Development of a Decision Framework and a Knowledge Management System for Make/Buy Determinations in Manufacturing

by
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B. S. Mechanical Engineering, University of Cincinnati, 1992

Submitted to the Sloan School of Management and the
Department of Mechanical Engineering in partial fulfillment
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Abstract

This thesis describes a process for managing manufacturing sourcing decisions for final products and specifically addresses the Make/Buy issue. Background information describes the steps undertaken to develop this process, including a summary of best practice information. The process has three main elements that are described in detail:

- A strategic management system with concepts and tools that facilitate the determination of the focus for internal and external manufacturing.
- A tactical process consisting of two frameworks and associated tools. The first framework guides a project team through the Make/Buy decision for new products. The output of this framework is the determination of the optimal manufacturing site for a particular product. The second framework guides the corporation through a periodic review of the plant/product matrix. This review facilitates re-optimization of the system in response to the continuously evolving business environment.
- A knowledge management system describing how various functions and levels in the organization must interact to ensure that decisions made at the tactical level are congruent with the strategic direction. The knowledge management system includes tools to enhance the communication of manufacturing sourcing information throughout the organization.

This process was developed especially for the Polaroid Corporation, yet the concepts and elements of the process are relevant to any organization wishing to optimize the manufacturing sourcing process.

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David E. Hardt, Professor of Mechanical Engineering
Stephen C. Graves, Professor of Management Science

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1 Introduction

In the past few years, many companies have had a renewed focus on manufacturing. But this renewed focus is much different than the focus of the past. Companies are increasingly concentrating on their core competencies, and for many organizations, that means rethinking the manufacturing function. Many organizations have determined that some of what they manufacture internally is not really core to the business. Companies are much more hesitant to build a new factory and hire new workers when a new product is developed. They are looking for new and novel ways to supply these products to the market. Manufacturing has expanded beyond the walls of most individual companies. They are looking for contract manufacturers, strategic manufacturing partners, and alliances to fill in the gaps.

But should certain products and processes remain in-house? Would you lose a competitive advantage by allowing someone else to produce these products? This decision is often referred to as the "Make/Buy" decision. You will either "make" the product internally, or you will "buy" it from someone else.

The goal of this research is to explore the Make/Buy decision within the larger context of the manufacturing sourcing process and to develop a framework to assist organizations in the successful strategic and tactical implementation of a structured management system.

1.1 Specifics of the Problem

This research is specifically intended to aid Polaroid's Global Hardware Manufacturing division. In response to the increasing challenges of today's global business world, Polaroid is refocusing its efforts to compete in this fast paced environment. Polaroid is in the middle of a major transition period. The company is evolving from a technology-based company with long lifecycle, stable products to a marketing-based company, focused on rapid product development and introduction of multiple new, shorter lifecycle products.

It is extremely important for the company to get new products to market as quickly as possible, for the lowest possible cost. Cost reduction is also a critical focus for existing products.

Decisions are being made every day on who should make what – should they "make" or "buy" this product? These choices have critical importance to the overall profitability for any product, as well as to the current and future profitability of the whole company.

The scope of this project is to map the improvement opportunities in the manufacturing sourcing process, analyze the key criteria in successful Make/Buy decisions, develop a strategic process and a tactical framework to guide these decisions, and provide an implementation approach to optimize this process for the organization. The process is to be implemented as a standard procedure that is followed for all Make/Buy decisions and continuously improved upon based on learning from each iteration of the process.

1.2 Statement of Objectives

Although this research focuses on the need for a manufacturing sourcing process specific to Polaroid, the majority of the concepts can be applied to many other companies and industries. The main objectives of this thesis are to document the research conducted at Polaroid, and detail a decision framework and knowledge management system that can be applied to manufacturing sourcing decisions at many companies.

Specifically, the current situation at Polaroid is described. "Best practices" information is summarized and the key criteria used to make these types of decisions are determined. The manufacturing sourcing decision process is laid out as it was developed for Polaroid, and a description of how this process could be applied in other organizations is given.

In order to describe the multi-faceted manufacturing sourcing process that was developed, this thesis details the process at the strategic and the tactical level.

At the strategic level, the goal of this thesis is to provide guidelines and tools that can be used by upper management to refine the overall manufacturing sourcing strategy and communicate this strategy throughout the organization.

At the tactical level, this thesis provides a framework and tools to guide individual product teams through Make/Buy decisions on new products, and a separate framework to facilitate periodic review of the entire manufacturing system.

Knowledge management tools assist with the implementation and eventual institutionalization of the overall process.

1.3 Methodology of Research

To efficiently tackle the Make/Buy problem, a research methodology was developed to lay out the key actions required and the basic flow of the steps to be performed. The project flow is depicted below.

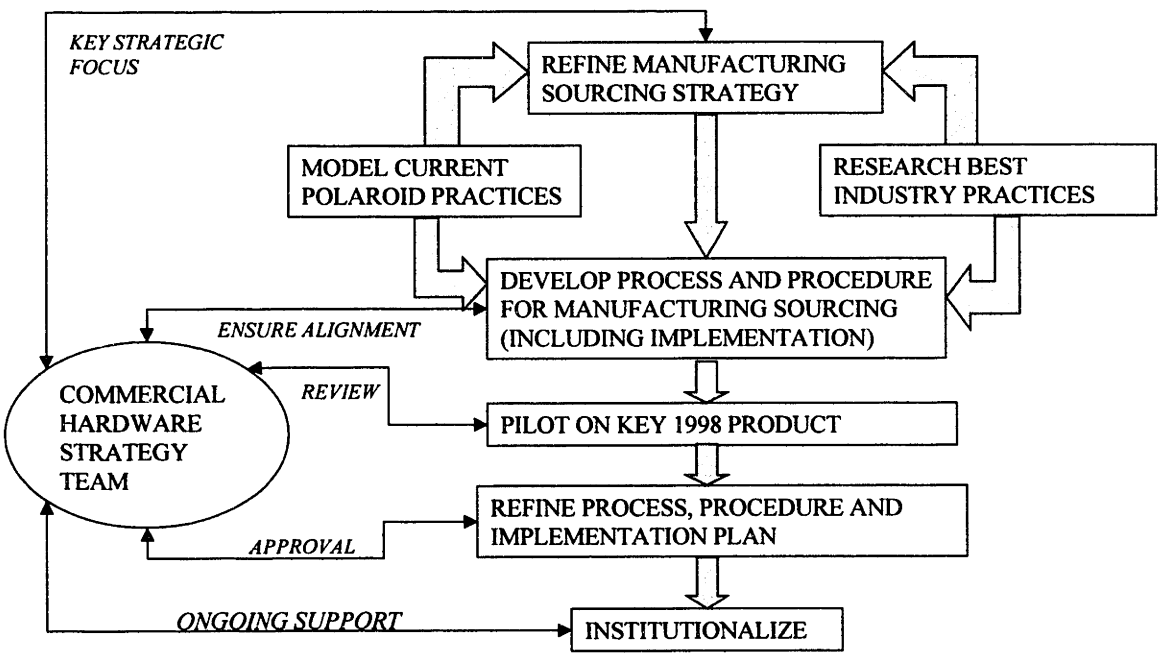

Figure 1: Make/Buy Project Flow

The first step was to gather and analyze current practice and best practice information. A gap analysis was then performed to determine the main areas of potential improvement for the Make/Buy process. All of this data was used as input into refining the manufacturing sourcing

strategy at a macro level. Development of a process for individual manufacturing sourcing decisions (a tactical/micro level process) followed. Piloting, refining, and institutionalizing the process, both at the strategic and the tactical level, were the final steps in the project flow. Each of these steps is discussed in further detail in the subsequent sections.

1.4 Terminology

Although the term "Make/Buy" greatly simplifies the "manufacturing sourcing" process, the terms are often used interchangeably in industry. The subtle differences in these terms, particularly as used in this research, are worth noting. Literally, "Make/Buy" refers to the decision to *make* a product using internal (also referred to as "in-house") manufacturing capabilities, or to *buy* the product from an outside source. This term is tactical in nature. The "manufacturing sourcing" process is a higher level more strategic term that addresses the management of the entire manufacturing system, the plant/product matrix, and how the overall manufacturing strategy is intertwined with individual Make/Buy decisions.

"Outsource" and "contract manufacturing" are often used interchangeably with "buy". "Outsource" is a generic term used for activities that are performed for the company by a third party. The details of the relationship are not clear when using this term. "Contract manufacturing" generally refers to a relationship where a third party manufactures a specific product for a company based on a contractual agreement. "Partnerships" and "alliances" are outsourcing arrangements that are more strategic in nature, often involving multiple products and longer periods of time.

This research concentrates on the sourcing of the final product, not individual components.
In industries such as Polaroid's Imaging Hardware Business, parts and subassemblies are purchased separately and much of the actual final processing is assembly. The final product is classified under the "Make" heading if it is assembled internally regardless of the source of parts.

1.5 Thesis Organization

The thesis is organized to accomplish two main objectives:

1) Document the manufacturing sourcing research conducted at Polaroid.
2) Provide a process and tools that can be adapted by other organizations to guide manufacturing sourcing decisions.

Chapter 2 provides background information including Polaroid history relevant to the specific research conducted. This chapter also describes the information used as a starting point for the research.

Chapter 3 discusses the data gathered in the development of the process. This chapter summarizes the best practices data gathered from numerous resources and the data describing how Polaroid made manufacturing sourcing decisions.

Chapter 4 contains a gap analysis comparing the best practices and current practices, defines the key criteria in Make/Buy decisions, and summarizes the recommendations for the development of the new process.

Chapter 5 presents the manufacturing sourcing process. Strategic guidelines and tools to be used to refine the overall manufacturing sourcing strategy are described. The tactical frameworks and tools used to guide individual decisions are presented in detail. A knowledge management system is also described which details the interaction and information sharing necessary between different constituents in the organization.

Chapter 6 describes the proof of concept of the process, and describes the implementation at Polaroid to this date.

Chapter 7 concludes the thesis by presenting ideas on how to apply the framework at other companies. Lessons learned during the research are discussed, and ideas for future work are introduced.

2 Background

A historical perspective of Polaroid is included to give the reader insight as to the starting point of this research. This information is summarized from the book Polaroid Access Fifty Years (Wurman, 1989). This type of background information is especially relevant when forming implementation plans to ensure integration of the new processes with existing processes, the organizational structure, and the culture of the company.

2.1 Polaroid Corporation History

The Polaroid Corporation grew out of the innovations and inventions of its founder, Edwin H. Land. The Polaroid Corporation was formed in 1937, with Land as President, and acquired all the patents and patent applications owned by Land at that time. The original mission of the company was to develop light polarization technically and commercially. "Throughout it's history, Polaroid has set itself three goals: to offer quality products to a wide public, to insure employees of a fair and challenging work experience, and to create an environment for advanced research" (Wurman, 1989). These values are still evident in the company today.

Land first conceptualized the one-step photographic system in 1944 while on vacation with his family. The technical knowledge gained in the development and production of polarizers facilitated the transition from conceptual idea to a working prototype of the entire photographic system, including the camera and film, in a mere three years. The one-step photographic system was presented to the public through the Optical Society of America in 1947, and the first camera went on sale at the Jordan Marsh Department store in Boston in 1948.

Although Land dabbled in several related inventions, including sunglasses, glare reducing headlights, and the failed instant motion picture system, the majority of the profits continued to come from the instant photography business.

2.2 Brief History of Manufacturing and Make/Buy Decisions

There is a rich history of Make/Buy decisions at Polaroid, starting the year Polaroid was formed with the contract-manufactured Polaroid desk lamp. Although Polaroid developed as a

technology-based company, the emphasis of the technology has always been on product research, not manufacturing. The scientific knowledge that goes into each picture is tremendous. Therefore, Polaroid film has always been manufactured within Polaroid. Hardware, on the other hand, is developed to sell film. The most important business characteristic of hardware is the film "burn" or usage rate. Although there are important technical characteristics of the hardware, such as the critical roller mechanism that spreads the chemical along the film as it is exposed, hardware manufacturing is generally thought of as "lower tech" than film manufacturing. In fact, all of Polaroid's cameras were contract manufactured until 1972 when Polaroid first assembled the SX-70 camera in-house. In 1975, Polaroid established its first international camera operation in Scotland. Also in the mid-seventies, a Contract Manufacturing Group was formed within Polaroid to focus on relationships with outside manufacturers.

Make/Buy decisions on hardware have been critical decisions for the company since the mid-seventies. With the establishment of both in-house manufacturing and the Contract Manufacturing group, they have capabilities to perform well in both arenas. How can the best decision be reached for individual products? This is a question Polaroid and many other companies have been struggling with for several years. The effectiveness of these decisions became increasingly important for Polaroid as the business environment continued to evolve.

2.3 Changing Business Environment

Throughout the last half of the 1900s, Polaroid continued to improve the instant photographic system by introducing lower cost cameras, color film, integral film (as opposed to peel-apart), and continually improved images. In 1974, Polaroid estimated that over one billion instant prints were taken that year. Polaroid had sales of over $787 million and net earnings of over $28 million, with 13,000 employees. Land resigned as president of Polaroid Corporation in 1975, but continued as CEO and Director of Research.

Polaroid continued to thrive through much of the 1970s and 1980s. The 1990s have proved to be a tougher time for the Polaroid Corporation, its employees, and stockholders. Although the core film business continued to develop and has held relatively steady for the past few years, several other endeavors have been less than profitable for the company. Competition from "point and

shoot" 35mm cameras, Fuji film, and newly developed digital technology has increased. Polaroid initiated a restructuring effort in 1995 including a headcount reduction program in order to save costs. In the last five years, Polaroid has had earnings growth of –153%, compared to the photographic equipment and supply average of 13.1% and the S&P500 growth of 13.9% (YahooFinance, WWW, 1998). The following table shows net income for the same time period (IBID).

Net Income (loss)	1997	1996	1995	1994	1993
in millions	($126.7)	($41.1)	($140.2)	$117.2	($56.3)

Figure 2: Polaroid Net Income

In the Letter to Shareholders from the Polaroid Corporation 1997 Annual Report, Chairman and Chief Executive Officer Gary T. DiCamillo stated:

> *"Today...we are in the midst of ...profound changes, within both Polaroid and the field we now call imaging. We are reinventing Polaroid and the way we approach customers, while at the same time digital technology is enabling new ways to create and use images. Both changes are providing Polaroid new, more effective ways to serve shareholders and customers."*

Additionally, the 1997 Annual Report contains a section in which four industry experts give their opinions on the future of imaging technology. The section opens by stating:

> *"Increasingly conflicting predictions about the future of imaging are giving pause to even the sharpest industry observers. Virtually all recognized experts agree that new technology is visiting major change on the industry at an ever-quickening pace. But relatively few are certain of exactly how technological change will affect traditional imaging companies."*

Polaroid is taking a proactive approach to dealing with these external changes and improving their internal performance.

2.4 Reaction to Changes

Polaroid's Chairman and CEO DiCamillo is transforming the company from a technology-based company to a marketing-driven company. In the shareholder letter he stated:

> *"Equally as important as the changes occurring in the marketplace are the changes occurring inside Polaroid. The Polaroid culture is undergoing a significant metamorphosis. Sparking growth in our top line requires us to introduce a steady stream of new products required by the evolving marketplace. We expect 20 to 25 percent of Polaroid's revenue to be coming from products – digital and silver-based – that have been in the market less than three years. We have been creating a capability and process able to deliver between 20 and 40 new products every year."*

Several critical factors have been identified to help the company focus on new products, including a cost reduction focus, reduced cycle time initiatives, and increased flexibility and agility goals. Within the manufacturing organization, the primary goals are to reduce time-to-market of new products, and continually reduce the costs of production for all products.

A key element of the emphasis on new products was the establishment of a Product Development Process Roadmap. The PDP Roadmap, as it is referred to, is a confidential Polaroid process and therefore will be talked about in conceptual terms. The PDP Roadmap outlines the steps that product teams follow to take a new product from the "Fuzzy Front End" stage to commercialization. The map depicts over 100 individual steps, broken into seven stages, with management reviews at the end of each stage. Although this map is a great aid towards efficiency, thoroughness, and speed to new product introductions, there are several steps in the process that need more development. One of these steps involves the development of the manufacturing sourcing strategy for the product, and one element of that is the Make/Buy decision. This remainder of this paper focuses on the development of a process for manufacturing sourcing decisions and tools to assist with the process.

2.5 Boundaries, Barriers and Issues

To bring additional focus to the project, the following boundaries were determined. As stated above, the primary concentration of the research was hardware products. The effort focused on manufacturing, not development or marketing. In contrast to component sourcing, this project concentrated on the manufacturing of end products, but included some major sub-assemblies, and system integration. All stages of the product life cycle were included in the study - specifically, inception, full-scale production and end-of-life production. Lastly, the research would not just determine "make or buy", but would determine where to make, or where to buy, and how those decisions should be made.

Several issues and barriers were identified at the beginning of the project that would need to be addressed either to support the research, or to ensure that critical aspects of the problem were not omitted. These issues are listed below.

- Identification of who should be involved in the Make/Buy process for individual product decisions
- Integration of the Make/Buy process into Polaroid's Product Development Process
  - When should the process be activated?
  - When should the decision be complete?
- Adherence to the Make/Buy process
  - May need support from upper management initially
  - Long-term adherence will test usefulness and user-friendliness of process
- Long term support
  - Who owns the process?
- Information management support
  - Initial development
  - Long-term support
- Who needs to review/approve the process before it is put in place?

2.6 Starting Point

There were two existing bodies of work that served as starting points for the project at Polaroid. The starting point for the macro view of the project was a body of work regarding manufacturing strategy that the Commercial Hardware Strategy Team had recently synthesized. The other body of work was a decision process that had previously been mapped to assist with individual product decisions. Together, these works represented the current manufacturing sourcing strategy.

A sub-group of personnel from global hardware manufacturing referred to as the Commercial Hardware Strategy Team had recently performed a review of the current hardware manufacturing capabilities (internal to Polaroid) and determined what manufacturing capabilities would be needed in the future. This work was used as a springboard to begin the project of developing a Make/Buy process. Specifically, this work was used as input into the macro view of the manufacturing strategy. This group had identified the key strategic focus of hardware manufacturing to include:

- Rapid product development and introduction to market of low to medium volume specialist commercial products.
- Creation of an agile organization with core skill set to manage fluctuation in product demand, technology developments, and product development program needs.
- Optimization of manufacturing capability and application of Kaizen to reduce costs and maximize agility.
- Increased support to develop original equipment manufacturer (OEM) opportunities working with contract and OEM groups.
- Optimized collaboration between appropriate internal divisions.

This key strategic focus served as a basis for developing the overall manufacturing strategy at a macro level.

As a starting point for the tactical level, there was an effort by the Contract Manufacturing group in the early 1990s to map the critical issues in the Make/Buy decision. A flow chart was

developed with five basic questions regarding ownership of design or development, strategic positioning, strategic supplier alliances or geographic issues, volume and complexity, and a general question regarding the "best deal". This chart is depicted below as Figure 3. Answering these questions leads the decision-maker towards outsourcing or insourcing (producing at Polaroid). If the product is to be insourced, another step reminds the user to consider cost and synergy when choosing between the sites within Polaroid. The title to this decision process includes "with Management Judgment" in parenthesis, signifying that the process is a guideline, not a comprehensive process.

Decision Process For Commercial Products (w/Mgmt Judgment)
Note: Changes Over Time

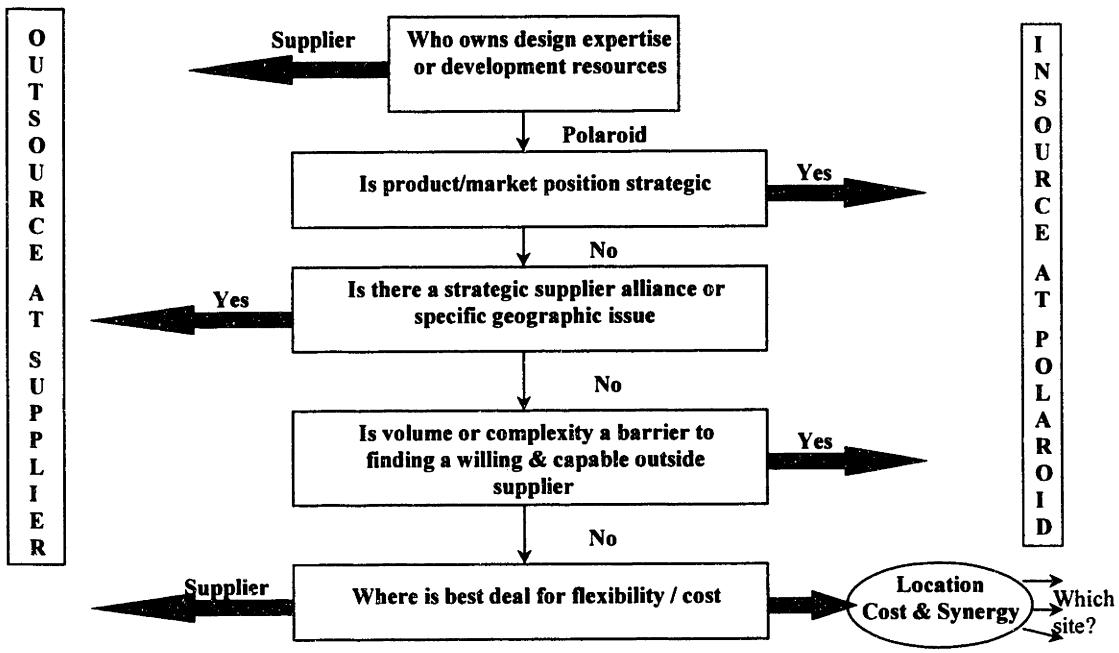

Figure 3: Polaroid Decision Process

In reviewing this existing decision process at the start of this research, the following points were identified as potential improvements to the process:

- Quantify "management judgement" as much as possible.
- Determine what defines a strategic product or market.
  - What current products are strategic?
  - What products in development are strategic?
  - Should strategic products be defined and agreed upon at a corporate level?
- Capture information on current strategic alliances and partnerships.
  - How should this affect manufacturing decisions?
- Define possible geographic issues.
- Gather more information on barriers to finding outside suppliers.
  - Are there ways to knock down these barriers?
- How do you quantify the "best deal"?

3 Data

This chapter contains a summary of the information currently available from the academic, consulting, and industrial segments regarding manufacturing sourcing and Make/Buy decisions. This information is referred to as the best practice data. Data is also presented regarding the current practices at Polaroid. The next chapters describe how this information was used to develop an improved manufacturing sourcing process.

3.1 Best Practices Data Collection Methodology

Data from industry sources, academia, and consultants was gathered and synthesized to determine the current thinking on the optimal process for manufacturing sourcing decisions. There is a wealth of information available on Make/Buy decisions and manufacturing sourcing decisions. Unfortunately, the majority of the best practice information available publicly is qualitative. Additionally, a large portion of the information available is theoretical in nature, as opposed to actual "best practices" of existing companies. Most of the data available about actual company practice shows the lack of a formal process for manufacturing sourcing decisions (Ford et al, 1993). Still, the information available is helpful in determining the leading theories behind Make/Buy decision processes.

In total, best practice information was gathered from over 20 sources. The majority of this information was found through internet searches on the key words of "make or buy", "manufacturing sourcing" and "outsourcing". A tremendous amount has been written on outsourcing, but somewhat surprisingly, the majority of the information sources concentrate on outsourcing information technology (IT) functions. References used include articles from the Harvard Business Review, MIT working papers and theses, consultant and company web sites, interviews with Polaroid personnel and review of Polaroid documents.

3.2 Best Practices Data

The information gathered as part of the best practice effort is summarized below. There are several studies that contain quantitative data on project time lines and project costs in the references listed. The data contained in this report is a qualitative summary of the information

available. This qualitative form of information is consistent with the Polaroid Current Practice data collected.

Buy Benefits	Make Benefits	Buy Risks (long-term)
Lower cost	Process Innovations	Decrease in internal capabilities
Higher Flexibility	New Product Development	Increased capabilities of suppliers
Improved Resource Allocation	Faster new product introduction	Loss of competitive advantage
Access to capacity, technology and capability	Communication	Loss of control

Figure 4: Make/Buy Best Practices Summary

For a large number of organizations, there are many benefits to outsourcing manufacturing. These benefits include lower cost of product, often primarily because of lower labor costs. A large number of U.S. manufacturing companies have moved labor intensive activities to Mexico or the Far East to take advantage of the lower labor cost (McGrath & Hoole, 1992). Another source of lower cost is scale economies (Bruck, 1995). There are instances in which a contract manufacturer may be able to reap the benefits of scale economies in manufacturing because of other similar manufacturing activities (Quinn & Hilmer, 1995). Likewise, there is a potential for higher capacity utilization, resulting in lower costs. There is also potential for more flexibility in the production schedule, and the parent company may be able to order increased or decreased production volumes without directly feeling the downside effects of resource allocation. The majority of these benefits are subject to the terms of the contract between the parent company and the manufacturer (Everest, 1998). The parent company may also see some benefit due to efficiencies created by competition between manufacturing suppliers (Bruck, 1995).

There is much discussion on the application of the core competencies model to manufacturing (Venkatesan, 1992 and Hewlett Packard, 1998). If a company's core competencies lie in research and development, they may find it more efficient to outsource the entire manufacturing function. If the company has a manufacturing competency in complex electronic systems, they may want to outsource the production of simpler products. If a manufacturing provider focuses primarily on manufacturing rather than development and marketing, there is potential for higher efficiency due to increased management attention. Correspondingly, the parent company can refocus its efforts on other strategic activities such as product development and marketing.

Although the current trends are towards outsourcing manufacturing, there are still a number of recognized benefits to maintaining manufacturing capabilities internally. The majority of the benefits center on communication efficiencies between functions, such as Product Development and Manufacturing or Manufacturing and Marketing. Many, but not all organizations find it more efficient to communicate within an organization than across organizations. Many real obstacles negatively affect inter-organizations communication such as distance, language, culture and time zone differences. The difficulties in managing outsourcing relationships are often underestimated (Everest, 1998). Implementation of efficient information technology systems is decreasing some of the negative effects. Other perceived barriers are differences in company cultures, organizational vernacular, divergent goals, and general mistrust.

Many of the inherent difficulties of cross-organization relationships are enhanced in new product development situations. It is often more difficult for the product development team and manufacturing to work together. The product is often designed without the benefits of input from manufacturing, resulting in a product that is more difficult to produce or more costly than optimal (Siekman, 1998). If manufacturing is involved in the design process, it is often later in the process, resulting in a sub-optimal design for manufacturing (DFM). There is also less opportunity to design the product with new process innovations in mind, eliminate potential problems early and learn from previous mistakes. All of these effects combine for slower new product introductions, more costly products, and lower quality output.

Several of the same effects are seen in day-to-day production. Problems in manufacturing are less likely to be communicated to the product development personnel for future product upgrades. The manufacturing personnel sometimes have less incentive to develop and implement process innovations due to lack of ownership of the product. And quality problems in the field are not always relayed back to manufacturing.

Although there are often quantifiable short-term savings in outsourcing manufacturing, the long-term ramifications of these decisions are more difficult to examine. Several of the likely outcomes of outsourcing manufacturing could have serious detrimental effects on a company in the years to come. First, there is a decrease in internal capabilities (Wheelwright & Hayes, 1985). This decrease may not only affect manufacturing capabilities, but also could affect the company's ability to trouble shoot problems with existing products, therefore decreasing customer satisfaction. Outsourcing manufacturing could also negatively affect the ability of Product Development to bring newer, improved products to the market. Conversely, outsourcing manufacturing allows your suppliers to increase their capabilities. This may allow them to have the upper hand in the negotiating agreement, either simply because they have more information, or because the parent company has no viable alternative to the existing supplier (Quinn & Hilmer, 1995). Ultimately, capabilities of suppliers can be increased to the level that they become competitors, as exemplified in the television market in the 1960s and 1970s. American television manufacturers first started using overseas companies to produce small electronic parts. The overseas companies progressively offered to supply more and more parts, and could produce them cheaper than in the United States. Ultimately, companies like Sony and Panasonic completely took over the television manufacturing, putting several of the original American manufacturers out of business.

If you outsource your manufacturing, then the intimate details of any competitive advantage of your product are known and affected by an outside party. There is risk that this supplier could purposely or inadvertently share this information with your competitors (Aspen, 1998). Also, any process advantages developed on your product are not your own, and can be employed to improve your competitor's product also. Process changes, either implemented for your product or another product, are outside of your direct control. A process change that the manufacturer

did not relate to you may have a negative effect on your product, but you will not know it until you get a complaint from a customer.

Lastly, several other key elements of getting the product to your customer are one step further from your control. You are relying on the supplier to meet or beat the quality you and your customers expect. On-time delivery is in the hands of your supplier, and this issue is often compounded if you are manufacturing overseas but the main customers are in the United States (Markides & Berg, 1988).

The following figure summarizes the effects of certain dimensions on the risks of outsourcing. This table is adapted from information presented by Khosravani in her Leaders for Manufacturing thesis (1995).

Likelihood of success in outsourcing

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High probability of success — Low probability of success

DIMENSION	Outsourcing Spectrum		
product category	commodity/simple	medium complexity	custom complex
process category	standard	non-proprietary	proprietary
technology level	low	medium	high
design stability	stable	minor improvements	unstable
life cycle	long (>5 years)	medium	short (<1 year)
volume	high	medium	low
location (compared to development and technology support)	co-located	within a day travel	different time zone

Increased risk in outsourcing

---------->

low risk — high risk

Figure 5: Outsourcing Risks

Outsourcing of manufacturing operations is often a "Catch 22" situation. To get the real benefits of outsourcing, you want to go with a cheap labor manufacturer who has scale economies and manufacturing expertise due to manufacturing similar products. But with this choice, you often expose your company to the risks of losing your competitive advantage through shared information. Much of the research shows that long-term agreements and partnering situations are required to truly get the benefits of outsourcing manufacturing (Bendor-Samuel, 1998). The automobile industry is a prime example of this need. Although the automobile industry has settled on the "make" decision, at least for the final assembly of cars, they have developed an extensive network of suppliers to deliver both individual parts and major sub-components. Still, much of the buyer power and flexibility that makes these outsourcing arrangements attractive for the parent company is stifled by a detailed contract or long-term relationship.

The "Catch 22" of manufacturing sourcing decisions is further analyzed in several works about categories of supplier dependency. The references Khosravani (1995) and Fine & Whitney (1996) detail the categories of supplier dependency and the best uses and benefits of each category.

Dependency for Capacity

Company has the knowledge to MAKE, but BUYs because of lack of time, money, space, or management attention. For the short term, this is a logical relationship. The danger in the longer term is that the company may lose the knowledge it has, or technology may advance, and the company will then be "Dependent for Knowledge".

Dependency for Knowledge

BUY because of lack of skills to MAKE. This situation is somewhat more perilous for the company, unless a good agreement is in place. The company must be very aware of the value they are bringing to the table and cognizant of any efforts of the manufacturer to obtain this part of the value chain elsewhere.

The following quotes summarize the best practice thinking on outsourcing manufacturing.

> *"The key to successful outsourcing is a clear understanding of your organization's capabilities, core competencies and business goals."* (Blumberg & Blumberg, 1998)

Understanding where your company can best add value is key (Normann & Ramirez, 1993). Defending that part of the value chain is at least as important as initial identification. It is crucial that there is a clear strategy for the company, communicated and understood throughout the organization. Manufacturing strategy is part of the overall strategy and needs to be consistent with the overall goals (Clark, 1998). Individual product or project decisions are guided by the overall strategy of the company, and individual Make/Buy decisions are guided by the manufacturing strategy.

> *"The choice of suppliers and partners can affect market opportunities for years to come."*
> (Fine, 1999)

It is often difficult to develop a vision beyond the individual project at hand. But for the long-term success of the company, it is crucial to take time to think through the ramifications. To reap the optimal rewards, choice of suppliers and partners should be thought of as the first step in developing a long-term, multi-project, trusting, and mutually beneficial relationship to reap the optimal rewards. If you concentrate on getting the lowest price for a certain contract, you may not fully see the risk of choosing a certain manufacturer. You could also hurt your chances of supplier cooperation in the future.

> *"Many of the benefits of outsourcing are easy to see, the benefits of retaining manufacturing capabilities are not easily seen."*
> (Octant, 1998)

> *"Short term profitability does not equal long term success."*
> (Octant, 1998)

Outsourcing manufacturing often brings about immediate, tangible cost savings. It can also free up resources (people, plants, equipment) for other critical tasks. Again, successful managers must be able to weigh the short-term gains against the longer-term risks.

3.3 Current Practices Data Collection Methodology

Current practice data was collected inside Polaroid to determine the current methodologies for performing Make/Buy decisions. Basic questions to be answered were:

- Is there a consistent process for determining Make or Buy decisions?
- Do the individual product decisions tie into the overall manufacturing strategy?
- Does the current decision process produce successful outcomes?

Several methods were used to collect and analyze the current practices regarding Make/Buy decisions at Polaroid. A questionnaire was developed as a guideline for personal interviews within Polaroid. The questionnaire was developed to gather qualitative and quantitative data on past experiences. More than 20 Polaroid employees from Manufacturing, Contract Manufacturing, Marketing, Project Management, and Product Development were interviewed. A copy of the questionnaire is included as Appendix A. Two contract manufacturing sites were visited and information was gathered from personal interviews and tours. Case study information was gathered on past product decisions. Current decision processes were observed for two key products.

3.4 Current Practices Data Assimilation

Since much of the data gathered was qualitative, it was difficult to synthesize the data into usable facts. The data was not of much use as hundreds of individual facts. Some data was only brought up by one individual, but several facts were repeated by numerous sources. After much deliberation, a language processing technique (Shiba, Graham & Walden, 1993) was used to analyze the information from the Polaroid personnel interviews. The qualitative data was separated into single fact phrases, and then each individual fact was placed on a small card. Cards were then grouped together to form higher level statements that could more easily be used in the strategy refinement and process development steps of the overall project. In total, there

were more than 200 individual data points gathered from the interviews. These individual statements will not be shared, but the assimilated data is detailed in the section below.

Case study data was gathered on six hardware products. Although the actual raw data is not shared in this paper, the general format of the table used to capture and share the data is shown below.

Project	A	B	C
What *What was the decision?*			
Who *Who was involved in making the decision?*			
When *When in PDP was the decision made?*			
How *What process was followed?*			
Why *What were the key drivers?*			

Figure 6: Recent Make/Buy Decisions

Separate reports were written for the contract manufacturing site visits, and data gathered from these sources is also synthesized in the data section below.

3.5 Polaroid Current Practices Data

The data gathered on how Polaroid has historically performed manufacturing sourcing decisions for products is summarized below. In order to make the data more translatable for the purpose of refinement of the manufacturing strategy and development of a Make/Buy process, the data has been synthesized under major headings.

Process

Process refers to the methods used to make manufacturing sourcing decision. From the data gathered, the following observations were made:

- There is no formalized, consistent process for Make/Buy decisions.
- There is little consistency as far as who makes the decision from one product to the next.
  - Decisions have been made at numerous levels in the company.
  - Several functions have been dominant in the decision process.
- There is little consistency in when decisions are made (within the Product Development Process)
  - Polaroid's Process Development Process Roadmap gives guidelines, but it often occurs differently.
  - Decisions are often made very early in the project, and sometimes manufacturing is not involved in the decisions making process at all.
- There is no formal listing of what criteria should be assessed when making a manufacturing sourcing decision.
  - Previous criteria sets range from no identifiable criteria (gut-feel) to a formal analysis with multiple criteria identified on a per product/project basis.

Knowledge

Knowledge refers to the level of experience and expertise that Polaroid personnel possess in regards to making manufacturing sourcing decisions versus the level of knowledge needed to reach optimal decisions.

- Some Polaroid personnel have extensive knowledge on how to make these decisions.
  - Official Contract Manufacturing Group with many years of experience
  - Personnel have experience from other companies.
- No major failures could be identified in past Make/Buy decisions, but there was general agreement that improvements could be made.
- Many sourcing decisions are obvious (just fall out):
  - Spin-off of existing product
  - Branded products
  - Key technologies owned by others

Knowledge Management

Knowledge Management is defined as how Polaroid as a corporation uses the knowledge it has and the knowledge that individuals possess for the benefit of the whole company. Knowledge Management infers sharing of expertise throughout the company, and continuous improvement in regards to the Make/Buy decision process.

- Make/Buy decisions are often determined on a one-off product basis, without considering the optimal vendor management system as a whole.
- Vendor knowledge is held individually and is not managed for ease of knowledge transfer.
- The process for determining vendor capabilities is not formalized and consistent.

Key Decision Drivers

From the data gathered, these are the Key Decision Drivers that are currently being used to make manufacturing sourcing decisions.

- Cost is the key driver in Polaroid Make/Buy decision-making.
  - Often, all other criteria are insignificant compared to cost.
    - There is some lack of consistency in the definition of cost and what all is included.
    - One some occasions, decisions have been made on standard cost alone.
    - Support and contract costs are sometimes omitted.
    - Total supply chain costs (i.e. shipping, inventory and tariff costs) are sometimes omitted.

Logistics

These points identify the how the geographical proximity of the manufacturer and the product support team have affected past projects.

- The greater the distance (actual and cultural) between the product support team and the product, the tougher (higher cost, longer delays) it is to produce a product.
  - The negative distance effect is magnified during the development and inception phases.
  - The negative effect is also magnified with complex products.

Strategy

Strategy refers to the overall manufacturing sourcing strategy and how individual product decisions are integrated with the overall strategy.

- Divisions within Polaroid have developed internal guidelines for in-house manufacturing.
  - Focus on new product introductions
  - Focus on cost reductions
- The introduction of digital imaging technology has increased the options for future product development and competition strategy in the industry.
- Manufacturing strategy is not considered key to new product decisions.
- Company-wide, internal Hardware Manufacturing is not recognized as having significant core competencies.
- The importance level of manufacturing hardware products is highly correlated to how the product, or a specific part of the manufacturing process of that product, affects the control of film development and the quality of the resulting photograph.

Culture

What effect does the strong history and culture of Polaroid have on manufacturing sourcing decisions?

- Polaroid has a strong history as a Massachusetts company, making internationalization a challenge.
- Polaroid has traditionally supported individuality.
- Proceduralized processes are not well accepted in the Polaroid culture.

The current situation regarding manufacturing sourcing decisions at Polaroid can be summarized as follows. There is no formalized process that is currently followed as to who makes decisions, how decisions are made, and what criteria are assessed for manufacturing sourcing decisions. Polaroid personnel have a lot of knowledge about how to make these decisions, but the information has not been captured for ease of knowledge transfer. The link between the overall manufacturing strategy and individual product manufacturing sourcing decisions is not well established. These types of decisions will become more and more important as Polaroid transforms itself to a new products company.

4 Analysis and Recommendations

In order to determine where efforts should be concentrated in the development of the Make/Buy process, the "Current Polaroid Practice" information was compared to the "Best Practice" information. Specifically, a gap analysis was performed to denote areas for improvement. From this information, recommendations for major improvements to the process were developed.

4.1 Gap Analysis

There are several aspects of making manufacturing sourcing decisions in which Polaroid currently excels. There are several other areas that were noted for improvement. These results are summarized below.

What Polaroid Does Well
➢ Contract Manufacturing Group has been established to focus on relationships and negotiations with outside manufacturers.
➢ Personnel have high levels of knowledge and experience in manufacturing decisions.
➢ At project team level, advantages of group decisions are recognized.
➢ Make/Buy is a recognized process step in product development process.
➢ For some products, very detailed and analytical evaluations have been performed.

➢ For other products, quick decisions have been made due to knowledge of a capable vendor.
➢ In-house manufacturing is focused on development support and inception of new products.
➢ The in-house manufacturing focus is moving towards low volume, specialty high technology and/or complexity, short life-cycle products.

Areas for Improvement
Identification of Core Products and Processes
➢ Products and technologies which are defined as strategic or core are not identified and recognized company-wide.
➢ Different functions consider different products strategic.
➢ There is not clear understanding between the business units and functional units as to what is core.

Manufacturing support for rapid new product development
➢ Manufacturing must maintain a broad technology base to contribute to the new product introduction goals.
➢ Manufacturing must stay flexible and agile to be able to quickly adapt to the challenges and opportunities of the future.
➢ Manufacturing must provide a flexible work force to quickly ramp up on new products.
Knowledge Management
➢ Existing and potential manufacturing provider information should be shared throughout the company.
➢ Consistent information on vendor capabilities should be captured for comparison.
Management of Vendor Base as a whole
➢ Evaluations should consider overall best EVA for Polaroid, not per product, taking advantage of: Established relationships

Lower contract cost Less risk Scale economies (manufacturing, support, and shipping) Company power vs. vendor power
Consistent Process for determining WHO is involved in new product decision-making
➢ Multi-disciplined teams should be used for evaluation and decision-making.
➢ Decisions should be made at the correct level (may be different for different products)
➢ Decisions should be driven by the people with the correct knowledge of the situation
Consistent Process for determining WHEN decision is made
➢ The process for determining when a decision is made must be consistent, but the timing of the actual decision may be different for different products.
➢ Decision timelines for individual products should be based upon the information that must be known before a vendor can be selected.

➢ Some decisions are best made jointly with chosen manufacturer.
Consistent Process for determining WHAT criteria are assessed
➢ The level of assessment may be different for different products, although there should be a structured process for determining the key criteria.
➢ Customer requirements on per product basis should determine which criteria are most important.
➢ Process should ensure that important criteria are not overlooked.
Cost Analysis
➢ Decisions should be driven by NPV analysis of total costs: Standard Cost Capital Costs Support and Contract Costs Shipping, Inventory and Tariff Costs.
➢ Cash flow restrictions must be considered.

4.2 Recommendations

Polaroid's business has changed dramatically in the past few years. New management is in place and a new culture is evolving. Polaroid is transitioning from a technology-based company to a marketing-based company. Based on the information gathered, the implementation of a well thought-out manufacturing sourcing process could provide a substantial positive impact to Polaroid's business. A Manufacturing Sourcing Decision process and applicable tools will integrate well with the existing Product Development Process. Additionally, managing vendor knowledge will become increasingly important as Polaroid moves towards becoming an innovative product development company.

The results of the research provide a great amount of insight into the theoretical "dos and don'ts" of developing an optimal manufacturing sourcing strategy. The challenge is to take this information and apply it to the current situation of Polaroid to develop and implement a process that will work.

The primary recommendations from the gap analysis can be summarized as follows:

I. Manage the product base as a whole.

II. Define strategic products and processes.

III. Drive product sourcing decisions based on customer requirements (key criteria) and total supply chain costs.

In order to **manage the product base as a whole**, Polaroid must ensure that all applicable information is gathered regarding the manufacturing requirements for each product and that critical information is not overlooked. This information must then be used in the manufacturing sourcing decision process. Likewise, consistent manufacturer capability information for all potential manufacturing partners, both internal and external, must be captured and efficiently shared throughout company. For individual project decisions, it is often easy to find the local optimal solution for manufacturing, but to manage the product base as a whole, it is critical that

individual project decisions are driven to maximize the total EVA[1]. This may mean that a particular project sees a higher cost for a particular task, but the overall Polaroid benefit is positive.

Products and processes strategic to the company must be in alignment with the overall strategy of the company. The company must decide what is proprietary knowledge, what are their competitive advantages, and what are their biggest risks. What do they not want others to make? Core competencies must be taken into consideration. What does the company want to make? What competencies do they need to acquire? Strategic products and projects are not always easily defined. This determination is often left in the hands of personnel at lower levels who may not have all the information necessary to make these decisions. Also, discrepancies arise as to which products are strategic. Personal biases and survival instincts can get in the way of logical determination. It is critical to define which products and processes are strategic to the company's future, and to communicate this information throughout the company. McKinsey's research confirms that successful companies use a neutral party such as a special committee to determine which products and processes will be defined as strategic (Kluge, 1997). This is a cross-functional task, with input needed from research, product development, marketing, manufacturing, and external manufacturing experts, if available. This is also an on-going task. As company objectives, technology, and competition changes, the manufacturing focus must also change. Good managers at high levels in the organization will be the owners of this process.

The **decision drivers** for manufacturing sourcing decisions should be clear. First and foremost, the company must understand and meet customer requirements. Risks that are not directly quantifiable, such as quality, supply, and increased competition risks, must be added into the overall decision equation. If customers demand a zero defect rate, the manufacturing sourcing decision must support this requirement. Also, economic decisions must be driven by total supply chain costs over the life of the project. It does not make sense to make a decision based on a low labor rate if labor is only 5% of the product's cost. Capital investments, training, raw materials, labor, transportation and shipping, support and contract costs, inventory holding costs, taxes and duties must all be taken into consideration. Again, the overall goal for each individual project is

[1] EVA = Economic Value Added; EVA = (Operating Profit After Tax) – (Earnings * Cost of Capital)

to contribute the most to the EVA of the company. This requires that the company take a long-term view of profit potential.

4.3 Key Criteria

When thinking about the critical aspects of a product in regards to the manufacturing sourcing process, it is essential to determine the key criteria for the product. Best practice data has pointed out that decisions made on cost aspects alone are seldom optimal (Aspen, 1998). Organizations must define the qualitative aspects that are critical to these decisions. What are the most important aspects of the product for manufacturing? What aspects would the customer consider to be the most important? The specific key criteria will likely be different for each product. To make the process of determining the key criteria easier, it is helpful to think about what areas need to be explored. From the best practice data and the current practice data at Polaroid, the key decision areas for manufacturing sourcing decisions can be segmented as follows: Technology, Product and Process Support, Quality, and Supply Chain Issues. Thinking about the following questions under each of these decision areas will help you to further define the key criteria.

Technology

- What technologies are used in manufacturing a given product?
  (plastics molding, metal fabrication, surface mount electronics, automated assembly)
- What are the critical technologies for the product?
- Is it acceptable for parts of the production process to be subcontracted?
- What technical capabilities are required from the manufacturer?
  (product design, materials management)

Product and Process Support

- What level of experience and expertise is required in each technology area?
- How complex is the product and the process?
- How much support is the parent company willing to provide to the manufacturer?
- Does the manufacturer have internal capabilities to troubleshoot the process, reduce costs in manufacturing and implement improvement processes?

Quality

- What are the customer's requirements for quality?
- What will be their reaction to poor quality?
- Do customers expect this product to last forever?
- Will the customer pay more for higher quality?

Supply Chain Issues

Supply Chain issues can be further broken down into volume and flexibility requirements and delivery and availability requirements.

- Where are the primary customers located?
- What will customers do if the product is not available when they want it?
- What is the obsolescence rate of the product?
- What are the transportation issues in getting the product from the manufacturer to the customer?
- What governmental policies (tariffs, quotas, etc.) do you need to consider?

The Product Requirements Form that was developed to help Polaroid personnel think about these issues is attached as Appendix B.

5 The Manufacturing Sourcing Decisions Process

All elements of the Manufacturing Sourcing Decision Process developed at Polaroid will be described in this chapter: the process for developing the strategic direction, the frameworks for tactical decision making, the tools to assist in this process, and the knowledge management of the entire process.

The strategic manufacturing sourcing process involves managing the core capabilities in operations and propagating those aspects that help maintain current competitive advantages and/or develop new competencies. As part of this objective, the determination of products and processes important to maintain in-house must be managed. The operations focus must be communicated and understood throughout the company.

The tactical level details how decisions are made on individual products or projects. A Decisions Framework and associated tools were developed to assist with these decisions. Each decision is tied to the strategic management of the system, ensuring alignment of the whole process.

The Knowledge Management System contains three elements. The Knowledge Exchange Network explains how individual constituents must interact and share information for the efficiency of the system. Two knowledge management tools, the Plant/Product Information System and the Manufacturers Capability Knowledge Database were developed to disseminate specific information critical to the manufacturing sourcing decision process. These tools will be discussed in detail.

5.1 Strategic Management of the Manufacturing Sourcing Process

To effectively manage the manufacturing sourcing process, there must be a clear understanding of the company's core capabilities in operations, and how these abilities effect the overall competitiveness of the company. The manufacturing strategy must be in line with the overall strategy of the company. It should be the responsibility of a high level management team to determine the manufacturing sourcing strategy and guide the company in the implementation of

this strategy. This management team will be referred to as the Global Operations Steering Team for the remainder of this paper.

In guiding the manufacturing sourcing strategy, the Global Operations Steering Team is charged with the management of core competencies in manufacturing and the determination of those processes and products important to keep in-house. With only a short research period resulting in limited experience at Polaroid, an attempt was not made to determine the core competencies of the company. The research conducted has led to the development of guidelines to assist management in this determination.

The following figure outlines guidelines for determining which products should be considered for in-house production, versus outsourcing of manufacturing. Although the categories seem fairly simple, they can provide a great amount of insight when attempting to link the manufacturing strategy to the overall company strategy.

We Should Make:

WHAT WE DON'T WANT OTHERS TO MAKE

Because of:

- Proprietary knowledge
- Knowledge which can be used for future product development
- Competitive Advantage
- Potential that manufacturer could become competitor
- Information which could be (inadvertently) shared
- Other Risks (i.e. quality, supply)

WHAT WE WANT TO MAKE

Because of:

- Competency involved that we want to learn for future product development
- Competency that we want to learn for process developments and improvements
- Overcoming supplier power for single source items
- Increased control for changes/improvements in product
- Overall lowest EVA for the company
- Balance of products/volume in-house to maintain talent and distribute fixed costs

WHAT OTHER CAN'T/WON'T MAKE

Because of:

- Low volume
- High complexity
- Low profit

BUT, if a company can make it cheaper than we can, we should be willing to pay them to do so. Look for opportunities to combine lower volume products.

WHAT WE CAN MAKE CHEAPER

Because of:

- Knowledge, skills, experience or desire (ownership) to meet customer requirements for less cost.
- High tech, low volume, low labor content, short life cycle products.

Considering:

- All-in costs - standard cost, cost of quality risk, technical support cost, contract costs, process knowledge for continuous improvement and cost reduction.

WHAT WE CAN MAKE QUICKER (TIME TO MARKET)

Because of:

- Easier communication between development and manufacturing

As seen with:

- In-house developed products or processes.
- Emerging technologies.
- Processes requiring substantial technical support.

Figure 7: In-House Manufacturing Guidelines

The Global Operations Steering Team is also charged with managing and communicating the manufacturing focus, including the specific focus for individual internal sites, and the focus for external manufacturing. The external manufacturing focus will either include details for individual external manufacturing sites, or guidelines as to when to use contract manufacturers, strategic partners, alliances and joint ventures. The guidelines above and the information in the "Best Practices" section will help management to determine this focus, but there is no easy answer. Manufacturing management is charged to show its true value when performing a task such as specifying the manufacturing focus.

There are several dimensions of manufacturing that must be thought through to specify focus. These dimensions include Product Complexity and Technology Level, Process Category, Product Life Phase (i.e. development, ramp-up, full-scale production), Volume, Product Life Cycle, and Core Skills Required. In order for a site to be truly focused, and therefore efficient, there must be consistency across several if not the majority of the dimensions for the products produced there. For Polaroid, the following matrix was developed to help management think about the individual focus areas.

	Process Category	Product Complexity and Technology Level	Product Phase	Volume	Life Cycle	Core Skills
Plant Site A	Manual Assembly and test	High Technology and High Complexity	Manufacturing	LOW	SHORT	test technology, flexibility
Plant Site B	Surface mount electronics	Medium tech products	Development and manufacturing	LOW	MEDIUM	materials management,

Figure 8: Manufacturing Focus Matrix

After this tool is used to develop the manufacturing focus, it can be used to communicate this focus throughout the organization. The manufacturing dimensions identified in this research can be applied to the majority of industries. Again, it takes a concerted effort of a talented, experienced, cross-functional team to determine the optimal focus for the manufacturing sites, but thinking along these dimensions will assure a thorough process.

5.2 Tactical Level Management (Decisions Framework)

After understanding how the manufacturing sourcing decision process is managed from a macro view, it is now important to ensure that each manufacturing sourcing decision for individual products and projects is aligned with the strategic level management of the system. Two decision frameworks and several associated tools were developed to guide this process. The New Product Manufacturing Decisions Process Roadmap (Figure 9) and the associated tools provide a framework for determining the optimal manufacturing/sourcing provider for individual new products. The Existing Product Manufacturing Decisions Process Roadmap (Figure 10) and the associated tools provide a framework for periodic review of the existing products and the manufacturing facilities, ensuring the continued optimization of the system. Each Roadmap provides a systematic structure to expedite a complete and thorough analysis.

The **New Product Manufacturing Decisions Process Roadmap** guides each Product Team through the process of identifying the key criteria for the production and sourcing of the individual product along the key areas of technology, product and process support, quality, and supply chain issues. After these criteria have been identified, the Roadmap then facilitates the process of narrowing the pool of potential manufacturing providers in several successive steps, resulting in the identification of the optimal manufacturer who fits the product requirements for the overall best EVA for Polaroid.

The Roadmap lays out the individual steps to be carried out by the Product Team, the informational inputs required from the Global Operations Steering Team, and the associated tools that have been developed to further facilitate individual steps in the process. Referring to Figure 9, the process steps to be carried out by the product team are depicted in the middle of the map. The ovals on the right-hand side depict communication with the Global Operations Steering Team. The bullet points on the left direct the users to the associated tools developed to further guide the process. These tools are detailed below.

Alignment with the strategic direction is ensured by the critical input from the Steering Team regarding the manufacturing focus.

New Product Manufacturing Decisions Process Roadmap

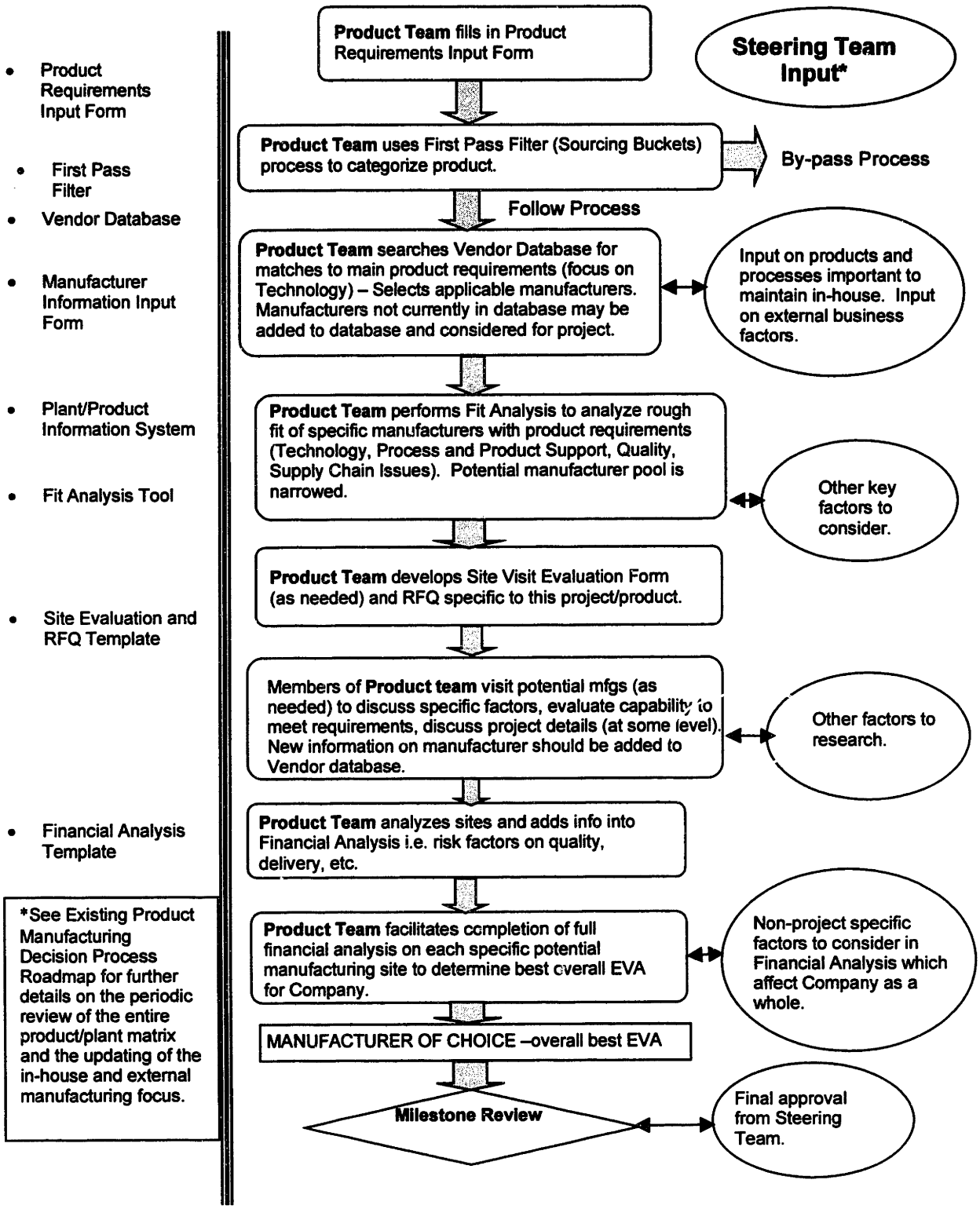

Figure 9: New Product Roadmap

The **Existing Product Manufacturing Decisions Process Roadmap** guides the periodic review of the entire plant/product matrix to ensure continued optimization in the face of changing product conditions, manufacturing site capabilities, and business needs. Referring to Figure 10, the Roadmap leads the group through a periodic review and update of the current product requirements for individual products, and the manufacturing capability information for individual manufacturing facilities. The fit of individual products with current manufacturing facilities is analyzed, and product location changes are recommended. The overall system is then reviewed, financial analyses are performed, and changes are implemented to optimize the system.

The Roadmap provides a tie-in to the strategic management of the manufacturing sourcing decision process through the Steering Team. Updates to the manufacturing strategy can be implemented by changes to product manufacturing locations. Likewise, updated information on the product requirements and manufacturing capabilities can be used as input for updating the manufacturing strategy. With the additional input from Marketing and Research and Development functions regarding new products, technology access plans can be implemented to develop in-house and external manufacturing capabilities as needed. This step assures that the manufacturing organization does its part to speed the process of bringing new products to market. Several of the tools developed to assist with the New Products Roadmap, along with a few other tools, are used to further guide this process.

Several functions play key roles in the completion of the periodic review. Marketing Managers (also referred to as Category Managers) play a large part in this process and are crucial in identifying changing product requirements. Manufacturing Site representatives and Contract Manufacturing representatives play a parallel crucial role in identifying changing manufacturing capabilities. The Global Operations Steering Team continues to play a valuable role in the process by providing critical knowledge for the links to the macro manufacturing sourcing strategy. With so many functions, it is crucial to identify one group to own the process, ensure it is carried through, and implement changes and improvements as needed. In the case of Polaroid, a small group of managers in Global Operations was identified to own the process. This group is referred to as the Global Operations Representatives (Global Ops Reps) on the Roadmap.

Existing Product Manufacturing Decisions Process Roadmap

TOOLS

- **Product Requirements Input Form**
- **Vendor Database**
- **Manufacturer Information Input Form**
- **Fit Analysis Tool**
- **In-house Manufacturing Focus guidelines**
- **Manufacturing Focus Matrix**
- **Plant/Product Information System**
- **Financial Analysis Template**
- **Plant/Product Information System**

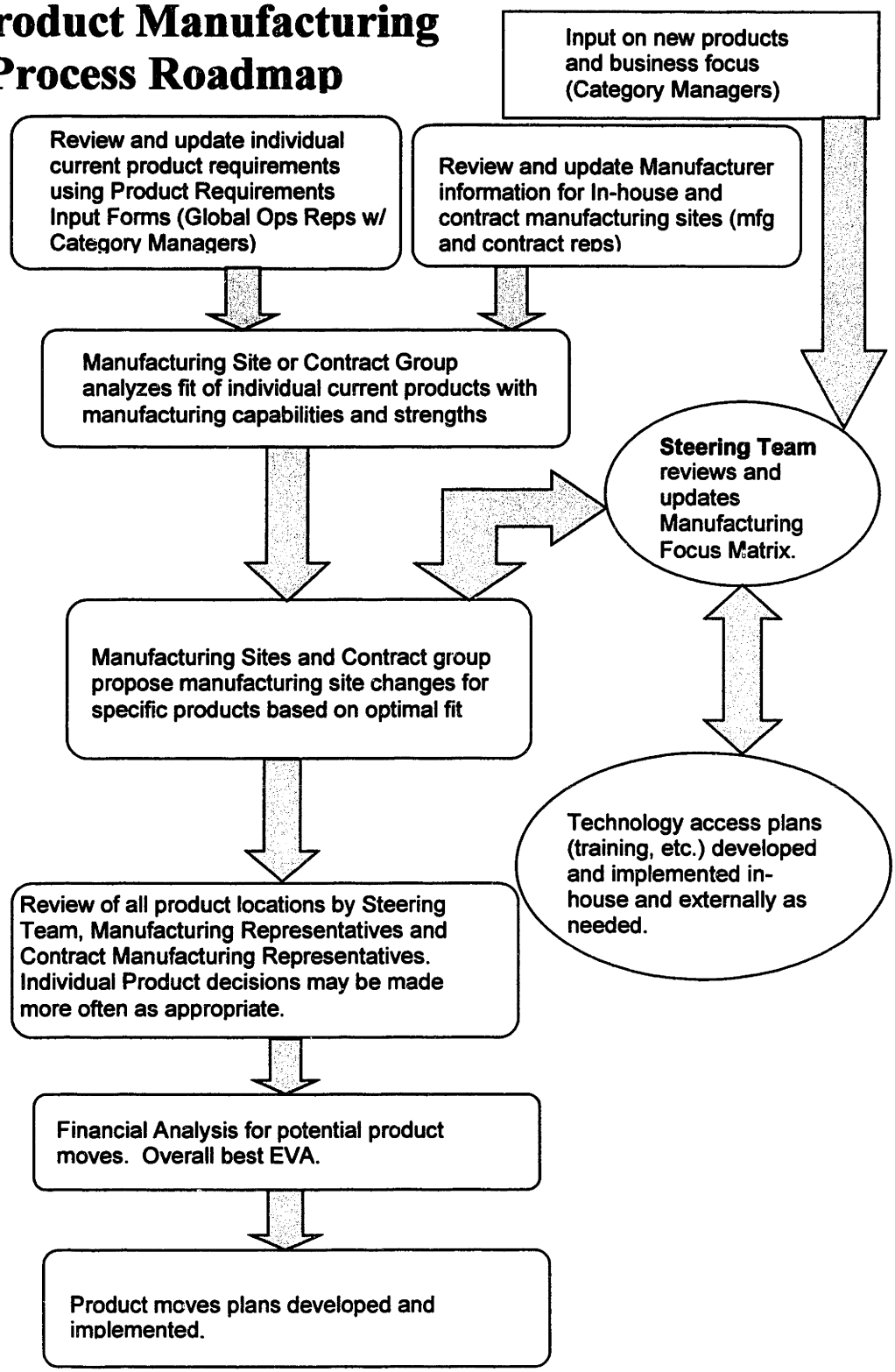

Figure 10: Existing Product Roadmap

5.3 Manufacturing Sourcing Decision Tools

Several tools were developed to further assist the user with the manufacturing sourcing decision process. Some of these tools will be discussed further in the Knowledge Management System Section. Each of these tools is referenced in the New Product Manufacturing Decisions Process Roadmap and/or the Existing Product Manufacturing Decisions Process Roadmap. The tools range in scope from templates to databases to guidelines. Their purpose is to provide further assistance in the manufacturing sourcing process. They support the goals of consistency and thoroughness in the process. They help to ensure that each project is looked upon with a total supply chain view, and that each decision optimally contributes to the overall EVA of the company. Used in conjunction with the Roadmaps, they will speed the process towards achieving the optimal goal. As with the rest of the process, the tools will need to be updated and improved with changing business conditions. These tools were developed by taking the best examples of how these process steps are currently accomplished, and improving upon the current methods with knowledge gained from the best practice research. These tools were developed especially for the Polaroid hardware business, but as with much of the research, will provide assistance to many companies and industries with little or no modification. The tools are detailed below.

The **Product Requirements Form** provides a consistent and thorough format for the Product Team to capture product and customer requirements information critical to the manufacturing sourcing decision. This template ensures that critical manufacturing requirements are not overlooked. The template focuses on total supply chain costs.

The Product Requirements Input Form developed for Polaroid is shown in Appendix B. The key requirements were split into four main headings: Technology, Quality, Process/Product Complexity, and Supply Chain. Supply Chain issues can be further broken down into volume and flexibility requirements and delivery and availability requirements. Questions were developed specific to the Polaroid Hardware business to further categorize the needs of the product. This information is then used to match the product requirements with the manufacturing capabilities of individual sites to find the optimal fit.

The **First Pass Filter** tool is a categorization flowchart to determine what products should by-pass the overall Manufacturing Sourcing Decisions Process. This flowchart provides a systematic short cut for those products in which the sourcing decision is relatively easy.

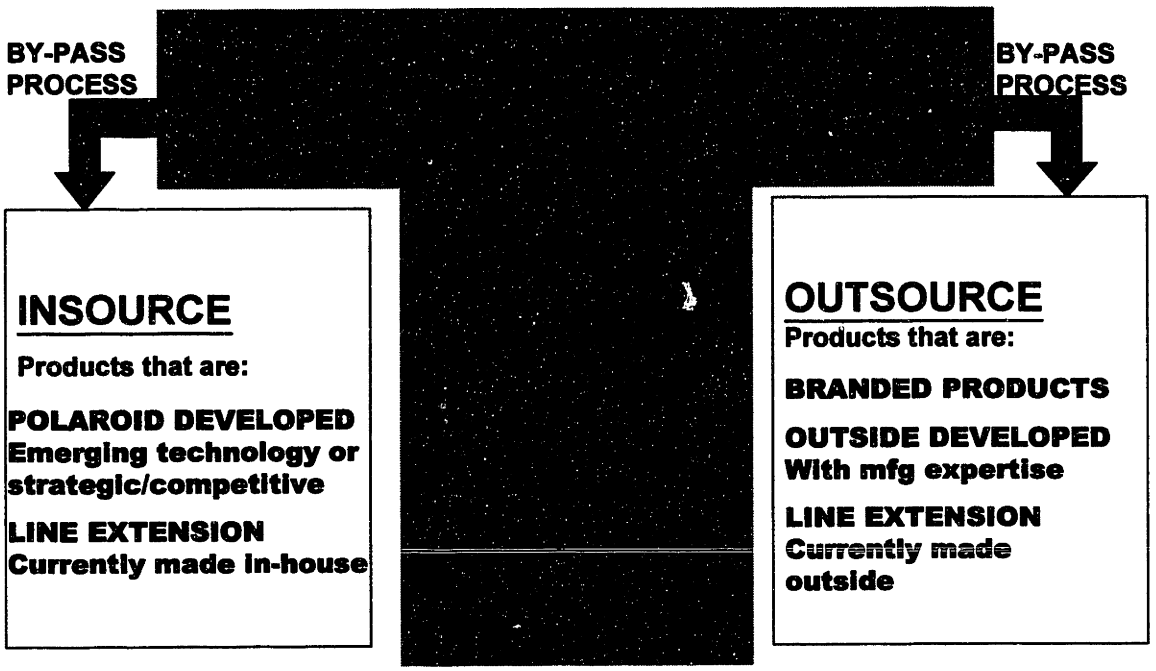

Figure 11: First Pass Filter

The flowchart separates products into three categories: those that should be insourced (manufactured in-house), those that should be outsourced, and those that need to go through the process in order to reach the optimal decision.

The **Vendor Database**, or the Manufacturers Capability Knowledge Database as it is referred to in the Knowledge Management section, provides an accessible and searchable storage location for all manufacturer information. Although the term Vendor Database is used, the intention of this database is to capture the capabilities of both in-house and outside manufacturing providers. The database should be updated any time there is contact with a manufacturing site and new information is gathered. As shown in the Roadmaps, the Vendor Database is used to assist in

new product decisions, to analyze existing product locations, and to periodically review the entire Plant/Product system. This system is discussed in greater detail in the Knowledge Management section below.

The **Manufacturer Information Form** is the parallel to the Product Requirements Form. It provides a consistent and thorough format to capture manufacturing plant experience and capabilities to be matched with product requirements. This information is input into the Vendor Database. The Manufacturer Information Form is attached as Appendix C. As with the Product Requirements Form, it is broken into the four requirement headings of Technology, Quality, Process/Product Complexity, and Supply Chain issues.

The **Plant/Product Information System** provides information on manufacturing locations including contact information, products, and historical sales data (where available). Information is provided in a graphical map format with hypertext linked information to assist in optimal management of entire Plant/Product matrix. This system is discussed in greater detail in the Knowledge Management section below.

The **Fit Analysis Tool** provides a consistent format for matching a product's needs with a manufacturer's capabilities. The Fit Analysis Tool helps the user to make use of the information gathered in the Product Requirements Form, and determine how a particular manufacturer's capabilities fit with the needs of the product. The manufacturer information may be provided by the Vendor Database, or it may be new information gathered with the assistance of the Manufacturer Information Form. The Fit Analysis Tool is attached as Appendix D. It leads the user through a scoring process to determine the fit between the product and the manufacturer on the categories of Technology, Process/Product Support, Quality, and Supply.

A **Site Evaluation and RFQ Template** provides a uniform format for detailed manufacturing site evaluation and request for quotation. This template is provided to ensure consistency of information and reduce time in re-invention. At the time of this writing, this template has not yet been developed for Polaroid.

The **Financial Analysis Template** provides a format for detailed financial evaluation. The template guides the team towards a full supply chain analysis of overall costs to the company. The template is provided to ensure consistency of information and reduce time in re-invention. The template developed for Polaroid is attached as Appendix E.

The following tools were developed especially for the strategic management of the system. These tools provide further details on the periodic review of the entire product/plant matrix and the updating of the in-house and external manufacturing focus. These tools are also discussed in the Strategic Management section above.

The **In-house Manufacturing Focus Guidelines** provide assistance to the Manufacturing Sourcing Steering Team in determining what technologies, products and processes are important to maintain in-house. These guidelines are depicted in figure 7 above.

The **Manufacturing Focus Matrix** provides a format to be completed, reviewed and updated regarding external and internal manufacturing focuses, including the focus of individual internal facilities. Dimensions of manufacturing included are Process Category, Product Complexity and Technology Level, Product Life Phase, Volume, Life Cycle, and Core skills. This tool is to be used by the Global Operations Steering Team for the annual review and update (or more frequently as needed) of manufacturing focus and for on-going communication of manufacturing focus to the rest of the company. The matrix is shown as Figure 8.

5.4 Knowledge Management System

The goal of the Knowledge Management System in the manufacturing sourcing decision process is to ensure that knowledge that exists within the company is shared and employed as effectively as possible. The Knowledge Management System will be used to assist in managing the system both strategically and tactically. The overall system should ensure that each decision made on the micro level truly maximizes the total EVA for Polaroid. The macro level management should control the determination of products and process important to maintain in-house and provide for communication of this information throughout the company. Other critical

knowledge, such as information regarding the capabilities of individual manufacturers, should be captured and shared throughout the company. There are three main components to the Knowledge Management System. The first component is a Knowledge Exchange Network, established to formally recognize the importance of managing the manufacturing system, and the need for effective knowledge exchange and communication between several divisions and levels within the company. The second and third components are knowledge management tools: the Plant/Product Information System and the Manufacturers Capability Database.

A **Knowledge Exchange Network** should be established between upper level management and the individual constituents involved in and affected by manufacturing sourcing decisions, i.e. product development teams, the internal manufacturing sites, and the contract manufacturing contacts. Within upper level management, individuals from multiple disciplines should be identified to be part of a group charged with managing the manufacturing system. I refer to this group of managers as the Global Operations Steering Team. Representatives should include members of manufacturing management, product development, marketing, finance, and the legal function. This knowledge exchange network is depicted below.

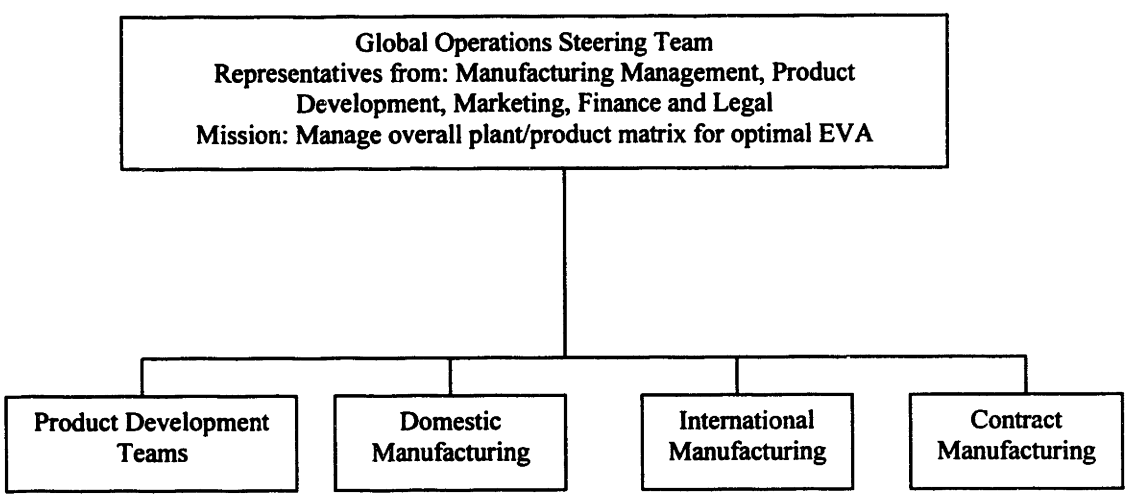

Figure 12: Knowledge Exchange Network

The recommendation to establish this knowledge exchange path does not imply organizational changes or large changes to any individual's critical functions. Rather the recommendation is for formal ownership of this critical task. Perhaps, as in the case of Polaroid, the decision-makers needed for the Global Operations Steering Team already meet as a group for other critical decisions. Likely, they are already part of some of the individual manufacturing sourcing decisions. The critical addition is formal recognition of the importance of knowledge management in regards to manufacturing decisions.

Each of the constituents, the Global Operations Steering Team, the internal manufacturing sites, the Product Development teams, and the contract manufacturing representatives, plays a critical part in maintaining the optimal function of the knowledge exchange network.

As stated above, the Global Operation Steering Team is charged with managing the core capabilities in operations. The Global Operations Steering team must also work with the Product Development Teams and assess new product manufacturing location suggestions as shown in the New Product Manufacturing Decisions Process Roadmap. The Global Operations Steering Team must also assess recommended product location changes from the in-house manufacturing and contract manufacturing groups following the Existing Product Roadmap.

In all of these tasks, the value of the Global Operations Steering Team lies in their ability to bear in mind information not considered by the other parties, including key knowledge to which personnel at lower levels may not have access. This includes information such as existing and planned partnerships, mergers, and acquisitions. Business deals may exist, or be in the works, which greatly affect the optimal manufacturing sourcing decision for a certain product, but the Product Development Team may not have access to this information. The Global Operations Steering Team should also consider the effects of individual decisions on all of the company's products, including those from other divisions, and those which are still in concept and development. Again, the goal is the highest overall EVA for the company. An individual product development team or manufacturing site may not be able to realize how a decision on one product will affect other products. Lastly, the Global Operations Steering Team should provide input regarding government and regulatory incentives and issues. Overall, it is more

efficient for these critical issues to be researched and analyzed at one level in the company. There may be business reasons that the company wants to start production in a country where they have not previously manufactured. Because all manufacturing sourcing decisions go through the Global Operations Steering Team, they are in a position to determine which project and product would be optimal for a new business venture.

The Product Development teams should follow the decision framework as laid out in Figure 9 to determine the best fit for manufacturing of individual products. The Product Development teams should make optimal use of the knowledge exchange path to acquire information on existing manufacturing capabilities, both internal and external, and to obtain input from the Steering team on other issues that may affect decisions.

The main focus of the Manufacturing Sites, both internal and external, is to make product, meet the specifications, meet the schedule, and reduce costs. When a system is set up where manufacturing decisions for each new product are carefully assessed and multiple options are analyzed, as suggested in this paper, the role of manufacturing sites is greatly increased. It is crucial that Manufacturing actively participate in the knowledge exchange path. Manufacturing is no longer solely charged with making product. They must play an active role in attracting new products. Sites must now determine how to best market the skills they have. They must also develop skills as needed, optimally before the skills are required, and advertise these skills. They must assess the fit of current products, and identify other products that might fit their portfolio so that their facility is optimized and costs are minimized. Facilities also must manage the overall production volume, the headcount of workers, and the retention of skills, with a future-looking approach.

It is the responsibility of the Global Operations Steering Team to manage the overall plant/product matrix. Knowledge and management of this system can quickly get overwhelming, as most companies deal with hundreds of products, and multiple internal and external manufacturing facilities. A simple knowledge management tool, the **Plant/Product Information System** was developed to assist Polaroid managers in overseeing the system. A graphical, multi-level interactive computer system was developed as a model of the real system.

This tool is referred to as the Plant/Product Information System. The top level of the model shows a graphic of the world, with icons representing areas where Polaroid has manufacturing operations, including internal and external manufacturing sites.

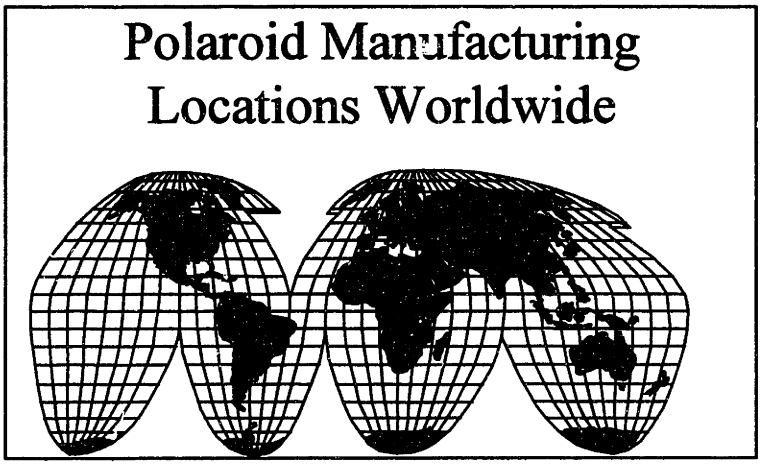

Figure 13: Plant/Product Information System

The user can click on any of the icons to get more detailed information. From the worldview, the user could go to North America, then to the United States, Massachusetts, and Polaroid's Norwood manufacturing facility. The model developed for Polaroid then has links for key contacts at the company, and lists the Polaroid products manufactured there. By selecting a specific product, a trend graph can be seen of the product volume and sales over recent years. This type of system truly provides an easy visual model of a potentially complex product/plant system. The system is easily updated, and can be modified in any way the user sees fit. The system would optimally be linked into other systems so that information, such as updated sales data, could be automatically updated. This type of model is very valuable in understanding and managing the plant/product system.

A second very useful knowledge management tool, the **Manufacturers Capability Knowledge Database**, was also developed at Polaroid. Part of the efficiency of the Knowledge Exchange Network is that one group or individual gathers information that can then be shared with the rest of the company. This decreases the amount of time each project group must spend gathering data, and likely improves the level of knowledge acquired for the decision. The gathering and

sharing of manufacturing capability data for individual plants and sites are optimal uses of this network. At many companies, only a few individuals in the company hold capability information on particular manufacturers, especially external manufacturers. If a Product Development Team does not contact the individual who holds this knowledge, they may not consider this manufacturer. Alternatively, they may contact the manufacturer directly, and waste valuable time and effort gathering information that is already available inside the company. Recent advances in information technology systems and the increased awareness of the importance of knowledge management have brought about several tools that allow us to efficiently manage the great amount of knowledge in a company.

In order to optimally manage the knowledge within the company regarding manufacturing capability at Polaroid, a knowledge management database was developed. The purpose of this database is to store and share basic knowledge regarding the capabilities and core competencies of manufacturers that the company currently uses, has used in the past, or has considered using. The database should be updated any time there is contact with a manufacturing site and new information is gathered. As shown in the Roadmaps, the Vendor Database is used to assist in new product decisions, existing product location analyses, and the periodic review of entire Plant/Product system.

The two key requirements of this type of system are that it is extremely user-friendly, and that it is easily searchable. User-friendliness is a key requirement to get people to use the system. A knowledge management system is only as valuable as the information it contains. The personnel with the knowledge must be convinced that this system will not replace them, but will enhance their work by decreasing the amount of time spent on initial evaluations and freeing up time to do more important detailed analyzes. It is a requirement that it not be much more difficult to input knowledge into this new system than the old "paper and pencil" method, otherwise people will not take time to update the system.

With the system developed for Polaroid, user-friendliness was accomplished in two ways. First, much time was spent researching the data important to collect regarding manufacturing capabilities. The data gathered on how past decisions were made and how decisions should be

made was used to develop a thorough questionnaire regarding manufacturing capabilities of an individual plant. The format followed the four key criteria identified from the best practice research: Technology, Process/Product Complexity, Quality, and Supply Chain Issues. Under each heading, questions were developed to prompt data gathering and input of the important issues. These questions are tailored to the current environment of Polaroid Hardware, and will need to be updated as the environment evolves. Other industries would likely find different questions more appropriate. Multiple choice answers were provided that covered the range of choices applicable to Polaroid Hardware products. These will also have to be maintained and updated over time as technology and business develops. Space is provided in the database to capture other comments. Below is one example of a question developed for Polaroid. In this category, the user is asked to select all the manufacturing technologies used in the production of the product from the predefined list. This information will be matched with manufacturer's capabilities. Refer to Appendix B for the Product Requirements form in its entirety.

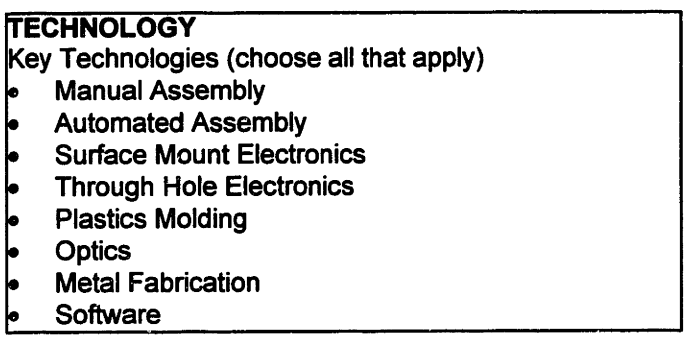

Figure 14: Product Requirements Example Question

The second factor for providing a user-friendly database is to make the user interface as simple as possible. In order to replace the pen and paper systems, the database must be accessible from each individuals desktop computer. It should be as easy to access as e-mail or the internet. Providing a consistent template for information input as described above provides great assistance to those using the system daily. Using a structure similar to that of many web pages, with multi-colors, and pull-down boxes, also makes the system seem less complex than a typical database.

On the knowledge retrieval side, the system needs to be more efficient for the user than the current method of gathering the information from several different internal sources and the manufacturers themselves. This "ease of use" function is easily met by making the database searchable. The search mechanism is set up much like search mechanism on the internet with key word access. To make the system more simplistic the search mechanism is set up in such a way that the user makes selections from a multi-question multiple choice menu. This system mirrors the data input system. The user can select "camera manufacturers" in "China" and the computer will bring up data on all manufacturers in the system meeting those criteria. It truly provides a quick and efficient way to perform the preliminary analysis of potential manufacturers.

The Polaroid database itself is rather simple, employing Microsoft Access as the building structure. The template structure of the data input enhances the ease of developing a searchable database. The database was set up so that anyone with access to the system can input new records, but existing records can not be manipulated. The identity of the person and the date the information was entered is recorded. There may be several records on one company, input on different dates by different people, all of which can be found through a simple search. The database is also set up so that potential answers under the multiple choice questions can be easily added or changed by a database administrator.

These knowledge management systems elements make optimal use of available information technology to increase efficiency of the manufacturing sourcing system. Increased communication helps to knock down some of the barriers created by a complex supply chain involving multiple organizations and assists in the efficient management of the system.

6 Proof of Concept and Implementation at Polaroid

Two analyses were performed to validate the manufacturing sourcing process developed for Polaroid. Implementation of the system is in progress. An example of one successful use of the process within Polaroid is described.

6.1 Validation

The following table restates the gaps between Polaroid's current practices in manufacturing sourcing decisions and the best practices. The identified gaps are matched to the tools that were developed to improve the process and close these gaps.

Identified Gap	Tools
Identification of Core Products and Processes	➢ In-House Manufacturing Guidelines ➢ Manufacturing Focus Matrix ➢ Existing Product Roadmap
Manufacturing support for rapid new product development	➢ Manufacturing Focus Matrix ➢ Manufacturers Capability Database
Knowledge Management	➢ Knowledge Exchange Network ➢ Manufacturer Capability Database ➢ Plant/Product Information System
Management of Vendor Base as a whole	➢ Plant/Product Information System ➢ Manufacturing Focus Matrix
Consistent Process for determining WHO is involved in the decision-making	➢ New Product Roadmap ➢ Knowledge Exchange Network
Consistent Process for determining WHEN decision is made	➢ New Product Roadmap, linked to Produce Development Process map
Consistent Process for determining WHAT criteria are assessed	➢ Product Requirements Input Form ➢ Manufacturer Information Form ➢ Fit Analysis Tool
Cost Analysis	➢ Financial Analysis Template

Figure 15: Identified Gap and Tools Relationship Table

As further validation, the following figure shows the documented decision process used as a starting point for this project and shows which parts of the newly developed process help to address the noted gaps.

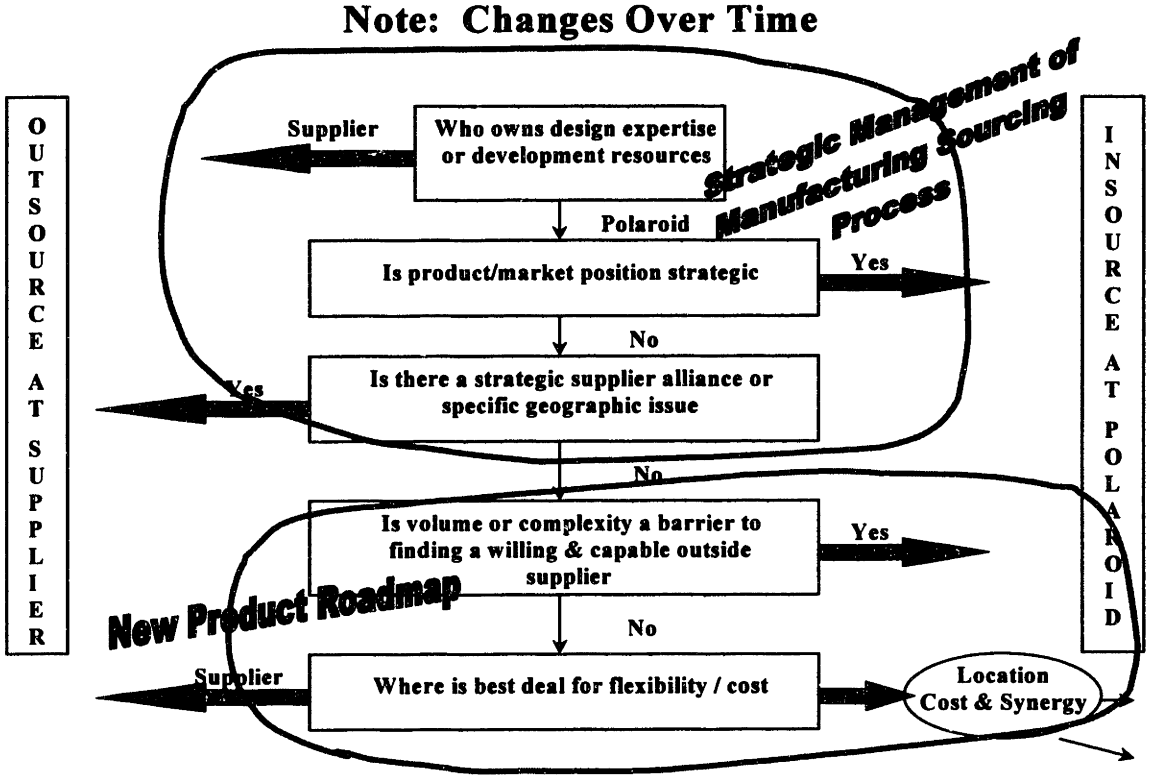

Figure 16: Validation of Process

The strategic management of the process helps to define who should own the design expertise before the project is initiated. The First Pass Filter tool will allow products to easily by-pass the manufacturing sourcing decision process if the company has made a conscious decision to outsource the technology. The Global Operations Steering Team will define the strategic products and market positions, and communicate relevant alliances and geographic issues. The New Product Roadmap and tools help to determine the key criteria of the product and determine the optimal match with a manufacturing site.

6.2 Implementation at Polaroid

Implementation of a new process is often more difficult than development of the process. Implementation difficulties are enhanced in a large global company like Polaroid.

Institutionalizing the process as part of the routine work rules is a primary key to the success of this process. At the time of this writing, the process has not been completely implemented. Portions of the process have been repeatedly tested with positive results. Upper management is supportive of the process. The author has turned over implementation of individual pieces of the process to key personnel within the organization. Refinement of the process and the tools as they are further used and tested is key to the continuing success of the manufacturing sourcing system.

At Polaroid, a management team with the constituents recommended for the Global Operations Steering Team was already in place to handle other strategic issues. After presentations by the author to upper level management, the existing management team was charged with adding the tasks of the Global Operations Steering Team to their goals. The Steering Team is essential to the overall implementation of the manufacturing sourcing process. They must police the system to make sure the process is being used as required and updated as needed.

As stated above, the Knowledge Exchange Network is not a formal network. The communication represented by the Knowledge Exchange Network follows from the formation of the steering team and the communication that is required to follow the decision roadmaps.

At this time, the Manufacturing Focus is being worked on by a separate effort developed in parallel with this process. The author has shared the insight from gap analysis and the In-House Manufacturing Guidelines with the manufacturing focus team. This information was used as input into their process.

At the time of this writing, several steps have been completed to establish Vendor Database. The structure of the database has been completed, including identification of the information to be gathered, development of the input and output screens, and primary development of the search functions. Future users have stepped through the program and have provided initial feedback that has been used to improve the system. Using the Manufacturer Information Input Form, information has been gathered from the major hardware providers, both internal and external. Next steps involve populating the database with the information and piloting the system with

future users. For the present, the database will reside in a company-wide server, and the front-end program will be installed on individual's computers. The future plans are to tie the database to the intranet to allow easy access to the system by anyone with proper security clearance.

The plans for implementation of the tactical process are to provide the frameworks and tools on Polaroid's intranet system, and link the New Product Roadmap to the Product Development Process which already resides on the intranet system. The associated tools and the Existing Product Process will be linked to the New Product Roadmap. This will allow easy access by all Polaroid personnel, and will make use of the Product Development Process that is already institutionalized at Polaroid. Another advantage of the intranet system is that improvements and updates to the system can be made quickly and easily and are instantly available to users.

6.3 Product Examples

During the development of the process, feedback was gathered on each of the tools individually. During a visit to the Polaroid Scotland (Vale of Leven) facility, the personnel at that site provided valuable information for the revision of the Manufacturer Information Input Form and the Product Requirements Form. The Fit Analysis Tool was developed with assistance from this group, and three products were piloted through the process to determine the "fit" with the Vale of Leven site.

A more thorough test of the system was performed on a hardware product that was being analyzed for a potential move from its current manufacturing location. Based on standard cost alone, it seemed that the product should be moved to an external manufacturing site. Previously, the analysis may have stopped here. The project team decided to use some of the new manufacturing sourcing tools to more thoroughly analyze the options.

The Product Requirements Form was filled out for the product in question. This brought out several points to consider, including volume, remaining lifecycle, and transportation issues. The Manufacturer Information Input Forms for the three sites to be considered were completed. The Fit Analysis Tool was then used to determine risks in matching the product with a particular site. It was found that there were additional risks in going with the external manufacturer due to

information uncovered in the Product Requirements Form. Using this information, a complete financial analysis was performed to supplement the qualitative analysis. The financial analysis included capital costs to move the process, transportation costs, and actual costs to Polaroid for production (standard cost, or actual savings by transferring product), considering volume and lifecycle projections. When this analysis was complete, it was apparent that the decision reached by looking at standard cost alone was not the optimal decision for Polaroid. Polaroid was better off financially and experienced less non-quantifiable risks by continuing to produce the product internally. Due to this thorough analysis, the product was not moved.

7 Applying the Process, Lessons Learned and Future Work

The majority of this thesis has been tailored towards the work done at Polaroid regarding the manufacturing sourcing process and Make/Buy decisions. This chapter discusses how the work can be implemented in other organizations. In addition, significant lessons learned during the research are shared, and ideas for future work that would enhance the learnings from this research are presented.

7.1 Application of the Manufacturing Sourcing Process at other Companies

The strategic management concepts, tactical frameworks, and knowledge management system developed to assist Polaroid with manufacturing sourcing decisions are based on the gap between the practices of the corporation and current best practices. Careful thought was put into how these systems integrate with other systems. Before applying elements of this system to another corporation, it is wise to understand the gaps in your current system and the most efficient areas for improvement efforts. Successful application of any new tool requires that it fit with existing processes and can meld with the company culture, or that there are plans to overcome barriers to the implementation.

On the other hand, this research has shown that there are many companies who are in similar positions to Polaroid in regards to manufacturing sourcing decisions. Other companies are struggling with the best ways to employ outsourcing without experiencing significant long-term risks to their competitive position. Many companies are struggling with how to optimally manage a large product line with fast product introductions. As corporations become more global and more functions are performed external to the organization, the value of understanding and managing the entire supply chain is increasing. For this reason, the strategies and concepts discussed in this thesis are relevant to a large number of organizations. Moreover, many of the elements of the specific systems and tools discussed are applicable. The optimal interfaces with existing systems must be explored at each individual company. Implementation strategies will need to be developed, and technical details adjusted. But the strategy, frameworks and knowledge management systems suggested provide a structured, tested system that will be a valuable model for any company seeking to optimize their supply chain system.

The following steps lay out a simple plan for using the information in this thesis to develop a custom manufacturing sourcing system for your corporation.

STEP 1:

Complete a **Current Practice Analysis** to understand how manufacturing sourcing decisions are made in your organization.

STEP 2:

Analyze the gaps between your current practice and best practices using the information in this thesis and other relevant information.

STEP 3:

Compare your "Areas for Improvement" from the gap analysis with those identified in this thesis.

STEP 4:

Refine the primary recommendations based on information from your individual company.

STEP 5:

Determine the improvements needed in the Strategic Management of the Manufacturing Sourcing Process.

STEP 6:

Determine improvements needed in the Tactical Management of the Manufacturing Sourcing Process.

STEP 7:

Implement a Manufacturing Sourcing Process for your organization, using the tools, frameworks and knowledge management systems described in this thesis where applicable.

7.2 Lessons Learned

The following summarizes the Top 10 lessons that were highlighted during my six-month research assignment at Polaroid.

Processes

1) The documentation of an existing process can be an improvement in itself as people are forced to discuss and collaborate regarding the best way to perform a task, thus increasing the overall effectiveness of the organization.

2) Documentation of a process provides the corporation with protection against "renegade" decision-makers. The process provides a check in the system.

3) When developing or improving a process, the instances when it is acceptable to by-pass the process should be documented. This maintains the structure of the system without compromising speed and efficiency.

4) Structured processes should be used to assist personnel with complex decisions. They do not replace the value of human input.

Information Technology (IT)

5) The potential value of IT is greatly outpacing its implementation in industry.

6) The actual value of IT systems are greatly affected by the culture of the organization, the input of key personnel in development of the systems, and the effective training of personnel expected to use the systems.

Culture

7) "Cultural Change" is likely the most difficult task one can undertake in a company, particularly if it is labeled as such.

Manufacturing Sourcing

8) Successful manufacturing sourcing requires a well-developed strategy and an integrated tactical process.

9) There is no magic formula for developing a great strategy.

10) Successful outsourcing of parts of the supply chain requires top-notch communication, business, and technical capabilities at the interface levels of each organization.

7.3 Future Work

Three main research areas were identified to supplement this research on manufacturing sourcing decisions.

Alliances and Partnerships

The first area for future work asks a question integral to the successful implementation of a manufacturing sourcing system with external partners. "How do alliances and partnerships fit in to the Make/Buy strategy?" The differences between contract manufacturers, strategic alliances and partnerships require different interface relationships between a company and the external manufacturer. Is a legal contract required? Is it sufficient? How much control should the parent company maintain? What details need to be agreed upon? These questions must be answered so that the optimal use of outsourcing can be determined and long-term risks can be minimized.

Make/Buy for Components

How do the concepts developed for final products apply to components? The following graphic shows how the decisions for a whole product can be looked at as a series of Make/Buy decisions.

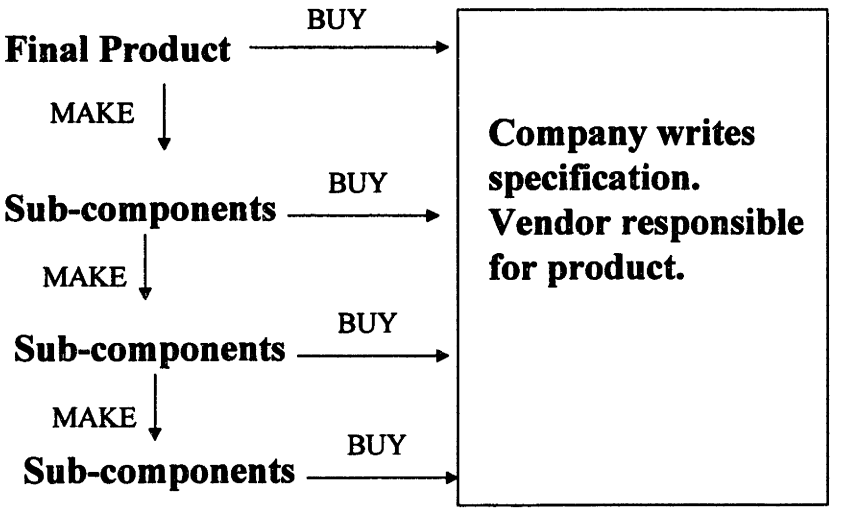

Figure 17: Make/Buy for Components

Many of the concepts developed for the final product Make/Buy decisions can likely apply for decisions throughout the supply chain.

Develop/Buy

Beyond Make/Buy decisions for manufacturing, many organizations are also exploring the benefits of outsourcing development activities. There are several critical interfaces between the Develop/Buy decision and manufacturing decisions. Companies need to think about the entire supply chain when selecting a development partner. One critical question that must be kept in mind is "what is the fastest and most economical way to get this product to our final customers?" In creating a Develop/Buy strategy, a lot of the concepts discussed for Make/Buy decisions apply. Companies could follow a similar set of strategic guidelines in identifying what they want to develop and what we don't want others to develop. The relationship with the development partner, and the required interface, is at least as important as it is in Make/Buy decisions.

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Appendix A: Make/Buy Interview Questions

Make/Buy Process Interview Questions

Name:

Department:

Date:

Current Situation

- Summarize your experience with make/buy decisions at Polaroid.
- How does Polaroid currently make manufacturing sourcing decisions? Is there a formalized process?
- What are the key business principles upon which these decisions are based?
- Does the overall Polaroid manufacturing strategy give clear directions for decisions?
- What drives a decision to look Inside Vs. Outside?
- Do you have a primary list of outside resources, or do you look at new possibilities for every product?
- How do you determine which companies to research for outsourcing?
- How do you determine if a company is capable of performing the task?
- How do you make a decision between two similar outside companies?
- Who do you work with on sourcing decisions? What are the roles of the individuals?
- Who are your customers, and how much involvement do they have during the process?
- What works well, what doesn't?
- What percent of our sourcing decisions do we make correctly?
- How would you grade Polaroid on our ability to make correct sourcing decisions?
- Do you have any current negotiations I could sit in on, learn from?
- Specific examples – Case Studies. Ask same questions with regards to a specific project.
- How do you determine the correct risk/reward ratio for Polaroid in manufacturing sourcing decisions?
- Does Polaroid prefer to have a single source or several? Why?
- What percent of the products you work with are made inside Polaroid Vs. outside?
- Overall would you say outside or inside manufacturing is better? Why?

- Of the outsourced products, what percent is transactional and what percent is strategic?
- Can you think of any model companies we should research on manufacturing sourcing issues?

For the Future

- What products should Polaroid be making? Why?
- What key principles of business should drive these decisions?
- Who should be involved in the process?
- What percent of manufacturing is it "safe" for Polaroid to outsource?
- What level of involvement should Polaroid have in strategic alliances? (quality assurance, technical support, etc.)
- What do you see as the future requirements/opportunities for tailored systems or customization?
- Should this be performed within Polaroid or outside? Why?
- List the minimum task involvement Polaroid should have in manufacturing a product if that product carries the Polaroid name?
- Should Polaroid look at transferring end-of-life products to OEM vendors? IF so, what products?
- What are the advantages, disadvantages?
- Should the Polaroid name still be attached to the product?
- What would be your preferred format for a Make/Buy process?
- (checklist, rated questionaire, computer program?)
- What would be the best way to institutionalize a Make/Buy process?

Appendix B: Product Requirements Information Form

PRODUCT REQUIREMENTS INFORMATION INPUT/CHANGE FORM

The information that you input into this form will be used to match the product requirements with the capabilities of potential manufacturers. The output of this process is a list of manufacturing vendors that meet the requirements of the product. Both internal and external sites are considered. For the selected vendors, you will be able to access the detailed information in the vendor database to further assist your analysis.

Name of Product_____

Contact Person _____

Phone Number_____

Fax Number_____

E-mail Address_____

TECHNOLOGY

The technology requirements of the product are matched with the manufacturing vendor's expertise and experience.

Key Technologies (choose all that apply)

- Manual Assembly
- Automated Assembly
- Surface Mount Electronics
- Through Hole Electronics
- Plastics Molding
- Optics
- Metal Fabrication
- Software

Type of Product Experience (choose all that apply)

- Mechanical
- Mechanical/Optical
- Electro-mechanical
- Electro-optical
- Electronic

Type of Product (choose one)

- Digital camera
- 35 MM camera
- Instant film camera

- Printers
- Scanners
- Projectors
- Software
- Electronic Component
- Media Handler Component
- Integrated System
- Film Holders/Camera backs
- Portrait/ID Cameras
- Still Video Cameras
- Other digital/computer equipment
- Other Hardware (non electronic)

Component Output
- Digital Output Component
- Thermal Media Output Component
- Integral Film Output Component
- Peel-apart Film Output Component

Technical Strengths Required (choose all that apply)
- Product Design
- Product Assembly
- Materials Management
- Process Design
- Test Equipment Design
- Test Plan Development
- Turn-key Systems (vendor provides everything)
- Manufacturing Technical Support – Troubleshooting
- Manufacturing Technical Support – Cost Reduction
- Manufacturing Technical Support – Process Improvements

Proprietary technologies – *Will manufacturing the product involve a transfer of information regarding proprietary technology?*
If proprietary technologies are involved, there is less risk involved in going with in-house manufacturing, or vendors that we have worked with before on similar issues.
- Yes
- No

QUALITY
The level of quality required for the product will be matched to the vendor's capabilities.

How important is the quality of this product to the customer?
- Extremely important – customer expects the product to be perfect and is willing to pay extra to ensure high quality level

- Very Important – customer expects the product to be high quality, and is willing to pay a slight premium
- Important – customer expects good quality without added cost
- Less Important – customer is more interested in other factors such as cost, service, availability

Quality Program – Select the quality system below that best matches the minimum requirements for this product.
- Minimum inspection requirements (established per product, minimal special skills/training required)
- AQL/AQS required (measuring, recording data, separate QA/QC function preferred)
- SPC experience required at the floor level, strong QC/QA function required
- True focus on quality, including continuous improvements programs (i.e. Six Sigma)

PROCESS/PRODUCT COMPLEXITY

The support requirements of the product and process are compared to the technical capabilities of the manufacturing vendors, and the proximity of expert and development support to the proposed manufacturing site.

Process Support Required – Select the expected level of support required
- High (expected >3 full-time engineers support)
- Medium (expected 1-3 engineers support)
- Low (expected <1 engineers support)

Number of distinct operational steps
- <X
- X-XX
- >XX

Complexity of Product
- Simple (commodity)
- Medium Complexity
- Highly Complex (Customized)

Number of Parts per Product
- <X
- X-XX
- >XX

Level of Customization – How much of the product involves "option" type items where one product may be different than the next depending on the customer's requirements/preferences?
- Every product is identical
- One or two minor items may be different from one product to the next
- A few minor items may be different, or one or two major items may be different

- A few major and minor items may be different

Stability of Design (expected number of engineering change orders)
- >10/month
- 1-10/month
- <1/month

Location of Technical Support (product development for new products, technical knowledge base for existing products)
- Massachusetts
- Other US location
- Vale
- Other UK location
- Europe
- India
- Far East

VOLUME/FLEXIBILITY

The volume requirements for the product are compared to the manufacturing capacities of the vendors. The estimated accuracy of the volume estimates, and the confidence that those estimates are correct is related to the capacity flexibility of the vendors.

Approximate product volume per year
- High (>XX per year)
- Medium (X-XX/year)
- Low (XX/year)

Accuracy of volume predictions – with HIGH confidence, we will hit the volume predictions with an accuracy of:
- +/- xx+%
- +/- xx%
- +/- xx%
- +/- x%

Expected stability of manufacturing orders
- Low (stable within 14 days, 10% change 14-30 days in advance, 25% change 30-60 days, any change beyond 90 days)
- Medium (stable within 30 days, any change beyond 150 days)
- High (Stable within 60 days, any change beyond 6 months)

Expected remaining product life cycle (before obsolescence or significant (>30%) drop in volume)
- Long (>7 years)
- Medium (3 years – 7 years)
- Short (12 months –3 years)

- Very Short (<12 months)

Platform Product - Is the product part of an existing platform of products?
If the product is part of an existing platform, the current manufacturing vendor of other products in the platform will be highly considered.
- Yes
- No

If so, where are other current products made?

Is product potentially the first in a line of platform products?
- Yes
- No

DELIVERY/AVAILABILITY
The requirements of the customer for delivery and availability will be compared to the vendors capability and past performance in these areas. Proximity of the manufacturing site to the final customer is also taken into account.

Customer Requirements – How important is delivery and availability of the product to sales
- Extremely important – if the product is not available when and where the customer wants it, we will lose the sale
- Very Important – There is a 50% possibility that the Customer will wait a few days if product is not immediately available
- Important – It is highly likely that the Customer will wait a few days if the product is not immediately available
- Less Important – Product has other key features which are much more important than availability, and customer is willing to order product and wait for delivery.

Location of final customer – Mark the location(s) of the major final customers for this product
- USA
- Europe
- Asia
- Central/South America
- Europe

Lead Time – What is the maximum lead time allowable (order to customer delivery). Consider the requirements of the customer, the needs of the product, the life cycle of the product, and obsolescence possibilities.
- < X time
- X-XX time
- >XX time

Frequency of Deliveries – What is the required frequency of deliveries from the manufacturer?
- One time delivery
- Less frequent than every 2 months

- Every 1-2 months
- More frequent than 1 delivery per month

COST

Cost requirements of the product are compared to the vendor cost structure. High labor content makes low wages attractive. High shipping costs causes proximity to be a concern.

Customer Requirement – how important is the price of the product in customer purchase decisions?

- Extremely Important – Purchase decisions are made on price alone and there is substantial price competition with substitute products
- Very Important – The customer will consider several factors in their purchase decision, but will weight price highest.
- Important – The customer will consider cost along with several other factors in their purchase decision
- Less Important – Within reason, customer purchase decision is not affected by the sales price

Labor cost - What percent of the cost of producing the product is estimated to be labor?

- <5%
- 5%-20%
- 20%-40%
- >40%

Shipping cost – Categorize the expected shipping costs as compared to the cost of the product. Take into consideration the cost of producing the product, versus the weight and volume of the product

- Low shipping costs (expensive, small, light – i.e. small electronic components)
- Medium-low shipping costs (less expensive, bigger or heavier – i.e. digital equipment)
- Medium-high shipping costs (combination of less expensive, bigger and heavier – i.e. cameras)
- High shipping costs (i.e. integrated systems with large components)

Appendix C: Manufacturer Information Form

MANUFACTURER INFORMATION FORM

The information you provide will be used by Polaroid to conduct Make/Buy manufacturing evaluations. The information is used as input into the Manufacturing Sourcing Decisions Process which matches manufacturer information with product requirements.

GENERAL INFORMATION

Company/Organization _____
Contact Person _____
Address _____
_____
_____
Country _____
Phone Number _____
Fax Number _____
E-mail Address _____
URL _____
Principles
President _____
Vice President _____
Others _____
Financials
Year _____
_Individual _Partnership _Corporation
Subsidiary of: _____
Sales _____
Total Assets _____
Current Assets _____
Current Liabilities _____
Fixed Assets _____
Inventory _____
Cost of Capital _____
Year Company Started _____
Key Customers _____
_____

Company Experience
Have we done business with this company before (previous or current)?
_____Yes _____No
Years _____
Products _____
_____
Internal Contact _____
Comments _____

Has the company previously been considered for business?
_Yes _No
Years _____
Products _____
Internal Contact _____
Comments _____
_____

MANUFACTURING INFORMATION

Facility Location _____

Other facilities _____

Square footage _____

Number of employees

Direct labor _____

Support _____

Does the company employ a temporary work force?

_Yes _No

% of work force _____

Average time at company_____

Union?

_Yes _No

TECHNOLOGY

Key Technologies (Choose all that apply. If technology is available through vendor, but is outsourced to another vendor, mark key technology, and specify as outsourced in notes)

- Manual Assembly
- Automated Assembly
- Surface Mount Electronics
- Through Hole Electronics
- Plastics Molding
- Optics
- Metal Fabrication
- Software

Comments

_____

_____

_____

Type of Product Experience (choose all that apply)

- Mechanical
- Mechanical/Optical
- Electro-mechanical
- Electro-optical
- Electronic

Product Experience (choose all that apply)

- Digital camera
- 35 MM camera
- Instant film camera
- Printers
- Scanners
- Projectors
- Software
- Electronic Component
- Media Handler Component
- Integrated System
- Film Holders/Camera Backs
- Portrait/ID cameras
- Still Video Cameras
- Other digital/computer equipment

- Other Hardware (non electronic)

Comments

_____

_____

_____

Component Output Experience (choose all that apply)
- Digital Output Component
- Thermal Media Output Component
- Integral Film Output Component
- Peel-apart Film Output Component

Comments

_____

_____

Technical Capabilities (choose all that apply)
- Product Design
- Product Assembly
- Materials Management
- Process Design
- Test Equipment Design
- Test Plan Development
- Turn-key Systems (vendor provides everything, very little Polaroid involvement)
- Manufacturing Technical Support – Troubleshooting
- Manufacturing Technical Support - Cost Reduction
- Manufacturing Technical Support – Process Improvements

Comments

_____

_____

_____

Proprietary Technologies – select most appropriate category
- Manufacturer has dealt with Polaroid proprietary knowledge in the past – no concerns.
- Manufacturer has not dealt with Polaroid proprietary knowledge in the past, but has worked in similar situations with other companies.
- It is not recommended to share proprietary information with this vendor at this time due to lack of experience or other factors.

Comments

_____

_____

QUALITY

Is Facility ISO certified?
_____YES _____NO

Quality Programs/Systems – This manufacturer has the following quality programs in place
- Quality is built into process by final inspection or similar means. Quality requirements are set up on product by product basis. No specific quality personnel.
- Some attention to quality - Measuring and recording of data is performed. Evidence of quality training for personnel.

- Good attention to quality - Separate QA/QC function. Quality policy/procedure is documented. SPC performed at manufacturing floor level.
- Quality is high priority – Quality systems in place including continuous improvements programs (i.e. Six Sigma).

Quality Improvement Systems
- The company is reactive in regards to quality problems.
- Some projects and/or programs have been initiated for specific quality improvement areas.
- There is a Quality Improvement Policy in place, and some evidence that it is followed.
- There is an active Quality Improvement Policy and personnel assigned to support the program.

Change Control System/Procedures (for product and process)
- No evidence of change control procedures
- Some evidence of change control procedures
- Change Control initiated on product by product basis as requested by customer
- Change Control followed for all products/projects
- Change Control is an integral part of the manufacturing process

Quality Documentation
- Little up-to-date quality documentation exists or there is no organization to the documents
- Documents exist in several different locations, little consistency
- Documentation is consistent and documentation system is well organized
- Documentation system is a well controlled, validated system

Product Quality Level – overall outgoing quality level, as compared to specifications
- 99.9% or more meet or exceed specifications
- 99.5% or more meet or exceed specifications
- >98%
- >95%
- >90%
- <90%

Comments

_____

_____

TECHNICAL SUPPORT CAPABILITIES

Self-sufficiency in Core Skills (troubleshooting and process improvements)

SKILL	>80% self-sufficient	>60% self-sufficient	<60% self-sufficient
Moldings			
Mechanical Parts			
Optics			
Software			
Assemblies			
Electronics			

Description of Technical Support Personnel Qualifications (degrees, certifications, experience, specialties)

_____

_____

_____

Comments

_____

_____

_____

PRODUCTION VOLUMES

This vendor is most capable/willing to produce products in the following annual volume range(s)

- High (>XX per year)
- Medium (X-XX/year)
- Low (<XX/year)

Total annual production of all products

- <X
- X-X
- X-XX
- >XX

Comments

_____

_____

_____

PRODUCTION FLEXIBILITY

Schedule Change Flexibility – Select the minimum order stability requirements of the vendor based on their scheduling system, staffing flexibility, and overall product portfolio.

Upside (increase in orders)

- Increase allowed at any time
- Order stable within 14 days, maximum 10% increase 14-30 days in advance, 25% change 30-60 days, any change beyond 90 days.
- Order stable within 30 days, any increase beyond 150 days
- Order stable within 60 days, any increase beyond 6 months

Downside (decrease in orders)

- Decrease allowed at any time
- Order stable within 14 days, maximum 10% decrease 14-30 days in advance, 25% change 30-60 days, any change beyond 90 days.
- Order stable within 30 days, any decrease beyond 150 days
- Order stable within 60 days, any decrease beyond 6 months

Order Size Flexibility - Can the vendor handle order quantities of drastically different size? (1 order for 5000 units, next for 200 units)

- Extremely flexible – can handle order size fluctuations or greater than 100%
- Highly Flexible – can handle order size fluctuations of up to 100%
- Very Flexible – Can handle order size fluctuations of up to 50%
- Flexible – Can handle order fluctuations of up to 25%
- Moderatly Fleixible – Can handle order fluctuations of up to 10%
- Not Flexible – Can handle order fluctuations of less than 10%

Demand Pattern Flexibility – The vendor is able to handle the following production downtime for a specific product without significant negative effects such as major ramp-up time or retraining efforts, or substantial additional cost.

- No downtime - Continuous production (at least once per month) only
- Vendor can stop production of a certain product for more than a month without significant effect
- Vendor can stop production of a product for up to 3 months
- Vendor can stop production of a product for up to 6 months
- Vendor can stop production of a product for up to a year
- Vendor can stop production of a product for over a year

Comments

DELIVERY

Based on Polaroid experience and data from other customers, this vendor meets or beats the scheduled (promised) ship date for orders:

- >99% of the time
- >95% of the time
- >90% of the time
- 80-90% of the time
- <80% of the time

Back-orders

- The vendor rarely has back-orders and is pro-active in this respect
- The vendor seldom has backorders and responds quickly to these orders
- There are often items on the back-order list
- There are always items on a back-order list

Proximity to Distribution Center:

- Within 60 miles
- Within 300 miles
- Within 600 miles
- Within 1000 miles
- Further than 1000 miles

Comments

Overall Strengths

Overall Weaknesses

Appendix D: Product/Plant Fit Analysis Tool

Technology

Does manufacturer have experience with the key manufacturing technologies involved in making the product (I.e. assembly, electronics)?

No/little experience = 0, Some experience = 1, Substantial experience = 2, Expert = 3

Enter Rating ☐

Does the manufacturer have experience with this type of product technology (mechanical, optical)?

No/little experience = 0, Some experience = 1, Substantial experience = 2, Expert = 3

Enter Rating ☐

Does the vendor have experience with similar specific products?

No/little experience = 0, Some experience = 1, Substantial experience = 2, Expert = 3

Enter Rating ☐

Does the manufacturer have experience with other components using the same output (I.e. digital, thermal media)?

No/little experience = 0, Some experience = 1, Substantial experience = 2, Expert = 3

Enter Rating ☐

Does the manufacturer have the technical capabilities required to support the product?

No/little experience = 0, Some experience = 1, Substantial experience = 2, Expert = 3

Enter Rating ☐

What is the level of risk associated with the potential of losing a competitive advantage?

Not recommended = 0, Some risk = 1, Minimal risk = 2, No risk = 3

Enter Rating ☐

FIT FOR TECHNOLOGY

TOTAL/6= ☐

0.0-0.7 Not a fit
0.8-1.5 Marginal Fit
1.6-2.3 Good Fit
2.4-3.0 Excellent Fit

Product/Process Support

Does the manufacturer have the capabilities to be self-sufficient in supporting the manufacturing processes?

Little self-sufficiency = 0, Fairly self-sufficient = 1,
Highly self-sufficient = 2, Totally self-sufficient = 3

Enter Rating ☐

From a technical standpoint, is the manufacturer capable of dealing with suppliers as needed?

Not capable = 0, Minimally capable = 1, Capable = 2, Highly capable = 3

Enter Rating ☐

Is the manufacturer qualified to provide troubleshooting as required?

Not qualified = 0, Minimally qualified = 1, Qualified = 2, Highly qualified = 3
Enter Rating

Is the manufacturer capable of developing and implementing process improvements?

Not capable = 0, Minimally capable = 1, Capable = 2, Highly capable = 3
Enter Rating

Is the manufacturer capable of implementing process improvements developed by others?

Not capable = 0, Minimally capable = 1, Capable = 2, Highly capable = 3
Enter Rating

What is the travel time between the manufacturing site and the process/product expert?

More than 4 hours flying=0, Within a few hours flying= 1,
Within a few hours driving distance= 2, Same site = 3
Enter Rating

Are there satisfactory methods for communication between the manufacturer and the process/product expert? (consider company, language and cultural differences)

Not satisfactory = 0, Minimally satisfactory = 1, Satisfactory = 2, Highly satisfactory = 3
Enter Rating

FIT FOR PRODUCT/PROCESS SUPPORT

TOTAL/7=

0.0-0.7 Not a fit
0.8-1.5 Marginal Fit
1.6-2.3 Good Fit
2.4-3.0 Excellent Fit

Is the manufacturer overqualified/underqualified in dealing with the technical needs of this product?

Substantially over/under-qualified = 0, Over/under-qualified = 1,
Minimally over/under-qualified = 2, Qualified = 3
Enter Rating

Quality

Can the manufacturer provide and support the quality systems necessary to meet the requirements of the product?

Not capable = 0, System not in place, but could be developed = 1,
Quality system in place for some products = 2, Overall quality system in place = 3
Enter Rating

Can the manufacturer provide quality improvement systems to meet the cost reduction and process improvement requirements of the product?

Not capable = 0, System not in place, but could be developed = 1,
Quality system in place for some products = 2, Overall quality system in place = 3
Enter Rating

Can the manufacturer provide and manage the change control systems to support changes to the product and process as required?

Not capable = 0, System not in place, but could be developed = 1,
system in place for some products = 2, Overall quality system in place = 3
Enter Rating

Does the manufacturer have experience providing the level of quality documentation required for the product?

No/little experience = 0, Some experience = 1, Substantial experience = 2, Expert = 3
Enter Rating

Has the manufacturer demonstrated the ability to manufacture products that meet the required product quality levels?

Never = 0, Some products/some times = 1, Most products/most times = 2, Always = 3
Enter Rating

FIT FOR QUALITY

TOTAL/5=

0.0-0.7 Not a fit
0.8-1.5 Marginal Fit
1.6-2.3 Good Fit
2.4-3.0 Excellent Fit

Is the manufacturer overqualified in dealing with the quality needs of this product?

Substantially overqualified = 0, Overqualified = 1,
Minimally overqualified = 2, Not overqualified = 3
Enter Rating

Supply Chain Capability

Is the manufacturer capable/willing to handle the required volumes?

Not capable = 0, Minimally capable = 1, Capable = 2, Highly capable = 3
Enter Rating

Can the manufacturer provide the level of flexibility (timing and order size) required in the delivery schedule?

Can not provide = 0, With come confidence = 1, With confidence = 2, With high confidence = 3
Enter Rating

Is there increased risk in dealing with parts and components suppliers due to the location of the manufacturer?

High risk = 0, Some risk = 1, Minimal risk = 2, No risk = 3
Enter Rating

Is there increased risk in meeting the customers delivery requirements due to the location and transportation options of the manufacturer?

High risk = 0, Some risk = 1, Minimal risk = 2, No risk = 3

Enter Rating ☐

Are there satisfactory methods for communication between the manufacturer and the Polaroid ordering systems?

Not satisfactory = 0, Minimally satisfactory = 1, Satisfactory = 2, Highly satisfactory = 3

Enter Rating ☐

Can the manufacturer meet the required delivery dates of the customer?

Some of the time = 0, Most of the time = 1, Almost all the time = 2, All the time = 3

Enter Rating ☐

SUPPLY CHAIN FIT

TOTAL/6= ☐

0.0-0.7 Not a fit
0.8-1.5 Marginal Fit
1.6-2.3 Good Fit
2.4-3.0 Excellent Fit

Overall Fit

check the appropriate box

	Not Qualified	Marginally Qualified	Qualified	Highly Qualified
Technology ***Score:***				
Process/Product Support ***Score:***				
Quality *Score:*				
Supply *Score:*				

Comments:

Is the manufacturer OVERQUALIFIED for the requirements of this product?

Technical Support Requirements	YES	NO
Quality Requirements	YES	NO

Appendix E: Financial Template

Note: This information was developed by David Mitchell, a financial expert at Polaroid in Scotland. The verbiage and models below were adapted from his work.

Below are three templates used to facilitate an accurate financial assessment. When comparing manufacturing options, always compares like with like (i.e. delivering the same amount of product of the same quality standard to the same destination over the same predefined time period). Also include a statement of basic assumptions (i.e. annual inflation rates and exchange rates where applicable).

The **Internal Model** focuses upon ensuring that all internal sites correctly disclose all relevant costs to be taken into account. One fact worth drawing particular attention to is the fact that it is only the incremental costs which should be taken into account when assessing the correct business decision. Another area where companies tend to fall short at present is with assessing cost of materials. They mistakenly assume these will be the same regardless of production location.

PROJECT NAME - _____

ASSESSMENT OF COST OF PRODUCTION OF SITE - _____

$'000s	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
CAPITAL RELATED EXPENDITURE						
Infrastructure						
Tooling & Equip't						
Others						
Grants / support						
ONGOING EXPENDITURE						
Labour						
Materials						
Overheads (incremental)						
Freight						
Duty / Transport taxes						
MISCELANEOUS ITEMS						
Grants / support						
Employee termination cost avoidance						
TOTAL EXPENDITURE						
NET PRESENT VALUE						
(discount at %)						

The **Vendor Cost Summary** is intended to summarize all costs payable to a particular vendor. The template is intended to provoke discussion to ensure that all costs are captured, e.g. claims from the supplier against the company for breaches on the supply contract (consigned material shortfalls, overtime working etc.)
Contracts typically fall into 2 categories.

1. Fixed price contracts where the supplier will not likely disclose his cost base and proposed profitability of the contract.
2. "Cost plus" contracts where there will be an open book cost agreement with the supplier who will receive a fixed % uplift on those costs.

This financial assessment will depend heavily upon the nature of the contract entered into with the supplier.

PROJECT NAME - _____
ASSESSMENT OF COST OF PRODUCTION OF VENDOR - _____

$'000s

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
ONE -TIME EXPENDITURE						
Tooling & Equip't						
Others						
ONGOING EXPENDITURE						
Cost of units produced						
Other costs						
MISCELANEOUS ITEMS						
TOTAL PAID TO VENDOR						
NET PRESENT VALUE (discount at %)						

The **Vendor Impact Assessment** takes the output of the Vendor Cost Summary above and compares it with the costs of the internal model.

PROJECT NAME - _____
ASSESSMENT OF FULL COST TO POLAROID OF VENDOR - _____

$'000s

	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
TOTAL PAID TO VENDOR						
Cash Flow benefit						
Freight to Polaroid						
Duty / Taxes to Polaroid						
Vendor Management costs						
Labour						
Travel						
Others						
Current costs avoided						
TOTAL COST TO POLAROID						
NET PRESENT VALUE						
(discount at %)						

THESIS PROCESSING SLIP

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▶ DEPT: Mgt

▶ YEAR: 1999 ▶ DEGREE: M.B.A.

▶ NAME: RUDOLPH, Leslie Prince