

**DESIGN AND DEVELOPMENT OF A SUPPLIER EVALUATION
PROCESS**

By Andrew Corum
B.S. Mechanical Engineering, Carnegie Mellon University, 2002

Submitted to the MIT Sloan School of Management and the Department of
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and
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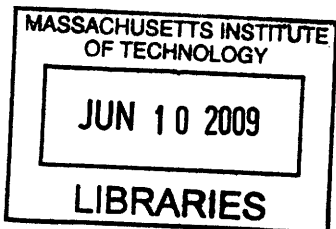
Signature of Author _____
Andrew Corum
Engineering Systems Division, MIT Sloan School of Management
May 8, 2009

Certified by _____
Daniel Whitney, Thesis Supervisor
Senior Research Scientist, Center for Technology, Policy and Industrial Development
MIT School of Engineering

Certified by _____
Richard Locke, Thesis Supervisor
Alvin J. Siteman (1948) Professor of Entrepreneurship
MIT Sloan School of Management

Accepted by _____
Dr. Nancy Leveson, Chair, ESD Education Committee
Professor of Aeronautics and Astronautics and Engineering Systems Division
MIT School of Engineering

Accepted by _____
Debbie Berechman
Executive Director, MBA Program
MIT Sloan School of Management



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Submitted to the MIT Sloan School of Management and the Department of Engineering Systems Division on May 8, 2009 in partial fulfillment of the requirements for the degrees of Master of Business Administration and Master of Science in Engineering Systems.

ABSTRACT

Low-cost sourcing is a strategy many companies, including Pratt & Whitney, use to reduce part costs. As they increase their efforts to resource products to low-cost regions, Pratt & Whitney needs a robust process to effectively evaluate potential suppliers and identify those suppliers that are most capable of satisfying their manufacturing and business needs. Through the development of a Supplier Evaluation Process, this need is realized and a case study is presented that highlights the use of such a process.

In addition, the topic of trust in buyer-supplier relationships is also explored. Through the process of developing new suppliers, Pratt & Whitney invests time, labor, knowledge and skills that they have developed to quickly improve a new supplier's business and manufacturing capabilities. The methods that Pratt & Whitney uses to accomplish this task, as well as the risks that they are subject to, are closely linked to what is deemed in the literature as trust building activities. This thesis seeks to understand the role of trust in the buyer-supplier relationship that Pratt & Whitney creates with low-cost sources and to highlight the benefits that Pratt & Whitney realizes as a result of these relationships.

Thesis Advisors:

Richard Locke

Alvin J. Siteman (1948) Professor of Entrepreneurship
MIT Sloan School of Management

Daniel Whitney

Senior Research Scientist, Center for Technology, Policy and Industrial Development
MIT School of Engineering

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1. Introduction

“In today’s global economy, success is not possible unless a company’s supply base is competitive on a worldwide basis.¹” As more companies are attempting to restructure their supply base, they are turning more and more to international outsourcing. Through these redesigned supply chains, companies have come to expect reduced labor costs, reduced need for capital expenditures, increased efficiencies due to economies of scale, reduced risk, and the ability to focus on their core business. What has not been mentioned is the risk involved with entering a business relationship with an untested, new supplier. Supplier issues can have negative impacts on a “companies’ customer relations, earnings, time-to-market cycles, sales and overall brand perception.²” With all of the proposed benefits and risks, how can a company go about outsourcing to be successful and gain these competitive advantages? I propose that through the development of both a supplier evaluation process and the development of high trust buyer-supplier relationships, these goals can be accomplished.

The process of outsourcing varies greatly from company to company. The task of identifying, evaluating and, finally, initiating business with potential suppliers is specific to the desires and needs of each individual company. This being the case, many companies create their own methods to find and evaluate suppliers. These evaluation methods, while they may be different, contain fundamentally similar evaluation aspects be they cost, quality, technical competency or others. This thesis seeks to identify the areas that are most applicable to help identify suppliers that will not only be able to provide great service but also those that may desire to engage in a high-trust relationship.

“In most industries in the West, one of the main objectives of traditional supplier relations has been to minimize ‘vulnerability’ to supplier opportunism and has consequently led to the two sides viewing each other as adversaries.³” Though these adversarial views may exist in current supplier relationships, the redesign of supply chains through outsourcing offers the buyer a chance

¹ Eric Meimoun, and Dick Locke, International Purchasing: Selecting, Engaging, and Managing the World's Best Suppliers (Houston: American Productivity & Quality Center, 1999). pp. 6.

² Austin-Tetra, For Most Companies, Dealing With Suppliers is Risky Business, 2005, Available: http://www.austintetra.com/Pdf/AT_Aberdeen_Study_Release_FINAL.pdf, 4/20/2009.

³ Ram and Susan Helper Mudambi, "The 'Close But Adversarial' Model of Supplier Relations in the U.S. Auto Industry," Strategic Management Journal 19.8 (1998)., pp. 776.

to improve on the previous generation of supplier relationships. In the automotive industry, Toyota Motor Corporation has long been viewed as a company with high levels of trust in their supplier relations. This view stems directly from Toyota's purchasing philosophy which states that "once nominated as Toyota suppliers, they should be treated as part of Toyota (as branch plants). Toyota shall carry out business with these suppliers without switching to others and shall make every effort to raise the performance of these suppliers."⁴ Toyota has used the trust that they have developed, managed, and maintained in their supply chain to create continuous improvements to their business operations and their bottom line. This thesis seeks to identify ways in which a company, such as Pratt & Whitney, is able to build trust in their supplier relationships in a new supply base in low-cost regions.

1.1 Project Motivation

Pratt & Whitney, henceforth P&W, has been involved with low-cost sourcing for many years but due to recent procurement cost increases, increased competition, and the launch of the PurePower⁵ engine line, the company plans to increase the amount of spend for increasingly complex parts to be manufactured in low-cost emerging markets. With this goal in mind, P&W needs a robust process to effectively evaluate potential suppliers and identify those suppliers that are most capable of satisfying their manufacturing and business needs. The main goal of this project is to realize this need by creating a technical- and business-based Supplier Evaluation Process that will allow P&W's Strategic Sourcing Organization to identify the best suppliers to work with through a consistent evaluation process.

In creating this evaluation process, I will also seek to understand the elements of trust in P&W supplier relationships. With their efforts to reduce procurement costs by increasing the global nature of their supply base, P&W is determined to create supplier relationships in low-cost countries. In general, when a company moves product from one supplier to another, there is an element of risk involved that arises from breaking relationships with the current suppliers as well as conducting business with, transitioning products to, and building relationships with a new supplier. Through the application of the Supplier Evaluation Process, P&W seeks to understand the risks

⁴ TMC, Toyota: A History of the First 50 Years. (Toyota Motor Corporation, 1988). pp. 76.

⁵ "PurePower" is a trademark of United Technologies Corporation/Pratt & Whitney.

involved with doing business with potential suppliers as well as to initiate a working relationship with these suppliers prior to signing a supply contract.

When it enters into a business relationship with a new supplier, specifically one located in a low-cost location, P&W seems to exhibit trust building tendencies with the new supplier. Is building trust in these relationships a deliberate act by P&W or is it a side effect of doing business with the supplier. If it is a deliberate act, how does P&W select the supplier with whom to build the trust relations? On the other hand, if building trust is a side effect, are there negative impacts P&W should be aware of and how should P&W conduct their business in order to mitigate these effects. My goal is to understand the role of trust in the aerospace environment and how it relates to the evaluation of suppliers along with the type of business relationships that are developed with these suppliers.

1.2 Thesis Overview

The topic of how to evaluate a supplier and the types of relationships that a company may develop with a given supplier is addressed throughout this thesis. Chapter 2 provides an overview of United Technologies Corporation and P&W. This overview is followed by an aerospace manufacturing industry analysis and highlights the causes that have led aerospace companies to pursue a low-cost sourcing strategy. In Chapter 3, the topic of trust is explored and is focused on the actions that are common to P&W's low-cost sourcing initiatives. Chapter 4 looks at the evaluation of suppliers and how this evaluation process can be used by a company to analyze the risks of moving their supply chain. Chapter 5 demonstrates the Supplier Evaluation Process that was developed specifically for P&W's Strategic Sourcing Organization. A case study is performed and the results are discussed in Chapter 6 while Chapter 7 summarizes the main points discussed in this thesis as well as my recommendations and suggestions for the next steps P&W and the Strategic Sourcing Organization should take.

2. United Technologies Corporation and Pratt & Whitney Overview

Chapter 2 provides a brief introduction to the United Technologies Corporation and its largest business division, Pratt & Whitney. In addition to the company introduction, a Porter's Five Forces analysis of the aircraft engine industry is provided. This analysis identifies some of the main

strategic issues that Pratt & Whitney faces as well as some potential solutions to these issues, specifically cost reduction through low-cost sourcing. The chapter concludes with an introduction of the main organization responsible for leading low-cost sourcing efforts at Pratt & Whitney.

2.1 United Technologies Background

United Technologies Corporation, henceforth referred to as UTC, is a \$57.8 billion dollar corporation (2008) that consists of seven business divisions in the aerospace, industrial, and power industries. These seven businesses include Otis (elevators), Carrier (air conditioners), UTC Fire & Security (fire and security products and services), and UTC Power (fuel cells and power systems). The last three businesses all relate to the aerospace industry and are Sikorsky (helicopters), Hamilton Sundstrand (aerospace and industrial), and finally P&W (aircraft engines).⁶

2.2 Pratt & Whitney Background

With an operating profit of \$2.12 billion on revenues of \$12.97 billion in 2008, P&W is one of the largest divisions of UTC⁷. P&W is a world leader in the design, manufacture, and service of commercial and military aircraft engines, industrial gas turbines and space propulsion systems. Some of the current highlights of these product lines are the PurePower engines, currently in flight-test, and the F135, the engine of choice for the F-35 Joint Strike Fighter. P&W's main competition is from General Electric (operating profit of \$3.68 billion on revenues of \$19.23 billion)⁸ and Rolls-Royce (operating profit of £880 million on revenues of £9.1 billion)⁹.

2.3 Aerospace Manufacturing Industry Analysis

In analyzing the aerospace manufacturing industry, we will use Porter's Five Forces framework¹⁰ to focus on large engine aircraft manufacturing. Porter's framework suggests that an industry analysis may be accomplished by understanding the bargaining power of suppliers, the bargaining power of buyers, the threat of substitutes, the threat of new entrants, and the competitive

⁶ United Technologies Corporation: Facts & Figures, 2009, Available: http://www.utc.com/utc/about_utc/Fast_Facts.html, 3/8/09.

⁷ Pratt & Whitney: An Overview, 2008, Available: <http://www.pw.utc.com/vgn-ext-templating/v/index.jsp?vgnextoid=b78a0ac19a27a110VgnVCM100000c45a529fRCRD>, 3/8/2009.

⁸ General Electric 2008 Annual Report, 2008, Available: http://www.ge.com/ar2008/pdf/ge_ar_2008_financial_section.pdf, 3/8/09., pp. 27.

⁹ Rolls-Royce 2008 Preliminary Results, 2008, Available: http://www.rolls-royce.com/Images/prelims_pres_final2_tcm92-11101.pdf, 3/8/09., pp. 2.

¹⁰ Porter's Five Forces framework was developed by Michael E. Porter from Harvard Business School in 1979.

rivalry within the industry. Through this analysis, the competitiveness of an industry can be determined which in turn affects the profitability and attractiveness of the industry.

Bargaining power of suppliers:

The bargaining power of suppliers varies from low to high power depending on the specific products that the suppliers produce. Suppliers who make commodity or commodity-like products have very little power due to low switching costs for the purchaser. On the contrary, suppliers who make higher complexity and more capital-intensive parts may have significant amounts of power. In some cases, the capabilities required to make the higher complexity parts (knowledge, tooling, etc), is concentrated in a relatively small number of suppliers worldwide. When capacity or capability is scarce, supplier power increases due to the fixed global capacity as well as high switching costs for the purchasers.

Bargaining power of buyers:

There are two types of buyers: aircraft manufacturers (Boeing and Airbus) and end users (China Air, Delta, etc). With such a small number of aircraft manufacturers, the bargaining power of buyers is high. This effect is increased due to the small margins inherent in this industry. End users are usually price sensitive when purchasing aircraft and seek the lowest cost airplanes. Aircraft manufacturers therefore want to make their product as low-cost as possible and will seek the lower cost engines for their airplanes. The buyer power at initial sale leads the engine manufacturers to utilize the loss-leader business model for their products. The engine manufacturers will sell their engines at or even below cost in order to make a sale. Once an engine is selected by the end user and manufacturer, there are very large switching costs associated with retrofitting a plane for a new engine. This large switching cost reduces the end user's bargaining power for service parts and allows the engine manufacturers to make large profit margins on the service of their engines.

Threat of substitutes:

There is no threat of substitutes for a large aircraft engine since there are no other products that provide the same function that an aircraft engine does.

Threat of new entrants:

There is a low threat of new entrants in the aircraft engine industry. Since the buyers in the market are seeking low price products, the current aircraft engine manufacturers utilize a loss-leader business model. In this case, the manufacturer sells their engines at or below the product costs with the hope that they will be profitable through the servicing of their engines. The development and

testing of a new engine can take between six and ten years and can cost upwards of \$1.5 – 2.5 billion dollars. Incumbents are able to reduce this development and testing cost by developing new engines based on previous designs.¹¹ With the loss-leader business model, it can take up to a dozen years for manufacturers to make a profit on their sales through the servicing of their engines. Given the development costs, the industry business model, the amount of capital required, and the long payback period, the threat of a new entrant is low.

Competitive rivalry within the industry:

As mentioned previously, there are three primary competitors: P&W, General Electric and Rolls-Royce. Due to the costs associated with developing a new engine, a number of joint ventures between the competitors have been created in order to lower the development costs of new engines and share the associated risks. Through interactions such as these, the main competitors share the same basic technologies and designs for aircraft engines reducing the technical competitive advantage that they may gain when developing an engine on their own. In the case of P&W's PurePower engines, P&W solely developed an engine that outperforms the competition in fuel burn, environmental emissions, engine noise and operating costs.¹² The reduced operating costs and environmental improvements associated with the engine make this a highly desirable engine by both aircraft manufacturers and end-users. However, the research and development of this engine has taken over two decades – a hefty cost for P&W to fund on their own. With exceptions such as the PurePower engine, overall product differentiation is low as each manufacturer has a similar engine that is designed to work with each type of aircraft.

In addition, the aircraft industry is highly cyclical with high fixed costs and high exit barriers. Given the loss-leader business model, the profitability of this industry depends on the number of engine sales that a manufacturer can make and then service for the next decade or so. Since the aircraft manufacturer and end-user have high bargaining power and are price sensitive, cost is usually the main differentiator between the competitors and is the main area of competition. With all of these industry forces, the competition between the P&W, General Electric, and Rolls-Royce can be very high. In this environment, being able to reduce costs in the manufacture of aircraft engines is a main driver for future profitability and for current competition.

¹¹ Lawrence Zuckerman, "Boeing Picks G.E. to Build Engine for Its Long-Range 777 Jet," The New York Times 3/8/1999.

¹² Pratt & Whitney: PurePower PW1000G, 2008, Available: <http://www.pw.utc.com/vgn-ext-templating/v/index.jsp?vgnextoid=59ab4d845c37a110VgnVCM100000c45a529fRCRD>, 4/28/2009.

2.4 Low-Cost Sourcing at P&W and United Technologies

In an industry where competition is based on product cost, the desire to reduce part costs is high. This cost reduction can be accomplished through many means: internal operational improvements, improved business processes, reduced supplier costs, etc. At P&W, cost reduction occurs across the business through the application of the ACE (Achieving Competitive Excellence) operating system. Applicable to the plant floor, to business processes, as well as to suppliers, ACE helps align P&W and their suppliers with the end goal of producing competitively priced engines.

In addition to applications of ACE, P&W also utilizes outsourcing to reduce their part costs. Through outsourcing, companies are able to gain access to world-class capabilities while simultaneously reducing their operating costs and sharing the risks of business with their suppliers. P&W strategically evaluates and pursues outsourcing opportunities through their Strategic Sourcing Organization.

2.4.1 Strategic Sourcing Organization

The Strategic Sourcing Organization evaluates, selects, and assists new suppliers in order to reduce part costs as well as to reduce costs in their supply chain. Re-organized in 2008, the Strategic Sourcing team is split into two groups: a Project Team and a Technical Team. The Project Team orchestrates part sourcing transfers from one supplier to another while the Technical Team works directly with the new suppliers to help them build their technical and manufacturing competencies. The amount and type of help that the Technical Team provides varies based on the supplier, but help is provided on-site at the supplier's facilities as well as through remote means.

To evaluate their cost reduction efforts, the main metric that the Strategic Sourcing Organization uses to track their progress is the Purchase Price Variance (PPV). PPV measures the change in the purchase price of a component at two points in time. If the purchase price is reduced during these two points in time, this is deemed a positive result and the PPV metric goes up. Through the tracking of every component's PPV, a general PPV metric can be created by summing each PPV into a total PPV for the company. Although PPV provides a way to track cost reduction efforts, there are many hidden costs that can affect the organization and company that will not affect PPV. Since it is based solely on the purchase price, PPV does not take into account performance variables such as quality, on-time delivery, and shipping costs which may outweigh the benefits of the reduced part cost. As Brian Feller argues in his thesis, if you are dealing with a domestic supply base, PPV may be a reasonable metric to use as the effect of the performance variables that are

mentioned may be minor compared to the material cost. When dealing with an international supply chain, these performance variables have a much greater effect and may render PPV inadequate to effectively monitor and evaluate performance. “Products with PPV savings of 40-50% would end up with 10% savings or even a higher cost when the total landed cost was considered. In fact, in some cases, products with higher material cost had lower landed costs when all factors were considered.”¹³

2.5 Chapter Summary

This chapter provides a brief overview to UTC and P&W and then delves into an industry analysis of the aircraft engine manufacturing industry using Porter’s Five Forces Framework. This analysis uncovers one of the main drivers of the industry: to operate on a loss-leader business model. This business model creates an incentive for engine manufacturers to reduce production costs whenever and wherever possible. Through this revelation, we understand P&W’s push for cost reduction efforts, such as ACE implementation, as well as their efforts to increase and improve their low-cost sourcing activities. In the following chapter, we will look at the role of trust in the buyer-supplier relationship and identify how trust in these relationships can assist P&W in their cost reduction efforts.

3. The Role of Trust in the Supplier Relationship

This chapter begins a discussion on trust and provides a view into its importance and the potential cost-reduction benefits of a high trust buyer-supplier relationship. A literature review on the different views on trust, deterrence-based versus process-based, is also provided. Finally, a method with which to manage and build trust in the buyer-supplier relationship is presented. This method is compared to P&W’s low-cost sourcing practices in order to determine the level of trust P&W is attempting to build in their buyer-supplier relationships.

3.1 What is Trust and Why is it Important?

While there is no single agreed upon definition of “trust” in a buyer-supplier relationship, there is a lot of literature about the role of trust and its impact on improving bottom line results. Articles on Supply Chain Management (SCM) and supplier relationships extol the virtues of this

¹³ Brian Feller, "Development of a Total Landed Cost and Risk Analysis Model for Global Strategic Sourcing," Massachusetts Institute of Technology, 2008., pp. 42.

concept but the ability to identify, harness, and use trust to improve a supplier relationship is a relatively rare skill involving an inherently fragile state of existence.

Since there is no one definition of trust, it takes on many forms in the literature and an attempt to capture the essence of these forms follows. Two views of trust that stand out most are a deterrence-based view and a process-based view. In the case of deterrence-based trust, companies use formal contracting to outline inter-company transactions and the underlying behavior of both parties is based on acting in accordance with their own self-interest. In the case of process-based trust, it is believed that trust can be built through positive, repeated interactions over time.¹⁴

Deterrence-Based Trust

Gibbons states in “Trust in Social Structures: Hobbes and Coase Meet Repeated Games,” that “the state can provide public goods more efficiently if it also is charged with providing social order.” In the case of the buyer-supplier relationship, the buyer can take on the form of the contractor (one who provides social order), the predator (one who extracts value from economic transactions), or varying degrees of both. In the case of maximum predation, “the ruler takes most of the gains from trade, as long as she leaves the citizens better off...they will not rebel.” In addition, Gibbons states that in a repeated game, “if (the supplier) can understand (the buyer’s) long-run self interest, (the supplier) may ‘trust’ (the buyer) not to yield to short-run temptations.¹⁵”

MacDuffie and Helper argue in “Collaboration in Supply Chains With and Without Trust” that although the level of collaboration may increase between suppliers and buyers, “contrary to customary expectations for collaboration, these supply-chain relationships do not always involve high levels of trust.¹⁶” They point to the dual nature of US businesses in that although the engineering functions may involve a great deal of collaboration in manufacturing and product design, this is shadowed by the governance functions who, in selecting and writing contracts with suppliers, are distrustful and even adversarial.

Process-Based Trust

¹⁴ Sunil Chopra, and Peter Meindl, Supply Chain Management (Upper Saddle River, NJ: Pearson Prentice Hall, 2007). pp. 512.

¹⁵ Robert Gibbons, "Trust in Social Structures: Hobbes and Coase Meet Repeated Games," Trust in Society, ed. Karen S. Cook (New York: Russell Sage Foundation, 2003). pp. 347

¹⁶ John Paul MacDuffie, and Susan Helper, "Collaboration in Supply Chains With and Without Trust," Collaborative Community, ed. Charles Heckscher and Paul S. Adler (Oxford University Press, 2005). pp. 420.

Dyer and Chu's research shows that there are prescribed processes and routines that a company can perform in order to create trusting supplier relations and that these processes "are transferable across national and cultural boundaries."¹⁷ The most impactful processes and routines that help build trust is communication between the buyer and supplier in reference to re-winning business (i.e. - if the incumbent supplier re-wins the business they are more likely to trust the buyer) and the buyer's reputation in the market in reference to their historical actions when the potential for switching suppliers occurs (i.e. - the more often a buyer switches between suppliers the less trust that the supply base will have for the buyer). In addition, the most significant variable in building trust is the offering of assistance to the supplier to reduce their costs, increase quality and improve delivery.

In "Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration," Gilson Sabel, and Scott suggest both that it is the "non-contractual social and network bonds and informal cooperation (that are) the mechanisms that support collaboration by constraining opportunism"¹⁸ and that "the process of collaboration ... erects a barrier to taking advantage of the other party's specific investments."¹⁹

The problems that may arise with a lack of trust in the supply chain relationship include localized optimization, opportunism, duplicated efforts, and lack of information sharing. The bullwhip effect is just one way these types of problems can create a major impact on the supply chain. The bullwhip effect occurs when demand variability changes and is only partially communicated through the supply chain (lack of information sharing). As each organization in the supply chain seeks to solve the problem on their own (through localized optimization and potentially opportunism) inventories, efficiencies, and costs all increase and oscillate with large swings as the system grows out of control. In addition, without trust, the transaction costs - including inspection, certification, and verification of the supply chain partners and their products - in the supply chain increase. By creating a trust relationship, a company is able to reduce these cost

¹⁷ Jeffrey H. Dyer, and Wujin Chu, "The Determinants of Inter-firm Trust in Supplier-Automaker Relationships in the U.S., Japan, and Korea," (1997). pp. 24.

¹⁸ Ronald J. Gilson, Charles F. Sabel, and Robert E. Scott, "Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration," (2008). pp. 2.

¹⁹ Gilson, "Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration." pp. 3.

drivers and improve their supply chain efficiency and performance by mitigating the bullwhip effect.²⁰

3.2 Managing and Building Trust in Supplier Relationships

Although trust is inherently fragile, researchers have shown that it is possible to build, manage, and maintain trust in a supplier relationship. While both the deterrence-based and process-based views of trust have their supporters, I prefer the view as proposed by Locke: that “economic actors manifest trust when, in situations of incomplete information and uncertainty, these actors nonetheless expose themselves to the risk of opportunistic behavior by others because they have reason to believe that these others will not take advantage of this opportunity.” Locke continues by stating that trust can be built through a company’s own “self-interest, government intervention and the development of mechanisms for self-governance,²¹” where “government intervention” does not necessarily mean the government, but “some body (even one constituted by P&W and its suppliers), that plays a broader, coordinating role; that has the ability to create positive and negative incentives to get people to abide by their agreements.²²”

Locke’s view combines aspects of both the deterrence-based and process-based views of trust; however, I believe that segmentation of the supply base is required for this view to be applied. For example, if a company is in a situation where they face a supplier only one time, the likelihood of the company or the supplier to trust in the other is limited. In the case of a commodity supplier who mainly competes based on price, their trust in a buyer to continue business with them if their competitor’s price suddenly drops is minimal. While a buyer may possess a short term contract with this commodity supplier, they may opt to switch suppliers at the end of the contract if they find a lower price elsewhere and the switching costs are not too great. When we have repeated interactions between a buyer and a non-commodity supplier, the buyer and supplier are more apt to enter into long-term contracts and asset-specific investments.

Methods of Segmenting the Supply Base

²⁰ Chopra, *Supply Chain Management*, pp. 511.

²¹ Richard Locke, "Building Trust," (Massachusetts Institute of Technology), pp. 9.

²² Richard Locke, "Re: Memo III," ed. Andrew Corum (Cambridge: 2009).

	Item Purchased in Low Volume	Item Purchased in High Volume
Item being sourced is firm critical	Bottleneck Suppliers: Nonequity-based collaboration Minority equity investments	Critical Strategic Suppliers: Investment Integration Joint Ventures Strategic Alliances Asset ownership
Item being sourced is not firm critical	Noncritical Suppliers: Arm's Length Modified vendor contracts	Leverage Suppliers: Modified vendor contracts Long-term contracts

Figure 2: A supplier segmentation framework adapted from Beckman/Rosenfield.

Combining the information in these two matrices, we see that the more complex a part is to produce and/or the more critical the part is to the buyer's business and/or the harder it is to find a substitute supplier, the higher level trust relationship a buyer should seek with the supplier.

3.3 Trust at P&W

When it enters into a business relationship with a new supplier, specifically one located in a low-cost location, P&W seems to exhibit trust building tendencies with the new supplier. The Strategic Sourcing Organization is tasked to assist their suppliers to understand (through blue print or part specification interpretation) the technical requirements they need to meet, to reduce their manufacturing costs, and to improve quality and on-time delivery. In order to complete these tasks, the Strategic Sourcing Organization requires frequent communication with the suppliers as well as on-site visits to the supplier's manufacturing facilities. As a result of these interactions, the supplier is able to build their skill base and improve their manufacturing capabilities but simultaneously support P&W's desire to reduce their own costs.

In most cases, as the supplier's skills and capabilities develop, P&W seeks to source larger and more complex parts from the supplier. This increased level of responsibility involves further support from the Strategic Sourcing Organization to help the supplier achieve the required benefits both for the supplier (developing their ability to understand the requirements and lean tool application) and for P&W (further cost reductions).

According to Dyer, Chu, Gilson, Sabel and Scott, trust is being built in this buyer-supplier relationship through these processes and interactions of collaboration and communication between P&W and the supplier. Although this scenario is potentially reminiscent of Gibbons' ruler and

citizen scenario, according to Locke, it is the results of these interactions that make up the self-interest factor that is the first requirement for building trust.

While helping the suppliers, the Strategic Sourcing Organization introduces various ACE tools (3P – Production Preparation Process - events, value stream mapping, and other lean manufacturing and business tools) to identify areas for improvement as well as to start aligning the suppliers with the way that P&W conducts business. Through this alignment with ACE, P&W is able to identify the suppliers who are willing to buy-in to the operating system of UTC and possibly be selected to participate in the UTC Supplier Gold Program. The Supplier Gold Program “facilitates and accelerates supplier performance improvements while recognizing suppliers who have achieved exceptional performance. This Supplier Gold Program establishes four levels of supplier achievement- Gold (the highest standard), Performing, Progressing, and Under-performing. The goal is to enroll key and critical suppliers in this program and have all of those suppliers reach Performing or Gold.²⁵” Through the Supplier Gold Program, the performance of individual suppliers is tracked and evaluated by the UTC Supply Management Council, a collection of Vice Presidents of Supply Management from each UTC business division.

The Supplier Gold Program and the Vice Presidents of Supply Management seem to provide the last two factors required to build trust: mechanisms for self-governance and government intervention, respectively. Through ACE, the Supplier Gold Program and the Supply Management Council, it seems that P&W is attempting to build high trust relationships with their supply base. By segmenting their suppliers, P&W is able to signal their intentions for developing high trust relationships by limiting which suppliers are able to participate in the Supplier Gold Program. Meanwhile, the supplier is also able to demonstrate their interest in P&W through their self-selecting action of actively participating in the Supplier Gold Program, if selected. If a supplier is selected to participate and actively buys-in to ACE and the Supplier Gold Program, they have positioned themselves to move to a higher trust relationship with P&W. As proof of this ability to build trust, P&W has a joint venture in Chengdu, China as well as Rzeszow, Poland that started in this same stepping stone capability improvement process. On the other hand, if a supplier does not buy-in to

²⁵ United Technologies Corporation: Supplier Development, 2009, Available: http://www.utc.com/utc/About_UTC/Supplier_Development.html, 3/31/2009.

the ACE system they may still receive work from P&W, but they will not improve their trust relationship and may be limited as to what quantity of work they receive in the future, if any.

3.4 Chapter Summary

This chapter introduces the topic of trust in buyer-supplier relationships. Through a literature review on this topic, the factors affecting the development of trust and the associated benefits of trust are discussed. P&W's practices in regards to new supplier relationships are compared to a method of managing and building trust. Through this analysis, we see that P&W has designed their supplier development activities in order to develop new suppliers but also the level of trust that these relationships contain. With the understanding that P&W is intent on building trust in their suppliers, the trouble of evaluating suppliers takes on a new dimension – how do you perform a supplier evaluation and maintain high levels of trust? Chapter 4 will discuss supplier evaluations and the factors to keep in mind when designing and performing an evaluation in order to maintain trust in the buyer-supplier relationship.

4. Why Perform Supplier Evaluations?

Chapter 4 provides an initial view of the complex nature of the supplier evaluation. While evaluations are used to gain an understanding of a given supplier, the evaluation process may stress the buyer-supplier relationship so that maintaining or developing high trust relationships is not possible. This chapter seeks to understand the elements of the evaluation process that help and hinder the trust building process. Once these elements are identified, a successful supplier evaluation process can be developed that provides a thorough view of the supplier and simultaneously builds trust.

4.1 Motivation for Evaluating Suppliers

In the globalized world in which we live, the pressure to outsource production and other services is ever present. The cost savings of outsourcing to a low-cost location can be as much as 15% to 25% over the cost of sourcing from the United States or Western Europe²⁶. Though the cost savings are potentially great, when outsourcing occurs and production is moved from an

²⁶ Jason Busch, Chris Connell and Jack Lee, "Low-Cost Country Sourcing," (2003), 3/25/09
<<http://pdf.edocr.com/73547c620d64e547d9df293b6eef8fa6f1bd280d.pdf>>. pp. 2.

internal company location to an external supplier, the risks associated with the product increase greatly. These risks may not be limited to product delays and quality issues but may also involve the loss of production skills and intellectual property, to name a few. These risks may contribute to a bottom line impact of millions of dollars of extra costs over the lifetime of a supply contract. The cost of poor quality (COPQ) alone has been estimated to be 10 percent to 25 percent of sales with the cost of poor supplier quality making up 25 percent to 70 percent of the COPQ.²⁷ While these values may vary depending on the industry, the potential impact of the supply base to a company's bottom line can be substantial. With so much on the line, a company will want to be very selective about who they work with when selecting a new, untested supplier. In general, companies accomplish this task by utilizing a supplier evaluation process. Through these evaluations the company hopes to gain an understanding of the supplier and the capabilities they possess that will benefit the company.

There are a number of companies that provide information and evaluations of domestic suppliers, or the tools with which to do so, such as Dun & Bradstreet²⁸ or ThomasNet.²⁹ On the international stage however, there are fewer available options. In many cases, the company has to find the suppliers on their own and then perform their own evaluations of the suppliers. With so much riding on finding new low-cost suppliers, how should a company go about evaluating them and getting the most from these new relationships?

One common mistake of an evaluation is to evaluate a supplier only in a few specific areas. While doing so may prevent a number of the issues discussed in the following section, the information that you gain from the evaluation may not give a full picture of the supplier and their ability to satisfy the buyer's needs. Let's look at the case in which there is a technically excellent supplier that is able to produce anything the buyer needs while maintaining a high level of quality and low price. If this supplier is evaluated solely on their technical capabilities, the risks associated with conducting business with this supplier are still mostly unknown. How is the buyer to know if the supplier is in financial trouble, or that their operations while capable of producing great products are not carrying high inventory levels, or worse that the supplier is using child labor or exploitative

²⁷ Gordon, Sherry R. Supplier Evaluation and Performance Excellence. Fort Lauderdale, FL: J. Ross Publishing, 2008, pp. 10.

²⁸ Dun & Bradstreet website: <www.dnb.com/us/>

²⁹ ThomasNet website: <www.thomasnet.com/>

practices to produce these products. At the end of the day, the supplier's actions reflect directly on the buyer as global corporations are often "depicted as agents of exploitation, taking advantage of developing countries' low wages and weak social and environmental regulation."³⁰ If the buyer has no intention of exploiting the developing countries, by conducting business with suppliers who do not conduct their business properly the buyers are guilty by association.

With these additional pressures, the buyer will likely want to evaluate most aspects of the supplier's business, and potentially their sub-tier suppliers, be it their technical competence, their financial records, their operational ability, their quality processes, their management's experience level, and their take on environmental, health and safety issues in their plant. By evaluating all of these aspects, the buyer will more fully understand the risks associated with conducting business with a given supplier. While the buyer desires almost infinite information about the supplier, gaining access to all of this information for a supplier and their sub-tier suppliers is nearly impossible. When entering into a new relationship, there is always going to be an inherent level of risk. It is the buyer's responsibility to understand the different sources of risk and to determine which risks are critical to the buyer's company and which risks may be tempered through the buyer-supplier relationship. With a high level trust relationship, the buyer may be able to "rely on the good judgment (of the supplier) in avoiding these (risky) situations."³¹ Through the trust relationship, the buyer therefore may be able to reduce the expense of evaluating the sub-tier suppliers as the supplier will actively try to reduce risks on behalf of the buyer because when buyers and suppliers "trust each other, they are more likely to take the other party's objectives into consideration when making decisions."³²

4.2 Common Problems and Benefits of Supplier Evaluations

There are a number of benefits and problems associated with creating a supplier evaluation as well as in actually performing an evaluation. An Aberdeen-Penton Media study³³ highlights that the process of performing an on-site evaluation or assessment of a foreign supplier is one of the biggest challenges that supply managers deal with. Some of the functional and relationship issues with supplier evaluations and supplier scorecards are:

³⁰ Richard Locke, Fei Qin, and Alberto Brause, "Does Monitoring Improve Labor Standards? Lessons from Nike," Industrial and Labor Relations Review 61.1 (2007)., pp. 3.

³¹ Meimoun, International Purchasing: Selecting, Engaging, and Managing the World's Best Suppliers.

³² Chopra, Supply Chain Management. pp. 511.

³³ "The Global Sourcing Benchmark Report." Aberdeen Group and Penton Media. 2003.

- Data collection can take on a life of its own
- Data feeds from disparate systems
- Data integrity
- Punitive use of scorecards
- Scorecards don't tell the whole story³⁴

Functionally, a supplier evaluation is a means to evaluate how a supplier operates, not how they fill out paperwork. Collecting the data for a supplier evaluation may take longer than anyone expects, so keeping the questions at a high level, but simultaneously acquiring an accurate view of the supplier is critical. In order for this to occur, you need to get the right data and make sure that the data is right. Whether you are asking questions of a supplier, a company employee, or pulling information from computer system, you need to worry about the integrity of the information that you are receiving. People take in the world around them in different ways - this is true no matter where you are in the world. So the likelihood that two people will fill out a supplier evaluation identically is low. This is also true about computer systems. Just because one system treats data in one manner does not mean that another system will treat it identically. Spending time while developing the system to make sure that the questions and answers are as straightforward and as objective as possible will pay off in the long run.

On the relationship side, communication is very important. Companies need to take the time to explain what the evaluation tool is going to be used for and how it may affect the supplier. A knowledgeable supplier is a happier supplier versus a supplier left in the dark. As Kwon and Suh proved, "information sharing reduces the degree of uncertainty (in a relationship) which in turn enhances the level of trust."³⁵ So "think of the purpose (of the evaluations) as raising important questions and facilitating productive conversations and providing information to ground those conversations."³⁶

The punitive use of scorecards is also a big threat to developing a trust relationship because scorecards do not tell the whole story. "The ultimate purpose of the scorecard is to find opportunities for improvement...the scorecard should help give insights into performance that

³⁴ Gordon, Supplier Evaluation and Performance Excellence: A Guide to Meaningful Metrics and Successful Results. pp. 117-119.

³⁵ Ik-Whan G. Kwon, and Taewon Suh, "Factors Affecting the Level of Trust and Commitment in Supply Chain Relationships," The Journal of Supply Chain Management: A Global Review of Purchasing and Supply 2004.

³⁶ Jonathan Hughes, "Supplier Metrics That Matter," CPO Agenda: The Business Review for Procurement Leaders 2005.

enhance performance and the relationship, not lay the blame on the supplier.³⁷ To ensure success with a supplier evaluation process and to use the evaluation as a means to build a trust relationship, communication with the supplier is essential both prior to the evaluation as well as after the evaluation and the resulting decisions have been made.

4.3 Chapter Summary

In this chapter, the general motivations for evaluating suppliers such as cost reduction and risk mitigation are discussed as well as the common problems and benefits of performing evaluations. Due to limited third party supplier evaluation tools for the international supply base, we see that most companies are left to create and perform supplier evaluations on their own. Faced with this added responsibility, companies must be mindful to create a thorough evaluation tool that provides a complete view of the supplier but that also builds, or at least preserves, trust with that supplier. Suggestions to accomplish this task are mentioned in this chapter. These suggestions will be incorporated into the development of the Supplier Evaluation Process throughout the following chapter.

5. Supplier Evaluation Process Development

This chapter details the procedure that was followed to develop the Supplier Evaluation Process for P&W. In designing a Supplier Evaluation Process, each company values different aspects of the evaluation process in different ways. This being the case, there is no one right way to evaluate a supplier. In fact, there are virtually infinite possibilities in how to evaluate a supplier. So, while the actual tool and questions that help perform the evaluation are P&W Proprietary Information, the detail of how the tool functions overall is presented here.

The first step in creating the supplier evaluation process is to determine the current state process for evaluating suppliers at P&W. By first understanding the current state, the benefits as well as the limitations of the process could be identified and improvements could be made. Unfortunately, there is no standard process for evaluating suppliers at P&W. The most common evaluation process is conducted in the following way: A single P&W employee or a group of employees travel to a supplier's plant to perform a site-visit evaluation. The length of time spent at

³⁷ Gordon, Supplier Evaluation and Performance Excellence: A Guide to Meaningful Metrics and Successful Results. pp. 119.

the supplier varies from 2 hours to 2 days or more and the type and quality of information obtained on these visits is not standardized varies from site visits to other suppliers. Following a supplier visit, the information that is collected is shared through a travel debrief e-mail to the Strategic Sourcing Organization. This e-mail informs the rest of the organization about the capabilities of the supplier and the potential opportunities that P&W or other UTC divisions may be able to find at that supplier.

Although this method of evaluating suppliers has worked for P&W in the past, with their need to reduce part costs and their push for low-cost regions, P&W requires a more consistent evaluation process that allows for direct comparison of all suppliers as well as an evaluation process that utilizes the collected information in a more active way.

5.1 The Supplier Evaluation Form

In order to create a supplier evaluation form, i.e. the format of the physical evaluation as well as the style of questions and the potential responses, an extensive benchmarking of current and past evaluations from P&W, other UTC divisions, as well as of companies from other industries was performed. Through this benchmarking, the criteria for evaluation were determined as well as the style of the questions and responses. In a report on International Purchasing by the American Productivity & Quality Center, the best practices for evaluation criteria included cost structure, environmental standards, quality, on-time delivery as well as technical criteria such as design capability and leadership in technical innovation.³⁸ This information was included and expanded in order to cover the needs of P&W.

In order to provide a thorough evaluation of a potential supplier, we determined that the following evaluation criteria would provide us the required visibility of the supplier:

- Experience
- Environment, Health and Safety
- Logistics and Delivery
- Quality
- Operations
- Communication
- Financial Records
- Technical Competence³⁹

³⁸ Meimoun, International Purchasing: Selecting, Engaging, and Managing the World's Best Suppliers. pp. 17.

³⁹ See Appendix 1 for more detailed information on each section.

In addition, the best practice for the question and response format was determined to be a direct question that has pre-defined specific and objective responses. By phrasing questions in this manner and restricting the responses to a pre-defined answer, the results of the evaluation would be consistent both across suppliers as well as the evaluators.

In crafting the evaluation tool, a number of questions and responses were created for each of the evaluation sections. Through focus groups, these questions and responses were refined or removed and then related questions were placed into subcategories. These actions simultaneously reduced the number of questions to a workable number as well as created focused subsections to give the evaluator the ability to answer all the related questions at the same time.

In addition, every response for a question was given a score between one and five. A response score of five on a question would signal that the supplier was at the leading edge of best practices in that particular area while a response score of one would signal an area of opportunity for the supplier (see Figure 3 for an example of a subsection of questions, answers, and their associated scores).

Company	1	2	3	4	5	Response	Comments
Does the Supplier have any experience with the aerospace industry or Pratt & Whitney?	No experience with the aerospace industry		Experience with the aerospace industry but not with Pratt & Whitney or UTC		Experience with Pratt & Whitney and/or UTC		
Does the Supplier currently serve any Fortune 500 companies?	No				Yes		
How long has the Supplier been in business?	0 years		5 years		>10 years		
How long has the Supplier been involved with the aerospace industry?	0 years		5 years		>10 years		

Figure 3: Example of an evaluation subsection. Each question is followed by five potential responses (notice that only two or three responses are allowed for these questions). The corresponding score to the intended response can then be entered into the “Response” column. Also, a “Comments” field is provided for each question in case there is additional information that the evaluator wants to capture.

By scoring the individual responses, a subsection score can be calculated once all the questions in a subsection are answered. The subsection score can be calculated by summing all of the response scores. The subsection scores can then be summed and multiplied by the sections weighting in order to provide a section score. Each section has a specific weight that can be adjusted in order to identify the sections that are more or less important to P&W.⁴⁰ In addition, if more

⁴⁰ Note: the sum of all the section weights must sum to one.

visibility is desired, these weightings can be extended to individual questions in a subsection. Finally, a Supplier Score can be determined by summing all of the section scores. The Supplier Score helps to define the attractiveness of a specific supplier by comparing it to other supplier's Supplier Scores. A high Supplier Score suggests that the supplier is more capable and experienced while a low Supplier Score suggests that the supplier has more areas for improvement.

In addition to the Supplier Score, a Supplier Scorecard is also generated for each supplier. The Supplier Scorecard provides a visual representation of how well the supplier performs in each section in comparison to the best possible score for that section (see Figure 4 to see an example of the Supplier Scorecard). As you can see, every evaluation section mentioned above is listed except for the Technical Competence section. This section is omitted from the Supplier Scorecard as there is no way to functionally evaluate and compare the technical competence of two suppliers that supply different products. For example, a supplier of paper products has significantly different machinery and technical competencies than a supplier of automotive glass therefore you must evaluate each supplier in relation to the products that they produce. In order to perform an evaluation in this case we need to know what products we are interested in sourcing. The supplier evaluation process is designed to accommodate this type of situation through the supplier-part matching tool.

While performing a site visit, the evaluator fills out the Technical Competence section for every supplier. Depending on the evaluator's inputs, the Technical Competence section prompts the evaluator with different questions depending on the process capabilities that the supplier is able to provide. If the evaluator inputs that the supplier is capable of providing coating and heat treat, the evaluator will then be prompted with further questions about the coating and heat treat capabilities of the supplier. This process is continued until the evaluator has entered information about all of the capabilities of the supplier – including the processes, materials, dimensions, tolerances, etc. Once the Technical Competence section is completed and the rest of the evaluation performed, the Supplier-Part Matching tool is now ready to be utilized.

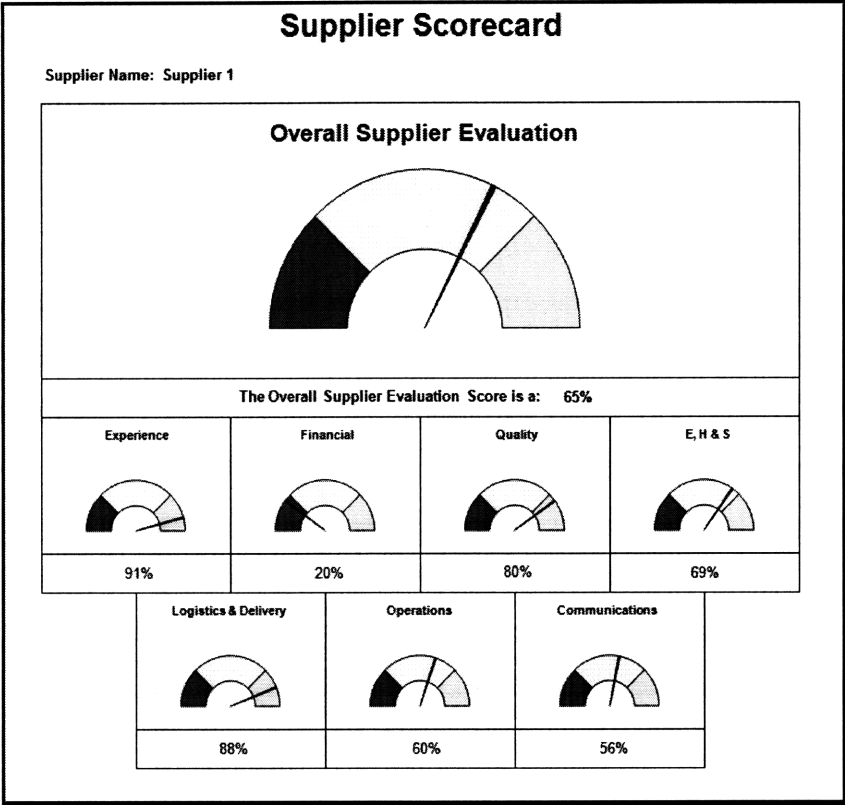


Figure 4: Example of a Supplier Scorecard. This visually represents the evaluation results of Supplier 1 normalized with the best possible score in each section.

5.2 The Supplier-Part Matching Tool

In order to match a supplier to a specific part, you need to match the capabilities that are required to produce the part with the capabilities of a given supplier. A method has been presented to capture the capabilities of the suppliers, but how about the capabilities required to produce the parts? This problem is solved by one of the daily activities of the Strategic Sourcing Technical Team. One aspect of the Technical Team’s job is to perform a technical assessment for every part that is to be sourced. These technical assessments are a collection of all the product specifications that are required to produce a part. Using these technical assessments, we created a matrix that coordinates the product specifications with the process capabilities determined from the Technical Competence section of the supplier evaluation. Using this matrix, we can calculate the potential ability of a supplier to produce a given part (see Figure 5 for a representation of the supplier matrix on a small scale – the real matrix is over 1200 specifications and 210 process capabilities).

Spec Description	Spec Name	Process 1	Process 2	Process 3	Process 4
Specification 1	S1	1			
Specification 2	S2		1		
Specification 3	S3			1	
Specification 4	S4				1

Figure 5: A small scale example of the specification and capability matrix. If a given specification requires a certain process, a '1' is placed in the corresponding matching cell.

By entering the supplier process capabilities and the part specification requirements into the Supplier-Part Matching tool, the tool is able to identify the supplier that is best able to fulfill the part requirements. For example, if we have a part that requires Specifications 1, 2 and 4 (from Figure 5) with the following Suppliers' (Supplier 1, 2 and 3) process capabilities (Figure 6):

	Process 1	Process 2	Process 3	Process 4
Supplier 1 Capabilities:	0	1	1	0
Supplier 2 Capabilities:	1	1	1	0
Supplier 3 Capabilities:	1	1	1	1

Figure 6: An example of the Supplier Process Capability input.

We can perform a matching process by performing the following steps for each supplier and specification (let's focus on Specification 1):

- 1) Sum the number of process capabilities Specification 1 requires (in this case, there is one process required for this specification).
- 2) Take the sum product of the Specification 1's required processes and the supplier's process capabilities (in this case, for Supplier 1 we find that we get an answer of 0, Supplier 2 a 1 and Supplier 3 a 1).
- 3) Subtract the results of Step 2 from the results of Step 1 (in this case, Supplier 1 has $1 - 0 = 1$, Supplier 2 has $1 - 1 = 0$, and Supplier 3 has $1 - 1 = 0$).
- 4) Analyze the results. If the result from Step 3 is equal to zero (as in the case of Supplier 2 and 3) the supplier has the ability to meet this specification's process requirements. If this number is greater than zero (as in the case of Supplier 1), this supplier does not have the capability to perform this specification's process requirements.

If we perform this calculation for each supplier and every required specification, we find the following results (Figure 7):

RESULTS:			
Supplier #1	Supplier is capable of this spec:		S2
	Supplier is NOT capable of this spec:	S1	S4
	Ratio of Capable Processes to Total Processes:	33%	
Supplier #2	Supplier is capable of this spec:	S1	S2
	Supplier is NOT capable of this spec:		S4
	Ratio of Capable Processes to Total Processes:	67%	
Supplier #3	Supplier is capable of this spec:	S1	S2
	Supplier is NOT capable of this spec:		S4
	Ratio of Capable Processes to Total Processes:	100%	

Figure 7: The results from an example Supplier-Part Match.

As we can see in this example, Supplier 3 is able to meet 100% of the requirements while Supplier 2 is able to meet 67% of the requirements and Supplier 1 is able to meet 33% of the requirements. In this case, we choose Supplier 3 as the best supplier to work with in order to produce the part in question. Although this example is drastically simplified, these calculations may be performed for any supplier and any number of parts that you would like to evaluate.

5.3 Implementation and Integration of Supplier Evaluation Process

By combining the results of the Supplier Evaluation and the Supplier-Part Matching Tool, it may be evident which supplier is the best supplier to work with when sourcing these parts. For example, if we take the example from Section 5.2, we may get the results as shown in Figure 8:

	Supplier Score	Supplier-Part Match Ratio
Supplier 1	65%	33%
Supplier 2	80%	67%
Supplier 3	90%	100%

Figure 8: Example of the combined results of the Supplier Evaluation Process

The results of this example lead us to the conclusion that Supplier 3 is the best supplier to work with as this supplier has the highest Supplier Score as well as a perfect match to the required part specifications. However, if our results look like the ones in Figure 9, which were run with a different set of parts that we are interested in sourcing, the conclusion is not as straightforward:

	Supplier Score	Supplier-Part Match Ratio
Supplier 1	65%	90%
Supplier 2	80%	67%
Supplier 3	90%	15%

Figure 9: Second example of the combined results of the Supplier Evaluation Process

In the second case, we aren't sure which of the suppliers is the best one. Should we work with Supplier 1 who has the highest Supplier-Part Match Ratio or should we work with Supplier 3 who has the highest Supplier Score and teach them how to make the part? What about Supplier 2? Should we be at all interested in working with them? In a case such as this, we find that the Supplier Evaluation Process provides a high-level analysis that helps match parts with potential suppliers. The process provides a good first step in identifying which supplier the company should work with but the company should follow-up on these results. A suggested follow-up analysis would be a business case analysis as well as a strategic analysis of how the supplier fits in P&W's strategic goals.

5.4 Chapter Summary

This Chapter details the steps involved with creating a Supplier Evaluation Form. A method for making the collected information more active is suggested through the development of a Supplier-Part Matching Tool. The Chapter ends with a sample implementation of the Supplier Evaluation Process and the Supplier-Part Matching Tool. In this sample implementation, the results from two sets of data are compared in order to highlight the limitations of the Supplier Evaluation Process. In the following chapter, the Supplier Evaluation Process is applied to a current resourcing project that P&W is working on.

6. Case Study: Application of the Supplier Evaluation Process

In 2008, P&W was interested in resourcing a basket of parts to a new supplier location. Although a location was decided on before this project was completed, the Supplier Evaluation Process was utilized in order to see how well the process worked.

6.1 The Suppliers

Throughout the last quarter of 2008, various Supplier Evaluation Forms were completed for nine different suppliers located in two different low-cost regions. The Supplier Evaluation Forms were completed in various ways depending on the knowledge level the P&W employees had in reference to each of the nine suppliers. In some cases, the suppliers were unknown to P&W and a site visit was performed in order to fill out the Supplier Evaluation. In some cases, P&W had been working with the suppliers for up to a year and the forms were completed by the P&W employees

and then forwarded on to the supplier for verification. In the final cases, P&W employees have been working with the suppliers for years and were able to fill out the evaluation form independently.

Once the Supplier Evaluation Forms are completed, we can determine each supplier's Supplier Score as shown in Figure 10. We can use the individual supplier scores to then rank the available suppliers. As shown, Supplier C is the best performer with an 82% and is marked with a gold color. Supplier B and A are second and third best, respectively, and are marked with a silver and bronze color. On the other hand, Supplier I is the lowest performing supplier on the evaluation and is marked with a red color.

Supplier	Scorecard
Supplier A	65%
Supplier B	67%
Supplier C	82%
Supplier D	33%
Supplier E	51%
Supplier F	58%
Supplier G	46%
Supplier H	50%
Supplier I	

Figure 10: Case study Supplier Scores

6.2 The Parts

As mentioned earlier, the most suitable supplier to work with will depend on the requirements of the specific parts that we are interested in resourcing. The basket of parts that P&W is in the process of resourcing consists of over 150 different parts. These parts vary considerably from one another but can all be classified as a small machined part. Roughly, a small machined part can be made out of a number of different types of material but requires a machining process and has a maximum dimension of fifteen inches. Another requirement is that it has not previously been classified in another category such as airfoils, rotating seals, etc. A small sampling of representative parts is provided to give an understanding of the types of processes and technical capabilities that are involved in the production of these parts.

Spacer – A spacer is used to separate segments of the diffuser case. The final form of the spacer is a fifteen-degree segment of a circle that has two bolt holes used to attach the part as well as two relief slots to reduce the part weight. The spacer is produced from a full rolled ring of stainless steel. Using a lathe, the inner and outside diameters of the ring are turned. The ring is cut it into rough fifteen degree segments using a wire EDM (electrical discharge machine). The rough edges of the segment are machined to the finish dimensions. Finally, the bolt holes are drilled and the relief slots are

milled to finish the part. The tolerances of the linear dimensions require $\pm 0.010''$ while the holes require $\pm 0.005''$ with a true position of $\pm 0.010''$.

Sleeve – A sleeve, also known as a bushing or a tube, is often used as a bearing. The part is produced from bar stock made out of nickel inconel, an austenitic nickel-chromium-based superalloy suitable for high temperature applications. The first step in the production of the sleeve is to turn the inner diameter with a lathe – leaving the inner diameter slightly undersized. The outer diameter is turned using a lathe and a flange is cut around one end of the sleeve. The bar stock is then cut to the correct part length. Once this machining is completed, the inner diameter of the part is plasma sprayed to provide wear resistance. After spraying, the inner diameter is ground to the finish dimensions. The required tolerances are $\pm 0.010''$ for all dimensions other than the inner diameter which requires a tolerance of $\pm 0.002''$.

Groove pin – A groove pin is used to attach one part to another with a tight tolerance. This part is produced from a stainless steel alloy bar stock. The first step is to heat treat the material in order to harden the part. The next step is to turn the outer diameter and the thread on a lathe. The required tolerance for the outer diameter is $\pm 0.0005''$ while the tolerances for the rest of the dimensions are $\pm 0.010''$. Two holes are drilled into each end of the part which allow for locking wires to be inserted and allow for the groove pin to be secured. The part is cut to length and heat treated to provide the proper finished hardness. Finally, all dimensions are checked and an anti-gallant compound is applied to the outer diameter in order to finish the part. This anti-gallant coating provides a low friction surface to allow for part removal, if required, during servicing.

The descriptions of these small machined parts help provide a glimpse of the types of products, processes, and requirements the Supplier-Part Matching Tool is able to accommodate. While the representative parts do not provide a full range of manufacturing processes and requirements, they are enough to give an idea as to the potential capabilities of the tool as it is able to match processes, materials, dimensions, tolerances and special process requirements.

6.3 Matching Parts and Suppliers

In order to use the Supplier-Part Matching Tool, the technical requirements for the basket of parts need to be collected and entered into the tool. Using these requirements and referencing the suppliers' capabilities, we can add the Match Results to the Supplier Scores as seen in Figure 11. In

this case, the results were similarly color coded as the Supplier Scores with the top three results colored gold, silver and bronze and the lowest score colored red.

Supplier	Scorecard	Match Results
Supplier A	65%	41%
Supplier B	67%	16%
Supplier C	82%	50%
Supplier D	33%	14%
Supplier E	51%	19%
Supplier F	58%	44%
Supplier G	46%	14%
Supplier H	50%	50%
Supplier I	20%	14%

Figure 11: Case study combined results

Analysis of these results can occur in many ways. The most straightforward analysis would be to choose the top supplier in each category as well as selecting the suppliers who have the highest combined Supplier Score and Match Results. If we analyze the results in this way, we see that the top supplier for both the Supplier Score and the Supplier-Part Matching is Supplier C and Suppliers A, F, and H would also be included in the top suppliers list. These four suppliers would be identified as “suppliers of interest” and further steps would be taken to understand each supplier’s strategic fit with P&W through a business case analysis.

As mentioned, this basket of parts was already slated to be sent to one of the suppliers listed above: Supplier D. Based on the combined scores, Supplier D has been evaluated as the second least likely supplier that we would want to conduct business with, so why is Supplier D receiving these parts? Through discussions about these results, some reasons for the discrepancy between reality and the evaluation results were highlighted:

- P&W foresees future market potential in the supplier’s country
- Supplier D is part of a P&W strategic initiative
 - To increase global aerospace capacity
 - To improve Supplier D’s specific capability

As we saw in Chapter 3, P&W has created a supplier development process that allows them to identify suppliers that they would like to work with (through segmentation of the supply base) and that provides the supplier with a self-selecting mechanism (to participate in ACE or not) to buy-in to the supplier development process. In this case study, we observe that P&W is willing to extend beyond their supplier development process to try to develop a new supplier in order to gain access to future capacity and potential future markets. Through these actions, it appears that P&W is

simultaneously demonstrating more evidence of trust in this relationship as they are, in a situation of incomplete information and uncertainty, putting themselves at risk to build the capabilities of this supplier with the hopes that the supplier will not take advantage of the situation. This follows Locke's definition of trust as provided in Chapter 3. In addition to this, P&W is reinforcing Locke's framework for trust building as it is in P&W's own self-interest to gain access to future capacity and future markets for their aircraft engines so that they can continue to be a major competitor in the aircraft engine manufacturing business.

6.4 Chapter Summary

This chapter provides a glimpse into how the Supplier Evaluation Process can be used at P&W. The chapter outlines the methods utilized to complete the individual supplier evaluations as well as the steps that should be taken to ensure that trust is maintained with the suppliers. The types of parts that are being outsourced are briefly described to provide a view of the flexibility of the Supplier-Part Match Tool. In addition, this chapter highlights the limitations of the Supplier Evaluation Process. While the tool provides a high-level view of the best potential suppliers that P&W could conduct business with, a business case should be run on each of the individual suppliers prior to actually conducting business with these suppliers.

7. Conclusions

The Supplier Evaluation Process, that was developed for P&W, successfully provides the Strategic Sourcing Organization with a standard and consistent process to evaluate potential suppliers based on the requirements of the parts to be outsourced. This process is extremely flexible in that it can be applied to any supplier, in any region and for any parts P&W requires. In addition, to the Supplier Evaluation Process, this thesis has identified methods to build and manage trust in the new supplier relationships that P&W creates. The structure of P&W's supplier activities, be it the Supplier Gold Program, the Supply Management Council, and the Strategic Sourcing Organizations' offers of assistance, all help to create opportunities to build and develop high level trust relationships with their suppliers. With this structure in place, P&W should be able to continuously improve the level of trust in their supplier relationships along with their strategic goal of reduced part costs. With these results, P&W will be able to increase their supply base presence in low-cost

regions, reduce their part costs, as well as grow the global aerospace capacity and strategically position themselves for potential future markets.

7.1 Recommendations

As P&W continues to increase and improve their low-cost sourcing efforts, I believe that by changing their goal from “reducing costs by transitioning product to a low-cost supplier” to “building a high level trust relationship with a low-cost supplier to help improve performance” would enhance their efforts at ultimately reducing costs in the long run. The benefits associated with these high trust relationships, although they take time to develop, outweigh the one-time benefit of shifting a supply’s location. One idea that comes to mind is that by shifting their supply base to a low-cost region, P&W may be exploring the “collaborative alternatives to full integration in domains unencumbered by their legacy.”⁴¹ One might ask, has P&W damaged their ability to develop successful high trust relationships in their current supply base due to the legacy of their previous actions? I do not suggest that they have, but in looking forward, P&W should take advantage of their expansion into low-cost regions to create new, collaborative, high trust relationships with their suppliers. In pursuing this goal, P&W will see continuous improvement to their cost reduction efforts and their bottom line instead.

7.2 Next Steps

To improve the function and accessibility of the Supplier Evaluation Process, the tool should be automated and include Export Classifications for each part number. In its current form, the evaluation tool requires manual manipulation of data in order to perform supplier comparisons. Through the creation of a dynamic, on-line program with associated databases, the process for supplier evaluation and comparison would be faster, more user-friendly, and more attractive for daily use. By adding Export Classifications, the tool would further simplify the Part-Supplier Match Process as it would be able to automatically omit suppliers who are not allowed to produce the specified parts. With these changes, the Strategic Sourcing Organization could easily utilize the Supplier Evaluation Process and spend less time on identifying suppliers and more time developing trust in their new buyer-supplier relationships.

⁴¹ Gilson, "Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration." pp. 6.

8. Appendices

Appendix 1

Experience – This section primarily focuses on the experience level of the supplier and its employees. The experience gained through supplying large, international companies helps a supplier become attuned to the needs of the global business environment. Understanding a supplier's experience with international customers and the required expectations for quality and delivery before a supplier relationship is created may ease the need of supplier development.

Environment, Health and Safety – This section focuses on the supplier's efforts to minimize their effect on the environment as well as the health and safety of their employees. This section is important as purchasers do not want to expose themselves to a potential public relations issue or liability by working with a supplier who causes undue harm to the environment or their employees.

Logistics and Delivery – This section captures information on the supplier's ability to meet delivery goals for their customers, internally as well as for their sub-tier supply base.

Quality – This section focuses mainly on the approach the supplier takes towards maintaining and improving their product and production process quality levels.

Operations – This section looks at the general layout of the production process and material flow.

Communication – This section helps identify the level of openness the supplier has with the company as well as the state of their communication technology.

Financial Records – This section analyses the financial records of the supplier in order to identify any potential trouble or issues with bankruptcy, etc.

Technical Competence – This section goes into great detail about all of the process and manufacturing capabilities that the supplier is able to perform. This section merely collects this information and an evaluation of this section is not performed until the Supplier-Part Match Tool is utilized.

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