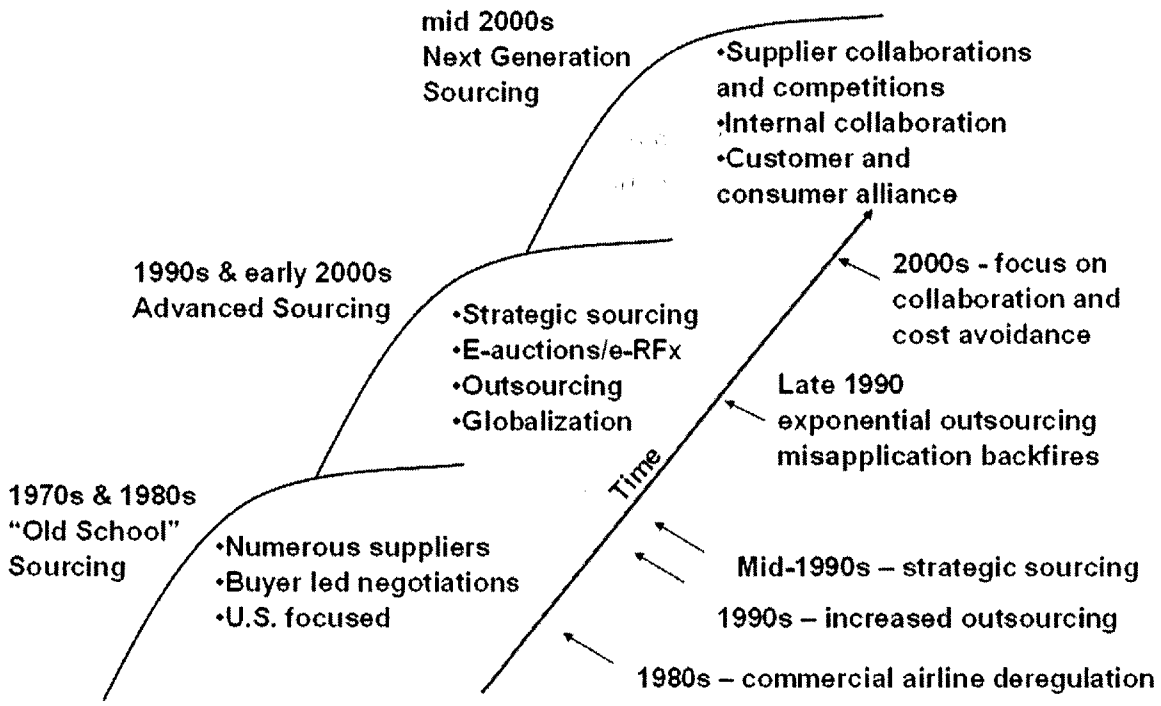

Figure 3. Aerospace sourcing frontiers and timeline[10]

In the 1970s and 1980s, aerospace sourcing was "Old School Sourcing" as it still had mainly buyer-led negotiations characteristics, and was mostly US-focused. Commercial airline deregulation in the 1980s provided aircraft customers with options to obtain lower cost parts from more suppliers.

The discovery of outsourcing, another cost lowering method, by the OEMs in the 1990s amplified OEMs' push of their suppliers to further lower prices and find ways to enter other market segments to survive. At that time, aerospace sourcing entered the "Advanced Sourcing" stage. In this era, strategic sourcing became popular, sourcing and price reductions were obtained through strategic sourcing initiatives such as spend consolidation and supply base rationalization (often referred to as supply base reduction), supplier-buyer relationship became strained and the strategic sourcing effort backfired.

[10] Chang, Yue "Getting Ahead in Sourcing Through Benchmarking and Understanding Internal Practices" Presentation to Honeywell Aerospace Global Sourcing, December, 2005

As sourcing organizations move forward to "Next Generation Sourcing", they realize that cost takeout is often exhausted, and they must focus more on cost avoidance. "Purchasing and procurement have been moving from a simple negotiation practice to a strategic interface with external resources" according to Bernard Gracia, Director of the European Institute of Purchasing Management (EIPM): "Procurement moved from simple procurement (dealing with discounts) to supply management (dealing with the optimization of supplier relationship: innovation, capacity...)."[11] This collaborative or balanced sourcing has been in the works since at least the late 1990s,[12] yet it is taking firms a long time to recognize the value.

The next generation sourcing frontier of many industries require sophisticated supplier collaborations and competitions. In engineering and manufacturing industries, the Japanese appear to be winning in this sourcing frontier thus far. The successful Japanese automakers Honda and Toyota, for example, have built strong relationships with their suppliers, including the same North American suppliers who have had "contentious dealings" with the Big Three in Detroit.[13] Sourcing is a strong force that drives success of Honda and Toyota, and its triumph is largely credited to the companies' supplier relationship building guide: The Supplier-Partnering Hierarchy. This type of cooperative relationship between OEMs and suppliers, as well as cooperative pricing is fundamental to balanced sourcing (Appendix I). Collaboration can be turned into competitive advantage but trust, dedicated assets, and shared knowledge are required.[14]

With sourcing advancing to the next frontier come challenges and opportunities, which is fitting provided the increasing importance of the sourcing profession.

The following chapters, especially three and four, will illustrate the framework that helped Honeywell Aerospace Global Sourcing' identify cost improvement opportunities, and offer it as a tool that can be applied to sourcing in other industries. Similar to previous LFM thesis work in

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[11] Rudzki, R, D Smock, M Katzorke, and S. Stewart, Jr., *Straight to the Bottom Line,* Fort Lauderdale, FL: J. Ross Publishing, Inc, 2006

[12] In 1998, Laseter published "Balanced Sourcing" and other publications also discussed collaborative sourcing

[13] Liker, Jeffrey K. and Thomas Y. Choi, "Building Deep Supplier Relationships," Harvard Business Review, December 2004

[14] Dyer, Jeffrey, H. *Collaborative Advantage: Winning Through Extended Enterprise Supplier Networks*, Oxford University Press, 2000

sourcing at Honeywell by Abu-Khalil (2005) on outsourcing and Henkel (2004) on global supply chain optimization in the Automation and Control Solutions (ACS) strategic business group, the tools offered by this thesis can be applied to any industry's sourcing practice.

1.5 Thesis Overview

The thesis proceeds as follows:

Chapter 1 introduces the sourcing profession and evolution of methods and success measures in this profession. It then discusses sourcing initiatives driven by changes in different industries. Next it discusses the thesis motivation and scope, as well as sourcing challenges in the aerospace and aircraft industry, and the next sourcing frontier.

Chapter 2 provides the business context for aerospace global sourcing at Honeywell, and describes the research approach and methodology applied in this work.

Chapter 3 illustrates the importance of benchmarking and describes benchmarking done by industry experts and past benchmarking initiatives at Honeywell and their current status. Much of the observations, results, analysis, and learning of Honeywell benchmarked against other aerospace incumbents are in this Chapter.

Chapter 4 offers a system view of past and recommended initiatives to show significance of understanding system implications, and application of system thinking to avoid creating problems for tomorrow with today's solutions.

Chapter 5 concludes by drawing general conclusions from the research that is applicable specifically to Honeywell, to the aerospace industry in general and broadly to the sourcing profession. This chapter reiterates the high level recommendations to Honeywell, other players in the aerospace industry as well as sourcing in other industries by tying the results and discussion of the preceding chapters together and offering a set of frameworks for sourcing to achieve the next frontier.

2 Background

This research was conducted jointly by Honeywell Aerospace and the MIT Leaders for Manufacturing Program (LFM). The data for this study was obtained through the Honeywell Aerospace Global Sourcing Team, an integral part of the Integrated Supply Chain (ISC) organization. The objective of the joint effort was to present Aero GS with implementable recommendations to further improve the material cost productivity or capture material cost reduction opportunities.

2.1 Research Setting

2.1.1 Honeywell International

Honeywell International is a Dow Jones Industrial and Fortune 100 company with sales of $25.6 billion in 2004. It is a diversified engineering and manufacturing firm consisting of four strategic business groups (SBGs): Aerospace, Automation and Control Solutions, Specialty Materials, and Transportation Systems employing 109,000 employees in nearly 100 countries. Honeywell has won several awards in technical and environmental fronts, and was listed by Fortune magazine 2004 as one of the "Most Admired Companies."

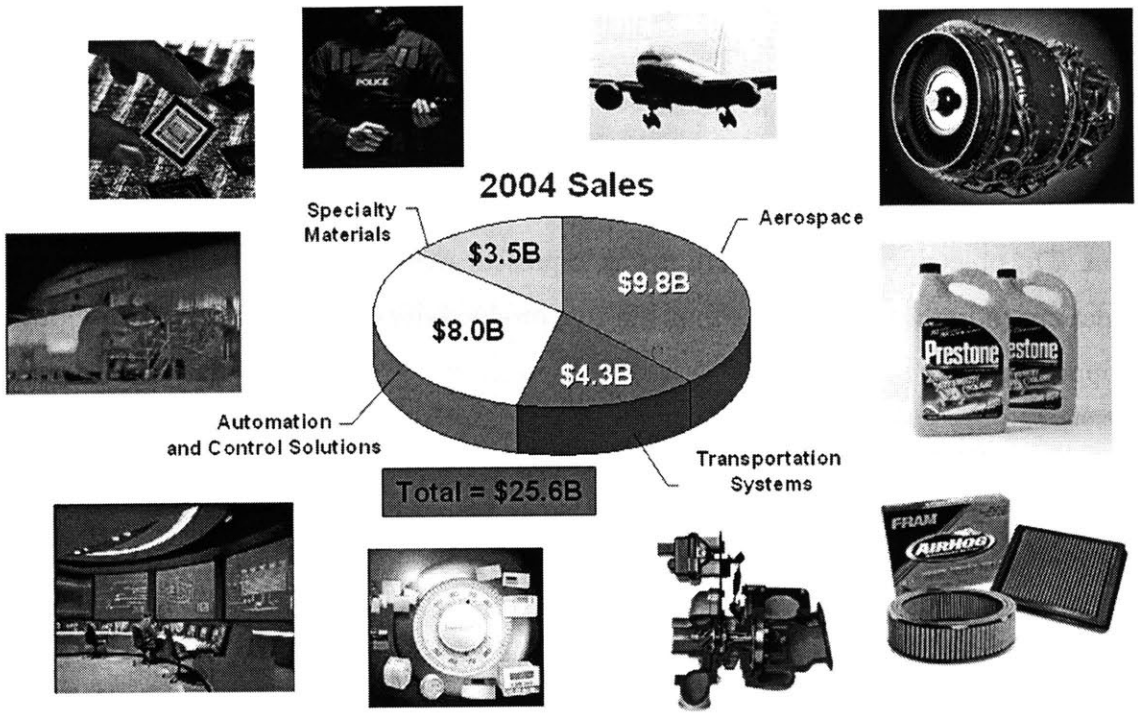

Figure 4. Honeywell 2004 Sales by Sectors

2.1.2 Honeywell Aerospace

The Honeywell Aerospace strategic business group is a "leading global provider of integrated avionics, engines, systems and service solutions for aircraft manufacturers, airlines, business and general aviation, military, space and airport operations."[15] There are three main strategic business units within Aerospace: Aerospace Electronic Systems (AES), Engines, Systems & Services (ES&S), and Aircraft Landing Systems (ALS)[16]. Reorganization began in June 2005 aimed to align one Aerospace voice to customers by combining AES and ES&S.

Aerospace Electronic Systems (AES) provides advanced electronics and avionics for large and regional air transport, business and general aviation aircraft, military aircraft, surface vehicles, defense systems, and space applications.

[15] Honeywell website, http://www.honeywell.com/sites/aero/AboutUs.htm
[16] Honeywell Aerospace website, http://www.honeywellaerospace.com/

Engines, Systems & Services (ES&S) provides aircraft engines for the business, general aviation, and regional aircraft markets, as well as auxiliary power units for the air transport market. In addition, Honeywell supplies systems and service solutions for aftermarket markets.

Aircraft Landing Systems offers highly reliable wheel and brake solutions and service support to help a wide range of aircraft stop smoothly and land safely.

2.1.3 Aerospace Organizational Structure and Integrated Supply Chain

Honeywell has a typical hierarchical organization to manage its businesses, which are organized rather independently down to the strategic business unit level. At the corporate level, each Strategic Business Group (SBG) has its own president and CEO. The next level is the Strategic Business Unit (SBU) level and there are president and directors for each line of business (Strategic Business Enterprise or SBE) and functional leadership such as Human Resources and Operations that works across the businesses. This results in a matrix organization (Figure 5) with business lines on the y-axis and functions on the x-axis in each line of business. For example, each business unit's Vice President of Operations reports both to the SBU president and that business group's Vice President of Integrated Supply Chain (ISC). At the next level, the directors of Strategic Sourcing (used interchangeably with Global Sourcing) report both to that SBU's VPs of Operations and the SBG VP of Strategic Sourcing who in turn reports to the SBG VP of ISC. This matrix organization also extends between any two levels of management. With the reorganization, SBUs are combined so that reporting will be by function.

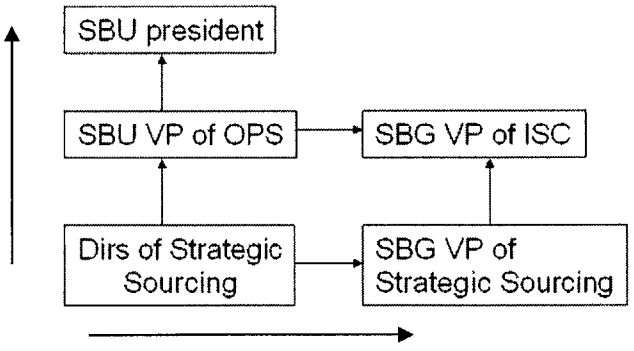

Figure 5. Matrix reporting structure at Honeywell

This research was originally intended to focus on the ES&S Global Sourcing activities within Aerospace ISC. Since the timing of the internship coincides with the Aerospace reorganization, the research spans across ES&S and AE&S sourcing activities.

2.1.3 Aerospace Operations Strategy and Global Sourcing

At Honeywell, there are three main activities in ISC throughout each year to plan and execute its operations strategies. The Aerospace operations strategy is developed in a Strategic Plan (STRAP), which is a five-year plan reassessed on an annual basis. The Annual Operating Plan (AOP) then focuses on execution of first year activities from STRAP. The Management Resources Plan (MRP) then focuses on resource issues directly related to carrying out the AOP. The activities involved in STRAP and AOP range from strategic sourcing, environmental health and safety, quality management, manufacturing productivity, footprint rationalization, and logistics.

2.2 Problem Statement and Deliverables

Material productivity improvements or cost reductions have been meager or nonexistent in the past year. With many challenges in the aerospace industry: rise of precious metals prices, diverse products and supplier base, and the stringent aerospace specific regulations, Honeywell Aerospace Global Sourcing (GS) is concerned it is not competitive or aggressive in strategic sourcing practices compared to competitors. The aerospace industry supply chain is complex as incumbents often span the chain: a key competitor may often be an essential supplier and/or a crucial customer. GS wants to significantly reduce its total cost of ownership by learning from industry trends, adopting best practices (what competitors do in sourcing that may address the industry-wide challenges) and leveraging its existing processes.

The deliverables from the study are the following with emphasis on benchmarking and recommendations:

- Benchmarking with key competitors in selected strategic sourcing initiatives, and include
    - Analysis of past initiatives' implications
    - Gap analysis of current processes
- Recommendations and targeted implementation from benchmarked results

There are many challenges in the course of this project. For benchmarking, it is challenging to effectively utilize limited time and resources to balance the many areas that can be benchmarked; for analysis, it is challenging to effectively qualify and quantify the data gathered, and sift information from that data; for recommending actions, it is challenging to translate what has been proven to work well to what will work well at Honeywell. Throughout the project, it is challenging to build frameworks that would apply to sourcing in general, is inclusive of aerospace industry specific sourcing challenges, and is directly applicable to Honeywell's firm specific improvement goals.

2.3 Approach and Methodology

The project begins with learning about the organization and its processes through the ongoing STRAP activities and discussing with Global Sourcing team members about top concerns and areas of interest for benchmarking. Examining internal processes and data, and researching industry trends were done concurrently to support and direct benchmarking data collection, analysis and recommendations.

1). Benchmark cross industries and with competitors:

- Benchmark sourcing of the aerospace industry with other top industries
- Benchmark GS with "what" competitors do
- Analyze "why" competitors do what they do
- Present list of opportunities and recommendations

Benchmarking setup and approach (illustrated in Figure 7 and further explained in Chapter 3)

- Identify key competitors
- Study internal practices
- Develop a list of interested topics
- Study benchmarking techniques and practices
- Draft questionnaire and revise as needed
- Compile a list of contacts (internal and external)
- Conduct interviews and summarize results

2). Examine internal processes:

- Interview stakeholders and study contracting practices and challenges
- Determine feasibility of the benchmarking results-driven initiatives

- Prioritize the recommendations by process availability and impact expectation
- Analyze material productivity improvement trend and recommend focus order

3). Research industry trends:

- Research industries with similar challenges in journal / periodicals regularly
- Examine consulting service industry's work in similar areas

Since many sourcing literatures are online, majority of the research will involve journal/news articles/papers from the Honeywell electronic library, MIT library, as well as the International Motor Vehicle Program (IMVP) at MIT, Lean Aerospace Initiative (LAI) at MIT, Leaders for Manufacturing (LFM) and System Design Management (SDM) publications.

The six sigma DMAIC and thought process mapping tools were applied throughout the project. In project scoping, DMAIC included the following:

- Define: customers, requirements, expectations, project boundaries, process and measure of Success
- Measure: develop a data collection plan and conduct stakeholder interviews
- Analyze: analyze collected data, identify performance gaps, and prioritize opportunities to improve
- Improve: design solutions to improve the target process and convey solutions' value and transfer learning early
- Control: generate buy in for target process early to keep implementation on course and anticipate any reverting back

As listed above, key methods used were benchmarking (questionnaire development, interviews, data collection, concept scoring), statistical analysis (of internal data) and system dynamics analysis. Tools used in addition to the Microsoft Office suite include Visio for flow chart graphing, Vensim for system dynamic charting, JMP for statistical analysis, six sigma DMAIC (Define, Measure, Analyze, Improve, and Control, focusing on DMA) and thought process mapping tools for guiding research processes. Thought process mapping is helpful in working with large problem spaces. Vensim is useful for mapping out system dynamics diagrams illustrating short term and long term solution implications.

The following goals were adhered to throughout the project:

- Provide GS with recommendations that can be implemented
- Analyze the ongoing sourcing paradigm shift and recommend what GS can do to get ahead
- Clearly identify project champions post internship and ensure early knowledge transfer

2.4 Chapter Summary

Honeywell Aerospace Global Sourcing (GS) is concerned about its competitiveness in strategic sourcing practices. GS oversees purchasing for a Strategic Business Enterprise with close to $10B in revenue and wants to significantly reduce its total cost of ownership in sourcing. The research approach, methodology, and deliverables are outlined as a guide to the following chapters. Recognizing that the sourcing industry in general (more than just in aerospace) is faced with growing importance, and similar challenges and opportunities, the research study focuses on developing a process framework from the aerospace perspective that can be applicable to sourcing in other industries.

3 Benchmarking

Benchmarking—the process of identifying and learning from best practices anywhere in the world—is a powerful tool in the quest for continuous improvement and breakthroughs, according to APQC Guidelines and Ethics For Benchmarkers[17]. As Honeywell Aerospace GS seeks breakthrough in cost reductions, benchmarking is a reliable start to identify improvement opportunities. Benchmarking is often regarded as the vehicle for change[18] and is deemed "essential on the path to world-class performance."[19] The goal of this study is two folds: to deliver benchmarking results to Honeywell Aerospace GS, and to develop a competitor benchmarking methodology applicable to sourcing in other industries. This chapter starts by illustrating the central motivation for this benchmarking effort (3.1), followed by discussing professional benchmarking findings (3.2), and past and current initiatives at Honeywell (3.3). A process is developed for competitor benchmarking, in which Honeywell is used as a case study (3.4). The results and derived recommendations are presented in the last section (3.5).

3.1 Decline of Material Cost Productivity

"...true change occurs only when people can visualize how alternative approaches will help them solve problems they face. That is the reason that benchmarking other organizations to identify opportunities for improvement often delivers meager results."

"It is only when that benchmarking is tied to a real challenge that people are positioned to begin questioning their own mental models."

- Janice Klein in True Change

Before benchmarking with competitors, it is essential to understand the actual problem faced by the organization, and if the actions being taken align with the cost improvement goals. It pays to know thyself, so one can get to know thy competitors, industries, and even the environment. The supplier, buyer, and customer relationships especially in the aerospace industry have become so

[17] "Benchmarking Code of Conduct," American Productivity & Quality Center: international benchmarking clearinghouse, http://www.orau.gov/pbm/pbmhandbook/apqc.pdf
[18] Morgan, James P. with Robert M. Monczka. Strategic Supply Chain Management. Newton, Massachusetts, Purchasing Magazine, 2001
[19] The Performance Measurement Group (PMG), a PRTM company, http://www.pmgbenchmarking.com/

complicated. Yet past data may show trends and patterns that could help prepare for the future in this often considered cyclical industry.[20] It is widely know at Honeywell that the material productivity has been declining, and is becoming a real challenge for GS to justify the competitiveness to the supply chain and its customers; however, it is unclear that anyone other than top management truly understands the extent of this growing problem. Figure 6 illustrates the material cost productivity decline of aerospace Engines and Systems in the recent few years (prior to combining with Aircraft Electronics Systems). The x axes of both linear graphs are the year, and the y-axes are the material productivity in millions of dollars (the difference of actual spend and projected spend with the values removed except for the reference value zero). The left graph is the Engines & Systems (E&S) productivity, and the right graph shows E&S cost productivity decline, as well as how it compares to other Aerospace segments' cost productivity.

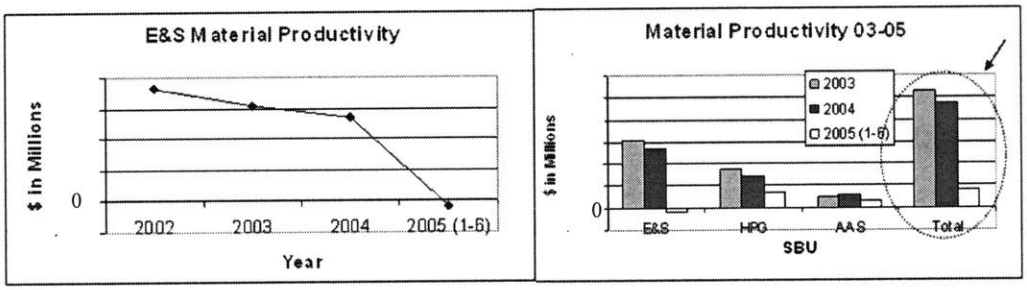

Figure 6. Material cost productivity 2003-2005

To better understand the above material cost productivity trends and to leverage the learning to identify and qualify improvement initiatives, the 2003-2005 GS's actual spend and save data with all of its suppliers are extracted from the central database. To comprehend and quantify where the downward trend for material cost productivity comes from, Honeywell's activities with the top spend suppliers and the top save suppliers are studied. In addition, three commodities (with some of their subcommodities) are selected for further spend and save correlation study to compare different categories and groups. The results and recommendations of this study are presented in section 3.5.

[20] Piepenbrock, Theodore F., current research presentation on Enterprise Architecting: industry cyclicality is an artifact contributed by major incumbents' behaviors., April, 2006

3.2 Industry Benchmarking

Data from several industry-wide benchmarking studies performed by academic and management consulting groups is publicly available. These studies provide an understanding of how the Aerospace industry sourcing compares with other industries and what the newest trends are. This is relevant in setting benchmarking direction when comparing Honeywell with its competitors.

The April 2005 cross industry procurement study done by the Center for Strategic Supply (CAPS) Research show that Aerospace/Defense industry's purchase spend as percent of sales dollars is slightly higher than average of 17 other industries studied[21]. Aero operation expense as percent of sales, purchase spend, or per purchasing employee in general are the highest among the industries studied. In terms of total savings, there is roughly an even split between cost avoidance (49%) and cost reduction savings (51%). The cost avoidance savings as percentage of total savings is among the top three just behind DOE/NNSA Contractors and Engineering/Construction.

AT Kearney 2004 assessment of excellence in procurement studied manufacturing, services, and process industries. Expectations from procurement in value creation are growing at about two times the rate of expectations in cost reduction,[22] and value capture is seen as the largest challenge faced in procurement. Procurement is one of the key internal functions that allow companies to benefit from external sources for creative ideas, and leaders of sourcing involve suppliers early and often in the product and service development process. Outsourcing is widely used and leaders in this course use it to strategically restructure their entire value chain. Leaders also use systematic process to evaluate and manage supplier and partner relationships (for example, Newell Rubbermaid's open communication to suppliers[23]). Advanced cost management strategies are more complex, and require greater internal and external collaborations. Sourcing leaders develop capabilities in other areas such as new product development and join efforts with sourcing to enable them to focus on value creation.

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[21] "Cross-Industry Report: Comparison of Standard Benchmarks," http://www.capsresearch.org/publications/pdfs-protected/CrossInd082005.pdf, Center for Strategic Supply Research (CAPS), 2005

[22] "2004 Assessment of Excellence in Procurement", A.T. Kearney 7/42388/A

[23] http://newellrubbermaid.com/newellco/aboutus/business.jhtml?id=id2&frag=supplierCommunicationfrag

Parallel to increasing corporate emphasis in sourcing organizations, management consulting firms such as PRTM and Bain showcase their clients' sourcing projects focusing on cost takeout (Appendix C). The consulting cases have a number of similarities and some key differences comparing to the problem statement at Honeywell: Honeywell Aerospace GS has an interest in cost cutting but does not have the same level of urgency as described in the cases, and while some companies are looking for short term gain, GS is looking for both short term and long term cost savings. These sourcing projects reflect an increased attention in sourcing cost reduction. Execution of cost reduction projects requires having formal processes and measurement techniques, so in order to gain sourcing advantage long term and get ahead in their industries, companies need to move beyond cost reduction to value creation.

Industry benchmarking shows a paradigm shift is occurring as companies move beyond cost takeout to value creation; Honeywell Aerospace is putting together a task force to work with all functions involved in design and sourcing to drive value creation. For this project, however, the initial project goal was to benchmark Honeywell's cost reduction effort, so the focus remains on cost reduction.

Another industry trend is centralization of the sourcing organization. According to Chris Sawchuck of Rockwell Collins, the most recent winner of Purchasing Magazine's medal of professional excellence, their biggest critical success factor is the organization, or the way their material and supply operation is structured[24]. An organizational analysis of past medal winners confirms his claim. From 1984 to 2005, 13 out of 22 winners (or 10 out of 13 post 1993) have centralized commodity management, 2 out of 22 (both before 1990) had de-centralized procurement and both subsequently evolved to centralized model, and the rest of 7 have hybrid models.[25] Centralized procurement model is a clear favorite especially post 1993 and will be the industry trend in the years to come.

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[24] Avery, Susan., "Lean, but not mean, Rockwell Collins Excels", http://www.purchasing.com/article/CA6250270.html, Purchasing Magazine, September 1, 2005

[25] Rudzki, R, D Smock, M Katzorke, and S. Stewart, Jr., *Straight to the Bottom Line,* Fort Lauderdale, FL: J. Ross Publishing, Inc, 2006, p47

3.3 Past and Present Initiatives At Honeywell

The past and present initiatives at GS to drive cost reduction are mostly strategic sourcing enablers and ongoing cost takeout drivers. For example, effort in developing parts database, upgrading supplier management tool which keeps information such as scorecards on suppliers, and expanding sourcing professionals' skill sets all aim to build a foundation to enable cost takeout and foster value creation. The material cost productivity drivers in use are negotiations, dual sourcing, and globalizing the supply base. These drivers all focus on commodities, which are materials, manufactured using similar processes (casting commodity consists of parts made by casting, and machining commodity consists of parts made by machining), and sub-commodities, which are subdivisions within a commodity (for example: different types of castings). Cost takeout functions in the pipelines to be implemented are standardization, design for cost, and multi-tier suppliers sourcing. These material cost productivity drivers have been set as goals for GS to achieve and have already been proven by other companies to work well, but will take time to be implemented.

Currently, the annual cost reduction goal is specified at the SBU level, and then different departments commit to manageable savings after negotiating with each other to ensure the goal is reached through the collective effort. Strategies for achieving each of their sub goals are developed at the commodity level. There is sharing of the development strategies within the business units, but for each SBU, independent commodity strategies are formulated, and duplicated resources and activities often take place. This decentralized-hybrid approach is expected to become more centralized-hybrid approach with the Honeywell Aerospace reorganization. For benchmarking purposes, the current decentralized-hybrid model is assumed.

3.4 Benchmarking Methodology

According to benchmarking experts, a successful benchmark involves knowing processes, identifying the purpose, determining the methodology, selecting sources, collecting data, analyze findings, recommending and executing initiatives.[26] In this case, GS wants to know how its sourcing practices compare to its competitors'. While there is a plethora of publications on the

[26] Stone-Ewing, Chris and Ron Dickson, "Benchmarking background -Benchmarking, Best Practices, Special Projects Learning, Training & Development," 2005

initiatives that have been and can be done by an industry, there is limited public information available on supply chain operation efforts of specific companies. One benchmarking method is to ask the competitor sourcing professionals the same set of questions on a list of interested topics. The process used to conduct benchmarking is illustrated in Figure 7:

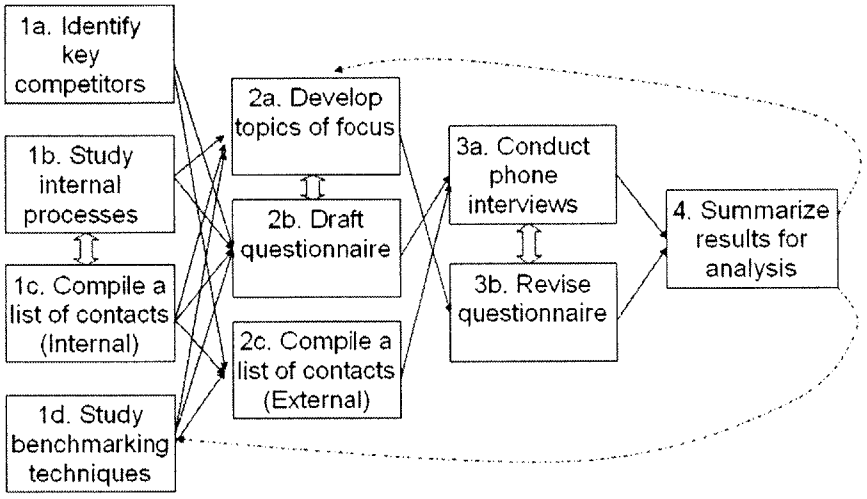

Figure 7. Steps for competitor benchmarking

To benchmark GS with "what" competitors do, one must first identify a list of competitors to benchmark with (Fig 7: 1a). There are 95 companies[27] registered in Thomson database under Aircraft engines and Engine Parts. Based on activities, 22 potentially compete with Honeywell Engines in Sourcing (14 are headquartered in the US and 8 are headquartered internationally). Among those 22, 9 have annual sales greater than $1B and can be considered significant competitors (5 are headquartered in the US and 4 are headquartered internationally). Four competitors are selected as benchmarking targets based on the result of this survey, the product characteristics of the 9 potentially significant competitors (high-mix, low-volume), and the interest of GS team members.

- General Electric Aircraft Engines (GEAE)
- Goodrich
- Pratt & Whitney (P&W)

[27] Thomson database

- Hamilton Sundstrand (H-S)[28]

There are three concurrent steps to identifying key competitors. The first is to study the internal processes (Fig 7: 1b). The importance of this step to draw information out and align with the recommendations is illustrated in 3.1. The second is to compile a list of internal contacts (Fig 7: 1c) who will both contribute to internal process examination as well as step two. The third is to study benchmarking techniques and code of conduct (Fig 7: 1d), as it is important to understand the legality, confidentiality and use of the sources and data, and build appropriate expectations prior to diving into the other activities.

The next step is to develop a list of topics of focus (Fig 7: 2a). Based on initiatives suggested in STRAP, ongoing activities and data availability, three areas of focus are selected and are shown on the Honeywell value stream to illustrate the relevance:

A. Contracting practices/strategies
B. Supply base rationalization
C. Emerging market sourcing

These three focus areas are all clustered at the distributor and the assembly stages in the illustrated machined-components value chain (Figure 8). Honeywell Aerospace sourcing activities also cover the foundry stage, but rarely go down to the mine stage.

[28] In cases where data is only available for United Technologies (UTC) as a whole, the subsidiaries Pratt & Whitney and Hamilton Sundstrand are discussed as UTC.

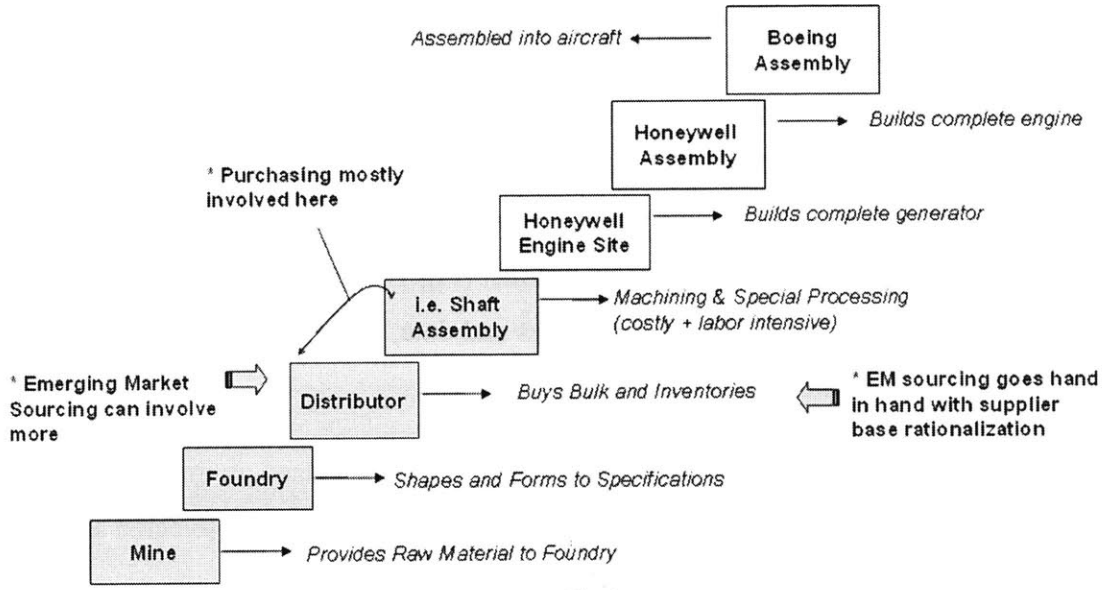

Figure 8. Value stream example (machined components) with the benchmarking focus illustrated

A. Contracting practices/strategies: this refers to the contracting portion of sourcing involving stating agreements between suppliers and buyers. In this case the contractual terms and conditions such as quality and on time delivery requirements comparisons with other companies were of interest, and were included in the focus.

B. Supply base rationalization: also referred to as supply base right sizing. Supply base design is an area of opportunity in corporations' ongoing effort to reduce costs and create value for the supply management process. This is because there are costs associated with keeping each supplier in the supply base, and more suppliers imply more cost. According to a 2004 report from the Hackett Group, 75% of world-class companies conduct considerable supplier rationalization reviews annually[29]. It is still an effort often neglected when other more pressing deliverables become due. This is probably short-sighted as the effectiveness of all other efforts is diminished through lack of resources to deal with an excessively large supply base.

C. Emerging market sourcing: low cost region sourcing or re-sourcing. It became a popular cost reduction area since the 1990s, and faces special challenges in the aerospace industry due to the regulatory environment and intellectual property (IP) issues.

[29] Avery, Susan., "Lean, but not mean, Rockwell Collins Excels", http://www.purchasing.com/article/CA6250270.html, Purchasing Magazine, September 1, 2005

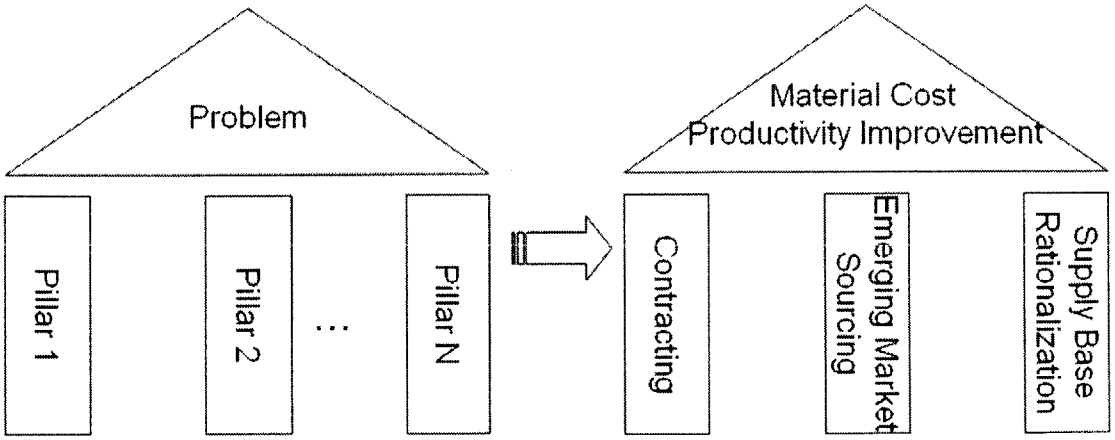

Figure 9. Pillars A, B, C for solving the material cost productivity improvement problem

There are two concurrent steps to step 2a in figure 7, and one of them is drafting a questionnaire on the interest topics identified (Fig 7: 2b). One important criterion was to keep the questionnaire brief so it can fit on a page, or fit in 30 minutes when interview is conducted by phone. A sample questionnaire can be found in Appendix H. The other concurrent step is to develop and compile a list of external contacts (Fig 7: 2c). Due to the complex relationships of suppliers, buyers, customers in the aerospace industry, the sourcing competitors are also Honeywell's customers or suppliers on other fronts. As a result, the sourcing team members have some contacts at those companies. Additional contacts in large suppliers and in large customers were also gathered to seek information on their other customers or suppliers who may compete with GS.

The next step is to conduct phone interviews (Fig 7: 3a). Twenty interviews involving personnel from listed competitor companies, suppliers, and customers were conducted by phone or in person on the three benchmarking areas. Questionnaire modification (Fig 7: 3b) and interview follow ups were done as needed to gather comparable information. The list of interviewees can be found in Appendix A.

Finally the interview results are summarized for analysis (Fig 7: 4). Though this is the last step in the competitor benchmarking process, it is by no means the end of the process, as it may be necessary to return to any of the previous steps to refine the study focus, add contacts, or consult benchmarking practices (two dotted lines are shown in figure 7 to illustrate this effect).

The benchmarking process can be further structured so parts of the process (such as internal/external contacts list generation) do not need to be redone each time, rather it would be built in the organizational functions. For example, sourcing managers' job description may require supporting one benchmarking each year.

3.5 Benchmarking Results, Analysis, and Recommendations

3.5.1 Internal Data Analysis Results

Analyzing internal processes and data is important in supporting and directing benchmarking data collection, analysis and recommendations. The focus at this point is on extracting information from the vast amount of GS data. Eliyahu Goldratt puts it well: "we are drowned in oceans of data; nevertheless it seems as if we seldom have sufficient information."[30] Spend, save, and scorecards data on individual suppliers as well as groups of suppliers is available, yet what information from that data can help sourcing professionals make sourcing decisions is unclear. Here the correlation between spend and save on suppliers within categories studied are examined. Positive correlation means that within a category, suppliers with higher spend accounts with Honeywell also provide higher savings, while negative correlation means that within a category, suppliers with higher spend accounts with Honeywell provide lower savings. The spend versus save correlation study on internal data introduced in section 3.1 yielded the following results:

- The top spend suppliers provide GS with most savings
- Suppliers providing highest savings are the ones Honeywell spends the most with
    - Due to a strong outlier, significant correlation is found (Figure 10)
    - If the outlier is removed, then top spenders and savers show little spend versus save correlation
    - Top savers correlate with spend better than top spenders correlate with savings (this means do not expect the most savings to come from suppliers who Honeywell spends the most with)

[30] Goldratt, Eliyahu M. *Sifting Information Out of the Data Ocean: The Haystack Syndrome,* Great Barrington, MA: North River Press, 1990, p3

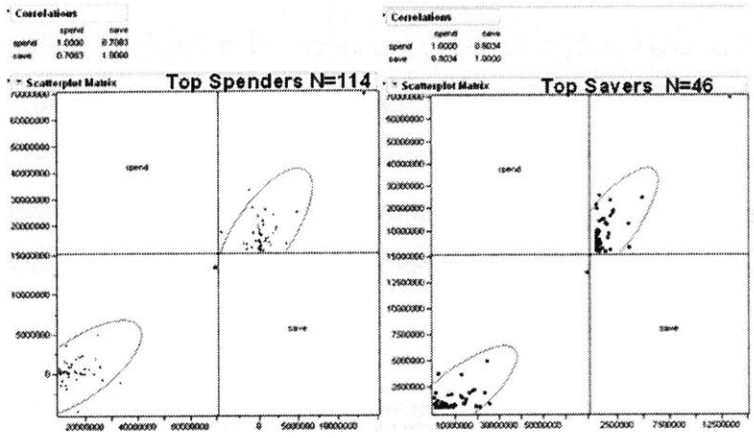

Figure 10. Scatter plots showing potentially positive correlation between spend and save for both:
The top spenders (suppliers with the largest buy from Honeywell) on the left and
The top savers (suppliers with the largest savings for Honeywell) on the right

- Commodity spend and save are not correlated
- Some sub-commodity spend and save are correlated: some correlations are stronger than others, but many are outlier(s) driven (Figure 11)

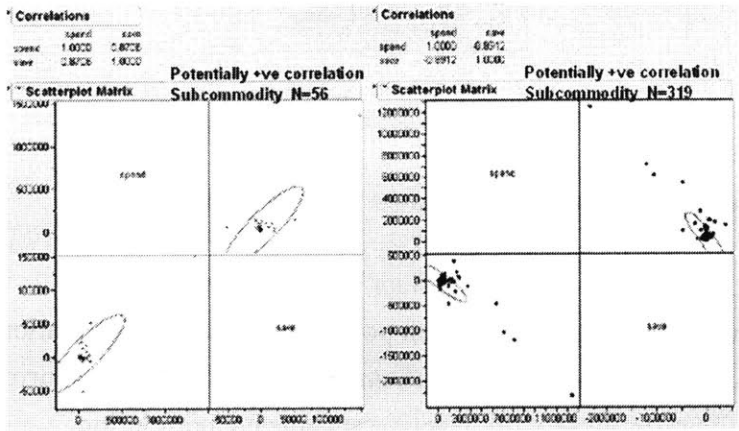

Figure 11. Scatter plots showing correlation between spend and save:
Positive correlation for one subcommodity on the left and
Negative correlation for one subcommodity on the right

This data analysis not only identified the trends but also the outliers that need further study, or should be studied from: there could be practices of that supplier that should be learned or avoided when applied to other suppliers. Spend and save correlation study results from 24 subcommodities are graphed in Figure 12, where the x axis denotes time (the year), and the y axis denotes the count for each correlation type (a count for each so the total adds up to 24). Overall, the number of sub-commodities that have negatively correlated spend versus save are

increasing from 2003 to 2004 and on to 2005 (shown in red or the darkest shade), and the number of sub-commodities that have positive spend versus save correlation (shown in blue or second darkest shade below the darkest) is decreasing each year. This means the number of categories have suppliers with higher spends showing lower savings is increasing, and the number of categories have suppliers with higher spends showing higher savings is decreasing. Both of these trends are alarming for GS.

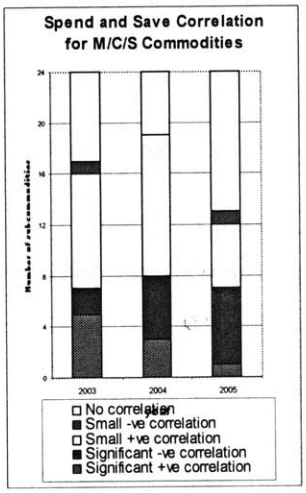

Figure 12. Spend and save correlation for three commodities

The following are the recommendations based on this finding:

- Contracting should focus on the suppliers with top spend
  - Start with subcommodities with positive spend/save correlation turned negative.
  - Then focus on those with significant negative spend/save correlation
  - Next focus on those with negative spend/save correlation

The subcommodities (categories) used to have aligned supplier spend and save or positive correlation but now have negative correlation should be the first ones examined by contracting professionals: for example: what are the reasons the savings have decreased? What status are the trend driving suppliers if there are any outliers? The next focus should be the categories that did not have any significant supplier spend versus save correlations, but now show statistically significant negative correlations, followed by those who show negative correlations but are not statistically significant.

- Supply base rationalization focus at subcommodities level

- Start with subcommodities with increasing number of suppliers
- Then focus on those with same number of suppliers but negative spend/save correlation
- Next focus on those with small decrease in suppliers but negative spend/save correlation

Note this data examination focused on the part costs and savings, which did not consider the total cost of ownership (TCO). TOC used to account only for the costs of buying and owning an asset, and has been expanded to evaluate "the total cost of sourcing and using any activity provided by a given supplier."[31] TOC evaluation is a sizable project on its own and generally follow a three-step process:

- Determine what activities to capture in TCO
- Identify and quantify which cost drivers to capture and what activity-based costing (ABC) to use for calculation
- Calculate the TCO on a supplier by supplier basis

In general, sourcing professionals believe that aerospace sourcing fit in with the Pareto analysis, also referred to as the 20-80 rule, where 20% of the suppliers supply 80% of the needs. GS data shows that is not the case: the top 10% suppliers (based on Honeywell's actual spend data) supply just below 80% of the need, where as the top 20% of GS suppliers supply over 90% of the total buy. The long tail in the supply base is not only a source of cost, but also a source of stumbling block for changes involving the supply base.

3.5.2 Competitor Benchmarking Results

Based on benchmarking result and research findings, the sourcing maturity status, or the level of sourcing development based on a set of criteria, for the four companies benchmarked is depicted on a maturity curve below. The curve was developed by R. Gene Richter, a famous American CPO is used to show the steps in the sourcing transformation process.[32] The four phases are I) getting started, II) ready to ask for more resources, III) ready to get performance reviews, and IV) almost perfect. The characteristics of each phase are described in Appendix D.

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[31] Van Mieghem, Jan A. *Operations Strategy: Principles and Practice*, to be published, Chapter 8, p214
[32] Rudzki, R, D Smock, M Katzorke, and S. Stewart, Jr., *Straight to the Bottom Line,* Fort Lauderdale, FL: J. Ross Publishing, Inc, 2006

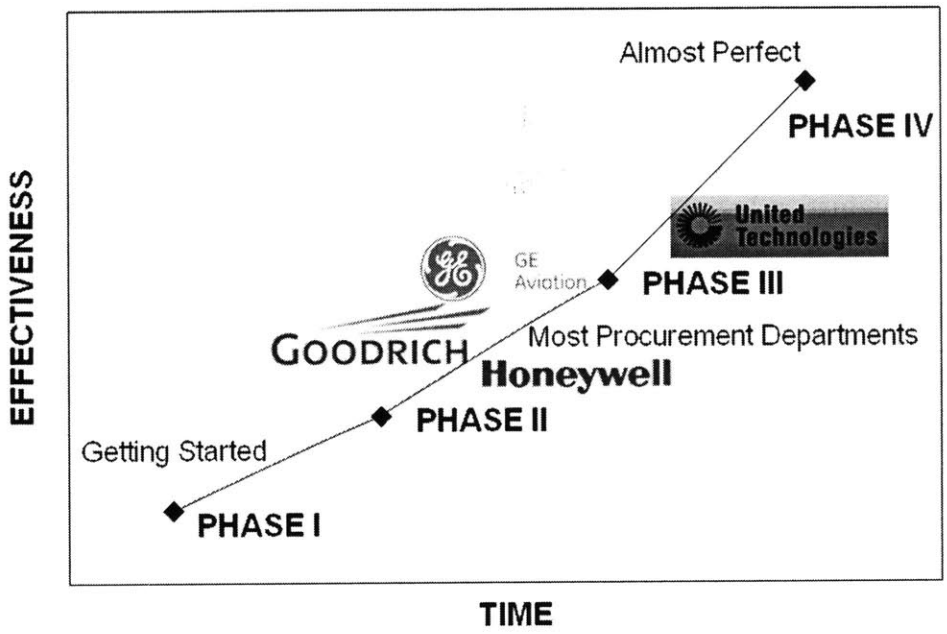


Figure 13. Benchmarked aerospace companies' positions in the effectiveness chart

As shown on the diagram, UTC is the leader developing in Phase III while Honeywell Aerospace GS lags behind competitors across the benchmarked dimensions:

A. Contracting practices/strategies
B. Supply base rationalization
C. Emerging market sourcing

A). In contracting practices/strategies benchmarking, United Technology Company (UTC) leads with a clear 8-step sourcing process and defined three sources for enhancement[33]. GEAE and Goodrich follow UTC in the benchmarking criteria such as material productivity commitment. Honeywell is less strict in contract requirements for quality and on time delivery (OTD) and trails in time required to reach contract agreements.

B). In supply base rationalization benchmarking, GEAE and Goodrich lead with smaller supply base. Both claim to have hundreds of suppliers and it is widely believed that GEAE's tier-1 suppliers manage a significant number of suppliers for GEAE. This tiering appears to work in letting GEAE push further with given resources, and such tiering would allow for concentration of effort at all levels. Supplier tiering exists at Honeywell, and there has been some discussion

[33] "Strategic Sourcing Makes an Impact" http://www.ism.ws/ResourceArticles/Proceedings/2003/VargasFH.pdf

about implementing tier-1 supplier managing smaller suppliers at Honeywell; however, it is still underdeveloped at this stage. UTC Aerospace has more than 3300 suppliers where around 500 of them supply to Pratt & Whitney, and around 600 supply to Hamilton Sundstrand. Honeywell Aerospace has more than 5400 suppliers based on 12 month spend activity in 2004-2005. With the largest number of suppliers compared to its competitors, the efficiency at which the suppliers can be managed is unavoidably lower.

C). In emergent markets sourcing, which focuses on sourcing in Mexico and South America, China and greater Asia, and eastern and central Europe, GEAE leads in China and Mexico in spend and presence, whereas UTC leads in Central Europe in spend and presence. GEAE's sourcing amount in China is more than 10% of GEAE's segment sales (Appendix B). Other companies' sourcing amounts in China are only ~0.25% of their respective segment sales. GEAE's sourcing amount in Mexico is about 0.8% of its segment sales compare to the other companies' <0.3%. UTC's sourcing amount in central Europe is about 0.8% of its segment sales compared to the others' <0.24%. Honeywell's amount of purchase is on-par with other non-leading competitors, but did not have a clear sourcing process or strategy for sourcing in those regions.

To achieve the next sourcing frontier where supplier collaboration and value creation are essential, supply base rationalization will have the most significant impact long term and is the most important area to work. Contract negotiation improvements deliver short-term results, whereas emergent market sourcing delivers short and intermediate term results. Both will impact supply base rationalization in the long term.

3.5.3 Competitor Benchmarking Data Processing

The benchmarking results presented in the previous section were collected during phone interviews in a free-flow format where interviewees answered a set of questions asked to them. Since much of the data is qualitative and some anecdotal, it needs to be quantified in order to compare and rank the incumbents. Two versions of concept scoring[34] from product design were applied. First a selection matrix was prepared and the criteria for ranking were identified. Next the interview data was put into the selection matrix (spreadsheet), and Honeywell was set as the

[34] Ulrich, Karl T. and Steven D. Eppinger. *Product Design and Development*, NewYork: McGraw-Hill, 2004, p136

reference incumbent. In the basic version, all criteria assume equal weights, a three-way rating (+, 0, -) is assigned to each criterion for each incumbent, and a score is calculated for each incumbent. In the advanced version, weights were assigned for each criterion based on the team's input to signify its relative importance. Each incumbent is scored for each criterion, and the weighted scores are calculated by multiplying the raw scores by the criteria weights. The incumbents were then ranked based on the total score, which is the sum of the weighted scores:

$$S_j = \sum r_{ij} w_i$$

where

r_{ij} is the raw rating of incumbent j for the ith criterion
w_i = weighting for the ith criterion
n = number of criteria
S_j = total score for incumbent j

In addition, many recommendations are expected to be drawn from the results and there also needs to be a method to distinguish the recommendations based on the comparative importance of the benchmarked questions. The benchmarking results for contract processes and supply base rationalization were ranked with the basic scoring system (as the winners and laggards are rather clear), and the emergent market sourcing benchmarking results were ranked with the advanced scoring system where asymmetrical information was available for the companies.

3.5.4 Competitor Benchmarking Result Analysis and Recommendation

3.5.4.1 Contracting Practices/Strategies

In addition to benchmarking key competitors, it was necessary to grasp suppliers and customers' contracting experience and how they compare Honeywell to others. Therefore, beside GEAE, Goodrich, and UTC (P&W, H-S), sourcing professionals from a large supplier and a large customer were interviewed to seek information on their contracting processes with Honeywell and their other customers/suppliers.

As indicated earlier, Honeywell Aerospace GS is behind the competitors in areas studied. Over ten recommendations (Appendix E) were inspired from examining the contracting processes and are presented with the following information:

- Honeywell Aerospace's current stage
- Competition based on benchmarked result
- Honeywell to-be or desired state
- Benefits and caveats

An example of this in a four-up format and implementation status is shown below in figure 14 and explained in detail.

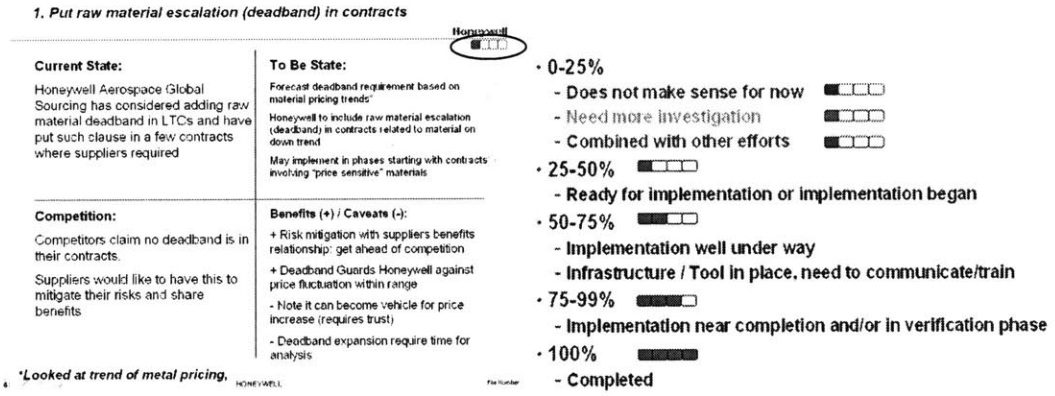


Figure 14. Benchmarking recommendation and status format

As an illustration, one recommendation is to put material escalation (deadband) in contracts: material escalation in contracts is not an uncommon risk mitigation concept for both suppliers and buyers, yet it does not appear to be widely implemented in Honeywell Aerospace GS contracts. The concept is that if raw material prices fluctuate over a certain range agreed by suppliers and buyers, the savings or the extra cost is passed through the supply chain. This avoids the situation where suppliers agree to a certain price, yet the material for making that product skyrockets, and suppliers are forced to supply at the old price that is no longer reasonable. On the other hand, buyers agree to pay a certain price, yet the material for making the product drops significantly, and buyer must still pay the old price. While some suppliers have added this as a requirement in their contracting terms especially many of them expect an upsurge of prices in the next contracting period, Honeywell GS is interested in adding this as a requirement for suppliers who source materials that are expected to drop in price in the near future. This clause would provide a degree of control for both the suppliers and buyer in the potentially volatile markets. This recommendation is in implementation phase and is expected to

provide data on supplier response (supplying quality and timeliness, for example) based on market conditions for comparison with the current supplying performance.

While this recommended contract term is expected to mitigate risk with suppliers and benefit relationship, some fear that it may become a vehicle for price increases as it requires trust from both sides to set the range. Another caveat is that any related change requires time for analysis due to the length of the contracts and variability of other terms.

The immediate implementation of the over ten recommendations from benchmarking appears to be important, yet it is overwhelming if not impossible to work on all of these at the same time. Concept ranking again was employed to rank the recommendations by the following criteria:

- measurable material productivity impact
- length of time before results
- benefit to current process
- drawback to current process
- difficulty of implementation
- Implementation time requirement
- resource requirement
- dependency on other activities
- disruption of activities
- risk

Note the criteria were deliberately set to favor short-term rather than long-term benefits, as this initiative is in many ways tactical and requires immediate benefits.[35] Based on the ranking results, the implementation of the recommendations is suggested to take place in four time phases (Appendix E).

3.5.4.2 Supply Base Rationalization

"We don't have the right supply base, so we are moving stuff from one bad supplier to another"

Anonymous at Honeywell

[35] If long-term criteria were favored, then supply base rationalization would predominate.

GS sourcing professionals have successfully purchased needed parts to get engines delivered to customers, so it may appear that the supply base suffices the needs of GS. However, the benchmarking results indicate significant opportunities in reducing the number of suppliers in the supply base. There is general agreement that there are large costs associated with certifying and managing each supplier in the supply base, but the actual cost of keeping a supplier is not well understood. For the purpose of this project, a percentage of the actual spend was used.

Keeping a supplier is expensive, but it is often quite expensive to disengage an existing supplier and qualify another supplier to meet FAA standards, or later having to come back to the same suppliers. A transition team handles transitioning aircraft parts from one supplier to another and often finds that their transition projects are not necessarily for low cost reasons: transitions are often due to specialty shops deciding to close after earning enough revenue, or some others may have capacity issues so they are not able to accept volume fluctuations, and yet others may be forced to exit the business when the cost of doing business becomes higher and margins become lower. GS scores its suppliers based on their performance and future relationship to either grow, maintain, or phase out, and goals for reducing the number of suppliers is set each year. Supply base rationalization is considered an area of opportunity; however, other efforts such as aggressive contracting, dual sourcing, alternative sourcing, and emergent market sourcing potentially hinder the effort by diluting the supply base and hurting existing supplier relationships. The dynamics of these will be discussed in detail in Chapter 4.

Supply base rationalization is an ongoing effort, and to understand the past results, twenty-four sub-commodities were selected at random and their numbers of suppliers from 2003 to 2005 were compared.

2003	5	7	11	15	25	27	29	48	52	58	60	61	61	81	109	114	138	146	167	234	267	291	335	350
2004	20	7	12	19	26	29	33	52	53	52	54	59	70	79	108	110	147	155	155	263	282	288	341	347
2005	18	7	13	19	23	24	36	47	46	46	51	56	67	67	103	97	144	138	134	235	252	269	319	343
					↑	↑		↑	↑	↑	↑	↑		↑	↑	↑		↑	↑		↑	↑	↑	↑

Table 1. Supply base size comparison for sub-commodities 2003-2005

As illustrated, 16 out of 24 (columns with arrows) had a net decrease of number of suppliers from 2003-2005, yet more than 50% (14 out of 24) actually had a supply base expansion in 2004, and more than 25% (7 out of 24) had an increase in the number of supplier going from 2003 to

2005 (shaded ones). For the 16 that had a reduction in the number of suppliers, the aggregated reduction was less than 9%. This shows that the supply base rationalization work thus far does not appear to be effective in reducing the number of suppliers.

Supply base rationalization benchmarking results show that different companies have different strategies/approaches to grow their supply base. Some focus more on organic growth, so the base would not grow too quickly. Some focus on modularizing the first-tier, while others focus on supplier integration with selected few. GS needs to set a realistic and achievable goal for controlling the supply base size as past top-down goals of reducing the number of suppliers by 10% or 25% did not receive sufficient attention or desired results. The best practices gathered from competitor benchmarking and literature research are the following:

- Identify the current spend volume, both per supplier and per category
- Determine category-specific supply base strategy (segment by high/low criticality and high/low volume)
- For each category, select the appropriate number and specific suppliers based on the strategy of that segment, with a clear understanding of decision factors such as supplier capabilities, firm's ability to manage the suppliers.
- Define the preferred relationship with the selected suppliers (identify suppliers into different tiers), emphasizing value-added performance and continuous improvement (promotes information sharing and integration)
- Manage the defined supplier relationships as above
- Monitor supplier performance and customer satisfaction

Another way to help the suppliers (and in turn, help Honeywell) based on the current raw material cost escalation and shortage issue is to aggregate the materials demand and source from a selected few raw material suppliers. Suppliers in general find their own raw materials suppliers and manage those contracts, and Honeywell does not interfere with where they source and how much they source for as long as Honeywell contracts are fulfilled. There is no problem when raw materials are abundant and inexpensive; however, when raw materials are in short supply and prices escalate, small buyers for those raw materials have neither the volume nor the margin to justify purchases and shortage of raw materials translates to shortage of parts for the OEMs. In fact studies have shown that shortage of materials is a leading cause for Honeywell product delinquencies. Aggregating the demand across multiple suppliers and sites increases volume and leverage, thus provide price and on time delivery advantages. Another effort to gain cost

leverage is in combining parts into product part families, where there is synergy in better matching parts with suppliers and increase sourced volume from suppliers. Based on the current commodities division, a number of suppliers with notable raw material shortages were selected for aggregation efforts. This effort in conjunction with the raw material escalation guarding in contracts can positively impact the price, volume, and on-time delivery of materials.

3.5.4.3 Emerging Market Sourcing

Emerging market sourcing is also referred to as Emerging Region sourcing, and is synonymous to low cost sourcing in this context. Assuming the raw material cost is similar across different regions, the labor rate is generally where the "low cost" comes from. Cost leaders are often ahead in pursuing cost migration, with more than two thirds of the self-claimed cost leaders moving greater than 20% of their supply chain costs to low cost countries (LCCs), whereas only 13% of the self-identified laggards had moved 20% or more.[36] Labor intensity and transportation costs are the most important factors of consideration in cost migration. A large percentage of many of Honeywell aircraft engine components are outsourced so the labor cost is embedded in the parts cost. GS uses the same calculation for costs for emergent market sourcing, and that will need to change to accurately capture the cost saving motivation. Vestring et al also talks about "think functions, not factories" when moving, and this implies moving the source for product part families that are used in multiple engines rather than a set of parts for a particular engine. When moving "functions," GS could potentially task the top tier suppliers to perform some of this supplier management work to both foster the relationship as well as share the risks.

For aerospace companies, there are three main low cost regions: Latin America and Mexico, Asia (including China and India), and central and eastern Europe. Prior to benchmarking Honeywell and competitors in emerging market sourcing, it is essential to understand the US regulatory climate on the implications of The Buy American Act, Free Trade Agreements (FTAs), and Export Compliance Trends:

> The Buy American Act implications: though mainly targeted for defense contracts, this complex act codified in 1933 to provide a preferential treatment for domestic sources of

[36] Vestring, Till., Ted Rouse and Uwe Reinert., "Making the Move to Low Cost Countries," Harvard Business Review, 2005

manufactured and un-manufactured goods and articles has presented challenges for sourcing professionals. In addition, the American Job Creation Act of 2004 and other potential political climate change present more complication to sourcing professionals as these may limit global sourcing.

Free Trade Agreements (FTAs) implications: the US has broad free trade agreements with a number of governments (NAFTA, AUSFTA). While there is much debate over the implications of free trade and globalization today, the FTAs serve to ease equipment and component imports and exports.

Export Compliance Trends implications: currently, there are a number of countries on the monitor list. For example, there is no military content allowed to be sourced from China, and for India, this restriction was lifted recently. While technology growth in emerging markets continues to increase, sourcing professionals hope for and expect that new technologies can be better controlled so there would be less export restrictions.

Aerospace companies and their sourcing professionals should be well aware of any changes in the regulatory climate that may create or lift barriers for global and emerging market sourcing while implementing changes to accelerate emerging market sourcing.

The three low cost regions are the three emerging markets, the leader of each of the three regions is examined, best practices are analyzed, and implications for Honeywell are derived.

Latin America and Mexico: GEAE leads sourcing in Mexico. Its sourcing amount as percentage of segment sales is 3-4 times compare to Honeywell Aerospace, H-S, and Goodrich. The latter three have similar sourcing amount to segment sales ratios. P&W has relatively little sourcing activity in this region. Honeywell shares scores of suppliers with other leading competitors, while those competitors use additional suppliers as well. Best practices illustrated here are top-down executive support and push for global sourcing and utilize centralized purchasing system to save cost and increase hedging.

Asia (including China and India): GEAE leads sourcing in China. Its sourcing amount as percentage of segment sales is >50 times compare to Honeywell Aerospace, P&W, and Goodrich. The latter three's sourcing spend are similar to their activities in Mexico but

are expected to increase their activities significantly. H-S has relatively little sourcing activity in this region. Quality capacity seems to be the main problem, and there is significant large-first-mover advantage (the large mover to claim the manufacturing capacities first would be able to keep that advantage for a while). Honeywell is viewed as not aggressive in both direct and indirect sourcing. Best practices illustrated here are again centralized purchasing system enabling consolidation of ordering and hedging, equipment transfer to low cost regions planned up front, up-front payment for long-term contract expecting to develop supplier, investment of a team at the International Procurement Office (IPO) for indirect purchasing, and revenue/risk sharing partner with supplier.

Central and Eastern Europe: P&W leads sourcing in Poland. Its sourcing amount as percentage of segment sales is >4 times compare to Honeywell Aerospace, GEAE, and Goodrich. H-S's activities in this region involve sourcing with P&W. Both OEMs and their customers (Boeing and Airbus) are tapping into precious metal reserves in this region (titanium in Russia). Operations here are very vertically integrated and have long cycle times so local presence is extremely important. OEM customers experienced similar pressure to move jobs locally when winning deals in this region, which in turn drive OEMs to source and make products here (Lockheed Martin's F16s to Poland). Best practices establish dual source where one source is international, and the other source is domestic (i.e. P&WC JSF F135)[37], internally compete with outside suppliers (i.e. P&W's requirement to bid on new parts), acquire and develop capabilities based on the characteristics of local operations, and assign direct and indirect materials procurement responsibilities to senior executives to raise visibilities of cost saving opportunities.

Centralized sourcing can be a competitive advantage here in offering a common platform to share better practices (for example, list of suppliers or opportunities in indirect sourcing); however, it is challenging for a decentralized organization where divisions are vertically integrated, and reporting structure is through the business units. In these cases, a "center led" hybrid may work well to both take advantage of best practice sharing, but still have direct business unit control for purchasing.

[37] MIT e-library, Vera database

Emerging market sourcing benchmarking results show that different companies have different strategies and approaches to expand in low cost countries. Some leverage their engineering research centers in those regions to establish sourcing bases, some focus on acquiring suppliers or establish joint ventures. Competitors are positioning for continued cost savings as they invested for restructuring internally and purchased supply capability in low cost regions, and Honeywell often is left to gather scattered capacity from different shops. GS needs to decide on sourcing strategies for each region. The best practices gathered from competitor benchmarking are the following:

- Drive EM sourcing efforts from executive level
- Maintain and develop internal capabilities on key competencies
- Dual source for smooth transition
- Share best practices across International Procurement Offices
    - Indirect and direct sourcing, across business units
- Invest in long-term supplier relationships
    - Acquire and develop, Joint Ventures, prepayment for Long Term Agreements

Cross industry benchmarking shows that aerospace industry sourcing may not be benefiting as much from emerging market sourcing as one would expect due to the high material and low labor content of the total cost. For example, in automotive industry, labor is estimated by KPMG in 2004 to be less than 10% of the overall cost in sourcing. Aircraft component sourcing cost structure is similar to that of automotive in terms of the proportion of labor and materials; therefore, the cost savings still needs justification even with much lower labor costs.

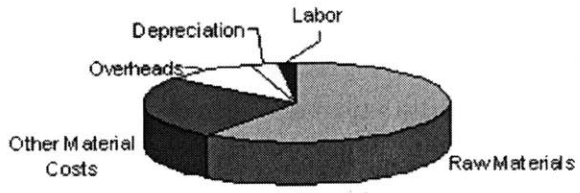


Figure 15. Estimates of supplier cost structure in China[38]

[38] Holweg, Matthias, Jianxi Luo and Nick Oliver, "The Past, Present and the Future of China's automotive industry," The International Motor Vehicle Program (IMVP) at MIT, working paper, 2005

GS is actively working on emerging market sourcing strategies, which is absolutely crucial not only for sourcing competitiveness, but also for the long term supply base rationalization planning. Emerging market sourcing decisions should not be made by emotions and goals alone, but rather should be a financial model along with risk factors in culture, politics, and trade, as well as other international considerations such as currency fluctuations.

3.6 Chapter Summary

This chapter consists of a significant portion of this research. It includes internal data analysis, industry trends analysis, and competitor benchmarking. The competitor benchmarking focused in three pillars of the declining material cost productivity problem: contracting processes/strategy, emerging market sourcing, and supplier rationalization.

The competitor benchmarking yielded results confirming that Honeywell needs to improve in all three areas. Over ten contracting recommendations were inspired from examining the contracting processes. Best practices are presented for supplier rationalization and emergent market sourcing. However, if these areas were to be improved concurrently, there would be conflicting components affecting GS operations. The interactions of the three benchmarked areas with each other as a system are examined in Chapter 4.

4 System Thinking

"Many of the problems we now face arise as unanticipated side effects of our own past actions."

-- John D. Sterman, Professor at MIT Sloan School of Management

4.1 System Implications

System dynamics is a tool that helps with navigation of complex systems. Aerospace sourcing is a complex system that involves many characteristics and challenges of policy resistance, unintended consequences, and counterintuitive behaviors. In "On the dark side of strategic sourcing: Experiences from the aerospace industry," Rossetti and Choi explained how the dramatic changes such as restructuring in aerospace companies resulted in significant outsourcing increase, which in turn increased misapplications of strategic sourcing. In "Avoiding the dark side of strategic sourcing," Ross addressed how shortsighted decisions undercut supplier health, and later come back to haunt the buyers. For Honeywell, system implication can be shown for the initiatives driving to accomplish the goal of improving material productivity. All recommended initiatives should go through system implication checks before full scale implementation. This does not mean initiatives should not be implemented if there is any negative impact, as that would exclude all initiatives. Instead, system implication checks provide an informative trade off and decision basis where short term and long term initiatives can both be implemented, monitored, and adjusted for best results. The following sections discuss three representative system negative feedback processes in simple, localized settings.

4.1.1 Policy Resistance

Policy resistance refers to unanticipated side effects created by policies intended to solve problems. Policy resistance can be found anywhere a policy exists, whether it is in sourcing, or in sourcing within the aerospace industry, or at Honeywell GS. The rebate clause (Appendix F) in Honeywell GS contracts can be used to illustrate this concept. Customers of Honeywell have demanded rebate, returning part of a payment, for parts that either arrive late or are defective. In an effort to pass on customer requirements, and more importantly to increase supplier quality and on time delivery performance, Honeywell Aerospace GS added rebate clauses in its supplier long

term contracts (LTC). The rebate clause requires suppliers whose on time delivery and/or quality do not meet the agreed levels to pay a percentage of Honeywell's total spend with those suppliers. There are also other variations of the clause that set a ceiling dollar value for rebate, or ask for a certain percent cost of delayed or damaged parts instead of a percent of total spend. At the time of the initial installation, the quality and on time delivery seemed to improve, so result was visible and the "policy" appeared to be a success. However, the quality and on time delivery improvement became less visible over time and even regressed. The system responded and suppliers found ways around the clause. The suppliers might have raised the per-piece price which would provide GS with negative savings. The 2005 data shows that the suppliers with the least amounts of savings (or most negative savings) tend to have higher defects and worse on time delivery than the suppliers who provide GS with the highest savings. GS intended to simultaneously improve material cost productivity, quality and on time delivery, but a policy change for the latter two (quality and on time delivery) invited an unintended drawback for the former (material cost productivity).

The financial benefit of rebate is not really well understood or captured. Based on 2005 data and assuming all rebate clauses were to mandate the same terms (1000 defects per million for quality and 90% for on time delivery, and 1% rebate), exercising the rebate clause implies getting millions of dollars from suppliers who do not meet agreed quality and on time delivery terms. This amount, however, is still $24 million less than the extra per-piece cost GS may be paying suppliers during the same period (assuming all negative savings are due to per-piece cost increase). In addition, the rebate clause is not exercised well currently due to the lengthy claim process and the fear of damaging supplier-buyer relationship. Thus, the gap between the predicted payback and actual payout is even greater.

The rebate clause is only one term/condition on the long term contracts (LTCs). The intent of analyzing it is to get sourcing professionals to reflect on all the other ones as well. Before any term or condition become implemented as a "policy" in a contract, it is essential to understand what and how much is expected from the policy, how much can the policy realistically provide us, how difficult it is to enforce the policy, and what hidden costs there might be. "Policy resistance arises because we often do not understand the full range of feedbacks operating in the

system."[39] Mapping out the potential policy resistance that could occur and forecast if any benefit offered by the policy would be countered will drive a more robust decision.

4.1.2 Unintended Consequences

Unintended consequence refers to the unexpected yet detrimental outcomes caused by anticipated problem solutions. Here an example from the aerospace industry is provided to illustrate this system feedback. Seeking to boost its quarterly results, GEAE increased its cash flow, stock price and earnings by forcing its suppliers to accept 90-120 day payment terms instead of the 30 - 60 days industry norm[40]. The suppliers could survive if they just need to satisfy one demanding customer; however, GEAE's "success" with its new "policy" led to other industry incumbents such as Pratt & Whitney and Honeywell to demand similar conditions from the same set of suppliers. The suppliers' costs actually increased as they scrambled to finance their operating needs to avoid getting out of the business. These costs would eventually be passed on to their customers, so this cost saving initiative actually resulted in an unexpected cost increase. As the snowballing icon in the center of figure 16 indicates, GEAE's action puts the system in a vicious cycle that eventually its pressure on suppliers to accept delayed payments has to reduce.

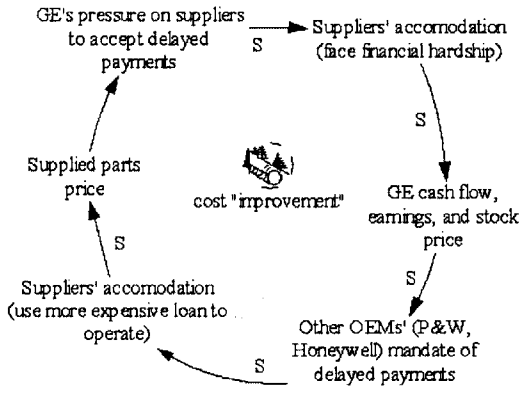


Figure 16. Snowballing effect of GE's cost "improvement" actions caught in a vicious cycle
(S: same direction for variable increase/decrease)

[39] Sterman, John D. Business Dynamics: System Thinking and Modeling for a Complex World. Boston: McGraw-Hill, 2004
[40] Ross, Judith, A. "Avoiding the Dark Side of Strategic Sourcing". Harvard Business Review, 2005

This case is also an excellent example of Nash equilibrium at work: when one incumbent benefits from a scheme, to maintain competitiveness, all others join and utilize the scheme; however, unintended consequences follow and the end result is unfavorable to all.

4.1.3 Counterintuitive Behaviors

Systems are more often cyclical than linear because people see interrelationship rather than linear cause-effect chains, and see processes of change rather than snapshots. Since the structure is circular, it is possible to begin the cycle from anywhere. Figure 17 shows a system where customers (Boeing, Airbus) request more price reduction for engines from Honeywell Aerospace account managers, and GS meets that request by increasing material productivity through more negotiations resulting in signing more agreements with suppliers, customers are satisfied and both parties are content. Note all variables of this loop reinforce each other (green or vertical arrows by the variables). As the number of customer requests for price reduction on contracts increases, account manager negotiations and agreements to customer demand increases; this leads to Honeywell Aerospace Integrated Supply Chain's increasing requirement of GS to improve material productivity which leads to GS's focus of materials productivity and execution of initiatives; as the focus on material productivity shows results, customer satisfaction with Honeywell increases, leading to increasing number of new contracts it captures, and potentially new customers; more new contracts and customers means more request for price reduction, and the cycle goes on. This growth engine paints a rosy picture, but there are problems: what if customers ask for unreasonable price reductions that are unachievable by material productivity initiatives or GS resources are overloaded and cannot perform all the actions needed to achieve the necessary agreements with suppliers? When that occurs, an accelerated decline and a deconstructive domino effect can be observed as the illustrated system variables still reinforce each other, but negatively.

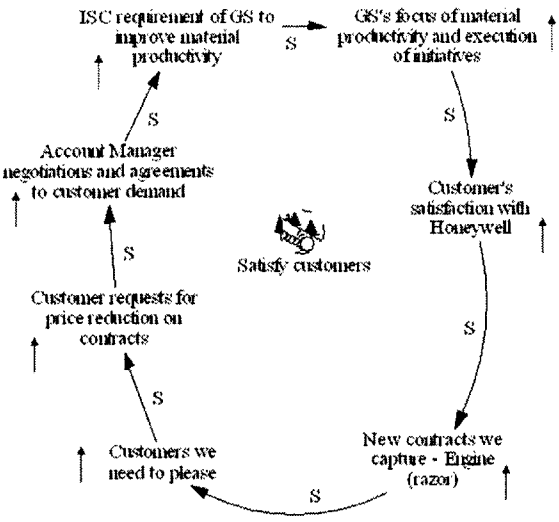


Figure 17. Snowballing effect of Honeywell's initiatives to satisfy customers in a virtuous cycle (S: same direction for variable increase/decrease)

Figure 17 is not the complete picture of material productivity improvement, as balancing or stabilizing feedback exists in any goal-oriented behavior[41]. As the following system view of driving and enforcing material productivity initiatives (Figure 18) illustrates, an endeavor intended to reduce costs may show counterintuitive behaviors that could eventually lead to higher costs. While the left loop is the same reinforcing loop as in Figure 17, the right balancing loop shows that as more work is put on sourcing professionals (commodity managers) to drive cost savings, there will be parts that do not achieve the set goals, and additional resources will be put to work on them. Suppliers become disconsolate and resent additional cost cutting by refusing to provide savings or stop supplying at all; engine cost rises for the buyer (Honeywell in this case) due to increased cost and the prices buyer (Honeywell) quotes to customers increase. Price increases affect competitiveness, and fewer contracts would be captured as a result. With fewer customers, the amount of customer requests on cost reduction would be fewer, and the left cycle progresses into a negative reinforcing mode. To change the behavior of the system, it is essential to find leverage in the balancing loop, not in the reinforcing loop. Here the variable "negotiations with suppliers" for more cost savings is the limiting factor and the leverage in the balancing loop for modifying the system behavior.

[41] Senge, Peter M. *The Fifth Discipline, The Art & Practice of The Learning Organization.* New York: Currency Doubleday, 1990. p79

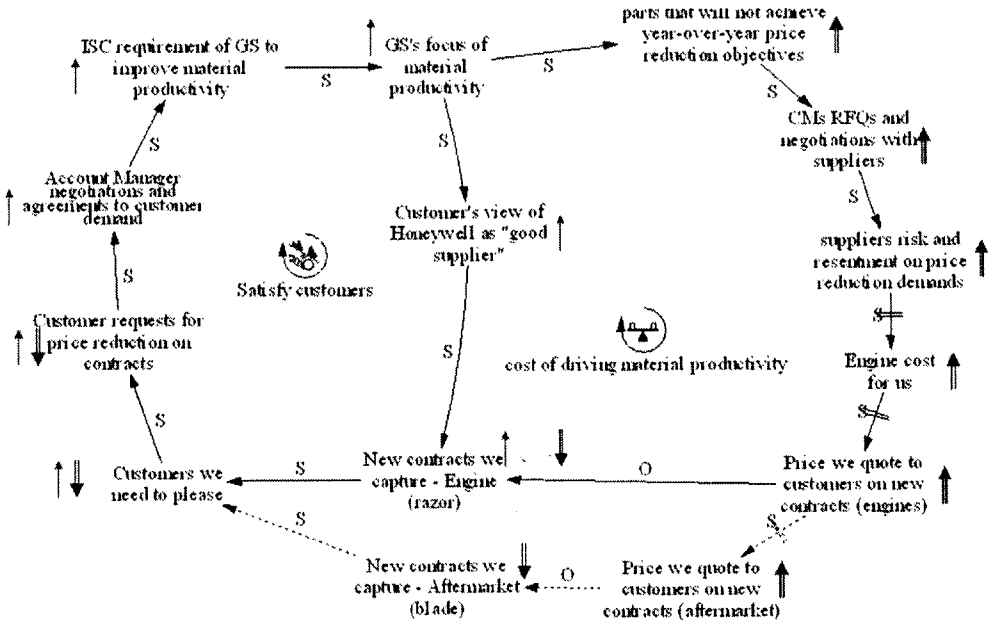


Figure 18. Snowballing effect of Honeywell's initiatives to satisfy customers balanced by the cost of driving material productivity
(S: same direction for variable increase/decrease; O: opposite direction)

4.2 Shifting the Burden in the System Environment

As illustrated earlier, Honeywell compared to competitors has the most number of suppliers for similar business sizes, yet despite supply base rationalization efforts, the number of suppliers quickly grows back soon after it is reduced. The GS data shows that the number of Honeywell Aerospace suppliers reduced by about 1% from 2003 to 2004. The problem to improve material cost productivity would be a simpler one if there are already the right number of (often fewer) suppliers who are closely tied to Honeywell.

It is a common complaint that everyone talks about supply base rationalization, but no one really devotes substantial effort to it because they are measured by cost saving within a year or even a quarter. Even though it is well understood that the supply base needs to be much smaller, other initiatives usually take precedence over that effort due to the need for more immediate results. Illustrated in the diagram is a "shifting the burden" view of relieving the symptom of insufficient material productivity.

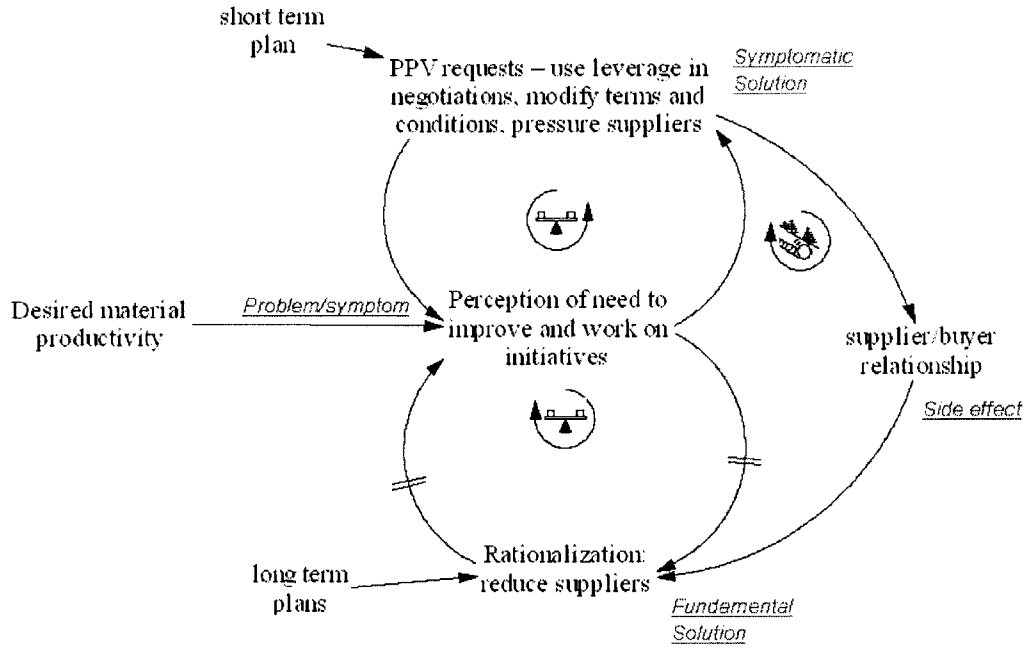


Figure 19. Aggressive cost reduction by negotiation negatively impacts supplier/buyer relationship, which is a fundamental enabler for long term initiatives

The shifting of burden structure can be detected with three tests[42]:

1. *There is a problem, and it slowly gets worse over time with sporadic improvements in between*: the material cost productivity is getting lower, but occasionally will get higher, then lower again; the supply base is getting larger, but occasional supply base rationalization effort gets it smaller.

2. *The overall system health gradually gets worse*: the aerospace industry's year-over-year purchase price variance (PPV) overall is shrinking, which is an indication of reaching an equilibrium; however, demand for higher PPV would increase and lead the system to worse balance.

3. *The feeling of helplessness grows as people think they solved the problem, only to find themselves to be victims to the problem*: people solve the material cost productivity by sourcing from additional suppliers, then find that there are too many suppliers that they

[42] Senge, Peter M. *The Fifth Discipline, The Art & Practice of The Learning Organization*. New York: Currency Doubleday, 1990

will have to reduce the number of suppliers. They find themselves to be the victim of the huge supply base, yet it was the solution for getting the desired material costs earlier.

Figure 19 begins with a shortfall in material productivity for the customer needs or competitiveness, which is often indicated by a gap between the desired and actual year-over-year cost reductions. While keeping design processes the same, this problem seems to get worse year-over-year as more cost reduction measures are taken.

In the short term, leverage in negotiations can be used to pressure suppliers to get more cost reduction to close that gap. During this process, some overhead cost may have to be sacrificed to achieve the per-piece cost. In addition, some supplier and buyer relationships may be strained.

In the long term, the goal is to reduce the total cost: overhead as well as the per-piece cost. One way this can potentially be achieved is by reducing the number of suppliers. Fewer suppliers require less resource to manage, and more resource can be focused on relationship building. The less resource would mean less overhead cost, and more focused relationship would mean more interdependence and integration – leading to less waste, and less cost.

Yet with the short term solution achieving limited success, and relieving the problem symptom of not enough material productivity, it diverts attention from the fundamental problem because there is no time or patience to wait for the long term solution to generate results. In the mean time, supply base grows larger, relationships are poorly maintained, adds more challenge for the long term solution implementation, and limits its potential to succeed with desired results.

A similar argument can be made for the relationship of contract negotiations and another material productivity improvement endeavor: emerging market sourcing, as well as for emerging market sourcing and supply base rationalization (Appendix G). With emerging market sourcing as a long term goal, resources and attention in sourcing (commodity) teams are consumed in the quick, measurable negotiations, and less energy is put in support in emerging market sourcing efforts (International Procurement Offices are expected to staff up to handle large sourcing goals, yet there is limited communication between the US sourcing team members and the international team members and uneven work distribution); suppliers in those negotiations who may be unsatisfied with Honeywell are less likely to share design capabilities (domestically or

internationally), creating challenges for Honeywell in emerging market sourcing. On the other hand, when discussed concurrently with supply base rationalization efforts, emergent market sourcing can be viewed as the short term solution, which increases the supply base size, as well as complicates sourcing knowledge transfer both within and outside of GS. This effort undermines the primary solution of effective strategic sourcing: supply base rationalization.

Whether a solution is symptomatic or fundamental is relative, the key takeaways from "shifting the burden" are recognizing and identifying the multiple ways in which a problem can be tackled, and grasping the reliance on symptomatic solution and its influence of further reliance. The leverage exists in identifying the potential negative "side effects," and strengthening the bottom balancing cycle where the fundamental solution is while weakening the top circle where the symptomatic solution is.

4.3 Applying System Dynamics

Problems with high financial, social, environmental and other impacts should be analyzed with system dynamics to bring out anticipated policy resistance, unintended outcome, and counterintuitive behaviors. The possible occurrence of shifting the burden also becomes more visible and can be effectively simulated and balanced. Here is an example from the Aerospace industry: driving cost of suppliers down often leads to one survivor for critical parts, and an unexpected consequence which is suppliers going into competition with their clients. Aerospace OEMs sourcing professionals have been in actual contract negotiations where suppliers would request a price increase, confidently knowing that there is no other alternative for the buyer other than to give in. At the same time, suppliers may sell the same product to the aftermarket, which is the cash cow for OEMs. According to several Honeywell sourcing professionals, the "hot buttons", or the topics that are most talked about are intellectual property (IP) and aftermarket market share.

The recommendations derived from benchmarking results, internal data analysis, and industry trend analysis should be studied for their implications prior and during their implementation. Though the system dynamics analyses discussed in this chapter are largely qualitative, one can simulate and test simple and complex models to identify plausible range of uncertainties, and test sensitivity of the parameters to aid decision making. For the three benchmarked areas, weights

can be assigned for the short term and long term initiatives, assumptions can be made for any unknown variables, and sensitivity analysis can be performed on parameters that are influential yet highly uncertain.

Problems often do not build up overnight, rather it is a result of long term ignoring of symptoms. Similarly, problem solutions often have side effects that are not detected immediately or are ignored until they cause other problems. This is where the phrase "yesterday's solution becomes today's problem" comes from. The recommendations for improvement, even the metric of material cost productivity, may have undesired side effects that would cause problems later. Effective decision making comes from learning complex systems' structures by expanding boundaries of mental behaviors to understand the dynamics' behaviors.

4.4 Chapter Summary

In this chapter, system implications: policy resistance, unintended outcome, and counterintuitive behavior, are explained with examples from Honeywell and other incumbents in the aerospace industry. The notion of shifting the burden is also introduced, and the three areas of benchmark's potentially harmfulness on each others' progress are explained. Due to the limited time of this project, system dynamics simulation effort was partially complete; however, it is critical that system dynamics analysis be recognized as a tool for helping sourcing professionals with decision making and sense making, and it can be applied to any industry.

5 Conclusions

There are three levels of conclusions from this research, corresponding to company specific learning for Honeywell, sector-specific learning for the aerospace sector, and general sourcing profession learning.

5.1 Firm Specific Learning

This research shows that Honeywell GS is lagging in all the benchmarked areas in the "advanced sourcing" stage of the 1990s and early 2000s, and it is anxious to catch up and become more competitive. Currently the prevalent problem Honeywell Aerospace faces is its enormous 5400+ supplier supply base, which is an issue often talked about but not effectively analyzed. Honeywell GS will not be able to compete as efficiently as competitors' sourcing organizations with supply bases a fraction of that size. However, the sourcing frontier is shifting to be more relationship and collaboration driven, and Honeywell can learn from others' mistakes and leapfrog to the next sourcing frontier. The following are conclusions for Honeywell Aerospace GS:

a. Understand the presence of gaps and problems:

Benchmarking results in Chapter 3 show that Honeywell GS is lagging behind compared to its competitors in all benchmarked aspects, and GS needs to understand this gap. GS must accept that current problems result from past practices, and employ system thinking in future decisions. Understanding and accepting are first steps in arriving at comprehensive solutions. Sourcing decisions involving millions of dollars should not be based on emotions – instead, it must be guided by internal data and system dynamics analysis.

b. Learn from OEM strategic sourcing mistakes:

Avoid sacrificing long term cost savings for short term price targets, as taking the low hanging fruit in one area may increase the total cost of the whole system. Here system dynamic simulations and analysis should be used to aid decision making. GS should remember that cost savings are derived from close suppliers-buyer relationships: the Japanese auto industry has done incredibly well in this front, and this can become a competitive advantage but requires

substantial investment in supply base rationalization and trust establishment with the chosen suppliers. In addition, GS should always keep abreast of the changing supply market and the governing regulations to plan for and adapt to changes in sourcing frontiers.

c. Utilize the assets and execute strategic sourcing right:

There is a sea of resources within, and internal data often contains messages that show implications of earlier initiatives. For this reason, it is essential to keep databases updated, to perform and use data analyses in order to share best practices and guide strategic decisions as well as to strike balance between long term and short term initiatives. Define lagging and leading metrics for the new sourcing frontier: material cost should not be the only metric whereas total cost of ownership should be, but it is not easily measured or updated. People as the knowledge asset of the organization should be valued as they are the ones who build and maintain relationships with suppliers and customers. GS should continue its efforts in building supplier-partnering relationships through value engineering, mutual risk and benefit sharing.

Most of the above recommendations have appeared in the literature before and have been available to sourcing professionals all along. However, the benefit of those potential solutions has not been realized as GS are often driven by measurable short term metrics.

5.2 Industry Specific Learning

Although much of this research focuses on one enterprise, Honeywell Aerospace GS, several conclusions can be applied to sourcing in other aerospace firms and industries. Aerospace, especially the high mix, low volume, and cyclic aircraft engine industry is increasingly becoming squeezed for margin. On the bright side, the market is expanding and the industry players are becoming more efficient. As illustrated in the thesis motivation in Chapter 1, aerospace sales are expected to exceed $180B in 2006, thus there are significant opportunities for the incumbents who maintains the most efficient supply chains: where the sourcing function plays a major role.

The key learning for the aerospace industry is to understand the misapplication of strategic sourcing initiatives during the "advanced sourcing" stage in the 1990s and early 2000s, and

"shed light on the dark side."[43] Three strategic initiatives closely tied to the benchmarked focus should be carefully considered on the journey to the next sourcing frontier.

In commodity management, the misapplication of strategic sourcing is that cost is used as the sole performance metric for commodity managers. As a result, long term sourcing interests are ignored. Firms should consider incorporating broader performance metrics to drive desired behaviors.

In supply base rationalization, the misapplication of strategic sourcing is over reduction of the supply base to the point where competition vanishes. As a result, buyers face monopoly or more powerful suppliers. Firms should try understanding supplier reactions to sourcing initiatives

In global Sourcing, the misapplication of strategic sourcing is providing a significant amount of co-developed IP and designs to global suppliers. As a result, existing suppliers lost certain competitive advantage and stopped future sharing of design capabilities. Firms should respect suppliers' talents and beware of suppliers who do not respect IP rights.

5.3 Learning Applicable to Sourcing in General

The era of "Old School Sourcing" of the 1980s is long past, and the benefits of "Advanced Sourcing" such as strategic sourcing from the 1990s and early 2000s are diminishing. The success drivers of the next sourcing frontier for many industries actually look quite familiar: there will be more supplier collaborations and competitions, firms will need to have more internal collaboration, and there needs to be more customer collaborations and alliance.

The Benchmarking-Internal data examination-System dynamics analysis models (or BIS) developed in this thesis can be applied as a framework/methodology in examining how a firm compares to its competitors in the next sourcing frontier and generating directions for continuous improvement. As for the frequency of such studies, it may be worthwhile in some industries to have periodical competitive benchmarking to coincide with industry-wide benchmarking. Similar to employee performance reviews and development plans, the BIS model can be used by benchmarking groups on a regular basis to evaluate companies' sourcing competitiveness, and to

[43] Rossetti, Christian and Thomas Y Choi. "On the Dark Side of Strategic Sourcing: Experiences from the Aerospace Industry," Academy of Management Executive, Feb2005, Vol. 19 Issue 1, p46-60

develop corporate improvement plans. The outcome of the BIS analysis can be used in corporate strategy and execution plan development.

Going forward, the organizational structure and business culture must recognize that the incentive structure drives the bias of valuing short term gains over long term benefits. When there is rapid churn of sourcing executives, who are pressured to deliver hard financial gains quickly at the risk of be replaced, similar pressure is propagated through out the corporate structure. This is counter productive to the firm's advancement to the next sourcing frontier where collaboration among suppliers, buyers, and customers are crucial.

5.4 Concluding Remarks

It is only in the past decade or so that sourcing and purchasing have received a more strategic role. As supply chains confront themselves to meet cost reduction goals, they face a number of challenges. The challenges are especially apparent in the high-mix, low volume, and often considered cyclical aerospace industry where customers' purchase decision emphasis is increasingly shifting away from technology-centric towards cost-centric. This thesis offers frameworks for identifying sourcing improvement opportunities through benchmarking, trading off strategies based on their near term and overall impacts and implications, as well as for identifying sourcing spend versus savings trends for evaluating past initiatives. This thesis also develops the Benchmarking-Internal data analysis-System dynamics model (BIS model) while working on finding cost improvement opportunities for Honeywell Aerospace GS. BIS will help not only Honeywell or other aerospace incumbents but also incumbents in other industries to reduce costs and build a competitive foundation to get ahead in the next sourcing frontier.

To become more competitive in sourcing, and ultimately in manufacturing, incumbents in the Aerospace and other industries will need to target the next generation sourcing frontier. They should aim at turning collaboration into cost avoidance advantage by building stronger supplier relationships, foster internal collaborations, and facilitate more customer cooperations and alliance.

APPENDIX A – INTERVIEW LIST

Industry Benchmarking Interviews

External Contacts:

Name	Company	Division
Bernard Oriol	GEAE	Controls & Accessories
Jim Welder	Goodrich	Blades
Tim Garbett	Goodrich	Turbine Fuel Technologies
Emil Gaumont	Perkin Elmer	Global Accounts
Patricia Verbryke	Honeywell	Global Business Accounts
John Skala	UTC	UTC aerospace division
Kevin Booker	Goodrich	Pump & Engine Control Systems
Dave Stagney	Moog	Server Valve

Internal Contacts:

Last Name	First Name	Department	Role
Crowley	Jack	Electro-Mechanical Comm Team	commodity manager
Greenman	Matthew	ES&S President's Office	Manager New Business Dev
Henley	Tom	Strategic Sourcing Sheet Metal	Manager Program
Jacobs	Christine	no long with Honeywell	program manager
Kang	David	no long with Honeywell	ISC mgr
Kienitz	Michael	Electro-Mechanical Comm Team	Leader Sourcing
Kim	Dean	AFS OPEX	Black Belt II
Lee	Gregg	Electro-Mechanical Comm	Commodity Manager
Oliver	Tina	ISC Aero Source Mech	Manager Commodity
Omole	Seun	Material Quality Assurance	Engineer IV QA
Prestwich	April	ISC Aero Source Mech	Manager Commodity
Redeker	Cory	ISC Aero Source Mech	Leader Sourcing
Roeloffs	David	Strategic Sourcing Mach C&F	Manager Commodity

Aerospace Emerging Market Sourcing Contacts:

Dyament	Allan	sourcing - central Europe	Leader Sourcing
Gutierrez	Oswaldo	ES&S Oficina de Monterrey	sourcing leader
Hollander	Kipp	AES Sourcing Ldrshp&Compliance	SC PUR Business Mgr III
Fallon	John	Specialty Materials	Procurement Project Manager
Lim	CheeKhoong	Propulsion	Site Leader
Wang	Richard	no long with Honeywell	sourcing leader

Marketing and Business Development Contacts:

Crouse	Daniel	Mktg/E-Business	Director Marketing
Greenman	Matthew	ES&S President's Office	Manager New Business Dev
Park	Charles	Marketing & Product Management	Director Strategic Marketing
Schalte	Mark	Marketing - MPM Mechanical	Manager Business Intelligence
Traxler	Bill	Marketing & Product Management Mechanical	Director Product Portfolio Mgmt

APPENDIX B – Benchmarked Companies' Segment Sales

based on SEC 2004 data (unless otherwise indicated)

	Honeywell[1]	GE[2]	H&S[3]	P&W[3]	Goodrich
sales (000's)	25,601,000	152,363,000	37,445,000	37,445,000	4,724,500
Net income	1,281,000	16,593,000	2,788,000	2,788,000	172,200
income/sales	5.00%	10.89%	7.45%	7.45%	3.64%
segment sales	9,748,000	12,500,000	3,928,000	8,303,000	1,939,600
seg Op income	1,479,000	2,508,642	610,000	1,143,000	264,900
segment notes	aerospace	aircraft engines	self	self	engine systems
seg op income / seg sales	15.17%	20.07%	15.53%	13.77%	13.66%
segment income/sales ratio is higher by X%	10.17%	9.18%	8.08%	6.32%	10.01%

1 1 segment is aerospace
2 2 2004 data was derived from 2003 OP income/segment sales ratio and overall 2004 sales (=C3*8% or $12.189B)
2004 data $12.5B is also on http://www.geae.com/aboutgeae/factsheet.html
3 3 overall data is UTC data
P&W Canada sales can be derived with 2003 data (Aerospace STRAP) 1,360,785

APPENDIX C – Management Consulting Sourcing Examples

PRTM, a management consulting company, showcased a project of dramatically reducing costs with strategic sourcing methods for a division of an aerospace conglomerate supplying commodity fasteners (source: prtm website http://www.prtm.com/results/one.asp?case_study_id=6422). The client was facing intense pricing pressure, and sought 15% in material cost reductions as opposed to its usual <5%. The approach included gaining supplier understanding and acceptance of this effort, data clean up to ensure valid data, then developed commodity strategies, trained teams to accelerate negotiation preparation, and worked with the teams to "execute the expected cost reductions by defining cross-commodity strategies by supplier, developing negotiating strategies and tactics, establishing target pricing, and negotiating terms and conditions with suppliers for over 16,000 unique part numbers." The company achieved the targeted cost reductions within four months. This case has a number of similarities and two key differences compared to the problem statement at Honeywell: Honeywell Aerospace GS does not have the urgency for cost cutting, and GS wants to find solutions for cost cutting amidst different environmental challenges.

Bain & Company presents a procurement cost saving case for DialCo, whose senior management was under pressure to reduce operations costs by 10% (http://bain.com/bainweb/Consulting_Expertise/capabilities_detail.asp?capID=69). DialCo already took initiatives to improve its procurement capabilities and processes, and asked Bain to help it realize significant short term cost savings and build world-class sourcing capabilities. Bain focused on management process and governance structure targeting program management and spend categories. Bain's recommendations to DialCo include consolidating its supply base, standardizing products, and reducing number of contracts. This case also has a number of similarities and two key differences compare to GS's problem statement: GS was just undergoing restructuring whereas DialCo had reorganized before going to Bain, and GS is looking for both short term and long term cost savings.

Both cases reflect an increased attention in sourcing cost reduction. While execution requires having formal processes and measurement techniques, to gain sourcing advantage long term and get ahead, companies need to move beyond cost reduction to value creation.

APPENDIX D – Procurement Organization Maturity Phases

Phase I: getting started

a) Substantial amounts of maverick buying
b) little coordination between procurement organizations organized in a decentralized fashion
c) a few major advanced contracts are negotiated annually
d) may need to ask suppliers about historical spending on materials and services
e) legal services acquiring, advertising, or employee benefits are not considered as "buying"

Phase II: where you want to depict being when asking for more resources

a) most major commodities are negotiated and leveraged
b) maverick spending is minimized
c) most transactions are automated
d) buyer training is starting to pay off
e) supplier pricing is under control and there is good coordination with accounts payable
f) people are starting to develop elaborate excuses for not involving procurement in the acquisition of legal services, employee benefits, and advertising

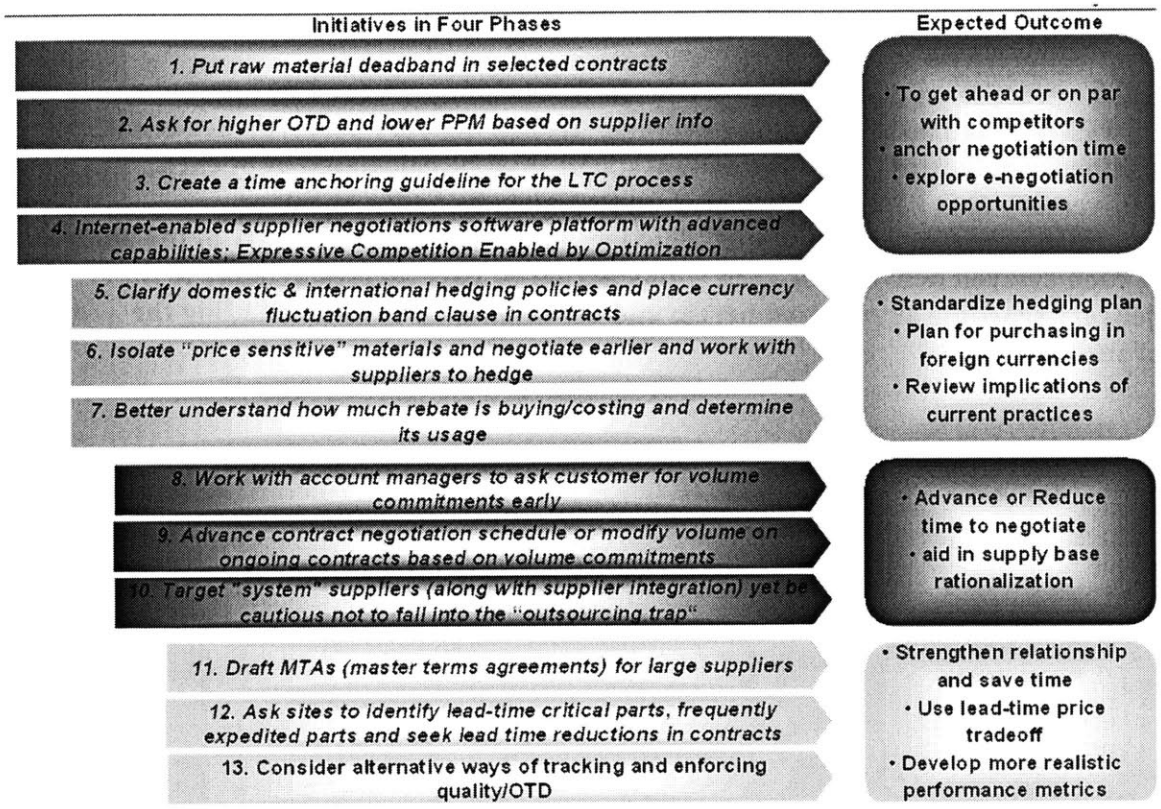
Phase III: where you want to depict being at performance review time

a) most sourcing decisions are now based on multiple factors instead of just price
b) the number of suppliers has been reduced to less than five in each global commodity category
c) all categories are managed by a multi-function, multi-geography team (led by a procurement member)
d) a written sourcing strategy exists for each spend category and is being implemented
e) procurement is being asked to get involved early in the design or project development process
f) there is virtually no maverick buying

Phase IV: almost perfect phase

a) all procurement decisions are perfectly aligned with corporate goals and objectives
b) within each category, each suppliers percentage of business correlates with its performance rating
c) suppliers rank your company as their best customer (not their easiest)
d) other functions within your company give procurement an 80-90% approval rating
e) employee morale is at an all time high

APPENDIX E – Ranked Contracting Recommendations

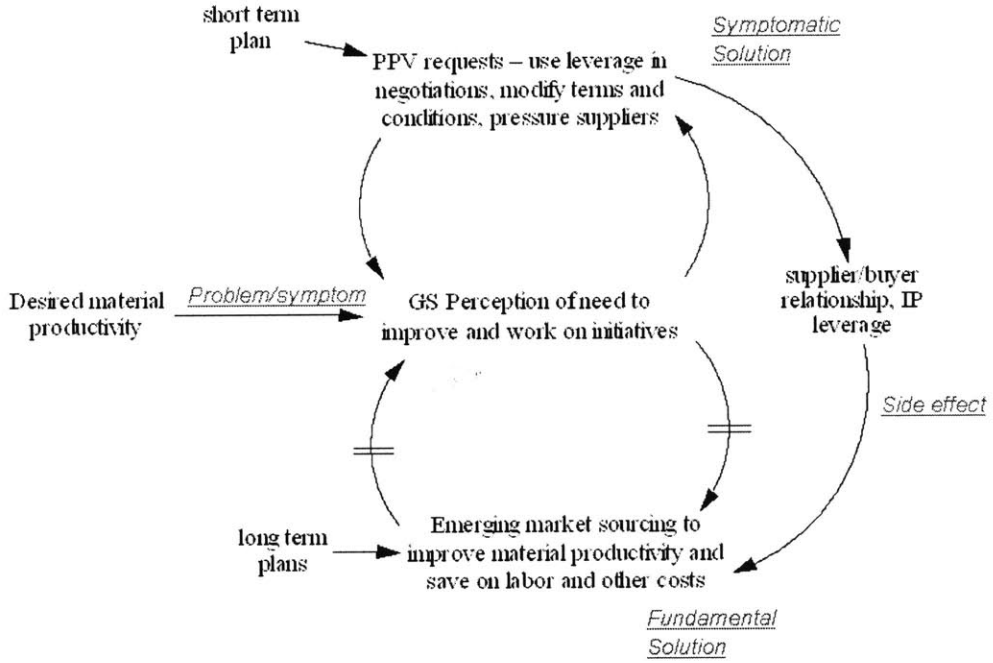


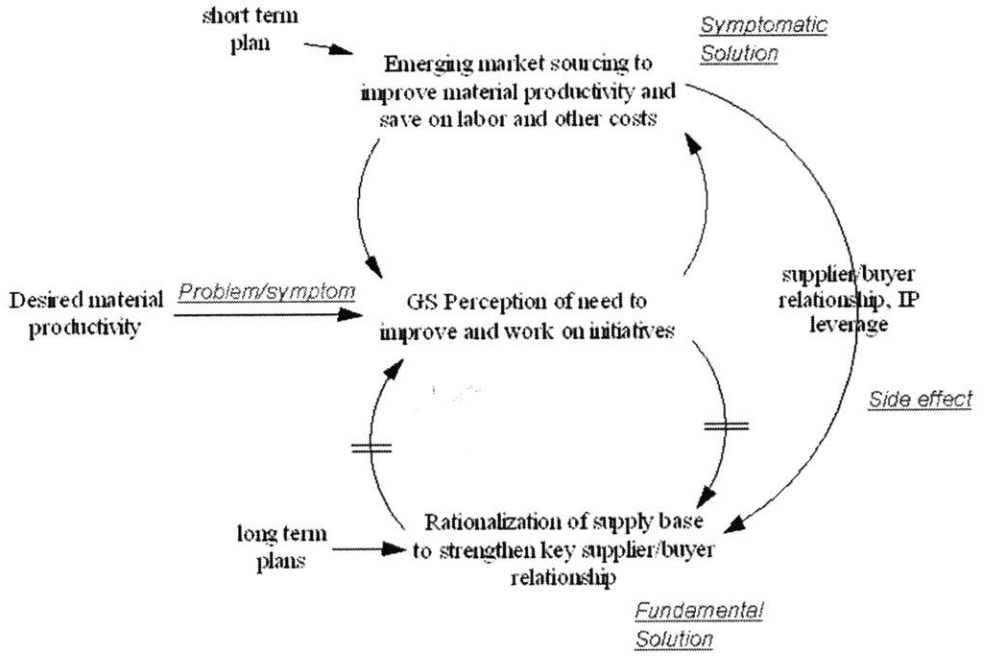
APPENDIX F – Rebate Clause Language

- **Seller agrees to an on-time delivery performance of ___% (or PPM performance of ___PPM), based on a ___ rolling average. If such delivery performance is not attained, a rebate of ___ of the annual spend shall be calculated as of each anniversary date hereof and be paid immediately by Seller to Buyer.**
- **_____ also agrees to pay liquidated damages to _____ as follows: __% of the amount of each delayed delivery for each __day period or part thereof of delay to the delivery schedule as required herein and continuing up to and including the __day of such delay.**

APPENDIX G – System Considerations

Both of these diagrams illustrate that long term successes may require balance change of short term initiatives.





APPENDIX H – Benchmarking Interview Template

Questionnaire for Boeing:

Preamble:

- **This study is part of Yue Cathy Chang's thesis development for MIT's LFM (leaders for Manufacturing) program, and information is shared with Honeywell, the sponsoring company. If you feel answering any questions asked may damage your relationship with your customer(s), feel free to decline comments.**

The Purpose:

- **Benchmarking Honeywell's procurement strategies with the best industry practices through the eyes of customers, and allow it to better work for the customers.**

Interview Candidates:

- **Customers who have multiple suppliers**

General Background Questions:

- **What is your role?**
- **What do you currently buy from HON? What products are they on?**
- **Do you work mainly with Honeywell? Which major suppliers do you work with?**

Contracting Process Questions:

- **What is the nature of our agreements with Boeing? Are we under LTC(s)? How often do we negotiate?**
- **What's the % breakdown of contracts (renewal vs. new) for the suppliers you work with? Where does HON stand?**
- **How long does it usually take for you and your suppliers to reach agreement on contracts? For renewals and for new contracts? How does HON compare with the norm?**
- **How does the procedure with Honeywell compare to your other suppliers (standardization, centralization, ease of navigation)?**
- **Do your suppliers have centralized or decentralized contracting/purchasing process/system? What is the % breakdown and where does HON stand?**
- **Are contract processes standardized across commodities for individual companies (your suppliers)? Is there information sharing across commodities? What's the perceived industry standard and where does HON fit in?**
- **Do you encourage in e-auctioning, and/or use other online tools (% of time spent on it)? Do your suppliers participate in those? How much do you utilize those tools in your contract processes? With HON?**
- **On the contracts, do your suppliers agree to use PPM to measure quality? What about on time delivery (OTD)? How do you enforce these? Do you ask for rebates if quality/OTD is not achieved?**
- **Do your suppliers give % year-to-year productivity on the contract? What about raw material escalation pricing adjustment? Is this the industry trend?**
- **How do contracts with customers impact/influence/dictate contracts with suppliers in terms and conditions?**
- **As supplier to Boeing, and customer to many suppliers, how is HON-Boeing relationship similar and different from our supplier-HON relationship?**

Globalization impact questions:

- **How much has Honeywell's globalization affected its business with Boeing, if at all?**
- **How much have your other customers' globalization activities impacted your business, if at all?**
- **What is your company doing to achieve better sourcing?**

Supply base Questions:

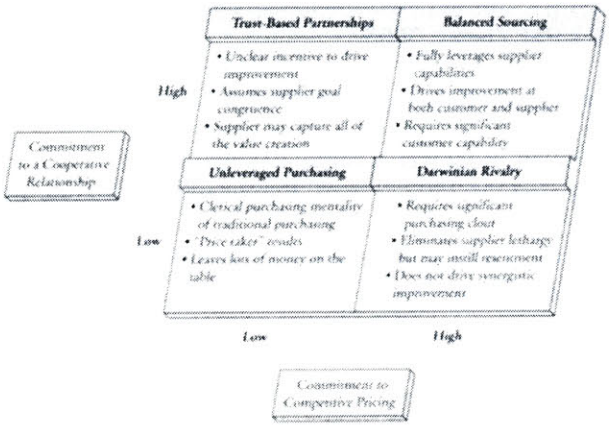
- **Did Boeing ever ask Honeywell to manage multiple suppliers' activities? What about your other suppliers?**

General Comments:

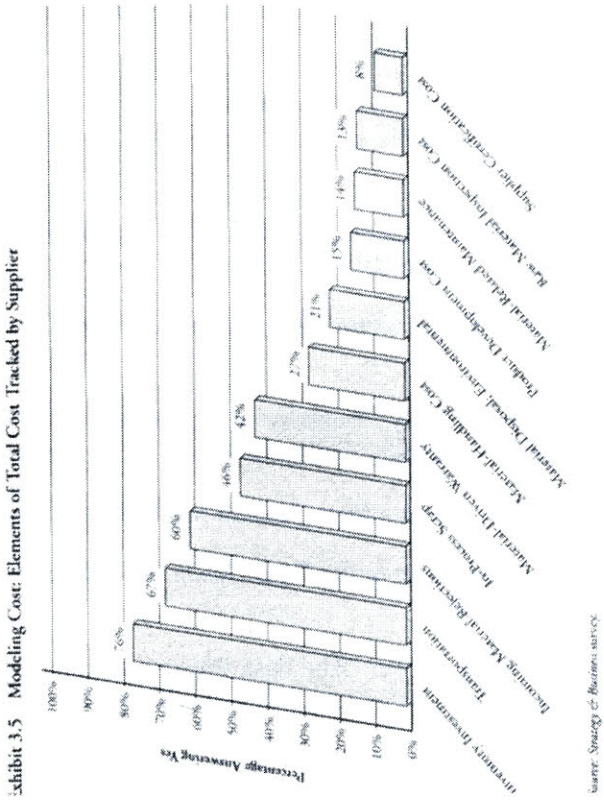
- **Is there anything else that you think I should know about Honeywell's contracting/procurement strategy, and how it benchmarks with the industry?**
- **Is there anyone else within Honeywell or Boeing that I might speak with to learn more?**

APPENDIX I – Balanced Sourcing

Cooperative Relationship:



Supplier-tracked Total Cost:



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