Strategic Cost Management in a Global Supply Chain

by

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Submitted to the Department of Mechanical Engineering and the Sloan School of Management in Partial Fulfillment of the Requirements for the Degrees of

Master of Business Administration
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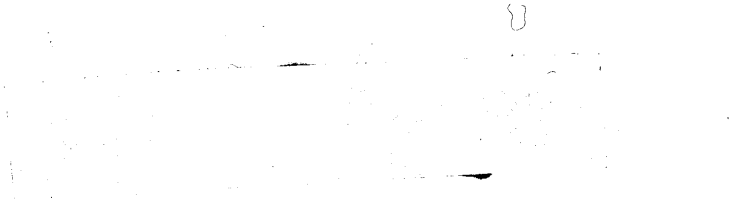

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Abstract

In the face of an economic downturn, cost has become a focal point of supply chain management. Cost management is increasingly being recognized as a vital core competency needed for survival. As companies transition from being vertically integrated to pursuing increasingly outsourced manufacturing strategies, modeling and monitoring the total cost of manufacturing products has become crucial, and complicated.

In the context of the automated test equipment industry, this thesis explores the impact of outsourcing on product cost and cost management practices. It examines prevailing cost management practices with reference to design and procurement, as well as methods to leverage information technology and re-engineer business processes to manage "spend" effectively and efficiently. It surveys capabilities that are available through software and examines cost-benefit tradeoffs that have to be addressed in selecting such systems.

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CHAPTER 1: INTRODUCTION AND OVERVIEW

1.1 PROJECT DESCRIPTION

While supply chain management seeks to optimize the performance of a company's supply chain along several dimensions – quality and reliability, lead-time and availability, cost and capacity – the sharp economic downturn at the turn of the last century has led to an increased emphasis on cost. For many industrial sectors, the crisis may have passed; however, there may be enduring lessons to be learned. The genesis of this thesis is a project sponsored by a semiconductor test equipment manufacturer. The sponsor company was aggressively pursuing a change in its manufacturing strategy. In recent years, a significant portion of manufacturing had been moved to contract manufacturers. This was in response to severe cost pressures exerted by the economy, competition and changing customer base. More recently, these operations have been transferred to low cost regions overseas. Given these changes, management had concerns regarding the verity of cost information that it was using to make decisions that impacted where the product was being built. This was the backdrop for kicking off this investigation. Foremost among these concerns was the visibility and quality of cost data, as an increasing portion of value was being added to the product further up in the fulfillment chain[1], outside the walls of the OEM's facilities. Another reason for the pronounced interest in cost reporting was the focus on cost figures reported by companies – the recent wave of corporate scandals had led to an increasing scrutiny of numbers reported by various functional organizations with the company.

However, the project went beyond examining the cost management practices in the fulfillment supply chain and looked the complete *value chain,* by examining prevailing cost management practices within the design function – in the development supply chain. Cost data is crucial for the continued effectiveness of not just the procurement function but also the design function. Design for cost initiatives rely on accurate cost information - a significant portion of product cost is locked in during the design phase. In relatively lower

1 In this context, the terms "fulfillment supply chain" refer to the processes that transform raw materials to finished goods at the customer location, and this is distinct from the "technology supply chain" and "development supply chain". These three supply chains constitute the complete value chain, as described by Fine, 1998.

"clockspeed" industries, such as capital equipment manufacturing, transaction-based cost data available through the Enterprise Resource Planning (ERP) system is generally adequate for decision-making. However, in recent years, such data has become inadequate on at least two counts in several industries:

- Average product selling prices, driven by increasingly aggressive customers, are rapidly reducing. The resulting margin erosion would limit the Company's ability to invest in new products and technologies - relentless cost reduction is critical. With the corresponding rapid change in product costs, historic cost data, such as transaction data, is of little relevance when modeling future profitability.
- The company is interested in tracking costs of parts below the "buy" level. This is because (a) design-for-cost initiatives require this data and (b) the sponsor Company manages certain strategic commodities at the piece-part level even though contract manufacturers purchase the parts. For parts below the "buy" level, cost data either does not exist - this is the case for new parts - or is outdated. Any means to update this cost information would have to be reasonably accurate and timely without increasing management overhead. While individuals within the Company have developed the means to mine data and generate reports, these methods are generally redundant, non-sustainable, error-prone or inaccurate.

The specific problem at hand was to assist management in answering questions in the following areas:

(a) Are the company's cost management practices and processes sustainable in the new outsourced manufacturing environment? Should the existing business processes be modified to respond to the change?

(b) Are the appropriate costs being tracked? What are the most appropriate metrics to understand the effectiveness of cost savings?

(c) Does the existing homegrown software system have to be modified to satisfy the requirements of the new environment? Are these modifications justifiable based on their costs and benefits? Should the company invest, instead, in an off-the-shelf software package to meet the new business requirements? Are there such software packages on the market?

1.2 APPROACH AND METHODOLOGY

The Supply Line Management (SLM) group within Operations was the primary stakeholder for this project. However, because Value Engineering, Design Engineering and Finance functions also had significantly overlapping cost-related processes, their requirements were also taken into account. Additionally, since the current system was rooted in an internally developed and relatively sophisticated software package, management expressed a desire to understand the approach taken by other companies. Given these issues, the approach taken was as follows:

Map the existing process and identify weaknesses

This involved identifying the various cost data types, sources (databases) and uses (reports) of data. Additionally, the resources required to execute these processes were also tracked.

Ascertain business requirements

This step involved conducting structured interviews with several functional groups, such as SLM – Revenue, SLM – New Products, Design Engineering, Value Engineering and Finance. In this stage, the processes required to support cost management were mapped, and the resources required for their execution were estimated.

Organizational and process benchmarking

In this stage, a survey was performed to compare the "best practices" of well-known companies across various industries.

Software survey

In an attempt to identify commercial off-the-shelf software packages that could potentially satisfy cost management business requirements identified earlier, a structured survey was conducted. The survey included interviews with software vendors, research analysts and users of such packages.

Recommendations

This phase involved synthesizing all the findings and determining the changes in infrastructure, processes and metrics required to support the ongoing cost reduction efforts. For the recommendations made, an estimate of the costs and benefits associated with them was made.

Figure 1.1 is a schematic that shows the major activities and their dependencies and the chapters in which these activities are described.

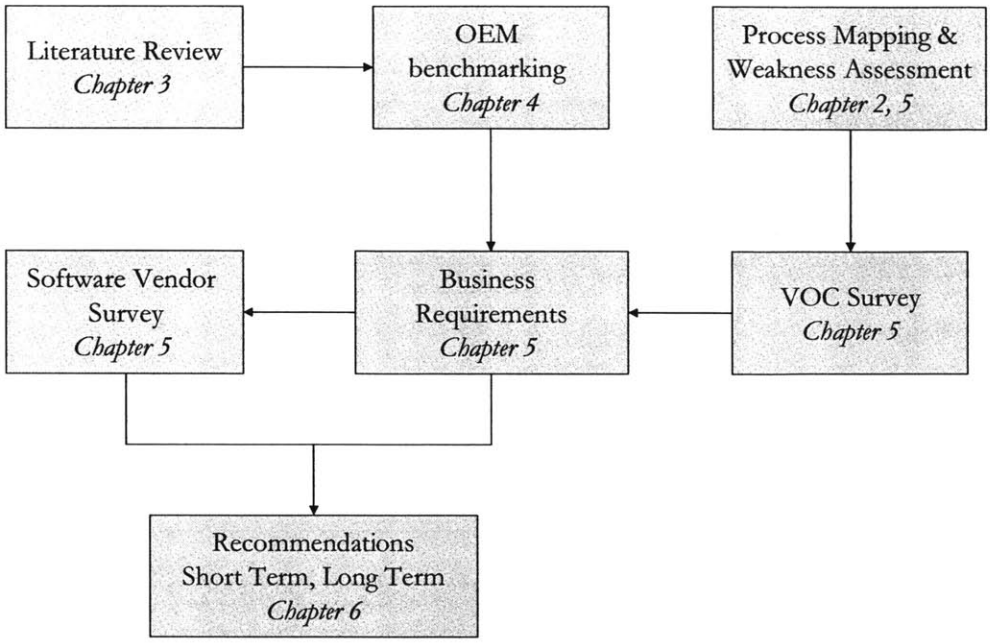

Fig. 1.1 Project Flow

1.3 PROJECT GOALS AND MEASUREMENT

As described earlier, the intended goals of the project were to map the cost data acquisition, cleansing and reporting processes as well as to prioritize cost-reduction activities based on cost impact. Included in these activities was a review of cost metrics in use at the sponsoring company and suggestions for modifying or extending them. Another goal was to recommend measures to make the processes more efficient and effective. Besides identifying infrastructural and process changes that could facilitate this, a cost-benefit assessment was also expected if the capital outlay for implementation was significant.

CHAPTER 2: PROJECT CONTEXT AND DESCRIPTION

This chapter describes the context, setting and impetus for the project. Initially, it describes the company and product, and makes a comparison with other competitors to validate the need for the project. Finally, the chapter describes the Procurement organization at the sponsor Company as well as the information infrastructure that facilitates the execution of its tasks.

2.1 COMPANY BACKGROUND

The sponsor company competes primarily in the automated test equipment industry. While the company has products that span the testing requirements, end-to-end, of electronic manufacturing processes, the largest market pursued by the Company is in the testing of semiconductor wafers. The company was organized around markets – thus there were distinct Groups dedicated to Semiconductor Test equipment (STG), circuit board testing and inspection and other miscellaneous systems. This project was sponsored by STG. Besides this, there are smaller groups that manufacture connection systems and provide manufacturing services.

2.1.1 Product Description

The family of products sold by STG is highly engineered. This is a characteristic of semi-conductor test equipment in general. Additionally, the Company has traditionally differentiated itself on the basis of performance and features of its products.

The Company segments its customer base into several categories based on functional requirements, performance, industry and willingness to pay. Its product platforms are designed to address one or more market segments. The market segments are defined by the product or device being tested, such as microprocessors, network processors, graphics chipsets, Application Specific Integrated Circuits (ASIC), networking equipment, System-On-Chip (SOC), broadband, microwave wireless, standard analog, power management, video, automotive, audio, baseband, microcontrollers, Programmable Logic Devices (PLD), Field Programmable Gate Arrays (FPGA) and Smartcards.

The Company adopted a modular product architecture to address the specific needs of customers. The product platforms are characterized by Zero-Pin configurations – the "skeleton" to which Options or Instruments were added. The Company or its sub-contractors manufacture some Options and Instruments – however certain Instruments were sourced from other Original Equipment Manufacturers (OEMs), in some cases competitor companies. Options and Instruments could be used with different platforms – or Zero-Pin configurations. Since the device being tested defines the features of the test equipment, the interface between the Tester and the Device-Under-Test (DUT) is specific to the DUT and the customer. This interface is called the Device Interface Board (DIB).

Demand and price characteristics

The demand for semiconductor test equipment is extremely volatile. In terms of the Bullwhip effect or the "volatility amplification" phenomenon, this industry is at the most susceptible end of the value chain – upstream. The unit price of ATE equipment sold by the Company can, depending on end-use and performance, range from $150K to over $2M. The recent shift in the ATE customer base from OEMs to contract manufacturers has the potential to reduce the volatility in ATE demand, because consolidation of manufacturing capacity from multiple OEMs in diverse industries can have a risk-pooling effect. However, this consolidation has also led to changes in the features demanded – contract manufacturers tend to prefer proven technologies over equipment offering superior performance. This has adversely affected the Average Selling Price (ASP) for ATE equipment and impacted the metrics by which ATE manufacturers and their customers evaluate product performance.

2.1.2 Customers

As described above, the semiconductor manufacturers and contract manufacturers (CMs) comprised the two main segments that STG targeted. Due to the recent emphasis on outsourcing, the segment of the customer base comprised of contract manufacturers was increasing. Additionally, major semiconductor manufacturers' willingness-to-pay for high-performance has reduced in response to reduced demand for their products. Additionally, the growing customer base among contract manufacturers was causing a resurgence in

demand for test equipment which the sponsor Company had previously viewed as End-of-Life, i.e. the older products were cannibalizing the sales of newer technologies.

The STG group was thus being pushed towards delivering cost-effective solutions rather than developing products with greater differentiation. In essence, this was pushing the semiconductor test industry towards greater commoditization and towards outsourcing their own production to the very contract manufacturers they serve.

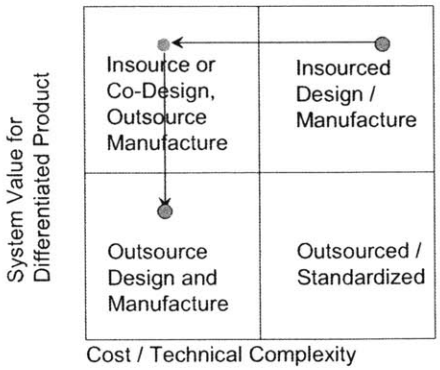

Fig. 2.1 Manufacturing strategy in response to customers willingness to pay for differentiated product functionality

Figure 2.1 illustrates the migration of market value for performance and complexity. The quadrants indicate the prescribed manufacturing strategy given the cost and technical complexity of developing the product and the customer's willingness-to-pay for a differentiated product. A decade ago, the Company was highly integrated, with both design and manufacturing performed in-house. As cost pressures built up and, in response, the Company simplified and standardized its designs, it became both necessary and possible to outsource the manufacturing of the products. Today, the Company only performs Final Assembly and Testing of the equipment within its facilities. The Company still competes on innovative solutions and bringing high-end products to market first – there is still a perception that customers are willing to pay a premium for their superior product performance and capability. As explained earlier, however, the growing proportion of contract manufacturers in the customer base has raised concerns that customer value would potentially shift from product differentiation to low cost.

2.1.3 Competitors

The company had two major competitors in terms of market share. However, in recent years, smaller domestic and international players entered the scene and were eating into the Company's market share. There was little doubt that the Company's products had an edge

over most competitors from a sheer performance and quality standpoint. However smaller competitors displayed an ability to bring new products to market faster and at a lower price-point than the Company, in part because their smaller size meant lower overhead, and hence lower cost structure, and allowed them to be more responsive to market needs.

The semiconductor automated test equipment (ATE) industry, like most capital equipment industries, was at the end of the proverbial value chain "bull-whip". In other words, volatility in demand by consumers of electronic devices amplified throughout the supply chain and peaked at the end. This made smaller players in the ATE space very susceptible to economic downturns. In 2003, there was widespread speculation among industry analysts that this industry was ripe for consolidation.

Figure 2.2 shows the relative market share of the Company (Sponsor Company) in the semiconductor test market, including memory test. As can be seen, the Company is one of the largest players in the space. This position has been attained largely because of the ability to differentiate its products through superior functionality. However, the low-cost economic climate is advantageous to smaller players, who because of their position as "fast-followers" have a lower R&D expenses and lower product cost structures.

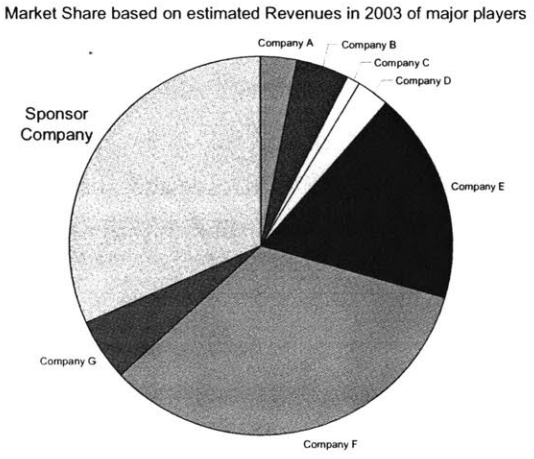

Fig. 2.2 Market share based on estimated Revenue in 2003 of major players

Spend comparison with reference to competitors

As a top-down validation of the need to inspect the Company's cost management effectiveness, we evaluated the Company's cost of goods sold (COGS) relative to its

competitors'. The overall average COGS as a percentage of sales revenue for the industry is ~63.5%.[1]

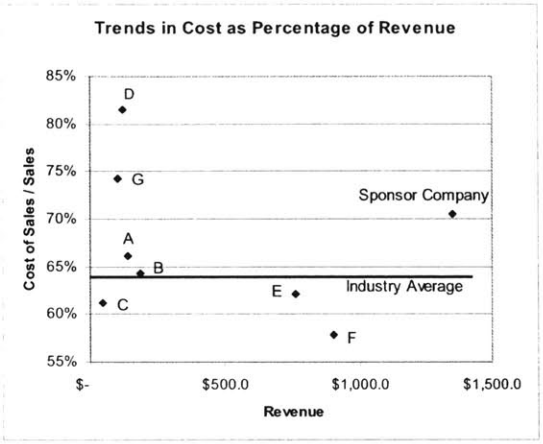

Fig 2.3 Trends in Cost of Sales as a Fraction of Revenue

As is evident from Figure 2.3, the sponsor Company's COGS as a percentage of Revenues is greater than the weighted average for the market and is larger than four of its competitors. Purely from a cost management perspective, this would suggest that there is substantial room for improvement. However, the sponsor Company's overall manufacturing strategy of competing on performance and innovation, and staying ahead of the market, may justify the relatively high COGS/Revenue figure.

Further, for each competitor, the COGS/Sales and Cost of Development[2] / Sales were determined. A scatter plot (Figure 2.4) revealed that there may be potential to improve the company's cost management practices, and move the sponsor company's ratios closer to the origin of the scatter plot. Both of these views are simplistic, but they provide some basis for comparing the company's overall cost management performance with reference to peers.

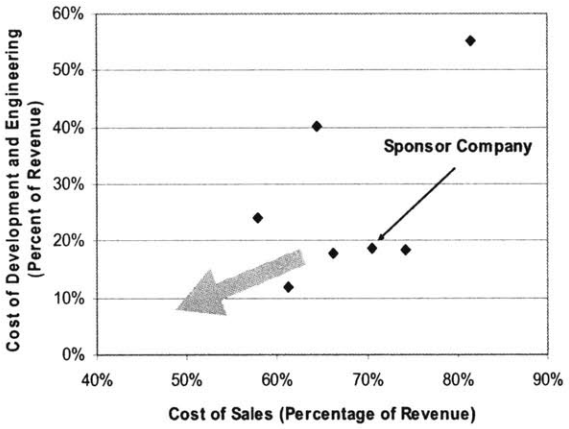

Fig. 2.4 Development Investment and Cost of Goods Sold at major ATE manufacturers

[1] To calculate the overall average, each company's COGS/Sales ratio was weighted by the market share of that company to determine its contribution to the overall average.

[2] Cost of Development was taken to be the combination of R&D expense and NRE costs, wherever available and applicable.

2.1.4 Suppliers and Contract Manufacturers

The sponsor company, in recent years, ceased several manufacturing activities, choosing instead to have sub-contractors build higher-level assemblies (HLAs). Only Final Assembly and Test (FAT) were performed in-house. The Company recently moved towards rationalizing their supply base. Parts are now sourced only from suppliers classified as preferred suppliers. Even during early phases of product development, a similar practice had been adopted – engineers were provided with a Most Likely Supplier (MLS) List. Any purchase from suppliers outside these lists was subject to scrutiny. Additionally, the Company had special relations with suppliers of highly specialized components, such as Application Specific Integrated Circuits (ASICs) that were specific to the company's products. Not only was there a greater level of cooperation and management by the Company to ensure the quality and coordination of supply of these components, but the Company also took on greater liability with regard to inventories of these parts at the suppliers' facilities.

2.1.5 Manufacturing Strategy

Outsourcing Manufacturing and its Impact on Cost Reduction

The overall strategy to reduce cost comprises better design through Design for Cost initiatives, rationalizing production operations, moving manufacturing operations to contract manufacturers to reduce fixed cost while gaining flexibility and strategic inventory placement. The impact of outsourcing, especially to low cost regions, was a rapid reduction of material costs and cost of value-add such as labor. However, the impact on the cost of inbound and outbound logistics was unclear. While there was no doubt that these costs increased, there was little evidence that costs of transportation were being tracked systematically and allocated to the cost of the product.

Design for Outsourcing

The outsourcing strategy exposed a weakness in the Company's processes. Technical specifications were incomplete, more geared towards internal use or towards suppliers who had traditionally developed detailed specifications themselves. Consequently, when the Company tried to develop alternate sources, they discovered that documentation and

specifications had to be refined and clarified. Additionally, the "tribal knowledge" that existing suppliers had developed proved to be a stumbling block – the Company now had to regenerate or elicit this knowledge. Obviously, the existing suppliers were reluctant to part with this information because of the implications.

2.2 SUPPLY LINE MANAGEMENT

This section describes the Procurement group within Teradyne and its various activities. As described earlier, the Supply Line Management organization had recently been divided into the SLM – New Product Introduction (NPI) and SLM – Revenue. The NPI organization was relatively new and was largely concerned with early stage supply chain activity, including value engineering and design for cost, supplier and part qualification and supplier development. In general, the resources in the NPI organization were allocated by product line. Most of the staff in this group had technical knowledge of the product and had some form of engineering training. This was in contrast to the SLM – Revenue organization which was largely involved with mature and end-of-life products. The emphasis for this organization was to ensure reliable, low-cost and responsive supply for products that were already being shipped in volume. This group was largely organized around commodities. Commodity management was a sub-set of this organization. The staff included experienced buyers and commodity managers – the profile of this group was less technical in nature. Through experience, these buyers and commodity managers had deep expertise pertaining to their specific commodities.

2.2.1 Introduction to Commodity Categories

In the ATE industry, commodities include the electrical, mechanical and semiconductor components that constitute test equipment. Some examples are printed circuit boards (PCBs), backplanes, castings, computers and peripherals, instrumentation, logic devices, manipulators, chillers, thermal equipment, memory and microprocessors, passive components, plastic parts, power conversion, switches and connectors.

2.2.2 Characteristics of Parts /Commodities Impacting Sourcing Strategy

<u>Price Volatility</u>

For certain commodities such as memory, the price of the component is highly volatile. This is driven by large fluctuations in the demand and supply of these components. The price of a tester, in turn, may be very sensitive to memory price fluctuations because there may be many instances, in some cases as high as a few thousand, of a single memory SKU in its Bill of Materials.

Commodity / Component Lifecycle in Relation to Product Lifecycle

The product lifecycle of a tester may span several generations of memory devices. Thus, there are frequent occurrences of "life-time buys" (LTB) that correspond with the end-of-life of the components. LTBs are expensive because of the need to qualify new suppliers and part substitutes. Additionally, updating documentation and databases with the new revisions adds significant overhead.

Capacity

This was a concern only during times where demand outstripped the supply of commodities that were required by multiple OEMs for their products. Suppliers based their decisions regarding capacity allocation on the purchasing organization's leverage over them, their relationship and contractual agreements. This not only had implications on the structure of contracts but also on the nature of the relationships that the Company developed with its suppliers. There are also technological implications – appropriate processes and infrastructure can ensure that the Company's demand and forecast are available to suppliers are helpful for capacity planning.

Quality / Reliability

The Company has well-defined processes to ensure suppliers' products and practices comply with the Company's product quality requirements. However, these processes also imply that new supplier and part qualification entails significant time and overhead. This is an important issue in the current climate where there is a rush of U.S.-based manufacturing companies trying to exploit labor arbitrage opportunities. In effect, being able to quickly and reliably identify suppliers in low cost regions globally and transfer operations to them is a temporary competitive advantage.

Lead-time and Inventory

In the case of certain commodities and components, achieving the Company's service level and lead-time goals required strategic placement of inventory throughout the supply chain. This translated into a high level of cooperation with suppliers of strategic commodities.

Leverage

A **single source** can be defined as the one source among others in a competitive marketplace that for justifiable reason has predominant qualifications for selection for contract award. A **sole source**, on the other hand, is the one and only source regardless of the marketplace, possessing a unique and singularly available performance capability for the purpose of contract award. The Company has, for the same reasons mentioned in the definitions above, single or sole source suppliers for certain parts. In such cases, the suppliers have significant leverage[1] in the relationship.

Base Configuration and Options

Since the ATE equipment manufactured by the Company has a platform architecture, the product may be divided into two categories: systems, also known as base or Zero-Pin configurations, and options, which could include channel cards and instruments. Parts that constitute the zero-pin configuration have a demand that is less volatile as compared to parts belonging to channel cards and instruments.

2.2.3 Outsourcing: Relationship with Contract manufacturers

As described earlier, several of the barriers to accomplishing cost management at the Company can be traced back to the recent transition to outsourced manufacturing. This section describes the agreements that the Company has with its contract manufacturers, particularly in the area of cost management. The procurement organization has laid down guidelines that it uses not just to orient the Electronic Manufacturing Services (EMS) providers but also its own buyers. These guidelines reflect current best practices. The following points summarize the guidelines currently in use at the Company:

- Transfer pricing is based on open book costing (material, labor, overhead and profit margin), and should be reviewed at regular intervals to ensure the "rolled-up" assembly prices were accurate.

[1] Another factor that impacts leverage is the extent that either the buyer's or supplier's revenue is dependent on the relationship. The greater the dependence of one party, the greater is the leverage of the other party.

- Variances from "standard" component prices set for a period determine Purchase Price Variance (PPV) and Inventory reevaluation until the next cost review, at which point new prices are set.
- Material cost is based on the best price available to the Company and the subcontractor
- The Company will not share subcontractors' piece-part costs with the Company's commodity managers and buyers.
- The Company is not responsible for unfavorable PPV caused by supplier execution errors.
- Suppliers will not be responsible for unfavorable PPV caused by market conditions, commodity pricing controlled by the Company and engineering changes - the Company will pay the PPV in these cases.
- The supplier should be provided incentives to initiate cost down work – either through a sharing of cost savings or preferred supplier status.
- The supplier will have a proactive cost reduction program with dedicated resources.
- When re-pricing parts that are specifically allocated to the Company but reside within the supplier facility, an inventory buy-down or buy-up will be considered to offset the price change.

2.2.4 Procurement Strategy and Infrastructure to Support Cost Management

This section describes the strategies followed by the SLM group at the Company in the area of Cost Management. The strategies explain why the current information technology infrastructure has been subject to ad hoc improvements that have added to its complexity.

Figure 2.5 illustrates the cost reduction process outcomes (metrics) and the means employed – Low Cost Region (LCR) sourcing, alternate sourcing, competitive quoting and leveraging volume-based price reduction - to accomplish them. Execution of the strategies and reporting of results were two areas where the Information Technology infrastructure could play a role in improving results. Accordingly, a few years ago the SLM organization invested in developing and implementing a "home-grown" data repository and reporting system called Cost Management Operating System (COSMOS).

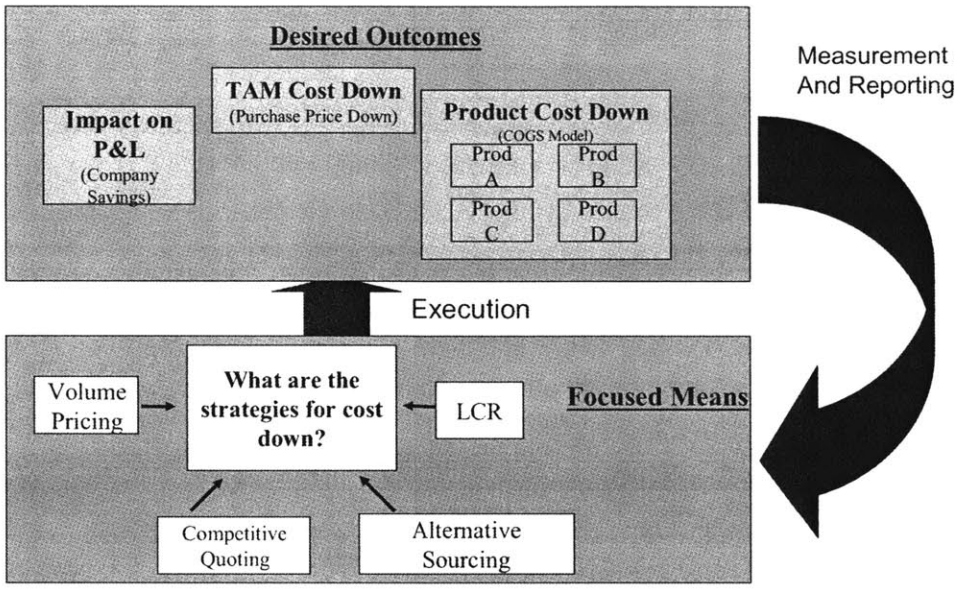

Fig. 2.5 Simplified View of Cost Management from a Procurement Perspective

COSMOS was specified and architected largely from a commodity sourcing stand-point. For example, indented Bills of Material (BOMs) were not available – data was only in the form of flat BOMs. In the traditional in-house manufacturing scenario this was adequate and appropriate. Recent changes in manufacturing strategy as well as ad hoc demands for new reports and data had rapidly made some of the COSMOS features obsolete, giving rise to peripheral databases as shown in Figure 2.6. As per the original design based on a largely in-sourced manufacturing environment, COSMOS was to be the sole repository of cost data. This included not only cost estimates based on history but also future cost estimates based on existing contracts, commodity managers' best estimate and blanket orders[1]. However, since installation, the transaction related data being captured by the system were not adequate. In order to supplement this data with the most recent information available to the commodity manager, as well as provide a means to apply "user-overrides" to the data, new

[1] A blanket order is a purchasing tool that enables a company to establish a mechanism which enables Procurement to request goods and/or services to be provided from a supplier on an as-needed basis for the period of time specified on the blanket order. The blanket order contains detailed specifications regarding the goods or services, the limit of funds committed, the funds committed to-date and the period of time the blanket order is valid.

"off-COSMOS" databases were generated and maintained by cost analysts. These are labeled as COSMOS2 and Cost Group Database (CGD).

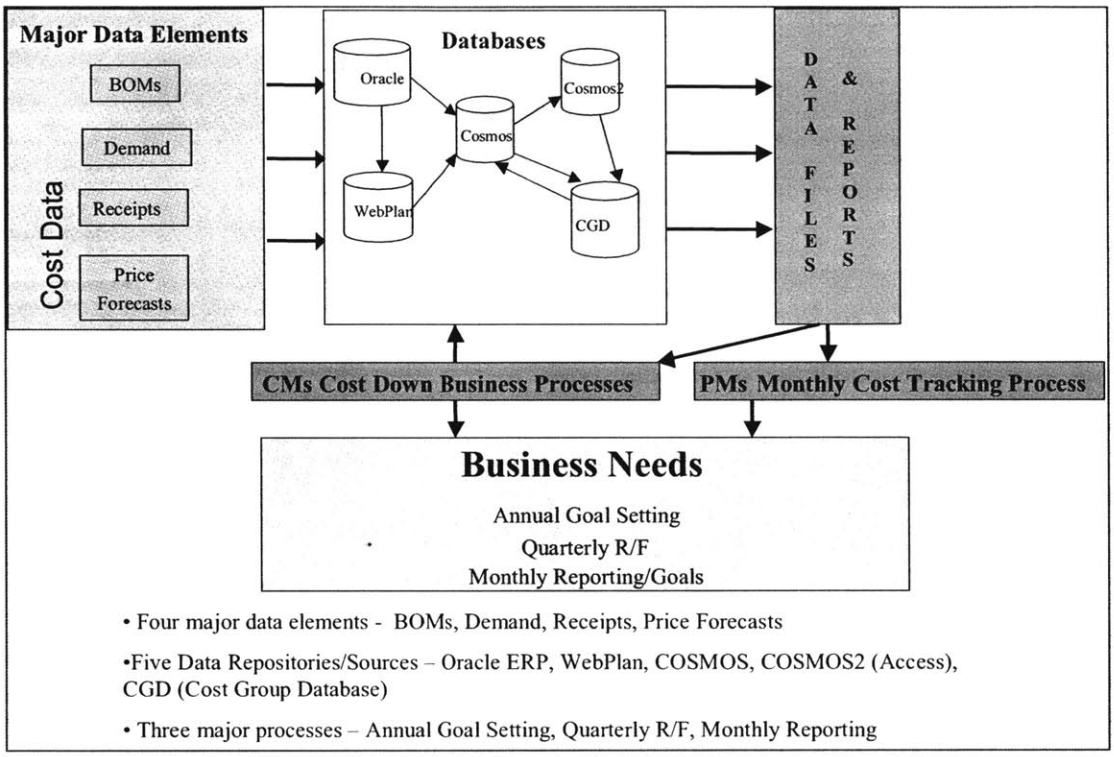

Fig. 2.6 Simplified Flowchart Depicting Data Sources, Repositories and Flow

Thus, a single cost management data repository metamorphosed into a relatively complex network of databases. As will be elaborated in chapter 6, this gave rise to several weaknesses in the cost management system.

CHAPTER 3: LITERATURE REVIEW

3.1 THE PURCHASING AND SUPPLY MANAGEMENT FUNCTION

The Sourcing function and its objectives are geared, like the rest of the enterprise, towards increasing the top line and the bottom line for the company, while managing the firm's assets. Figure 3.1 identifies three categories of activities that encompass the procurement function: Revenue Growth, Asset Management and Cost Management, as described by Monczka (2003). Revenue Growth metrics, the "top line" category", focus on reducing time-to-market and ensuring product availability. Asset Management, from a sourcing standpoint, focuses on inventory reduction and capital expenditure. The third category, Cost Management, was the focal point of this project. It encompasses processes that seek to ensure that the product cost structure, including the overhead to create the product, is competitive. It is noteworthy that there are strategies that are included in all three categories (for e.g. supplier selection, integration) – these require heavy integration with suppliers.

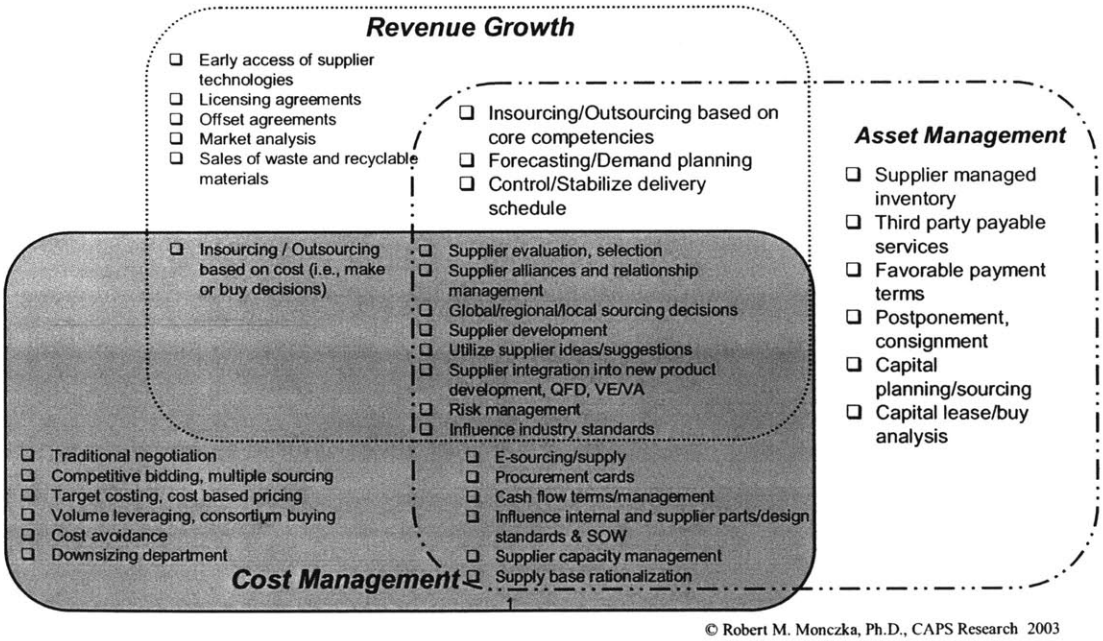

Fig. 3.1 Sourcing and Supply Chain Value Creating Strategies

3.1.1 Organizational Description

Best-in-class purchasing organizations surveyed by Ellram[1] had several commonalities in structure, incentives and processes. In a study that spanned several industries, Ellram concluded that organizational support at all levels is a critical element in strategic sourcing. Top management support is crucial in changing the attitudes of people and various groups. Most leading organizations, especially in the technology space, have gained market leadership through expertise in operational excellence, design innovation or consumer responsiveness. For such organizations, there is a tendency towards continuing emphasis on the same core issues – and it takes a high-level sponsorship to bring the importance of cost to the forefront. Another common trend that she observed was the fact that the organizational structure of Purchasing and Supply Management (PSM) at these companies was either centralized or a combination of centralized and decentralized. The centralization was crucial to get a global view of spending across various divisions, so as to have more leverage with suppliers. The decentralization was often driven by the nature of the product. Particularly in industries where the product was complex, companies tend to have a portion of their PSM personnel dispersed into cross-functional roles with matrix reporting structures. In these positions they are better able to influence decision making regarding product architecture and design to address supply chain related issues such as cost, quality and availability, at earlier stages of the product lifecycle.

One heuristic based on empirical observations[2] is that 70 % – 80 % of the product's ultimate acquisition or lifecycle cost is determined by decision made from concept stage through the development cycle. Decisions made after the product moves into production account for another 10% - 15% of the product's costs. The remaining 10% - 15% costs are a result of decisions that emerge from sales and marketing, administrative overhead and product distribution activities. With the majority of life-cycle product costs being 'fixed' by decisions made during the early stages of a project[3], there is all the more reason for a company to

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[1] "Strategic Cost Management in the Supply Chain: A Purchasing and Supply Management Perspective", by Lisa M. Ellram, Arizona State University, CAPS Research Study

2 "Achieving Target Cost / Design-to-Cost Objectives", DRM Associates

3 "Design for Assembly and Disassembly", Annals of the CIRP. 41(2), 625 - 636

focus its cost reduction activities as well as sourcing and supply-chain optimization efforts in the early stages of product development.

Figures 3.2a and 3.2b leverage Systems Dynamics to illustrate the tradeoffs that are implicit when a company chooses to focus its efforts on innovation and new product development.

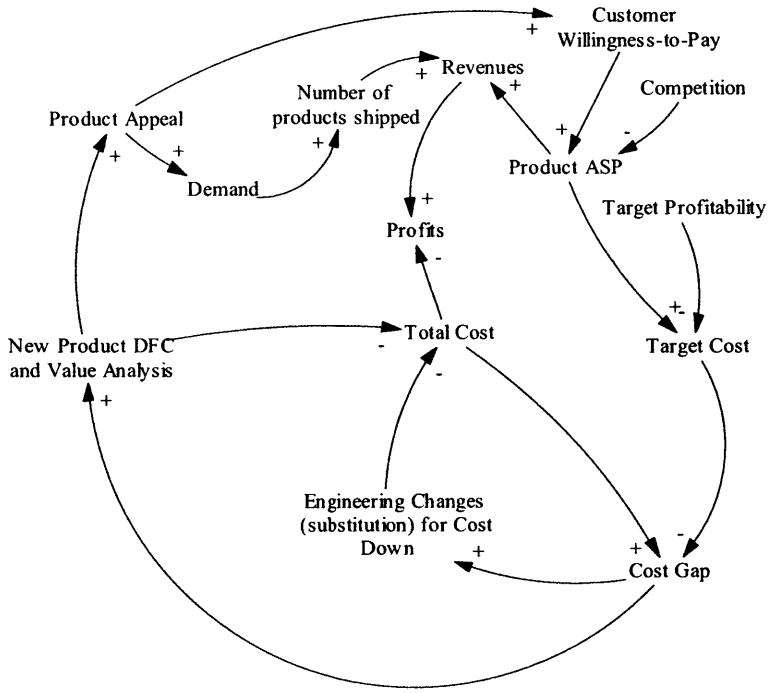

Fig. 3.2a Systems Dynamics Model Illustrating Impact of Cost Reduction Initiatives

Figure 3.2a is based on the idea that Profits are dependent on Revenues and Total Cost of creating and delivering products to the customer. Progressive companies maintain a Target Profitability. Based on the Product Average Selling Price, which is determined by the Competition and the Customer, the Company determines a Target Cost for the product. The Cost Gap (difference between the Total Cost and Target Cost of the product) drives efforts for cost reduction. Cost reduction effort during the early stages of product development has been represented here as New Product Design for Cost and Value Analysis. The other alternative to "design right the first time" is continuous cost reduction effort which may continue even after product launch. This approach requires Engineering

Change[1]-related activity. The advantage of focusing on new product DFC initiatives is the ability to incorporate customer value into the design process. The result is the potential to enhance Product Appeal which can increase Demand for the product as well as the Customer's Willingness-to-Pay. If the Company is able to meet the increased demand through an increase in Shipments, and is able to recognize and leverage the increased willingness-to-pay by increasing the Average Selling Price, Revenues increase and so do the Profits.

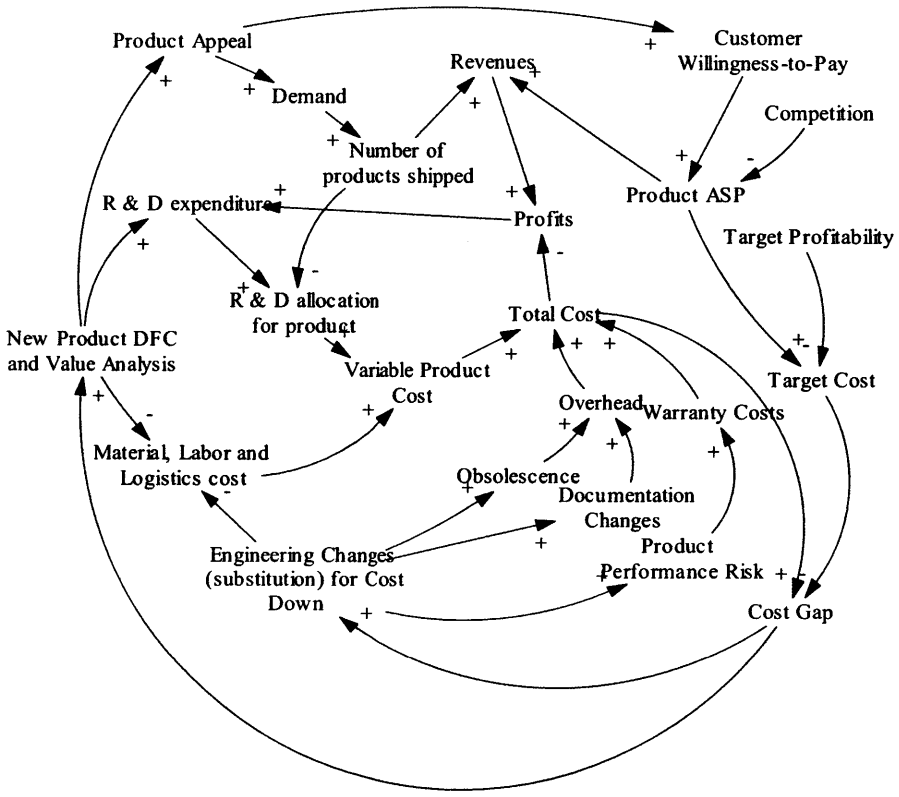

Fig. 3.2b Augmented Model Illustrating Impact of Cost Reduction Initiatives

In Figure 3.2b, this model is augmented to include the specific impacts of cost reduction initiatives. New Product DFC initiatives result in increase R & D expenditure. However,

[1] In this case Engineering Change pertains to the Engineering Change Order (ECO) and Engineering Change Notification (ECN) processes that are not only associated with time-consuming workflows but also significant resource usage. ECOs and ECNs are related to product changes later in the product lifecycle, when product structure (BOM) is fairly well-defined or the product has already been released.

with the increase in the number of products shipped, this expense could be allocated[1] towards a larger number of products. The end result could be that the R&D expense per product shipped is reduced. The other component that feeds into Variable Product Cost is the Material, Labor and Logistics Cost. This can be minimized through both the early stage DFC initiatives and the continuous efforts to reduce cost through Engineering Changes throughout the life of the product. However, Engineering Changes can create additional hidden burden on the cost of creating the burden. This can be in the form of increased Obsolescence of parts in inventory that have been replaced by cheaper substitutes, and may not have any resale value. Another impact is the additional expense of Documentation – in the form of updates and Engineering Change Notices (ECN) to keep customers and employees informed of the change in the product. Warranty Costs are likely to increase because late-stage product changes are naturally subject to less rigorous testing. All of these factors eventually cause an increase in Total Cost and reduction in Profits. This model thus illustrates that early stage cost reduction efforts – during the introduction of new products – may be favorable for sustained profitability in the long run. Note that as a company's profits increase, it can afford to invest in R & D activity, thus giving rise to a virtuous cycle.

3.2 GLOSSARY OF COST TERMS

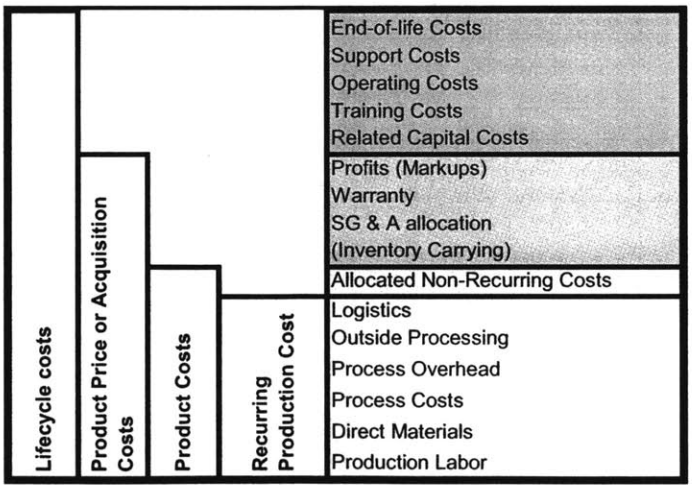

Table 3.1 Components of Cost

[1] While most companies may not allocate R&D expenses in this way for accounting purposes, this view helps understand the long-term benefits of up-front investment in R&D.

Table 3.1 shows the different components of cost that constitute the total lifecycle cost as a product goes from concept, development, production, consumption and disposal. Companies tend to emphasize or de-emphasize the importance of each of these cost types based on their relative magnitude and the market forces that are acting on the industry at any given time.

3.3 TOOLS FOR COST REDUCTION

3.3.1 Cost Modeling

While in rare instances, ad hoc estimation of costs may be adequate, either because the rate of product introduction is faster or the fact that the overall supply chain is in a state of constant flux. This is not true of most industries in existence today. For most companies, it is essential that they generate product cost models and constantly review them to identify cost reduction opportunities.

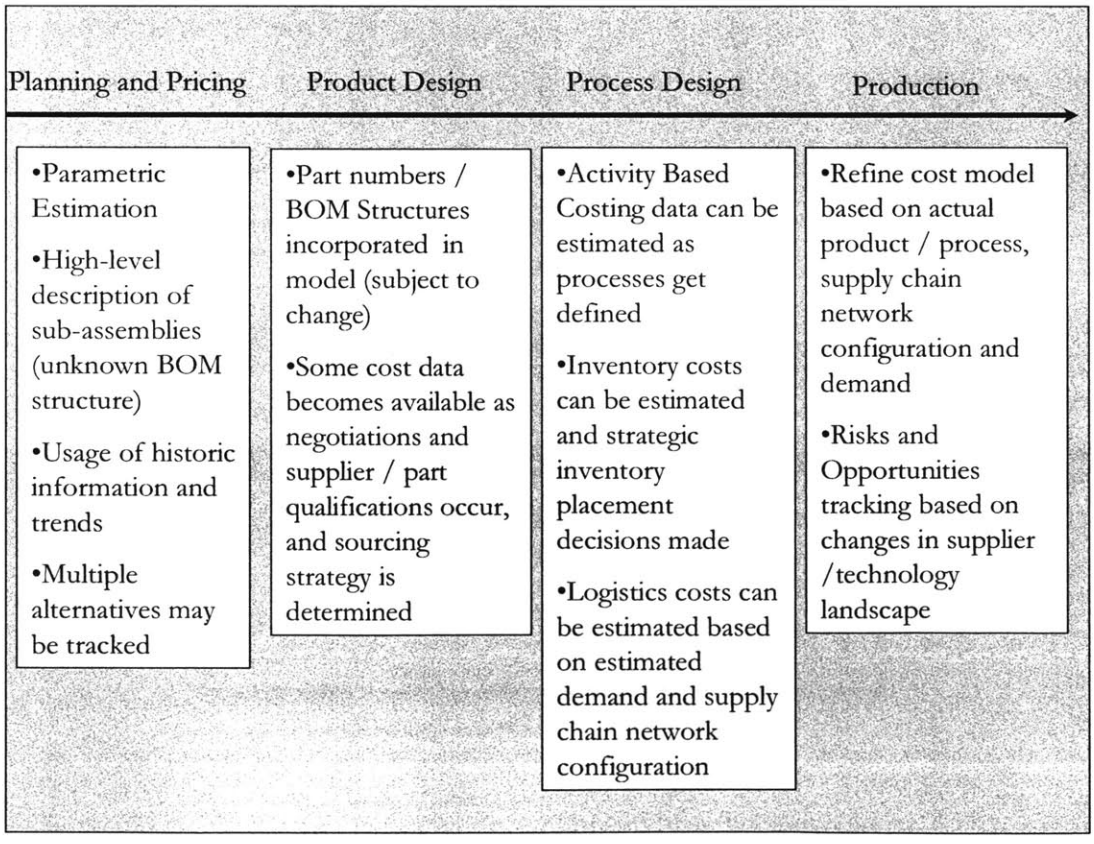

Fig. 3.3 Evolution of Cost Models throughout the Product Lifecycle

Cost models may look very different depending on the phase in the life of the product. Cost information becomes more and more accurate as one proceeds through the product development process. Figure 3.3 illustrates the differences among cost models during the planning and pricing phase, product design phase, process design phase and production phase. In the earliest stages of product ideation and customer value proposition development, cost models can be useful in determining the product architecture and functionality that will maximize product profitability and customer satisfaction. The models are, out of necessity, approximate, containing only a high-level description of the product. The Bill of Material (BOM) and part number information is, at best, incomplete. It may be necessary to track multiple product configuration options until design decisions are made. There is heavy information on historic product data and macro trends with commodities and suppliers.

In the next stage of the product lifecycle, the design phase, the product configuration, BOM structure and part number information start trickling in. The cost model can become more determinate as negotiations with suppliers are underway or finalized and the sourcing strategy is firmed up.

In the process design phase, which includes supply chain design, the activities associated with building the product are better understood. Accordingly, Activity Based Costing (ABC) analysis becomes feasible and should be incorporated into cost models. Similarly, the costs associated with logistics can also be factored in. As progressive companies make decisions regarding optimum inventory buffers and their placement throughout the value chain, the costs associated with the inventory should be tracked.

Finally, in the production phase, any modification in the product and process should be reflected in the model. Continuous maintenance of the model can be very useful in helping the Purchasing and Supply Management group to continuously monitor the technology and supply landscape for new risks and opportunities.

In reality, some portions of product planning, product design and process design occur concurrently, in keeping with best practices in concurrent engineering. The cost models should, in any case, incorporate the best possible information to enable decision-making.

3.3.2 Design for Cost

A realistic estimate of the customer affordability and the competitive pricing is a prerequisite for effective design for cost (DFC). Another prerequisite is that developers should be aware of costs of parts down to a level where they can be effectively managed. Developers should understand the cost drivers especially in the specification of product. For example, when certain features and specifications are inherited from previous product designs, it is important to consider whether tolerances and finish requirements can be relaxed. Developers should develop cost models whose sophistication matches the requirements of the environment. In certain cases, the product material costs far exceed the overhead associated with the building of the product. In such cases the material costs may be adequate. However, this is rarely true. Rather, companies mistakenly assume this to be the case. For instance, at the sponsor Company, the practice of tracking overhead related with the building of the product had only recently become popular. It is therefore important for companies to frequently re-evaluate their cost models to ensure that they are in keeping with current supply chain strategy. Additionally, certain industries are prone to extremely short product lifecycles and frequent changes in product functionality, such as electronics manufacturing. Companies may be able to use cost models in conjunction with industry and customer trends to *predict* future costs and customer willingness-to-pay for features and thus model profitability.

In complex supply chains, where product configuration, part sourcing and, consequently, part costs are constantly changing, reliable cost data is hard to obtain. In these circumstances, Cost Analysts who may or may not report to the Purchasing organization, play a crucial role. In essence, they function as the measuring instrument in the closed-loop cost management system.

Developers should look beyond the design phase and consider how their decisions will impact the cost of manufacturing the product. This is where Design for Manufacturability

(DFM) and the associated principles come into play. A common pitfall that DFM practitioners caution against is the blind use of software tools that are widely available today. While these tools are capable of making recommendations, they are only as good as the information that was fed in. DFM analysis should be performed by experienced personnel who are intimately familiar with the manufacturing process and who understand the importance and feasibility of various design parameters. This work can also be leveraged in understanding and estimating cost drivers such as number of person-hours required to execute a certain process. This facilitates activity-based costing (ABC) analysis.

Value analysis, which is covered in a later section, is an essential ingredient to effective design-for-cost. Value analysis and value engineering consists of maximizing the product functionality per unit cost to the customer. This brings the customer-centric perspective to the DFC process.

3.3.3 Benchmarking

There are two types of benchmarking that are in use at companies:

- Price-related
- Cost or Process related

Price related benchmarking

In this approach, purchasing organizations seek to determine the reasonableness of the purchase price of a commodity or component based on the price of similar items or substitutes sold by other suppliers. In the case of commodities, the spot market prices help to establish a benchmark. For components, catalogs may be used as a proxy. Where current benchmarks are hard to obtain, purchasing organizations resort to historic trends. For relatively complex purchased components, it may become necessary to factor in the differences in features and capabilities and the value added to the finished product as a result of the differences.

Cost / Process-related Benchmarking

Companies may seek to understand how peers in other industries or their own competitors are making make-buy decisions. The goal is to validate the company's outsourcing process. Additionally, companies may conduct benchmarking exercises to understand what the best

practices in strategic sourcing are. One may try to better understand how to structure a deal based on observations in the industry or other industries. For example, looking at commonly used terms and conditions can help companies reduce their liabilities and improve their ability to negotiate with suppliers.

3.3.4 Should Cost Analysis

"Should" Cost Analysis by purchasing organizations involves the determination of the ideal cost of a product, service or piece of equipment. This should-cost serves as a benchmark for gauging supplier quotations. Essentially, it is a bottoms-up approach to determining what is fair and reasonable – the OEM's purchasing organization uses available data and best estimates of material, labor and overhead to determine an estimated fair price for the product. This may be significantly different from the target cost for the part being procured, but it gives a basis for negotiation and evaluation. Some companies use cost rollups based on "Last Paid Price" (LPP) to develop should-cost; this may be reasonable in some industries, but crippling in others. An organization that plans and prioritizes its cost reduction measures based on LPP loses the opportunity to capitalize on rapid cost erosion that may occur on some commodities while unfairly rewarding certain cost "reductions" that occurred without requiring any negotiations or incremental efforts. Additionally, the historic data may be very outdated based on when the last transaction involving that part number occurred, since current transactions may only be addressing a high-level assembly (HLA) involving that part. In some cases, the piece-part cost information is also available from historic data because it was requested and obtained directly from the seller as part of the Request for Proposal / Request for Quote (RFX) process. In many cases, data from multiple suppliers is also available which improves the quality of the estimates. Where such data is unavailable, the benchmarks described in the previous section serve to develop better estimates or Should-costs for parts to be procured.

3.3.5 Value Analysis and Value Engineering

Value analysis strives to maximize product function per unit cost of product[1]. Function is usually a combination of performance, capability, emotional appeal, style etc. – anything that will make the product sell.

$$\text{Value} = \text{function} / \text{cost}$$

In certain cases, it is worthwhile to keep adding functionality, so long as the added functionality increases more than the cost. Another definition: functional worth is defined as the lowest possible cost required to obtain a given function.

The method:

The first, and arguably most critical, step is to identify the problem and scope – and function(s) thereof. This can be a challenge in itself. Care should be taken to ensure that the functions are identified based on the desired outcome rather than the actions that lead to the outcome. The functions should be classified into a basic function and multiple secondary functions. A Cost Function Matrix or Value Analysis matrix is then drawn to identify the cost of providing each function by associating the function with a mechanism or component part of the product. Product functions with high cost-function ratios can be identified and prioritized for improvement work. The next step is to gather detailed cost estimates to evaluate various improvement options.

The Value Analysis Matrix is a variant of the Function-Cost matrix. This matrix has its roots in the Quality Function Deployment methodology. It correlates customer requirements and the functions, thus enabling the importance rating of the customer needs to be related to the corresponding functions. Functions, in turn, are related to mechanisms, as in the Function-Cost matrix illustrated above. These relations are strong, moderate or weak, and are denoted with the same conventions as in the QFD matrices. The associated weighting factor is multiplied by customer or function importance and the value of each column is added.

1 "Value Analysis and Function Analysis System Technique", www.npd-solutions.com/va.html, © DRM Associates

As products have become more complex, the Value analysis techniques of yore have been adapted to create the "Function Analysis System Technique" (FAST). The FAST permits interaction among individuals with varying degrees of technical expertise and customer and product familiarity. The FAST builds upon Value Analysis by linking the verb-noun functions to address and describe complex systems.

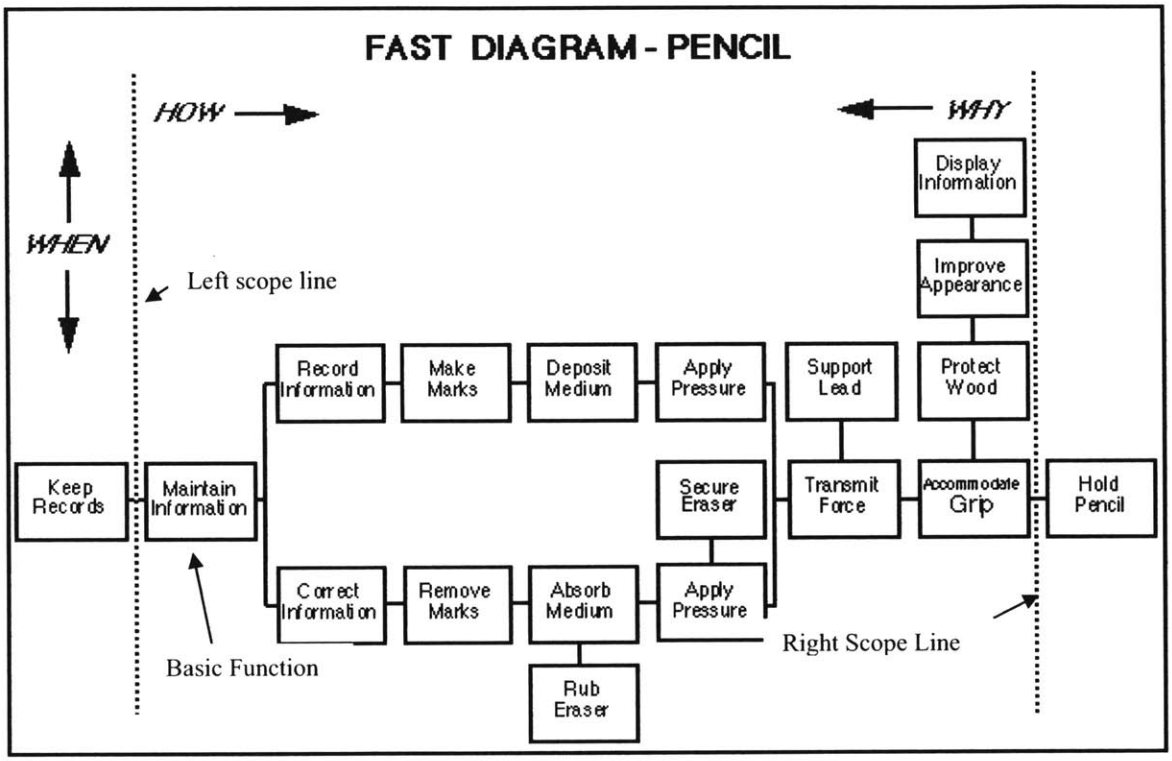

Fig. 3.4 Example of a FAST diagram developed for a pencil, by J. Jerry Kaufman

The difference from Value Analysis is in the use of intuition to determine function dependencies. Additionally, there is a graphical depiction of the system in the form of a function dependency model, shown in Fig. 3.4. The FAST[1] model shown here is for a commonly used product, a pencil. There is a horizontal directional orientation, the "How-Why" dimension. Starting with the basic function on the left, the question "How" is asked to get more specific information. Likewise, one can take the problem to a higher level of abstraction by asking "Why" the function is performed – starting from the right and

1 "The Power of FAST in Value Management", J.J. Kaufman, Canadian Society of Value Analysis, 1998

proceeding to the left. A good practice is to build the model in the How direction and to test in the Why direction. The vertical direction represents the "When" dimension – which indicates cause and effect (rather than a temporal relationship). Note that the functions to the right of the left scope line represent the product's main purpose, and are therefore called the Basic Function.

The model is then further refined to include information relevant to the functions, for example, responsibility, budgets, allocated target costs, estimated and actual costs, subsystem groupings, inspection and testing points, manufacturing processes etc. The final step is to draw boundaries around groups of functions to clearly delineate sub-systems. This can then be leveraged as a tool to illustrate cost reduction targets, divide cost reduction effort among product development teams and assign design-to-cost targets to new design concepts.

Integration of QFD with FAST[1]

QFD can be a powerful complement to FAST in developing a Value Analysis Matrix. Further developing the case of the pencil, described above, it is possible to build a Value Analysis Matrix as shown in Figure 3.5.

To combine QFD and FAST effectively, one approach is to

1. Gather customer requirements and perform QFD product planning with a product planning matrix
2. Translate customer needs into "verb-noun" functions (e.g. "record information" or "absorb medium")
3. Prepare a FAST diagram and develop the product concept in conjunction with the QFD concept selection matrix
4. Dimension the FAST diagram into subsystems.
5. Develop a system level Value Analysis Matrix. The customer requirements and importance ratings are determined from a customer FAST diagram or from the product planning matrix.

1 "Value Analysis and Function Analysis System Technique", DRM Associates

6. Complete the Value Analysis Matrix based on the subsystems, requirements and associated weights.
7. Add columns to ascertain the importance of the sub-systems, as determined by their role in meeting customer requirements and the relative importance of the customer requirements.
8. Normalize the "weights" of the subsystems.
9. Based on the target cost of the product and the normalized weights of the subsystems, determine target costs for the subsystems.
10. Gather actual costs of subsystems based on piece-part costs. This provides the development teams a basis for determining where the biggest gaps are, vis-à-vis the subsystems target costs and their current actual costs.

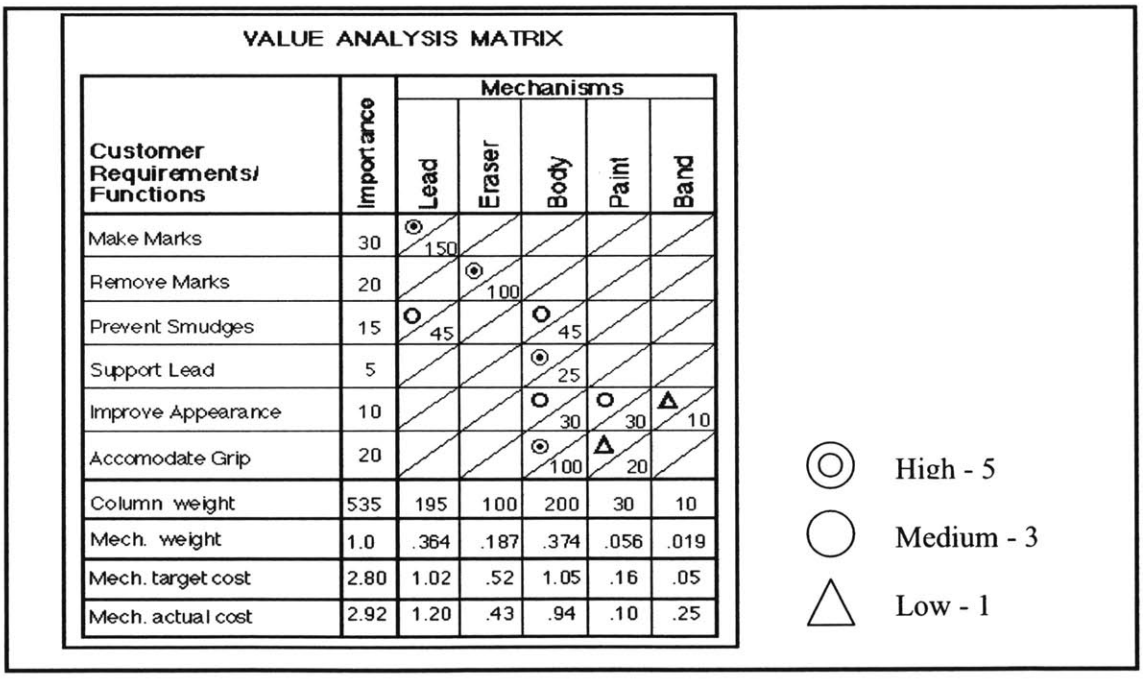

Fig. 3.5: Value Analysis Matrix, using FAST and QFD, on a Pencil.

In the case of complex subsystems, care should be taken to do this analysis at the right level of abstraction. For example, for a typical ATE product at the sponsor Company, one possibility would be to break up the product into the following high-level subsystems:

1. Device Interface Board

2. Test-head
3. Manipulator
4. Backplane
5. Instrument
6. Support Boards
7. Support Cabinet – Mechanical Subsystems
8. Support Cabinet – Electrical Subsystems
9. Thermal infrastructure
10. Computers, PC Interface and Cart Subsystem

One would then proceed to develop a FAST model for the overall system and use this to determine which subsystem(s) should be the focal point of the cost reduction effort. Once a subsystem is identified as a prime target, a FAST diagram may be constructed for the subsystem and the process is repeated.

3.3.6 Target Costing

Target costing is a disciplined approach to cost management and profit planning. Swenson et al.[1] list six key principles that engender target costing:

(a) Price-led costing

Essentially, market prices drive the allowable cost of the product. In other words,

$$market\ price - required\ profit\ margin = target\ cost$$

Note that the required profit margin is often based on investors' expectations of returns.

(b) Focus on customers

Value to the customer is paramount in this methodology. Before introducing any new features and functionality, the engineer should verify that the customer value created along dimensions that impact the customer, such as quality, cost and availability, exceeds the cost of the change.

(3) Focus on design

Particularly in the case of complex products, most of the opportunity for cost reduction is in the early phases – late-stage design changes can be very expensive because of the retooling

1 "Best Practices in Target Costing", D. Swenson, S. Ansari, J. Bell, I-W. Kim, Management Accounting Quarterly, Winter 2003

costs, documentation and obsolete inventory. Designing right is then imperative. For the sponsor Company, this was a major paradigm shift. Having traditionally competed exclusively on product differentiation, where emphasis on time-to-market was critical, the additional burden of focusing on costs in the early stages of product development was very tangible. To help through this transition, the Company re-organized its Purchasing organization into a "Revenue" group – which was involved in the traditional Purchasing function – and a new "New Product Introduction" (NPI) group. The NPI group is heavily involved in early stage design for cost activities and is staffed by employees that are well-versed with both the technical aspects of the product as well as the state of the marketplace, commodities and suppliers.

(4) Cross-functional involvement

Concurrent involvement from engineering, operations, finance, purchasing and marketing from concept generation through final production is essential for effective cost management.

(5) Value-chain involvement

Collaboration with members of the value chain, both upstream and downstream, is required to successfully accomplish target costing.

(6) A life-cycle orientation

Total life-cycle costs should be minimized for both customer and producer. This should include purchase price, operating costs, maintenance and distribution. With companies becoming increasingly oriented towards environmentally benign manufacturing, either from a sense of social obligation or in response to regulation, other measures of a product's "environmental footprint" such as disposal fees could also become significant components of how companies choose to view their product cost structure.

While the Value Analysis Matrix procedure based on FAST and QFD is a useful tool for setting targets on subsystems, it is quite possible that a significant gap between target and actual may be inevitable and impossible to reduce because of the cost structure of the subsystem. More practical variants of this approach have been developed[1]. At Caterpillar, the target costing approach taken is based on heuristics, known opportunities and current

1 "Best Practices in Target Costing", Management Accounting Quarterly, D. Swenson, S. Ansari, J. Bell, I.-W. Kim, Winter 2003

manufacturing and sourcing processes. The following example illustrates this in the form of a vehicle cost reduction study.

	Current Costs	Projected Savings	Adjusted Costs	Explanation of Known Adjustments
Assembly	5.4%	1.5%	3.9%	Efficiency improvements due to redesigning sheet metal, as documented on current production models
Cab	7.9%	0.8%	7.1%	Replace current cab with the "Classy Cab". PF quote received.
Engine	8.6%	0.7%	7.9%	Cost estimate from Engineering for switching to different configuration
Hydraulics	19.1%	1.6%	17.5%	New pump design
Powertrain	12.0%	0.0%	12.0%	
Structures	20.0%	0.0%	20.0%	
Linkage	18.0%	0.0%	18.0%	
Other	9.0%	0.0%	9.0%	
Total	100.0%	4.6%	95.4%	

Table 3.2 Caterpillar Product: Known cost reduction through design adjustments and substitutions

In the case of this vehicle, management's objective was to set the target cost at 94.6% of the costs of a comparable model built using existing manufacturing capabilities. For the product team, this translated to a gap if 5.4%. The cross-functional team first considered component substitutions that yielded cost savings without compromising product capability and performance. They then considered cost reduction through efficiency improvements. Table 3.2 illustrates these "guaranteed" cost savings. Given that 4.6% savings could be realized through these measures, the team then focused their efforts on how to best achieve an additional 0.8% in savings. To accomplish this, they surveyed the operational groups to identify cost savings opportunities. The questionnaires are not designed to reveal explicit opportunities; rather they seek to maximize the likelihood that cost reduction goals set for a specific subassembly may actually be realized.

	Assembly	Cab	Engine	Hydraulics	Power Train	Structures	Linkage	Other	Total
1 Are there more than five suppliers from whom you can purchase materials	0	0	0	1	1	1	1	0	
2 Are you more costly than best-in-class supplier (either Caterpillar or non-Caterpillar) cost breakdown	0	0	0	1	0	0	0	0	
3 Do you plan to survey your supplier	0	0	0	1	0	0	1	0	
4 Is the current manufacturing process younger than two years	0	0	0	1	0	0	0	0	
5 Does labor represent more than 40% of your total cost	0	0	1	1	0	0	1	0	
6 Is your "unit setup cost/total unit cost" ratio greater than 5%	0	0	1	1	0	0	0	0	
7 Do you see potential for material specification changes	0	0	0	1	0	0	0	0	
8 Do you see potential for tolerance loosening	0	0	0	1	0	0	1	0	
9 Does the current family of parts contain nonapproved parts	0	0	0	1	0	1	1	0	
10 Can the current design or manufacturing processes be subjected to emerging innovative technologies	0	0	0	1	0	0	0	0	
Total	0	0	2	10	1	2	5	0	20
Relative Proportions	0%	0%	10%	50%	5%	10%	25%	0%	100%
Distribution of .8% in Cost Reduction	0.00%	0.00%	0.08%	0.40%	0.04%	0.08%	0.20%	0.00%	0.80%

*Yes = 1; No = 0

Table 3.3: Modification of Current Product: Sample Questionnaire

In Table 3.3, each affirmative response indicates increases the probability that opportunities for cost reduction exist for the corresponding subsystem. By adding up the responses in each column, the team was able to determine the "weights" that they should assign to those subsystems. The 0.8% cost reduction target was then allocated across each of the subsystems in proportion to these weights, as shown in Table 3.4.

	Adjusted Costs	Distribution of .8% in Cost Reduction	Target Cost for New Product
Assembly	3.9%	0.00%	3.90%
Cab	7.1%	0.00%	7.10%
Engine	7.9%	0.08%	7.82%
Hydraulics	17.5%	0.40%	17.10%
Powertrain	12.0%	0.04%	11.96%
Structures	20.0%	0.08%	19.92%
Linkage	18.0%	0.20%	17.80%
Other	9.0%	0.00%	9.00%
Total	95.4%	0.80%	94.60%

Table 3.4: Modification of Current Product: Final Target Cost Assignments

Cause-Effect Analysis (CEA) for Target Costing

Chen[1] et al. have propounded the use of Cause-Effect Analysis as a tool to complement Value Engineering, QFD and DFM/DFA activities. One of the major benefits that they have observed as practitioners of CEA is that it is intuitive and easy for non-engineers to apply effectively.

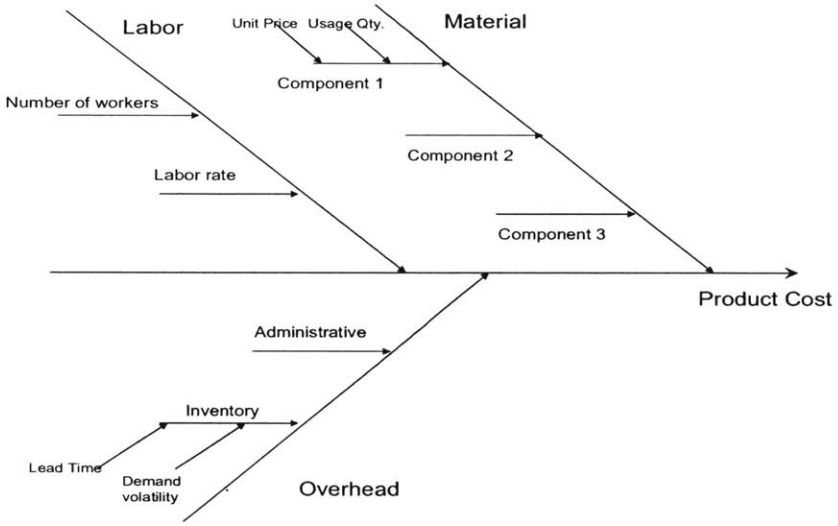

Fig. 3.6 Cause Effect Diagram for Cost Analysis

1 "Cause-Effect Analysis for Target Costing", by R. Chen, C. Chung, Management Quarterly, Winter 2002

This makes it consistent with TQM and Kaizen philosophies, wherein everyone, including accountants, can be involved in the continuous improvement process. A key element of effective CEA is the Ishikawa or Fishbone diagram. This pictorial representation of relationships and potential causes has been widely used for problem solving. In the case of product cost, the same concept can be easily applied, as shown in Figure 3.6. While this figure is simplified, it illustrates the approach. A team could, through a review of this picture, understand the cost drivers that impact material, labor and overhead costs. Once the magnitude of each of these causes is ascertained, a Pareto analysis can be performed to prioritize cost reduction activity.

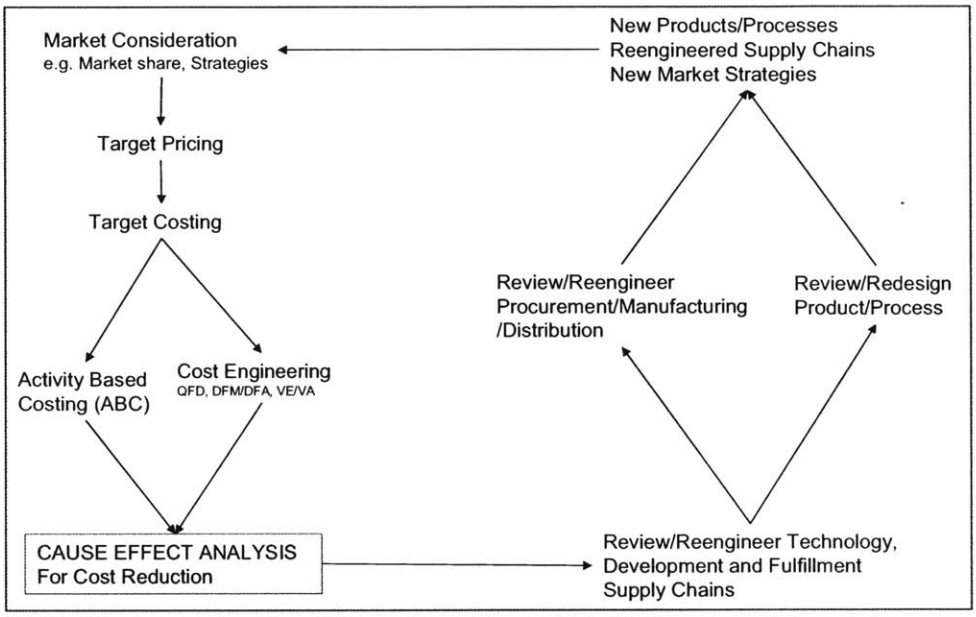

Fig. 3.7 Integrating Target Costing With Overall Operations Strategy[1]

Such use of CEA can enable accounting innovations like Activity Based Costing to be used in conjunction with cost engineering activities to identify cost reduction opportunities. Additionally, target pricing / target costing can be used with internal customers as well. Even without formal establishment of profit centers within a corporation, the target costing concept can be applied to any two functional entities that have a transfer-pricing relationship. Figure 3.7 illustrates the role of target costing in the broader framework of

1 Adapted from Chen et al.

operations strategy in a manufacturing enterprise. Note that CEA can also be an enabler for cost reduction efforts with suppliers, by virtue of the fact that it offers an effective communication medium.

3.3.7 Total Cost Analysis

For integrated companies, tracking the cost of material and labor is adequate to understand where the best opportunities for cost savings are. However, in today's global manufacturing firm, an increasing proportion of the cost to create and deliver a product is in its supply chain. This usually is in form of markups at the supplier, overhead and labor at the contract manufacturer, inbound and outbound logistics, tariffs, taxes and inventory carrying cost at various points in the supply chain. In order to enable continuous improvement and accurate prioritization, it is important to constantly or frequently monitor the evolution of costs due to market or regulatory changes. Companies typically track total cost when making strategic sourcing decisions, supplier decisions, supply chain structural decisions, or when assessing and managing risks and understanding supplier costs and customer decisions.

3.3.8 Supplier Development

Often, working with suppliers may provide tremendous opportunities for cost reduction. In some instances, the supplier has deep technical expertise with regard to a specific technology and may be able to suggest product or process design changes that may yield significant cost savings. The key is to provide the right kind of programs and incentive structures to encourage suppliers to share these cost reduction ideas. Several companies[1] such as General Electric have had success with "Supplier Originated Savings" programs, wherein suppliers providing viable ideas were granted an increased share in their business. Other companies reward the suppliers by passing on a portion, and sometimes all, of the cost savings to the supplier who offered the cost reduction idea.

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1 "General Electric Company – Transportation Systems Business Operations", J.L.Byrnes, Massachusetts Institute of Technology

3.3.9 e-Procurement

This section explores e-Procurement and its inherent benefits as a tool to accomplish cost reduction.

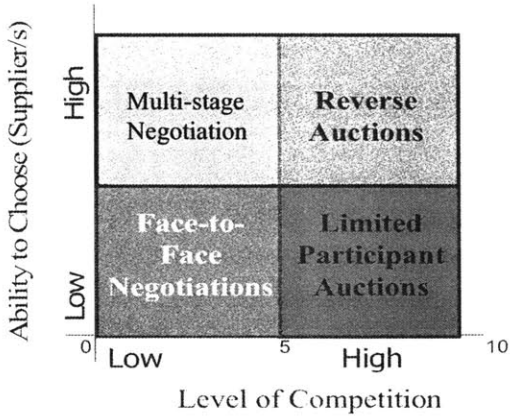

Fig. 3.8 Prescribed e-Procurement Strategies Based on Supplier Landscape

E-markets and e-Procurement rapidly gained popularity in the mid-1990's, because of the pioneering efforts of companies such as FreeMarkets[1], Ariba, VerticalNet and CommerceOne. The basic premise was the reduction of processing cost per order from as high as $150 per order in certain cases to as low as $5 per order[2]. While there were no clear benefits to suppliers, the clear value proposition offered by e-markets to buyers was:

- Service as the intermediary to suppliers
- Savings identification
- Broader supply base through identification, qualification and support of suppliers
- Platform for negotiations and bidding events

There are different types of negotiations that can be conducted using the infrastructure provided by e-markets. Figure 3.8 shows a framework that prescribes the appropriate negotiation type given the supplier landscape. Reverse auctions imply the sellers bid downward till the lowest possible bid price is attained. Competitive bidding is similar, but is open to a pre-screened group of suppliers thus requiring additional management before and during the process. Multi-stage negotiation is essentially a "give and take" process but with each competitor made aware of the existence of competition. One-on-one negotiation is also a "give and take" negotiation style given that switching is unlikely.

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1 "FreeMarkets OnLine, Inc.", Case Study, V. Kasturi Rangan, © President and Fellows of Harvard College
2 "Designing and Managing the Supply Chain", D. Simchi-Levi, P.Kaminsky, E. Simchi-Levi, McGraw-Hill Irwin

While Figure 3.8 is helps understand the various negotiation strategies and their appropriateness based on the supplier landscape, Figure 3.9 shows a more practical representation in the form of a spectrum rather than well-defined quadrants. On one end of the spectrum is one-on-one negotiation, ideally suited for feature and supplier discovery. At the other end is the reverse auction format, prescribed in highly commoditized price-competitive environments to provide the best price to the buyer.

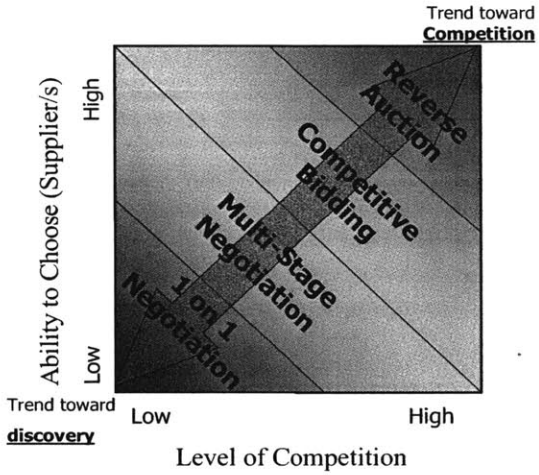

Fig. 3.9 Realistic Segmentation of e-Procurement Strategies based on Supplier Landscape[1]

Benefits of e-Procurement

Efficiency: The consistent benefit realized from the use of e-Procurement is a significant improvement in the efficiency of conducting negotiations.

Effectiveness of cost reduction: In the case where reverse auctions are warranted and employed, significant improvements in cost reduction are generally observed. This is not surprising because the reverse auction format permits smaller suppliers to compete and, in fragmented markets where brand is of little relevance, this can dramatically bring down the bid price. For the other negotiation styles, improvement in effectiveness is expected to be modest, if any, because the e-platform does not really change the dynamics of the negotiation process itself.

1 Based on presentation "Digitizing the Sourcing Process" by Quentin Samuelson, Motorola, Inc.

Augmenting supplier base: Particularly in the case of reverse auctions, a Competitive Bidding Event (CBE) can expose alternate suppliers for parts that are currently sole or single sourced. This may provide leverage for future negotiations for those parts and help drive their costs down.

Access to and analysis of spend data: One of the secondary benefits of utilizing electronic procurement platforms is that the data can be aggregated easily. This can surface opportunities to leverage volumes and combine purchased parts to create bundles for negotiation purposes. Additionally, data can be monitored for compliance as well as assimilated to generate credible reports.

Caveats associated with the use of e-Procurement strategies

Supplier relationship: When a company decides to use the reverse auction format, it should be certain that it does not wish to maintain a long-term relationship with its current supplier. By announcing a reverse auction, an OEM is essentially signaling that it does not care about any part or product differentiation and that cost is the only relevant dimension along which bids will be awarded. Current suppliers may shy away from such auctions and also discontinue relationships. This may have deleterious consequences particularly in the case where those suppliers are also suppliers of differentiated products for which the OEM considers, for example, quality and lead-time to be critical. Breaking the relationship with the supplier then would mean additional work identifying an alternate supplier or simply degradation in overall product or service quality.

Overhead of setting up documentation / specification: The discipline required in creating product and process designs that can be shared in a rigid structured electronic format with suppliers will generally improve the overall quality. However, there is no disputing the fact that there will be an additional burden imposed on the design and development function to adhere to certain specification formats and generate documentation that is meaningful outside the corporation. Therefore, companies choosing the electronic route should not discount this additional burden. Also, while the electronic option will be ideal for quality assurance and traceability of parts to the suppliers, the involvement of Engineering groups in preparing for the negotiation process may be considerable.

3.4 METRICS

While Purchasing organizations frequently report cost savings, the methodology used to arrive at the savings numbers is usually unclear. Apart from the fact that some kinds of data can be interpreted creatively, there are instances where multiple inconsistent views of the data may be available. This is where a fair, well-documented and consistent method of measurement is essential. This is true of both performance and outcome measurement in a Purchasing organization. In the case of outcome measurement, recent research has shown seven different techniques for measuring savings[1]:

3.4.1 Outcome Measurement

Price over Price

This method of measuring cost savings is perhaps the most elementary one – recording downward variances of contract prices and recording them as cost savings. However, it is important to consider macroeconomic trends, particularly where commodities are concerned. If the reduction in price of the appropriate Purchase Price Index outpaces the cost reduction of the new contract, then this should be recorded as a cost increase. This approach is particularly true in the case of raw commodities such as metals, but would be difficult to implement in the case of more complex processed goods.

Successful Bid vs. Average Bid

In this instance, the mean of all bids received during bidding process is used as the datum. Post-negotiation savings are calculated with reference to this mean. Care should be taken to exclude outliers so as to not skew the savings attained. Also, in certain industries, first bids are usually offered with a significant markup with the assumption that further negotiations are inevitable and will result in substantial price reduction. This should be factored into the metric so as to not over-estimate the extent of savings attained through negotiations.

Market Comparisons

As a consumer, this method of comparing the cost of products being procured with the value of equivalent products on the market seems intuitive. However, it is important to

1 "How good are your cost reduction measures?", Larry R. Smeltzer and Jennifer A. Manship, Supply Chain Management Review, May 01, 2003 © Reed Business Information US

recognize that merely looking at the catalog prices may give a skewed, favorable view of cost reduction effectiveness because it may not recognize the fact that catalog prices are often inflated to start with. Additionally, such a practice should take into account the volume of product being procured, and should look at the market price of equivalent products in the same volumes. For highly commoditized products such as memory, spot market prices are a good estimate of market price.

Total Cost

In today's global sourcing environment, developing a total cost perspective has become essential. At the very least, this has to be done at the time sourcing decisions are being made. The biggest barrier to doing this kind of analysis is that it is essentially complex. Monitoring material costs is elementary – and data gathering and analysis are easily facilitated by transaction-based automation systems, such as ERP systems. However, the relevant total cost for the organization may have to include transportation, inventory, warranty, payment terms and conditions and end-of-life costs. To develop a true total cost perspective requires understanding cost drivers in relatively complex manufacturing and processing environments and allocating overhead on the basis of their resource consumption. Determining these cost drivers requires analysis and institutionalizing the tracking of these costs requires persistence and discipline. The very first barrier to implementing an Activity Based Costing (ABC) system tends to be from groups or functions adversely affected by these measures, i.e. ABC analysis would allocate greater overhead to these functions. Additionally, traditional accounting practices also tend to be a barrier – companies are very hesitant to institute two views of cost, one satisfying reporting requirements for investors and one providing the right incentives for all divisions in the organization. Moreover, in the instance of the sponsor Company, material cost had traditionally been, by far, the largest component of the product cost structure. The recent globalization had significantly changed the picture, with logistics related costs such as tariff and shipping costs becoming significant portions of the cost of building a product.

Traditional GAAP rules have driven corporations to bucket shipping costs under the category of expenses – Purchasing organizations have to independently develop metrics for the sake of decision-making and performance measurement. The necessary cost data,

however, can be difficult to obtain because it must come from a number of different departments. For instance, the inventory cost is often "owned" by manufacturing or a materials management group in addition to the finance department. Certain types of costs such as end-of-life costs are, at best, crude estimates. Other total cost components such as international tariffs require frequent monitoring independent of when sourcing decisions are made, because these are driven by regulations. Meaningful synthesis of all these numbers is yet another complex challenge requiring significant overhead.

Target Price or Cost

The Target Cost approach was explained in an earlier section. The target cost is usually arrived at through consensus from various groups. This is therefore a convenient reference point from which to measure cost savings. If the final cost is estimated to come in under the target cost, this would be recognized as a cost savings. Companies should take care to ensure that quality is not compromised in the bargain.

Cost Avoidance

Although the effect of cost prevention and cost savings is the same, cost prevention is often not emphasized because it is harder to measure and hence rarely rewarded. Buyers often levitate towards solutions that offer short-term savings i.e. lower purchase price, despite the fact that a more reliable solution, though expensive, could prove to be cheaper in the long run given that the low cost solution would be prone to failure and require more frequent maintenance. Having appropriate metrics is a prerequisite to being able to justify the required long-term perspective and emphasis on intangible benefits. One approach is to determine the incremental costs associated with the "expensive" solution and then deliberate over how many repair instances of the "cheaper" product would cause the total lifecycle cost in the two cases to breakeven. Similar analogies can be made to most situations. At the sponsor Company, this approach was adopted when evaluating costs of information technology infrastructure and automation that offered functionality equivalent to that offered by the existing system - these figures drew much skepticism from the steering committee responsible for making such investment decisions.

Innovations or Product Improvements

Given that cost savings are generally tied to savings recognized at the time of a transaction, a buyer could potentially go unrewarded for procuring a functionally superior component for the same price as the component currently used in the product. For example, if a commodity manager was successful in replacing the CRT[1]-based display, which is one of the components of a automated test system, with a superior LCD[2] display through negotiations with the supplier. Suppose this is done at the same cost to the Company as the original CRT display. The LCD display being vastly superior has thus enhanced the attractiveness of the overall product to the end-customer. If there is no accounting for this kind of improvement work, commodity managers will have no incentive to work along the product improvement dimension. One way to remedy this situation is to evaluate the market value added to the product by the addition of the new superior component. This can be accomplished by benchmarking with competitors or other suppliers to determine the incremental value of the added feature. The same concept also applies to the case where a buyer negotiates improved service level from a supplier, all other terms and conditions remaining unchanged. In this case, the organization could potentially benchmark the new service level or perform a cost analysis to determine the value of the improved service level. In either case, it is obvious that this is not a trivial exercise and at some point management has to decide whether maintaining such metrics is worth the improved buyer performance measurement.

3.4.2 Performance Metrics

The best measures are reported directly by the people using them, and use data that is already available for other reasons .... It is wasteful to gather data for performance measurement alone.

Brian Maskell

Characteristics of good performance metrics

Studies have shown that performance metrics in high-performance purchasing organizations have some common characteristics. Maskell[3] provides guidelines to can help craft the appropriate performance metrics for the organization.

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1 Cathode Ray Tube
2 Liquid Crystal Display
3 "Making the numbers count", B. Maskell, Productivity Press

- The best metrics relate directly to corporate strategy

This is in contrast to outcome metrics. Corporate strategy influences manufacturing, development, marketing and sales strategies. Metrics should directly address these strategies. Keeping performance metrics aligned with the corporate strategy ensures that both the company and employees being measured have clear and consistent feedback. Additionally, metrics should be objective and tangible, so people being measured can relate to them.

- Metrics should be primarily non-financial in nature

It is often perceived that metrics that are inconsistent with financial reports are inaccurate or lack credibility. However, given that financial and accounting metrics frequently drive the wrong organizational behavior, it is imperative that performance metrics be crafted solely to align the Sourcing organizations practices with the overall corporate strategy. Another trend that can be harmful is that companies often translate all metrics into money terms. This can often be a disservice – depending on the context, people are able to relate to the operational metrics such as cycle time and yield rather than labor hour variances and cost of quality.

- Metrics should be allowed to vary from site to site

One of the most important prerequisites to being able to institutionalize metrics is having a champion to ensure success. Since champions are likely to develop their own flavors of metrics, it is imperative to not impose standardization. Additionally, using metrics to judge one site's performance with respect to another will breed unhealthy rivalry. Each site has its own unique challenges, because of customers, products and employees, and adopting a "one-size-fits-all" approach may be counter-productive.

- Metrics should be reviewed and updated, as required, over time

As the business environment changes and companies adapt, it is essential to frequently review metrics to ensure that they have not been rendered obsolete.

- Metrics should be lucid, and easy to use and interpret

Often, companies try to develop metrics that combine various distinct aspects into a single factor. In many instances, this merely serves to obfuscate the issue. The simpler the metric and the more meaningful it is to the people executing the task or process, the more effective it is.

- Reporting should be quick, to enable appropriate and timely response

The greater the lag between and event and when it gets reported, the greater is the overhead from deliberating over what went wrong, explaining variance and defending actions taken. This adds to the overall waste. Delayed metrics cause companies to use metrics and reports for "post-mortem" analysis rather than for identifying future opportunities and mitigating threats. In the manufacturing context, this is well understood – with companies striving to ensure that error-detection occurs as close to the source as possible. In Sourcing organizations, a direct analogy can be made with the frequency of reporting. The sooner a threat or opportunity is detected, the greater the likelihood that a buyer or commodity manager can mitigate or exploit it.

- Metrics should nurture improvement, not merely enable monitoring for compliance

In many organizations, metrics exist to ensure the people comply with rules and do not "misbehave". A more effective approach is to ensure that metrics exist to improve performance by aligning organizational and employee's personal goals.

3.5 COMMON PITFALLS IMPACTING COST REDUCTION MEASUREMENT

Unavailable or inaccurate data

This is a common problem that is typically observed when there are new commodity types, components (SKUs) or activities (e.g. a new transportation option or a border crossing) introduced in a company. In some instances, companies or their suppliers have a policy of not divulging their cost structure because they fear that the information may find its way into the hands of the competition.

Inability to integrate total cost measures

Divisions of companies often have multiple, competing improvement initiatives. An initiative that is meant to improve the company's product material cost structure may have a deleterious effect on product quality or availability. It then becomes imperative to have a unified view to present the inherent tradeoffs that are required – "total cost" is one such unified view. Many companies struggle with developing metrics and processes required to adopt this unified view.

Inability to measure product enhancements or impact of new product introductions

As mentioned in an earlier section, product enhancements and new products may provide a cost savings in the form of better performance at a low marginal cost. Traditional accounting would fail to recognize these cost "savings" – it is imperative that companies

have performance metrics to provide the right incentives for design engineers, suppliers and commodity engineers to continue their product enhancement initiatives.

No agreement on timing of cost measurement

An example of this issue is when commodity engineers complete a cost reduction initiative on a product that does not have any demand for another 6 months. This gives rise to conflicting claims of when to recognize the cost savings – at the time of completion of the initiative or when the actual sale of the product occurs. This is typically a problem in the case of low volume products.

Inadequate organizational commitment

While companies are quick to announce cost reduction as an important initiative in their organization, not many have the discipline to define sustainable processes to support this initiative. An earlier section described the relevance of having the right organizational structure and sponsorship for sustained focus on cost.

3.6 INFORMATION TECHNOLOGY AS A LEVER

Generally, PSM organizations stratify their efforts on managing their purchases by taking into consideration the magnitude of the spend on a commodity or part as a fraction of overall spend, market conditions, stage in product lifecycle and the importance of the suppliers. In order to support such prioritization of efforts, it is essential to have a data warehouse where historic transactions can be recorded, cleansed and processed into a format amenable to report generation. These data warehouses also enable the development of "what-if" scenarios, to assist in quantitative decision-making. Certain organizations use replicas of their ERP systems to support such activities. Additionally, the potential benefits of automating the sourcing process – negotiation and transaction - may be immense. This will be covered in a later section. In certain organizations, the information technology infrastructure is configured to alert management whenever "maverick" spending is detected, i.e., when buyers make purchases that violate corporate norms. Most companies have established "approved supplier" lists based on supplier quality and favorable negotiated contracts. If a buyer erroneously or intentionally attempts to make a purchase from a non-approved supplier when an approved supplier and approved part number exists, an alert is generated and reported to management. Such systems help to drastically limit spend especially on commodity parts.

CHAPTER 4: BENCHMARKING STUDY

4.1 INDUSTRY SURVEY

This chapter focuses on the outward-facing aspect of this study, i.e. looking at trends across industries and benchmarking best practices in a variety of situations related to cost management in purchasing organizations.

4.1.1 Methodology

The first step was to determine a representative set of companies from a variety of distinct industries with very distinct clockspeeds[1]. This was predicated on two reasons. While benchmarking a competitor would be ideal, it was unlikely that there would be straightforward means for gathering the required data from competitors. On the other hand, by looking at companies across the board, there was a greater likelihood of gaining insight into *why* companies did what they did in addition to merely understanding their processes.

The general idea in conducting interviews with these companies was to understand their cost management related processes. While the Purchasing function was the primary area of interest, the interviews were deliberately open-ended so as to understand how the various functions interacted to accomplish cost reduction work. Equally important was the need to understand the information technology infrastructure at these companies. The goal was to understand the capabilities of the systems in place and understand the costs of developing or acquiring and installing these systems as well as maintaining them.

The companies interviewed represented a leading aircraft manufacturer, a computer hardware manufacturer, two automotive Tier 1 suppliers, two communications equipment manufacturers and a computer peripherals manufacturer. All of the companies are major players in their respective industries.

1 "Clockspeed", Charles Fine, Sloan School of Management

4.1.2 Questionnaire and Interview Process

The questionnaire itself consisted of a combination of structured questions, based on areas of interest, as well as open-ended questions designed to elicit unusual or unanticipated insights. The questionnaire looked for responses to questions not only pertaining to tactical issues but to strategic issues as well. The questionnaire and interviews started with an explanation of the study and the motivation. The interviewee was asked to describe his or her industry, product and typical product lifecycle duration. He or she was then asked for an approximation of the total spend for the company, broken up into direct spend (costs related to material that goes into the product) and indirect spend (costs related to procurement of material and services that support production but do not appear in the end-product). Questions pertaining to the overall structure of the supply chain and names of major players in the value chain were asked. The questionnaire then focused on organizational issues such as the nature of sponsorship of cost management and the organization structure supporting this initiative. What specific cost management and cost reduction practices were being actively sponsored by top management? How did the company prioritize its cost reduction initiatives? Specifically, what processes did it have in place to accomplish this?

Specific questions were asked regarding the nature of commodities and parts procured by the company. How volatile were the prices of these commodities? Was the company able to leverage volumes to achieve cost reduction? How were its relationships with the suppliers? Was it able to leverage electronic systems to simplify and improve its processes? Did it use auctions for procuring any or all of its purchased parts? What impact did the auctions have on its relationships with those suppliers? Did the company need to forecast costs of purchased parts? What was the forecasting horizon?

Additionally, the interviews delved on the different components of cost that the company deemed to be relevant. Finally, questions regarding the decision support systems in place at the company were asked.

4.2 RESULTS OF SURVEY

A comprehensive list of best practices was developed via a literature survey as well as some initial conversations with the surveyed companies. During the interviews themselves, or as a follow up, more or less the same questions were posed to representatives of the surveyed

companies. Since the purpose of the survey was primarily focused towards getting data for making a recommendation to the sponsor Company, it was not as comprehensive and structured as an academic survey. Moreover, in some cases, because of confidentiality issues representatives were reluctant to divulge details. However, the survey was adequate to reveal the fact that the practices and processes discussed fell into three categories: widely-adopted, sometimes-adopted and seldom-adopted.

4.2.1 Widely-Adopted Practices

Within this category, there were several practices and processes that were fairly similar to the Company's own – in this case the widespread adoption served as validation.

Prioritizing Opportunities

Most of the surveyed companies prioritized their cost reduction activities based on the impact on total spending for the year. Of the companies surveyed, those that saw rapidly changing costs relied on customized or "home-grown" data-warehouses and decision-making systems to help with this analysis and to generate reports. The companies that had relatively stable prices, because of the slow "clockspeed" of the industry or because of the long-term nature of the contracts, relied on their transaction-based systems and data to generate these reports. To understand why companies do not pursue all cost-reduction opportunities, it is important to understand what is involved in a type cost-down project. For example, a commodity manager identifying a potential supplier that may have an ideal part substitute at a lower cost is only the first step in a time and resource consuming part / supplier qualification funnel.

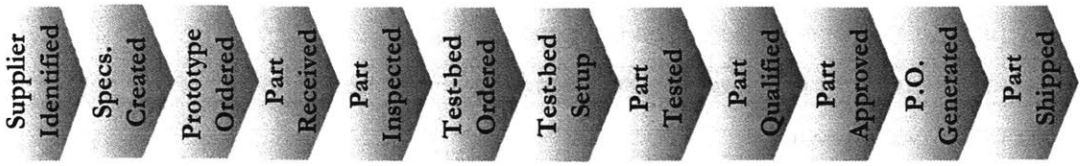

Fig. 4.1 New Parts / Supplier Qualification Process

Figure 4.1 illustrates the many stages involved in the part and supplier qualification process, and this emphasizes why companies seeking to rapidly exploit cost reduction opportunities have to prioritize their efforts.

Price Forecasting

Most of the surveyed companies maintained price forecasts on commodities with a time horizon that ranged from four to six quarters. The time horizon (how far out?) for making price estimates depended on how feasible it was to make such estimates and how critical it was to make these estimates. The feasibility was driven by the nature of the contracts – for certain commodities the long term nature of the contracts made it possible to reliably forecast the price for the commodity over a long period. High dollar value commodities – high demand and/or high unit cost – were critical because of their impact on the total company spend. It was therefore necessary to track the prices for such commodities and parts over a longer duration. For most companies, commodities that comprised the top 80% of spend by SKU[1] were prime candidates for forecasting over longer durations. The price forecasts were made on a per quarter basis, i.e., one forecast for each SKU per quarter. This was somewhat different from the Company's practice of maintaining one forecast per month. This had implications as far as the additional overhead to generate these forecasts and maintain the data, as well physical storage requirements. The frequency of forecasting prices (how often?) was a function of how often the prices themselves were revised. This depended on two factors: the volatility of the prices and the typical duration of contracts for that commodity or industry. Typically in the automotive industry, for example, because of the high cost of tooling associated with production of a component by a supplier, as well as the relatively large platform/component lifecycle, the contracts themselves were drawn over a period of a few years. This was in contrast with contracts that were valid for a few months, at most, in the electronics manufacturing business.

Third Party Cost Review

This refers to the practice of reviewing the piece-part costs of high-level assemblies (HLA) procured from contract manufacturers. As explained earlier, the Company recently

1 Stock Keeping Unit

transitioned to an outsourced manufacturing strategy and at this point the question that arose was – should the company continue to monitor costs below the buy-level[1]? From a tactical standpoint it seemed attractive to continue with old processes and stop trying to track piece-part costs. In reality, there was good reason for the Company to continue monitoring at least one category of parts, those that were managed completely by the Company for strategic reasons. ASICs, for example, were a heavily managed commodity, because once manufactured by an upstream supplier, they were committed towards the Company's production. From the time of manufacture, the Company was committed to purchasing all the ASICs built for their product – even if there was no demand for the product. Consequently, this category of commodities was completely managed by the company, from negotiation, through design to delivery to the contract manufacturer, who in turn would assemble it into a high-level assembly (HLA). Since the Company negotiated the volume and price for these ASICs, per agreement with the contract manufacturers any savings via cost reduction from the ASIC supplier was expected to be passed on to the Company.

Currently the Company tracked this "below the buy-level" piece-part data through an exchange of spreadsheets with the contract manufacturers. This was done on a limited basis – only a small group of Company employees was privy to the information shared by the contract manufacturers. The data therein was only used for auditing, since the agreement with the contract manufacturers required that this information not be shared with the commodity management organization or the design teams. The variances were tracked via spreadsheets and settled as per the principles described earlier. This practice, in itself, is not uncommon among OEMs. However the survey revealed that most OEMs leverage Electronics Data Interchanges (EDIs), Web Portals or the automated negotiations process[2] to gain access to contract manufacturer's cost structure and analyze variances.

"Should Cost" Analysis

[1] Buy-level refers to the level in the Bill of Materials of the final product at which the transaction occurs. "Below the buy-level" refers to data pertaining to the BOM structure of the part involved in the transaction.

[2] This encompasses electronic Request for Information (RFI), Request for Quote (RFQ), Request for Proposal (RFP) and bid award, often referred to as RFX.

While many OEMs are performing Should-cost modeling offline in spreadsheets, a few indicated that they were able to leverage engineering "sandboxes" – flexible decision making software modules that permitted tentative reconfiguring of BOMs to analyze scenarios and implications – to facilitate efficient cost modeling. This sandbox capability was not the sole reason for acquiring these "sandbox enabled" systems. Therefore it was unclear if the Company should invest in these capabilities for the Should-cost modeling alone. However it was clear the practice of Should-cost modeling was widely viewed as an indispensable practice.

There were also several widely adopted processes and practices that were in place at most OEMs organizations that seemed to provide significant advantages. These included:

Frequent resetting of standard costs with commodity management input

The standard setting process has traditionally been owned by the Finance and Accounting functions primarily because of the implications it has on the Balance Sheet and Income Statement. Standard costs, at a minimum, impact Cost of Goods Sold (COGS) and Inventory Valuation. The standard setting process involves some amount of overhead and the traditional approach is to reset standards only as often as dictated by the business environment. For companies and industries experiencing rapid changes, this frequency of standard setting should be reviewed. While this particular project did not entail a detailed study of the standard setting process, the realization that the Company was at a disadvantage because of its relatively long latency between standard resets implied that it was a valuable, even if serendipitous, finding. The observation was that most OEMs revalue standard costs either monthly or quarterly using current or future negotiated costs. This was in contrast to the Company's practice of resetting standards every six months. Another major point of contrast was that many progressive OEMs had gradually transferred ownership of the process, fully or in part, to the commodity managers. Ostensibly, this was in recognition of the fact that the commodity managers and buyers have the most forward-looking estimates of costs which is especially useful in an environment where inventory turns are high. While the sponsor Company competed in a low-volume high-mix industry, the recent efforts towards standardization as well as the rapid erosion of costs and prices made it both possible and necessary to increase the frequency of standard setting.

e-Procurement and Reverse Auctions

This was an area of particular interest to the Company. Thus far, the Company had not invested in automating the sourcing process. While the demand planning organization had developed customized methods to get electronic feeds of data from its various contract manufacturers, it had yet to develop an automated method to conduct negotiation and transactions.

During the survey, a few trends became clear. Practically every OEM had either experimented with or institutionalized the e-Procurement process. Opinions varied – however in all cases OEMs admitted to seeing improvements. The biggest benefits were seen in the area of efficiency improvements. This was because the extent of automation and detailed specification required for e-Procurement permitted suppliers to quickly respond to a Request for Information or a Request for Proposal. Regarding the greater effectiveness of online tools in generating cost savings, the reactions of OEMs were mixed. In industries that were experiencing rapid reductions in cost, such as electronics and telecommunications, the incremental cost savings realized through automated Procurement were significant. In industries with relatively stable prices, such as the automotive industries, e-Procurement was convenient and efficient, but incremental cost savings were marginal. Those companies that advised caution mainly did so because they had learned, in some cases experientially, that certain categories of commodities are more amenable to certain types of negotiations than others. Electronic platforms facilitate different types of negotiations and certain types, reverse auctions in particular, should be deployed with caution. For example when supplier relations are important and cost is not the only criteria – quality, service-level and capacity being more important – then reverse auctions are ill advised. For commoditized and highly standardized components, reverse auctions may be ideal.

As in all kinds of negotiation, it is important for the buyer to ensure that the supplier is able to meet cost, lead-time, quality and reliability requirements. Terms and conditions should include appropriate clauses that address these issues. One OEM suggested that if going down the path of e-Procurement, processes should be put in place to not only ensure that fit and function attributes are well-specified, but also ensure clear specifications for aesthetic and form-related attributes. This oft-neglected aspect can cause the finished product to look sub-standard. Another OEM said that the biggest benefit they had obtained following the introduction of e-platforms and reverse auctions was the identification of alternate suppliers,

especially for bundled commodities such as plastics and sheet metal. Additionally, the relevance and effectiveness of reverse auctions relies heavily on the balance of power in the buyer-seller relationship. It was clear that the Company needed to invest in setting up infrastructure that would, at a minimum, automate the negotiation process and, with some experience, deploy the appropriate negotiation type for the appropriate commodities and parts.

4.2.2 Sometimes-Adopted Practices

Of the processes that were observed in some of the companies, the following were also in use at the Company:

Simulation

The OEMs surveyed performed simulations to (a) assist in early stage product design for cost (b) perform "what-if" scenarios based on various demand, cost and product configuration scenarios, and (c) estimate Profit and Loss impact. This is illustrated in Figure 4.2. These were also done with varying degrees of sophistication. While some use simple spreadsheets and spreadsheet extensions, others have developed proprietary systems to perform such analyses.

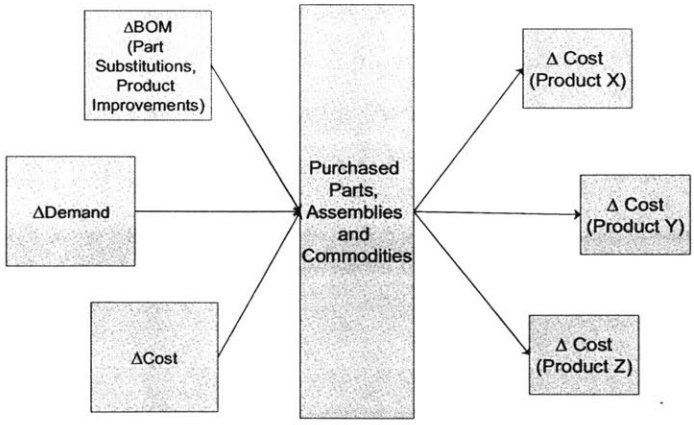

Fig. 4.2 Factors that Companies Can Simulate and Perturb To Predict their Impact on Product Cost

The following processes are either not employed or only partially implemented at the Company:

Visibility of Cost Information

In an earlier section, the need to monitor piece-part costs below the "buy-level" was explained. Essentially, the basic terms and conditions between the contract manufacturer and the Company required that Purchase Price Variances be settled in accordance with mutually agreed upon guidelines. Additionally, the nature of certain commodities such as ASICs which were directly managed by the Company even though procured by the contract manufacturer required that the cost structure of the purchased part be known.

Another reason for needing to know the cost structure below the "buy-level" is that the Company was still at a stage where design work was performed entirely in-house. This was an important competitive advantage and not likely to change in the near future. Engineers and developers were being urged to adopt Design for Cost (DFC) principles. However, performing DFC is impossible without having cost information.

The surveys revealed that the need to monitor the costs below the buy-level was quite common – especially among OEMs in the high-tech, high-clockspeed industries. There was a difference in the level of sophistication of the infrastructure used to share this information as well as the level of confidentiality. Some OEMs made use of Electronic Data Interchanges or Web Portals to enable suppliers to provide the required data. In some cases, the electronic request for proposal (RFP) / request for quote (RFQ) – referred to as RFX – was used to request and acquire cost data on specific commodities of interest that constituted the HLA being procured. However, in all cases the infrastructure required to get the data was not specifically put in place for the sake of data sharing – OEMs were able to leverage infrastructure that was created to automate transaction and negotiation. Therefore, while the need to have visibility into piece-part costs below the "buy-level" was validated, it was unclear whether the benefits in this area alone would justify investing in new information technology infrastructure.

Total Cost of Acquisition (TCA)

Some of the OEMs indicated that their organizations had developed standardized processes for tracking total costs. The primary use for this analysis was to make optimal sourcing decisions. The Total Cost view enabled them to make fair comparisons of various sourcing scenarios, by accounting for material cost, labor, overhead, markups, logistics, tariffs and inventory costs. Typically, this analysis was done on spreadsheets, during the product

planning stage while the sourcing strategy was being formulated. Additionally, ad hoc Total Cost analysis was performed when there were significant changes in the environment that could significantly impact the cost of acquiring the parts or commodities.

4.2.3 Seldom Adopted Practices

The final category of practices that were not seen as commonly undertaken by the companies surveyed was of interest for two reasons:

(a) Some practices might be unique to an industry and, if pertinent, the sponsor Company would consider adopting them.

(b) Some practices might be unique to the Company, in which case it would be advisable to understand whether there was a good financial or strategic justification to continue with these practices.

We look first at the areas where the Company's practices were not unique, i.e. there was at least one other OEM that reported similar practices.

Transitioning Data from New Product Introduction Phase

This was a challenge that the Company has been struggling with. New product-related data is tracked primarily on spreadsheets. When the product configuration is fairly well understood towards the end of the introduction phase, the data transitioned into systems and databases accessible by the complete enterprise. As early stage cost management became more sophisticated and richer in content, it became more complex and laborious to ensure that the data was captured in a central repository. While most OEMs indicated that their systems worked in the same way, one OEM indicated that the system they used provided functionality that enabled ease of data exchange with spreadsheets. This, in fact, became one of the features used to screen potential cost management solutions that might benefit the Company.

Engineering Sandbox

The Company's own proprietary system, COSMOS, as well as some other Procurement-oriented software on the market did not provide a means to retain the indented BOM structure. The rationale, no doubt, was that this relatively complex functionality was not required by commodity managers who did not need to know the exact BOM structure. Rather, all they needed was the exact number of a particular SKU that was used in a

particular configuration. However, given that entire sub-assemblies were now being outsourced, this view was no longer adequate. Additionally, there was a growing awareness that Design for Cost initiatives could be greatly improved if there were a tool that allowed engineers to quickly compare the cost implications of various alternative designs. Currently, at the Company, engineers submitted their alternatives to the SLM organization to "cost the BOMs". This was a wasteful process with unnecessary time delays. Some engineers developed their own tools and macros to automatically perform the cost analysis, but these suffered from inaccuracies because the cost data they used was often standard cost information maintained by the accounting group. Even if they took the effort to get data from the SLM central repository – which was intended to be the "vault of truth" with the latest information – in many cases, even this data was inadequate and not forward-looking. In other words, for design decisions to be optimized, a future view of cost and an analytical tool to apply these costs to various BOM configurations were necessary and currently unavailable. The Engineering Sandbox is a term that describes this functionality. Some OEMs indicated that they had Engineering Sandbox capability built into their centralized system. Others indicated that, like the sponsor Company, they primarily used spreadsheets or simple databases to perform such analysis.

Reporting Frequency

One concern with the sponsor Company's existing reporting capabilities was that the duration of the process was excessive. At the basic level, the reports required assimilating BOMs, cost data and demand information, aggregating this data in the form of "cost rollups" along different views – product, commodities or specific options – and providing Pareto charts that revealed opportunity areas. The process involved interaction among various groups, manual data entry, audit and cleansing, and significant *a posteriori* determination of issues that could have been mitigated. Some aspects of this process were fairly repetitive and consumed significant analytical resources. Senior management wished to understand if other OEMs were moving towards developing real-time capability in cost reporting, and whether other organizations also expended similar resources to track and report costs.

The results of the survey revealed that most OEMs have not moved towards real-time reporting – rather the reporting was at a monthly or quarterly cadence.

The following areas were found to be unique to the sponsor Company:

Tracking product cost at multiple confidence levels

At the sponsor Company, in the NPI domain, the cost of the product is tracked at three levels of confidence, as shown in Figure 4.3. This concept, though not new, has been highly refined. The worksheet shows the cost tracked at the highest level. The actual spreadsheet has "tabs" corresponding to each sub-assembly listed on the high level worksheet shown. Each of these sub-assemblies is also tracked at three levels of confidence. Additionally, comments are added where appropriate making this a useful tool for project management. The most "risky" estimate (<75% confidence) is actually the best estimate based on all cost reduction opportunities identified to date. When BOM structures and engineering data are unavailable, in extremely early stages of product development, parametric models[1] are used to confirm estimates. This model thus helps identify the areas requiring the most attention and specific measures such as design and manufacturing process changes, introducing competition in the supply base, Low Cost Region sourcing etc. can be planned.

New Product X Slot System Material Cost Summary

4/22/2004

Based on Sales Forecast v.999

Pin Instruments	Owner	Phase 2 Budget	Low Risk 95% Confidence	Med Risk 75% Confidence	High Risk <75% Confidence	Gap: Low Risk to Phase 2 Budget	% Gap to Budget: Low	Med	
Instrument X	L. Silver	$ 15,000	$ 17,000	$ 14,500	$ 14,000	$ 2,000	13%	-3%	-7%
Zero Pin									
Subsystem A	P. Hutt	$ 18,000	$ 24,000	$ 17,500	$ 17,000	$ 6,000	33%	-3%	-6%
Subsystem B	L. Silver	$ 18,000	$ 22,500	$ 22,000	$ 17,500	$ 4,500	25%	22%	-3%
Subsystem C	C. Sanders	$ 4,500	$ 4,500	$ 4,000	$ 4,000	$ -	0%	-11%	-11%
Subsystem D	L. Silver	$ 15,000	$ 20,000	$ 15,500	$ 15,000	$ 5,000	33%	3%	0%
Subsystem E	R. McDonald	$ 6,000	$ 6,000	$ 5,500	$ 5,000	$ -	0%	-8%	-17%
Subsystem F	T. Bell	$ 25,000	$ 28,000	$ 23,000	$ 22,500	$ 3,000	12%	-8%	-10%
Subsystem G	T. Bell	$ 18,000	$ 19,000	$ 16,500	$ 15,000	$ 1,000	6%	-8%	-17%
Subsystem H	R. McDonald	$ 4,000	$ 4,200	$ 3,800	$ 3,500	$ 200	5%	-5%	-13%
Subsystem I	C. Sanders	$ 10,000	$ 42,000	$ 41,000	$ 39,000	$ 32,000	320%	310%	290%
		$ 118,500	$ 170,200	$ 148,800	$ 138,500	$ 51,700	44%	26%	17%
Alternative Subsystem I	C. Sanders	$ 35,000	$ 35,000	$ 34,500	$ 34,000	$ -	0%	-1%	-3%
		$ 143,500	$ 163,200	$ 142,300	$ 133,500	$ 19,700	14%	-1%	-7%

Fig. 4.3 Hypothetical Example of Cost Model with Tracking at Three Levels of Confidence

1 These parametric models, depending on the nature of the sub-assembly, could leverage cost information from previous models normalized by features that define product evolution. For example, in the test industry, this feature for the basic platform can be the number of pins supported by the platform. The cost estimate for the new product being developed could then be extrapolated based on a regression of the cost per pin over time.

The model is constantly updated as new, more reliable information becomes available from design engineering and supplier quotes. Of the companies and individuals surveyed, none described a methodology similar to this method. However, similar, less sophisticated, models were described by two OEMs. Also, based on the results that had been achieved using this methodology, it was evident that the results justified the overhead required to maintain this model.

Project Tracking – 4W1H

4W1H (Who, What, When, Why, How) information related to projects was an essential component of project tracking at the sponsor Company. This data helped tie individual cost-down information and tentative cost-down estimates to individual projects. Additionally, this mechanism helped link cost management strategies, such as Low Cost Region sourcing or Dual Sourcing, to individual projects and parts / components. The benchmarking exercise revealed that this level of tracking was uncommon among the companies interviewed. Although two companies mentioned that they tracked risks and opportunities related to product costs, this was treated at a higher level of abstraction. While this did not bring the efficacy of the practice into question, it did make it clear that specifying this as a required feature in any software package that the Company was to purchase would be impractical. Currently, this data was tracked using a Microsoft Access database.

Contract Manufacturer PPV (Purchase Price Variance)

This refers to the ability to review contract manufacturers' costs[1] versus agreed upon standards for the purpose of settling variances. In the case of most companies surveyed, the responsibility of tracking and reporting the variances lay with the contract manufacturer. In the one instance where an OEM did admit that they went through the PPV process with their contract manufacturers, they clarified that the purpose was mainly to facilitate negotiations of future prices. Consequently, the benefits of the PPV process itself were reviewed and justified in terms of Return on Investment. It was decided, however, that

[1] In some cases, this process required that the contract manufacturer provide receipts for piece-parts procured by it.

because the process is non-standard and needs some degree of flexibility, continuing to use spreadsheets for PPV analysis was advisable.

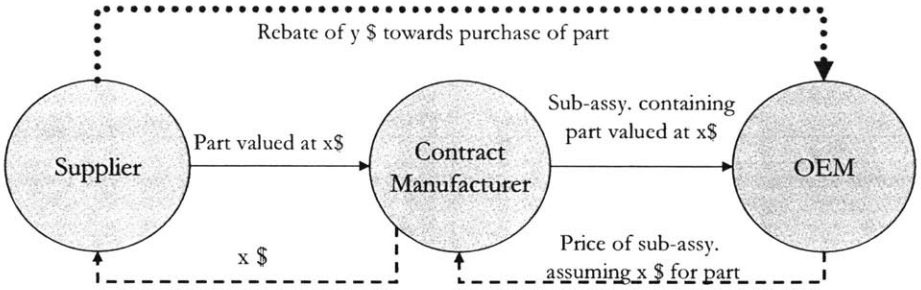

Fig. 4.4 (a) Price Masking to Conceal Preferred Pricing from Contract Manufacturer

In this regard, certain common industry practices were noted, namely, price masking and rebates. Price masking is a practice whereby OEMs may make agreements with piece-part suppliers such that the favorable pricing available to them is not known to the contract manufacturer who actually procures the part for the piece-part supplier for creating the assembly.

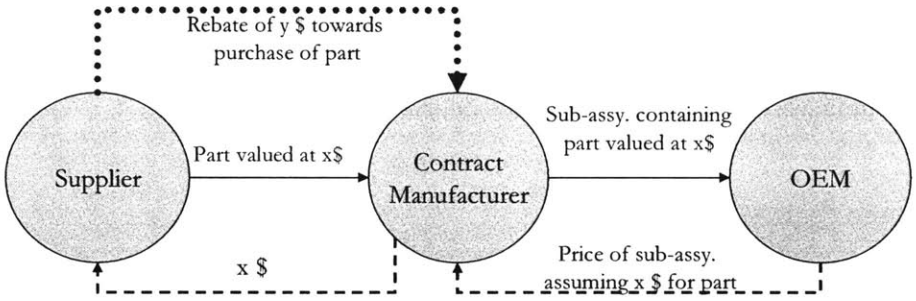

Fig. 4.4 (b) Rebates to Conceal Preferred Pricing from OEM

This assembly then gets sold to the OEM for a price based on the higher un-negotiated piece-part costs. The supplier then reimburses the OEM for the price that it paid over and above the negotiated piece-part cost. The contract manufacturer is thus oblivious of the fact that the net price of the piece-part to the OEM is lower than the price it paid to the supplier. Figure 4.4 (a) illustrates this idea. Rebates are the opposite mechanism, whereby the contract manufacturer conceals price-breaks that it has negotiated with the supplier from the OEM. Thus, even in a cost-plus arrangement, a contract manufacturer could extract a greater profit

margin than what was agreed upon with the OEM. Figure 4.4 (b) explains how rebates work.

Process Area	Industry Standard Practice	Company's RELATIVE Performance	Question	Recommendation
Prioritize Opportunities	Most Companies	Same		Improve on Best Effort Basis
Price Forecasting				
3rd Party Cost Review				
Should Be Costs				
Standards Setting		Different	Do we need to improve?	**Make Improvements**
On-line Reverse Auctions				
Simulation	Some Companies	Same		Improve on Best Effort Basis
Visibility of Cost Information		Different	Do we need to improve?	**Make Improvements**
Total Cost of Acquisition (TCA)				
Transition Data from NPI	Few Companies	Same		Improve on Best Effort Basis
Engineering Sandbox				
Real-time Reporting				
Confidence Levels		Unique	Is this an irrelevant strength where extra investment is not justified?	No Change - Continuous Improvement
4W1H				
Contract Manufacturer PPV (Purchase Price Variance)				

Fig. 4.5 Summary of Findings from Benchmarking Study

Figure 4.5 summarizes the findings from the benchmarking study.

Limitations of the study

The sample size of the companies surveyed was obviously limited – therefore the findings do not necessarily indicate a cross-industry trend. The intent of this study was, however, was to ascertain to what extent other progressive companies had invested in infrastructure dedicated towards cost management. Also, the focal point was the Procurement function. The individuals interviewed were involved in cost management activity to varying degrees and their responses were, accordingly, at varying levels of detail.

CHAPTER 5: SOFTWARE SURVEY AND FIT-ASSESSMENT

This chapter describes the process of determining the infrastructural requirements based on extensive interviews with individuals involved in Procurement, Design Engineering and Finance functions at the Company. Further, it describes the process of prioritizing these requirements, surveying software capabilities available in the industry, screening software vendors and determining alignment between available functionality and the Company's business requirements.

5.1 BUSINESS REQUIREMENTS ASSESSMENT

5.1.1 Leveraging Process Maps to Identify Stakeholders

One of the biggest challenges during the course of the project was defining the scope of Cost Management. As part of this exercise, the existing infrastructure and all processes related to cost management in the SLM group were mapped. Appendix A depicts a simplified map of the current infrastructure related to cost management currently in use at the Company. Appendix B illustrates two examples of processes which were mapped to determine the tasks performed, the people and groups involved and effort required to execute these processes. In addition to the fact that the functions within the Company have their own cost-management requirements, they also have well-defined processes to accomplish the related tasks. Often, the processes themselves generate secondary requirements which, over time, become indistinguishable from the original core requirements. The key, therefore, was to distill the information and extract the core requirements. Since this stage was critical for establishing the scope of the project and the boundaries of the system to be studied, all the possible stakeholders impacted by cost management of procured goods were interviewed.

5.1.2 The Interview Process and Interview Data Synthesis

The interviewees included individuals who had a possible need for procured parts cost data and reports, and who were instrumental in or directly impacted by cost reduction measures taken up by the SLM organization. After some initial interviews, it was also determined that

this study would be limited to direct material spend, i.e. costs and expenses related to the procurement of material became a component of the end-product.

Interviewees included individuals from Finance, SLM - Revenue, SLM-NPI and Engineering. The interviews consisted of a description of the project, its purpose and intended goals. A combination of structured and unstructured, open-ended questions were asked and responses recorded. Figure 5.1 illustrates the template used to conduct the interviews and record the responses.

Requirements Template - Cost management System

Cost category: **Date(s):**
Interviewer: **Participants:**

SPECIFIC QUESTIONS:
What items should be included in a cost management system?
What items should not be included in a cost management system?
At what level do you manage your parts/items (e.g. part number, commodity)?
What groups do you share cost data with?
Are there any Contract Manufacturer / supplier data requirements?

GENERAL QUESTIONS TO CONSIDER:
What current capabilities in cost management do you have that you want to keep?
What cost management functionality would you like to see that you currently do not have?
What are your business metrics?

E - Estimating
M - Monitoring
P - Projecting
R - Reporting
A- Achieving

								IS THERE A WEAKNESS?	
Existing or New	Need H/M/L	BUSINESS REQUIREMENT	DESCRIPTION / PURPOSE	Type (E, M, P, R, A)	PROCESS (Document or Description)	Freq. of Executing	Current System(s)	DESCRIBE	Category: time, accuracy, consistency, ability to cost reduce,

Fig. 5.1 Template used to Conduct Interviews for Business Requirements Assessment

The recorded results were then shared with the interviewees for their approval. At this point, interviewees were also asked to prioritize the business requirements as High, Medium or Low, depending on how critical that requirement was with respect to the execution of their functions. After conducting interviews, the responses were then synthesized and categorized into higher-level business requirements.

Figure 5.2 describes these higher level categories. Appendix C contains an exhaustive list of all the business requirements identified.

BUSINESS REQUIREMENTS CATEGORIES

Data (History and Transaction)		Integration with ERP / Engineering
	Contract Manufacturer / Supplier Data	Piece-part (Input)
		Shared (output)
		Archiving (snapshots)
		Miscellaneous Data Capture
Decision Support Systems	Data Estimates	Demand
		Tentative Costs
		Cost Trends
		Quality of Estimate
		Adjustments to Estimates
		Data entry efficiency
	Simulation Tools	What-if scenarios
		Flexible BOM Configs
	Analytics	Maintain Links Between Old/New Parts/Assys/BOMs
		BOM Compare
		P & L Forecasting
Reports		Reporting Capability
		Data Validation/Exception
Strategy		Sourcing Plan Support
		Focus Means
Infrastructure		Central Repository
		System Support
		Data Import / Export
		Security
		System Architecture
		User Support
		Scalability
UNCATEGORIZED	**Item**	**Possible Categories**
	Data, Infrastructure, DSS (Estimates)	Multiple Cost Types
	DSS (Estimates)	Data Transition from Offline to Online Cost Mgmt System
	Infrastructure	Re-use of Offline Templates

Fig. 5.2 Higher Level Categorized Business Requirements

The business requirements were assigned weightings based on relative importance as expressed in the interview responses. Figure 5.3 is a graphical illustration to depict the business requirements that were most important. These are arranged in a flow diagram to explain their relevance in the overall cost management process.

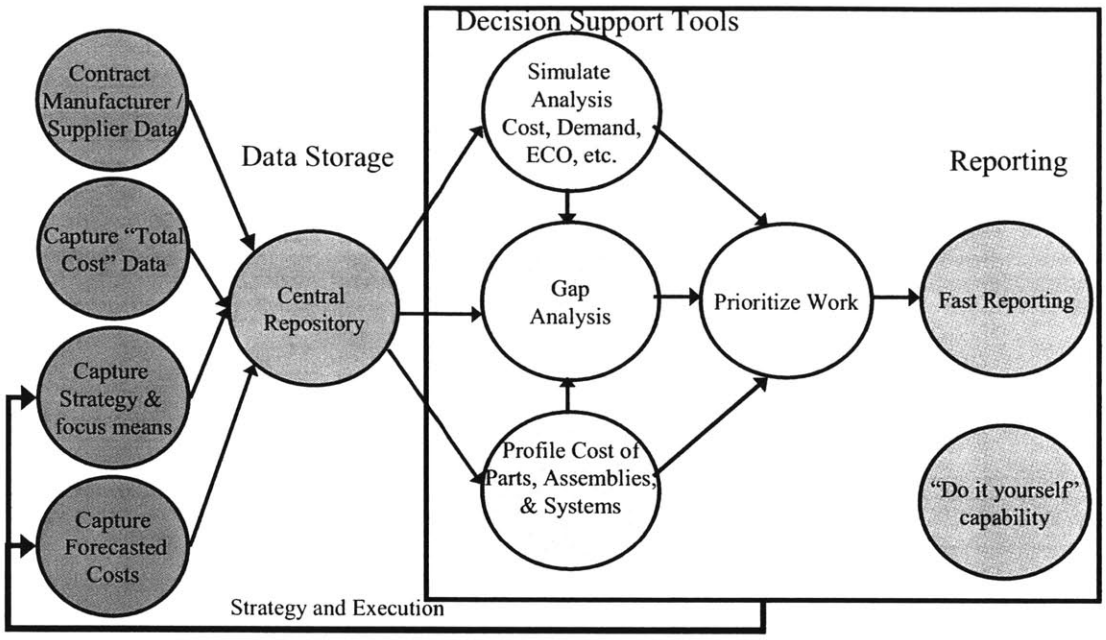

Fig. 5.3 Graphical Illustration of High Priority Business Requirements

Functional Requirements	Weighted correlation	Process related	Software related
4.1 Report Generation	55	Y	Y
4.5 Graph cost over time	35	-	Y
2.8 Simulation of change in demand, price, or BOM	20	-	Y
1.1 Common Data for purchased assemblies / parts (note: this applies to internal and 3rd party purchased parts, unless specified)	15	Y	Y
2.4 Measure gaps between cost estimates and cost budget (target)	15	Y	Y
3.1 Data transfer	12	Y	Y
2.2 TAM (total spend) compare	10	-	-
2.3 Measure actual performance vs. forecasted performance / goals to highlight areas to focus on for cost down work	10	Y	Y
4.3 Drill down capability	10	-	Y
4.2 Data validation, monitoring and compliance	9	-	Y
5.1 Method for achieving desired outcome	9	-	Y

Table 5.1 Functional Requirements and their Relative Importance Based on Business Requirements

In parallel, a list of functional requirements that related to the business requirements revealed during the interviews was generated. To identify the relative importance of

functional requirements, their correlation with the business requirements was captured on a matrix. The matrix helped to translate the business requirement weightings to the functional requirements, as illustrated in Table 5.1. This, in turn, helped conduct an effective fit assessment of potential software vendors. The weightings of the functional requirements were associated with the ability of the vendors to meet these functional requirements. The weighted sum then became one objective criteria used to evaluate the software vendors.

5.1.3 Explanation of Business Requirements Identified

Contract Manufacturer / Supplier Data

While this requirement was fairly well understood and has been described earlier, a few additional points were revealed through the interviews. Piece-part cost information, a pre-requisite for performing design-for-cost, was available on a limited basis – this data was only privy to one or two individuals who were forbidden to share this information with the rest of the enterprise. To change this, several changes would have to occur:

1) The Company would have to have greater leverage and/or better relationships over the contract manufacturer to get them to agree to share the details of their cost structure

2) The Company would have to be able to provide assurances that it would not allow the abuse of this privileged information; for example, it would not bypass the contract manufacturer and negotiate directly with the piece-part supplier on the basis of the cost and contract information,

3) The Company would have mechanisms to ensure that confidential information would not leave the organization, and

4) The Company would need a better infrastructure to reliably import cost, BOM and demand data from the contract manufacturer, with little overhead.

Total Cost Data Capture

This relates to the need, as described in Chapter 3, to develop a Total Cost approach to understand the cost of procuring parts and commodities. This was imperative given the global nature of the new supply chain at the Company. This had significant implications on the technology infrastructure of the company. To track the data feeds related to cost components that were previously not tracked, such as inbound and outbound logistics, and

tariffs, and incorporate these costs into the cost of a product through appropriate allocation, imposes requirements on the IT systems.

Capture Strategy and Focus Means

This refers to the ability to store data pertaining to specific initiatives identified or currently underway to achieve cost reduction. The challenge lay in tying back the data related to these initiatives to a specific part, commodity and product. The new system would be required to handle not only the entry and storage of such data, but also provide the linkages that would make it possible to correlate cost reduction strategies and specific product cost reduction.

Capture Forecasted Costs

Almost all the interviewees identified a future view of costs as a key enabler in their analysis and planning activity. Frequently, certain groups made projections into the future based on incomplete or outdated information even though better information was available, for instance, with the commodity managers who may have recently negotiated costs on that part or commodity.

Central Repository

This relates to the need for a centralized "vault of truth" that all functions could turn to for reliable and current information pertaining to purchased parts, assemblies or commodities.

Simulation

This set of requirements emphasized the need to perform "What if" scenarios based on cost, demand or BOM changes, to determine the financial impact.

Gap analysis

This requirement was rooted in the Company's quality management philosophy. The need for continuous improvement implied that the infrastructure should have the ability to support setting target values, tracking performance and gaps with respect to those targets.

Profile cost of parts, assemblies and systems

Implicit in this requirement is the ability to roll-up various versions of cost – historic, current and projected – as well as provide cost trends over time. One notable requirement was the ability to cost different BOM structures in addition to "standard" or released BOM configurations. This was a result of the architecture of the Company's new products which were based on platforms, thus making it advantageous to be able to track costs of individual optional sub-assemblies and BOM configurations based on combinations thereof.

Work / Opportunity Prioritization

This set of requirements related to the need for tools to identify and prioritize cost down opportunities for piece parts, sub-system, system, commodity or supplier by expected financial impact on the Company's profitability. The ability to provide Pareto charts and similar visual tools to assist in decision-making was also included.

Fast Reporting

This requirement encapsulated the various requests for *ad hoc* reports – there was a perceived need for reliable cost reports that could be generated, whenever required, from a single system without having to wait for the end of the month or quarter.

"Do it yourself" capability

This relates to the need, expressed by several stakeholders, to generate reports and perform analysis independently, without having to wait for cost analysts to execute the weekly, monthly, quarterly or annual cost analysis processes.

5.2 SURVEY OF SOFTWARE TOOLS FOR COST MANAGEMENT

5.2.1 State of the Industry

Cost Management software is available today in numerous flavors. Since most other categories of software provide some form of costing functionality, many of the sponsor company's cost management business requirements were met in some form or the other by many vendors' software. Software packages that provided Enterprise Resource Planning (ERP), manufacturing cost estimation, accounting, business performance management and strategic sourcing capability had significant cost management capabilities. There were also vendors that took a product centric approach to data management that was closely aligned to our business requirements. There was however a niche of vendors whose software professed to automate and facilitate Sourcing and Purchasing activities and decision-making. It was this niche that was of particular interest.

According to analysts that monitor the software industry and the adoption of software by corporations, there is a distinct "hype-cycle" pattern[1].

[1] Hype Cycle was a term coined by Jackie Fenn, an analyst at Gartner Group, to demonstrate general trends and events associated with the introduction of cutting edge technologies.

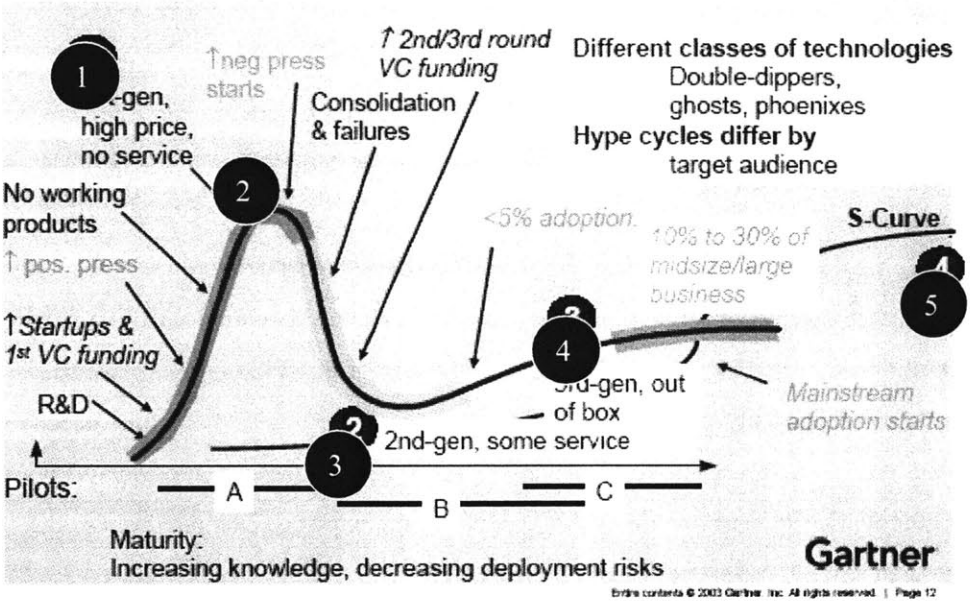

Fig. 5.4 Gartner's Hype Cycle and Indicators © 2003 Gartner, Inc.

Gartner's hype cycle is a five-part sequence:

1. Technology trigger: A breakthrough, public demonstration, product launch or other event that generates significant press and industry interest.
2. Peak of inflated expectations: A phase of over-enthusiasm and unrealistic projections during which a flurry of publicized activity by technology leaders results in some successes but more failures as the technology is pushed to its limits. The only enterprises making money at this stage are conference organizers and magazine publishers.
3. Trough of disillusionment: The point at which the technology becomes unfashionable and the press abandons the topic, because the technology did not live up to its over-inflated expectations.
4. Slope of enlightenment: Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the technology's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools become available to ease the development process.
5. Plateau of productivity: The real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and

third generation. The final height of the plateau varies according to whether the technology is broadly applicable or only benefits a niche market.

Based on this categorization and conversations with analysts as of the time of execution of this project, the cost management software industry was thought to be in Stage 4, the slope of enlightenment. This meant that the hype around software functionality was increasingly reflective of the actual capability of the software.

5.2.2 Different Flavors for Different Markets

An initial survey through interviews with analysts as well as internet searches revealed that cost management software is an emerging, fragmented market that has evolved in many different ways based on functional expertise. Several vendors have developed their own flavor of cost management based on their core business. For example, there are companies that specialized in delivering solutions that leverage Activity Based Costing. There are others that primarily compete in the Enterprise Resource Planning (ERP) space and offered basic Cost Management functionality as an option. There are also solutions available that offer the capability to perform shop-floor cost estimation based on product design. One breed of cost management software has its origins in e-Procurement. In recent years, during the economic down-cycle, Spend Management has become a mantra and software in this area offers advanced analytical capability based on cost data and expenses. Two of the well-known categories of software that are more closely aligned with functionality being sought after by the Company are Supplier Relationship Management (SRM) and Product Cost Management. The key was to focus on software that was designed around the requirements of the Procurement function. Nevertheless, the approach adopted was to investigate all the categories and look for the best economically viable fit.

Enterprise Resource Planning (ERP)

ERP software primary seeks to unify data relevant throughout the enterprise. These systems are designed to support and automate the business processes of medium and large businesses. Generally, they include manufacturing, distribution, personnel, project management, payroll, and financials. They are accounting oriented information systems that have their genesis in Material Resource Planning systems - they are useful for identifying and

planning enterprise-wide resources needed to take, make, distribute, and account for customer orders. In terms of Cost Management functionality, they offer BOM-based analysis and manipulation, automated workflow, compliance and monitoring capability for various transactional processes and cost roll-up generation based on BOMs. On the other hand, they are not designed for the flexibility required for decision-making analysis such as playing out alternate demand scenarios. Additionally, the interface is generally too cumbersome for cost management analysis. While various cost data types may be easily defined, it would require extensive customization to define the relationship between various cost types and define workflows to update expected price forecasts from period to period. In essence, the ERP systems could provide a conduit to the data and data structures, but did not offer any of the decision support functionality required. Moreover, the primary focus of transaction-based ERP systems is current and historic data – incorporating a forward-looking view in the data is currently not possible without extensive customization.

Spend Management

A category of software that focuses on spend management analytics seeks to better classify companies' expenses and provide tools to dissect this data by supplier, region, commodity or service category etc. The primary goal is to provide senior management with the ability to determine where the volume leverage opportunities lie. The analytical capabilities offered by this category of solutions are very attractive and well-aligned to the cost management business requirements. However, there is a fundamental drawback. All the software vendors interviewed agreed that there was inadequate support for product-centric analysis – in most cases, the software was not designed to even support an indented BOM structure. This fundamental deficiency implied that significant customization would be required before such as system could be used for Cost Management at the Company.

Data Marts and Report-writers

One potential approach that was considered was to use a collection of small databases, called data marts, that would contain the information that management needed to make strategic decisions. Additionally, there are software solutions that provide the ability to conveniently generate reports. With this combination, it is possible to build decision support systems catered towards the need of the enterprise or division. The problem, however, was that any

advanced functionality, such as the ability to store and manipulate BOM structures would have to be purchased and installed separately, or developed specifically to work with the decision-support system. This adds to the total cost of implementing an adequate solution.

Supplier Relationship Management (SRM)

This category of solutions seemed best aligned to the cost management business requirements of the Procurement organization. SRM solutions claim to provide analytical support to understand and measure strategic alignment of the procurement organization with overall company strategy. They provide "dash-board" capability to provide feedback and direction to commodity management and buyers. They also provide the ability to unearth the biggest opportunities for cost reduction and volume leveraging. The decision support capabilities are also closely aligned with the requirements of the Company's procurement organization.

5.3 RELEVANT SOFTWARE CAPABILITIES AND TOOLS

This section elaborates some of the tools and features offered by some software vendors that facilitate the strategic cost management process.

5.3.1 Supplier Collaboration

Through various mechanisms, software solutions are capable of providing channels for data sharing. While older systems rely on Electronic Data Interchanges (EDI), the current approach is to use XML (eXtensible Markup Language) which offers a more flexible protocol for transfer of rich data. This is particularly helpful for transferring indented BOM information. Additionally, cost data including its various pertinent components may also be shared.

5.3.2 Analytics

Component Cost Forecasting

Some packages offer the user the ability to enter forecasts for the cost of each part. In some instances, the future cost was automatically calculated based on contracts and the dates for which they are effective.

BOM Comparison

A key feature offered by many vendors is the ability to compare one BOM to another, or to a previous model or version. This can be extremely helpful in explaining changes in costs as well as planning for negotiations. In some instances, the ability to compare new BOMs with previous versions helps uncover errors and unintended changes in new BOMs.

Simulation or "What-if" Modeling

All the software vendors interviewed offer the ability to perform an impact analysis. These software solutions differ in their level of sophistication and their ability to allow for changes in cost, BOM structure and demand.

5.3.3 Cost Modeling

Contract Manufacturing Cost Model Support

Some vendors have developed features specifically geared towards companies that have outsourced their manufacturing services. Salient features of such systems is the ability to store and share detailed information regarding labor content and cost associated with it, tariffs, shipping cost, markup. In most instances, this data is requested by the buyer during the negotiations process – in the Request for Quote – and the final bid usually contains these details.

Best Cost Estimation

Best Cost Estimation (BCE) is a simple workflow concept. Essentially, it is a process of extracting the best estimate of cost from disparate sources. As mentioned earlier, one of the complications of cost modeling is that, in a fluid supply chain, data is rapidly outdated. One approach is to have a centralized "vault of truth". However, this database can still get feeds from multiple sources. BCE is a process that establishes a hierarchy for these disparate data sources. Consider the hypothetical case shown in Figure 5.5. Here the central repository carries all the relevant cost information. However, in order to determine the most appropriate cost for use in DFC efforts or for negotiations, one might consider the sequence shown. Initially, contract costs are applied to material costs to determine cost estimate. If this operation reveals that cost data is unavailable, the next step is to look for open Purchase Order (PO) costs. If there is an open PO, then the cost estimate is made based on this PO. If not, the next best estimate is obtained from the standard cost stored in the central

repository. In the figure, the best estimate of cost is the one labeled "1". In its absence, "2" is used and "3" is the default if no other data is available for a better estimate.

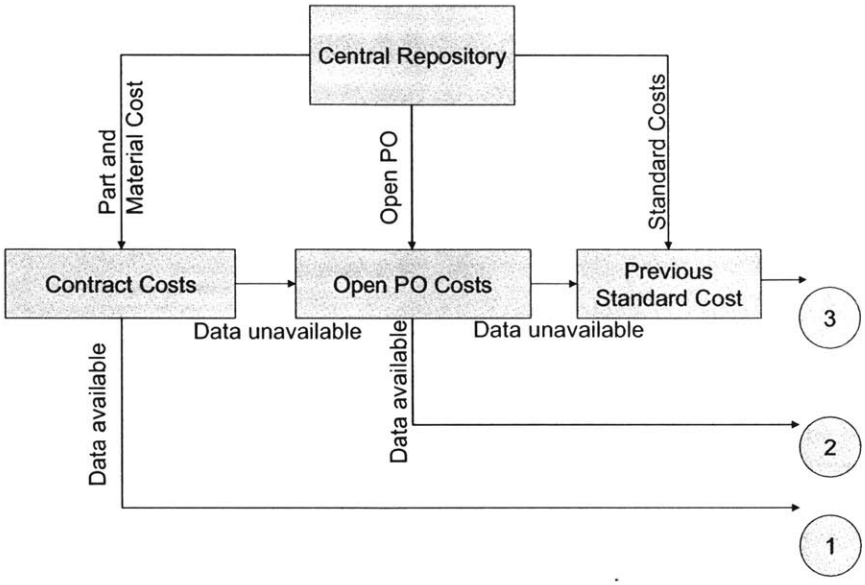

Fig. 5.5 Best Cost Estimation Example

Profitability Analysis

A few software vendors offer the ability to evaluate the Profit and Loss impact of specific products and options. Rather than calculate the profitability of a representative product configuration, these tools facilitate analysis of the profitability of each product configuration and feature. These packages also account for the temporal distortion introduced because of the timing difference between when the costs towards creation of the product were incurred and the time of sale.

5.3.4 e-RFX

This refers to automation of the negotiation process. The details of the different types of negotiations have been described in Chapter 3. This section describes how automation can facilitate the entire negotiations process.

Bid / Quote Management

As shown in Figure 5.6, when a decision to buy a new part is made, a Request for Quote (RFQ) is created. Some packages provide tools that facilitate the RFQ generation process as

well as distribution of the RFQ to the list of approved suppliers, if applicable. In some instances, there is a version of the software available for installation at the contract manufacturer's site which enables quick review and response to the RFQ. In some cases, because of the universality of data exchange format– such as XML – there is no need for the contract manufacturer to install a specific package.

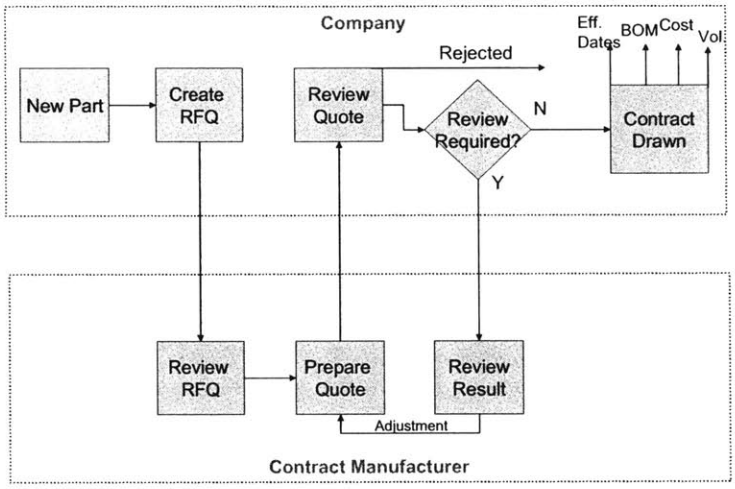

Fig. 5.6 Schematic of the Automated Bidding / Quote Management Process

The buyer has the ability to review quote against the RFQ and compare the differences. If changes are required, these can be resubmitted to the contract manufacturer. Otherwise, the bid may be accepted or rejected. Note that if the bid is approved, the contractual data, such as effective dates, cost, BOM structure and volume information are automatically imported into the system and are available for other operations such as price forecasting and profitability analysis.

5.3.5 Supplier Performance Monitoring

Since the contractual data is stored in the system of record, it is possible to monitor how suppliers are performing with respect to their contractual obligations. This historical information can also be used as leverage for future negotiations – even if the historical information pertains to a failed bid.

Purchase Price Variation (PPV) Assessment

A few solutions provide the means to track variances in purchase price with respect to contractually established prices. The process of settling these variances may also be automated as shown in Figure 5.7. The ERP systems shown in the figure are for illustration only – they could easily be replaced by any system that tracks and stores transaction information for the enterprise.

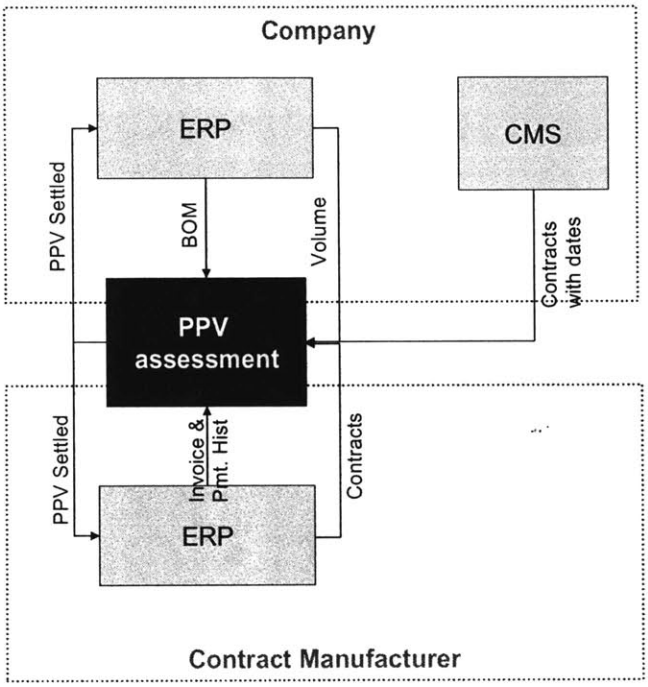

Fig. 5.7 Schematic illustrating the automated Purchase Price Variance process

Besides the features mentioned here, another noteworthy capability exhibited by some packages is the ability to support a multi-lingual interface. This is increasingly becoming important to companies that have global operations.

5.4 EVALUATION OF SOFTWARE PACKAGES

A shortlist of software vendors was developed based on advice from software industry analysts as well as references in the media. Appendix D shows a questionnaire which was the basis for interviews with these software vendors. As a first step, companies were asked to, as completely as possible, respond to the questionnaire. Based on the responses, a few software providers were eliminated. The remaining vendors were then invited to demonstrate their product capabilities to a cross-functional team. At the end of this stage,

an evaluation of each of the packages was made on the basis of numerous factors described below. Note that the purpose of this evaluation was to provide input to management and the IT steering committee in order to make an informed decision as to whether an investment was justified.

5.4.1 Business Alignment

As described earlier, the business requirements or process capabilities were weighted by the relative importance that interviewees had assigned to those issues.

BUSINESS REQUIREMENTS	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E	Vendor F	Vendor G
Work Prioritization Capability	◉	○	○	○	△	△	○
GAP identification	◉	○	○	○	△	△	○
Information availability (including demand and various views of cost down)	◉	○	△	○	△	○	△
Simulation (Cost, Demand, ECO etc.)	○	○	○	△	△	△	△
Cost Forecasting (Internal / External)	◉	◉	○	△	△	△	△
Centralized Repository	◉	△	△	○	△	△	△
Cost Profiles at various levels of BOM	◉	△	○	○	△	△	△
Stategy and Project Tracking	◉	○	△	△	△	△	△
Total Cost Capability	◉	○	○	△	○	△	△
User-friendliness ("Do-it-yourself" capability)	◉	○	△	○	△	○	△
Integration of Contract Mftr. / Supplier data	◉	◉	○	△	◉	△	△

Legend: ◉ Good; ○ Satisfactory; △ Deficient

Fig. 5.8 Business Alignment of Software Vendors with Company's Business Requirements

In Figure 5.8, the business requirements are listed – the columns pertain to software vendors' ability to meet these requirements. A 1-3-5 scoring scheme was selected in this

instance – with 5 corresponding to a High degree of alignment. The weighted totals were determined – this was the Business Alignment Rating.

5.4.2 Financial Viability

This was considered primarily because some of the companies under consideration were startups. Even the publicly-held companies had been badly affected by the poor economic conditions and there were concerns about their ability to sustain their operations. For the startups, the companies were requested for information regarding their burn-rate. This was expressed as the number of years before their funds were exhausted.

5.4.3 Technology Reliability

The primary source for this information was media reports as well as opinions expressed by analysts that had been following these companies and their products.

5.4.4 Technology Roadmap

The vendor company's technology roadmap was examined for alignment with future technology trends. For example, the compatibility of the software with the Company's current and future infrastructure was considered. Also considered were issues pertaining to the Company's plans to discontinue certain operating systems or databases.

5.4.5 Software Vendor's Business Roadmap

For some of the vendor companies surveyed, cost management of purchased goods was only one aspect of a total solution. It was important to ascertain whether their future vision included continued support and development of Procurement-oriented software.

5.4.6 Sponsor Company's IT Roadmap

In this category, all the issues related to the sponsor Company's information technology roadmap were considered. The information technology group at the Company was brought

in to determine if investment in any of the software packages being considered would cause conflicts because of existing relationship with other software suppliers.

5.4.7 Cost

The total cost associated with the qualification, purchase, implementation and maintenance of these technologies was determined. Appendix E shows a spreadsheet with the various components of the cost of acquiring, implementing and executing cost management processes.

Each of the dimensions mentioned here was then plotted on 2 x 2 matrices and presented to management along with a recommendation.

CHAPTER 6: RESULTS, RECOMMENDATIONS AND REFLECTIONS

This chapter leverages the benchmarking study, the study of internal business requirements pertaining to cost management and the survey of available off-the-shelf software solutions to make recommendations for cost management and the information systems to support it at the Company.

6.1 SUMMARY OF OBSERVATIONS REGARDING THE PROCUREMENT FUNCTION

6.1.1 Cross-Industry Observations

It is clear that well formulated, well-directed, though not necessarily precise, metrics are a key ingredients to procurement effectiveness. In general, purchasing and sourcing managers should be compensated as teams rather than individually. This mitigates conflicts regarding procedures for measurement and reporting of cost savings. A team-based approach keeps the entire organization focused on the same set of objectives. The incentive system then fosters cooperative rather than competitive behavior.

Metrics should be clearly understood by buyers and commodity managers prior to entering into negotiations, so they act in their own and the Company's best interests. It is equally important to ensure that executive management is aware of the metrics, their interpretation and implications. For the same reason, simplicity is essential – metrics based on complicated formulae, abstract or derived values often defeat the purpose of reporting the metrics in the first place. Apart from the more commonly tracked metrics, the company should also have rudimentary, conservative metrics in place to measure cost avoidance. Exceptional companies have developed methods for rewarding their purchasing managers for negotiating product and service-level enhancements. They have also developed methods to institutionalize the cost measurement process – the most effective one being to appoint a person or group as champion of cost savings and documenting the related processes.

6.1.2 Observations Specific to the Company

With respect to other leading companies, the sponsor Company has a reasonably sophisticated and effective set of practices for cost reduction. The information technology infrastructure supporting cost management has been rendered inadequate because of recent changes in a manufacturing strategy- other OEMs have either recently addressed or are experiencing similar problems.

6.2 WEAKNESS IN THE CURRENT SYSTEM

From the extensive mapping of the cost management processes, several vulnerabilities became apparent – these are listed below.

6.2.1 Infrastructure Weakness

1. Inability to track and report data requiring the cost structure of assemblies purchased from the subcontractors
2. Cost down process execution is complex, dispersed over multiple databases and relies on manual processing

6.2.2 Process Weakness

1. No consistent process documented or followed for updating price forecasts and blanket orders[1] in the system of record
2. No formal process exists for transferring cost and product information from spreadsheets to the system of record
3. Demand data is not available in a timely fashion in the cost management system

6.2.3 Organizational Weakness

1. Commodity management not held responsible for tracking and reporting true cost savings
2. Requests for new reports overwhelm the ability of the system – cost analysts, infrastructure and processes – to respond
3. No agreed upon metrics and reports regarding cost reduction

[1] Blanket orders are relevant not only from a transactional stand-point but also because blankets are treated as price forecasts over the period during which the blanket is valid.

6.3 SHORT-TERM RISK MITIGATION TO LIMIT LIABILITIES

To address some of the weaknesses highlighted in the previous section, the following steps were proposed. These measures required little or no incremental investment or resource allocation.

6.3.1 Redundancy in Personnel through Cross Training

This was accomplished through assigning a team, rather than an individual, the task of analyzing costs and generating reports. This team was to be cross-trained in all aspects of the process. While no additional staff was assigned to execute these processes, responsibilities were rotated among the existing staff.

6.3.2 Data Backups and Hardware Redundancy

In the existing system, backups of critical data were done on an ad hoc basis. Changes were initiated whereby a documented process was established for regular backups of relevant data in the system. A Direct-Attached Storage device was installed for the purpose of making the backups.

6.3.3 Documented Processes and Systems

While putting in measures to ensure cross-training, the teams created were tasked with documenting the processes that they would follow. This included measures to be taken when exceptions were encountered.

6.3.4 Screening of all New Requests for Data and Reports

By documenting the available data tables and reports, it was possible to provide management with a listing of what kinds of data were available or could be readily derived. Until such time as new infrastructure was installed, any requests for new categories of data and reports would have to go through a review process.

6.3.5 Increased IT Ownership of off-COSMOS Systems

Ownership of the off-COSMOS data tables and reports was partly transferred to the central information technology group. This ensured that the process of maintaining these systems was optimized.

6.4 MAKING THE CASE FOR INFRASTRUCTURAL CHANGE – A LONG TERM SOLUTION

The process for identifying software packages that were well-aligned to the Company's business requirements was described in Chapter 5. During the survey, it became evident that the cost management software space, from a Procurement perspective, is relatively immature. There are few commercial "off-the-shelf" software solutions available in this area. Software packages that are most aligned with the sponsor Company's requirements are new entrants in the industry - given the extent of consolidation in the software industry, investing in such packages will entail some risk. Despite this, an investment in such a solution could be justified based on expected improvements in both efficiency and effectiveness.

6.4.1 Efficiency

The first step in analyzing process efficiency was to leverage the detailed process maps, similar to those presented in Appendix B, generated earlier during the project. The process involved estimating the resources required to accomplish the cost data assimilation and reporting. Generally, the justification for investing in Sourcing software focuses heavily on transaction automation. However, in this case, the transaction automation process was not analyzed because the business requirements did not demand this functionality and not all software packages required installing such functionality as part of the core installation.

	Overhead	
Cost Group	$ 59,000.00	6%
Product Cost	$ 293,000.00	32%
Commodity Cost	$ 571,000.00	62%
	$ 923,000.00	

Table 6.1 Overhead Required for Cost Management Activities in Existing Infrastructure

The methodology involved leveraging the mapping exercise conducted earlier. For each task, the major cost driver was labor. Therefore the average cost of labor was determined for each of the tasks. Through interviews, the approximate number of hours required for the execution of these tasks was determined. In this manner, the approximate cost of assimilating and reporting cost data, and performing analysis, was determined. Included in

this figure was the effort required for identifying and reporting cost reduction initiatives for purchased parts and their expected impact. The lower bound for tracking, reporting and analyzing product and commodity costs was determined to be $923K. As a next step, the specifications of the systems that could replace the current system were reviewed against the steps in the current process map. As expected, several of the steps would no longer be required and the corresponding costs would be eliminated. In some cases, the steps would entail less overhead. Some examples of attributes of the new system that contributed towards the lower expected overhead for cost management are:

- Better user interfaces – the new system had features where multiple data fields could be rapidly populated with cost trends.
- Fewer databases – The new system would incorporate a truly unified "vault of truth" which translates into fewer steps required to enter, transfer and retrieve data.
- Reduced data cleansing – Fewer databases also mean fewer opportunities for inaccurate data or discrepancies.
- Automation of steps through workflows – An integrated system lends itself to automation, unlike the current system with multiple databases on disparate systems.

	Overhead		
	Current	"To Be"	Annual Savings
Cost Group	$ 59,000.00	$ 38,500.00	$ 20,500.00
Product Cost	$ 293,000.00	$ 90,600.00	$ 202,400.00
Commodity Cost	$ 571,000.00	$ 478,500.00	$ 92,500.00
	$ 923,000.00	**$ 607,600.00**	**$ 315,400.00**

Table 6.2 Comparison of Overhead Required For Cost Management in Current and Planned Systems

With these changes, the new streamlined system was expected to require significantly less resources to accomplish similar reporting and cost management execution. As shown in Table 6.2, a 34% cost reduction is expected.

6.4.2 Effectiveness

Based on better visibility of cost information further upstream in the supply chain and because of the improved accuracy of the data, incremental cost savings were expected. While this improvement was hard to quantify without actually implementing a pilot study, the approach taken was to familiarize the key stakeholders and analysts with the software under investigation. They were then required to estimate the incremental cost reduction they could expect, following the installation of the new system. Using this data, a return-on-investment analysis was performed. Note that costs for qualifying, acquiring and installing the new infrastructure were incorporated in determining the breakeven period for each of the options being considered.

Year	Savings Estimates	Vendor X Cum. Costs	Vendor Y Cum. Costs
1	$ 1.00	$ 2.90	$ 4.60
2	$ 3.10	$ 3.00	$ 4.90
3	$ 5.20	$ 3.20	$ 5.30
4	$ 7.20	$ 3.30	$ 5.60

Table 6.3 Comparative Costs and Savings for Two Options

Table 6.3 shows the estimates of cumulative savings and cumulative costs of installing, operating and maintaining software provided by "Vendor X" and "Vendor Y".

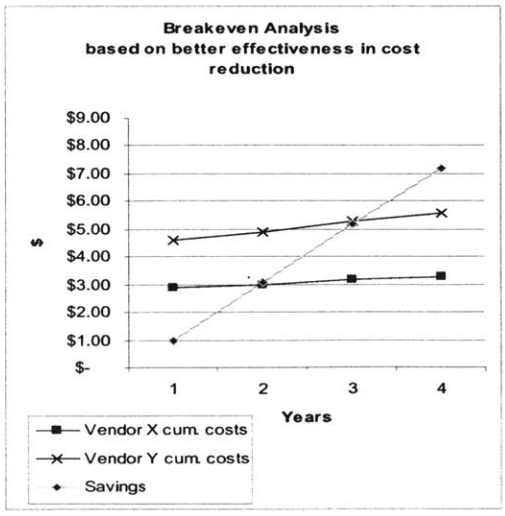

Fig. 6.1 Breakeven Analysis for Two Software Options

Breakeven[1] in the case of one software solution occurs within two years and three years in the other, as depicted in Figure 6.1. While this was a rough estimate, it did give management a basis for comparing this proposal versus other projects competing for constrained IT resources. The "rule of thumb" at the Company for an IT investment to be considered for implementation is that breakeven should occur within 1.5 to 2 years. Exceptions were made only if the project was of strategic importance to the Company. Given these considerations, an investment leveraging Vendor X's software package was presented to the Information Technology Steering Committee.

6.5 BUSINESS PROCESS IMPROVEMENT

6.5.1 Standard Cost Setting Process

Certain business practices can significantly simplify the cost management process. Notably, the enterprise-wide standard cost setting process can be leveraged to make the standard costs more relevant and reflective of current product costs. Currently, these costs are updated bi-annually – updating standard costs at higher cadence will not only improve the ability of the company to accurately value inventory, but will also make an already visible and widely used cost indicator more relevant for design and margin modeling. Moreover, Commodity Managers within the Purchasing groups of some companies are able to play a critical role in maintaining or auditing cost data in the system of record.

6.5.2 Automated Procurement

Additionally, e-Procurement – automating the procurement process – and electronic reverse auctions were identified as well-established "best practices" that can be leveraged to achieve cost reduction efficiently and effectively.

6.5.3 Total Cost View

Given the recent transition to a global supply chain, it is important to go beyond material and overhead costs and perform Total Cost Analysis for sourcing decisions. With the

[1] Note that the savings from improved efficiency described in section 6.4.1 were not incorporated in the breakeven analysis because staff would have to be eliminated to realize the savings and, relative to savings from improved effectiveness, these had negligible impact.

increasingly complex supply network, it is essential for the company to keep track of the relevant components of total cost, so the "low-hanging fruit" is always visible.

6.5.4 Metrics

Product Cost

The primary "cost indicator" that is common to various functions – design, manufacturing, marketing and finance – is the product cost obtained by doing a "cost rollup" of the Bill of Materials (BOM) for the product. However, this simple process gets complicated because of:

- Temporal distortion

There is a timing difference between the time that a part is purchased and when it is incorporated into a finished product and sold to the customer. In reporting the cost structure, there is potential for discrepancy based on whether the costs are based on the time of acquisition of the piece-parts or whether it is the cost of acquiring the piece-parts today.

- Unavailable data – lack of visibility of piece-part costs

As described earlier, the sponsor Company outsourced the majority of its manufacturing to contract manufacturers. As a result, the cost of piece-parts below the "buy-level" was no longer available. Traditionally, transaction based systems (currently ERP) played a major role in providing the data required to perform cost analysis. After the recent transition to an outsourced manufacturing model, the piece-part data was inaccessible through the ERP system.

Aggregate Commodity Cost

Another approach taken to measure the performance of commodity managers is the Total Available Market (TAM). TAM is a metric analogous to the PPP (Purchase Price Parity) used in macroeconomics. In this case, rather than a "basket of goods" against which inflation is measured, a demand view "frozen" at the beginning of the period was used to calculate the anticipated cost of purchasing that commodity for the entire year. Note that each time this metric was calculated, the current product cost was applied to the frozen demand view. There were two problems with this approach:

- Some groups erroneously tried to reconcile the cost reduction as projected by these reports to the expect cost savings reported to the investment community. This was

mainly a problem with not communicating to management the fact that this was purely a performance metric.

- There was no incentive for commodity managers to focus on early cost reduction work. So long as they got the cost reduction work (negotiations, redesign support, substitute part qualification) done before the end of the year, they were rewarded for their efforts. This was a problem given that it was quite likely that demand for the corresponding product might have been high at the beginning of the year and it would have been better if the cost reduction was achieved earlier on during the year.

6.6 FINAL NOTE

In an organizational context, it is difficult to justify investments for improvement of non-value-add activities and processes. Benefits are harder to quantify and are generally realized only indirectly. If current processes are adequately staffed, the "return" from any future efficiency gains can only be claimed on the basis of workforce reduction. Additionally, highly responsive, well-managed enterprises in volatile industries are susceptible to organizational "nervousness". This may result in long-term improvement initiatives being abandoned prematurely in favor of newer initiatives aimed at managing current or impending crises. In an exceptionally volatile industry, it is crucial for management to keep a long-term view while investing in infrastructure.

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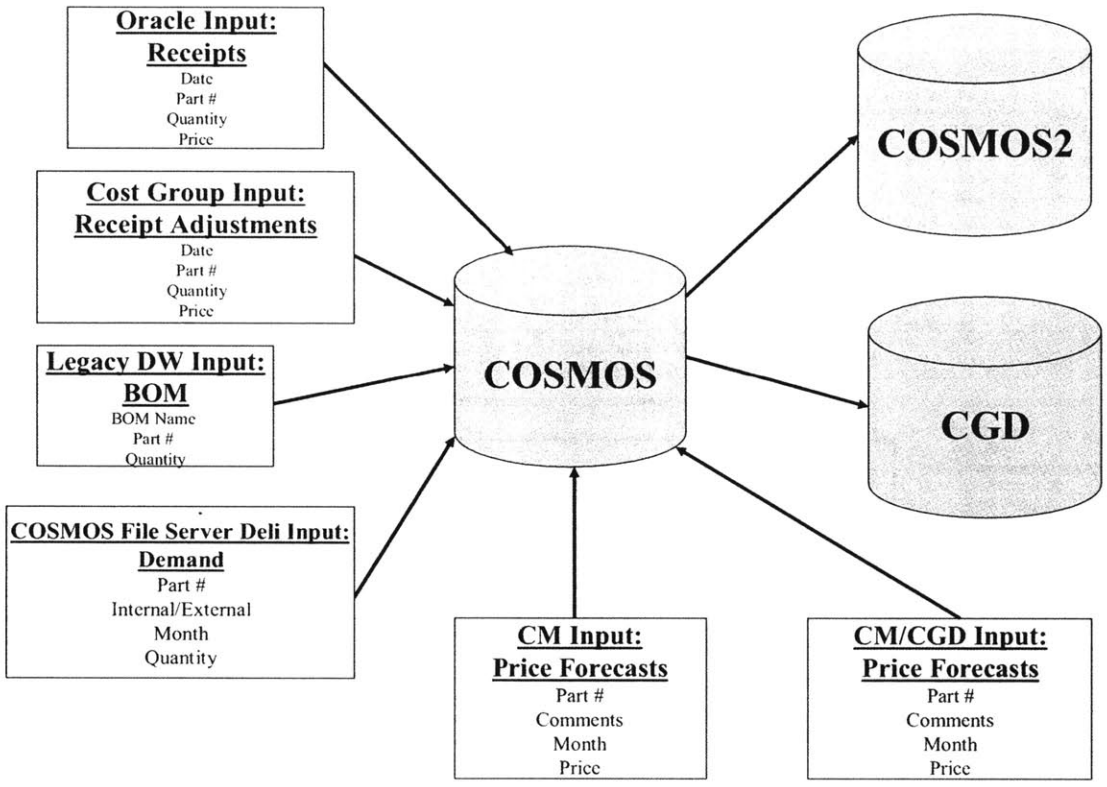
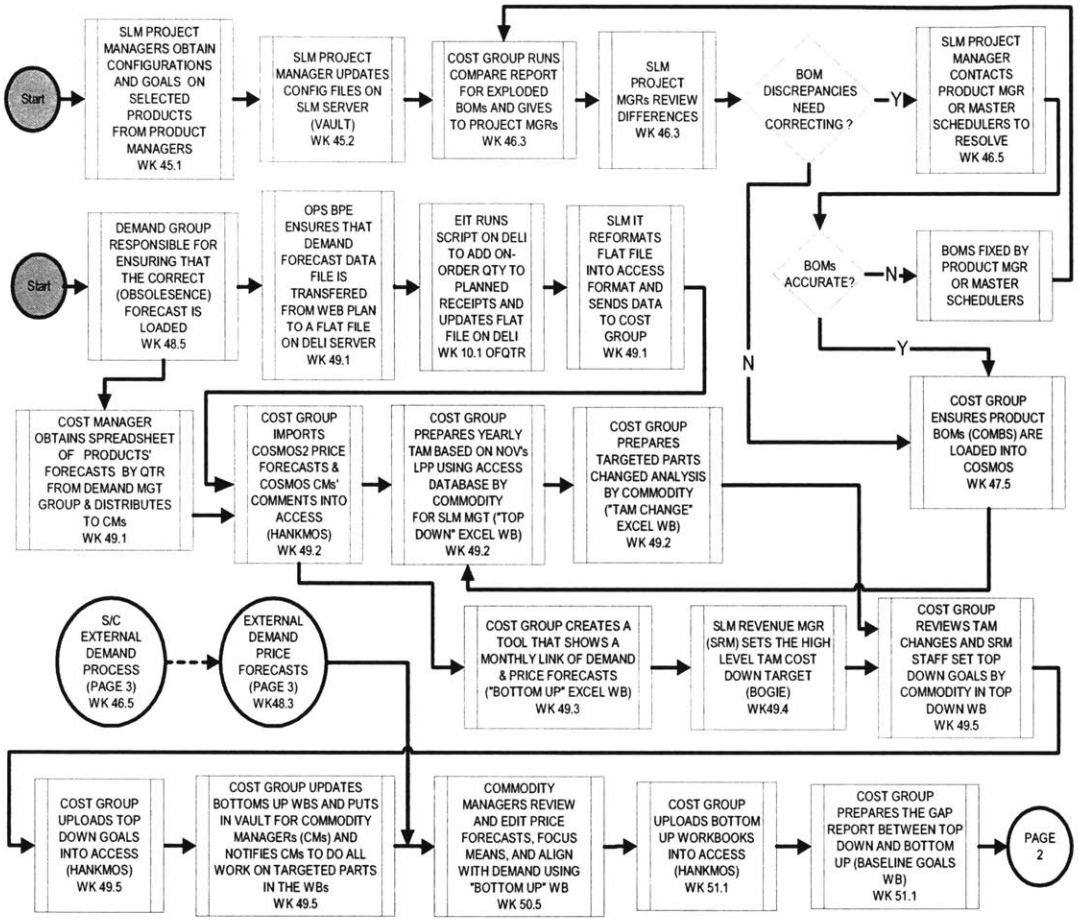
APPENDIX A: SCHEMATIC OF EXISTING INFRASTRUCTURE



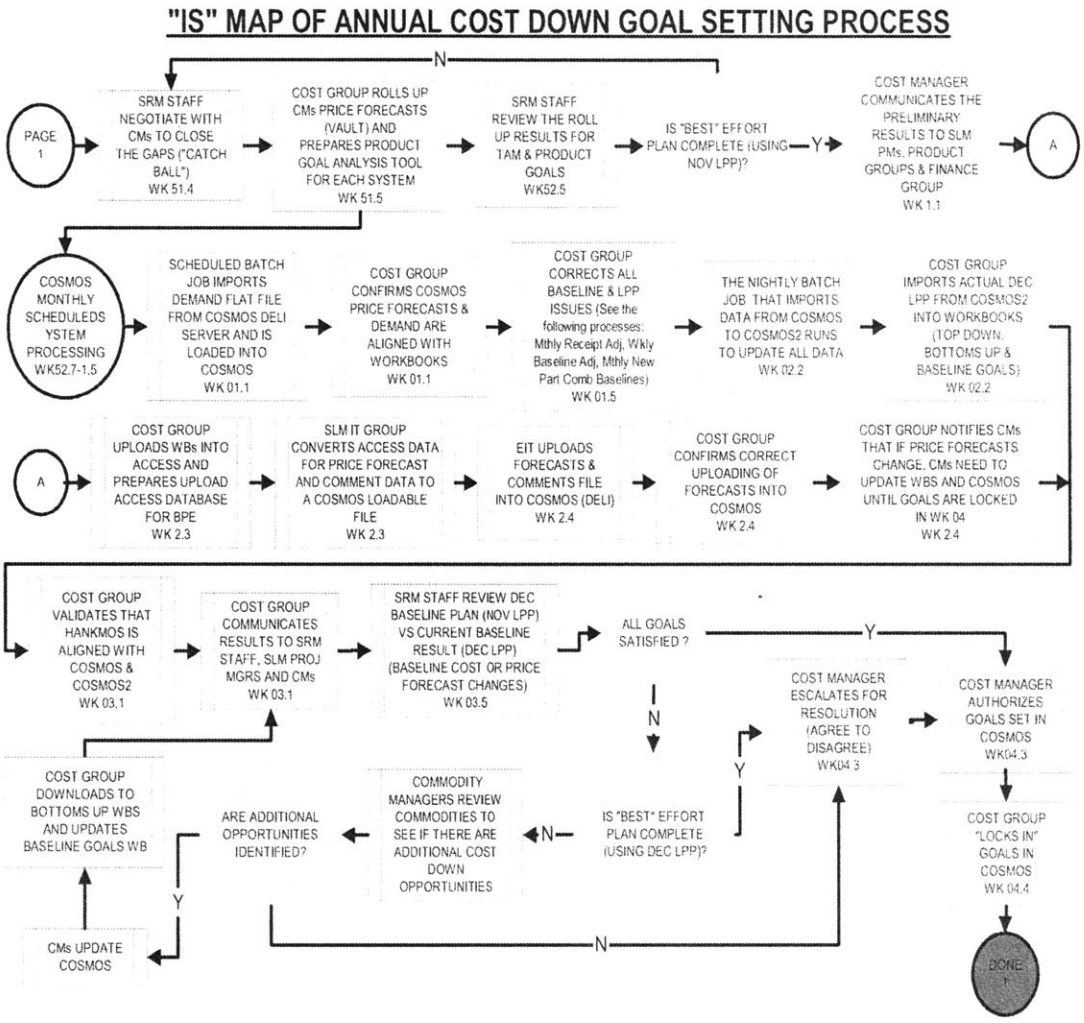
COSMOS: Cost Management System, home-grown software used to track cost of procured parts and commodities

CGD: Cost Group Database, an Access database containing the most recent, cleansed information. Updating of this database was being done using uncontrolled, undocumented processes.

APPENDIX B: MAP OF CURRENT COST REDUCTION GOAL SETTING PROCESS



APPENDIX B (Continued)



Business Requirements for Procurement Cost Management System

Requirements	Priority	Reference to Detailed Requirements Worksheet
1 Data requirements		
1.1 Common Data for purchased assemblies / parts (note: this applies to internal and 3rd party purchased parts, unless specified)		
1.1.1 Cost elements for Baseline Cost, Current/LPP (Last Price Paid) Cost, Standard Cost, Estimated (forecasted) Cost	H	SC15.3, SC15.4, SC15.5, SC15.6, SC16.3, SC16.6
1.1.1.1 NRE (Non Recurring Engineering) Cost	H	IN31, NF03
1.1.1.2 Total cost	H	SC19.1, NJ15, NJ12
1.1.1.2.1 Landed material cost		
1.1.1.2.1.1 Material cost	H	SC16.2, SC03.1, SC16.1
1.1.1.2.1.2 Material overhead cost (includes planning, purchasing, warehousing, kitting and packaging)	M	SC20.2, SC20.7
1.1.1.2.1.3 Freight / Shipping	H	NF05, IN21
1.1.1.2.1.4 Tariff	H	NF05, IN21
1.1.1.2.1.5 MMU (Material Mark Up) – 3rd party only	L	SC18.1, SC03.7
1.1.1.2.1.6 Premium charges (need to separate premiums from normal landed cost)	M	IN30
1.1.1.2.2 Non-material cost	H	IN22, FI06
1.1.1.2.2.1 Labor cost for assembly	H	SC71.1, SC17.5, SC03.2
1.1.1.2.2.1.1 Labor hours	M	SC17.2, SC20.5
1.1.1.2.2.1.2 Labor rate ($/hr)	M	SC17.2
1.1.1.2.2.2 Test cost for assembly	H	SC71.1, SC17.5, SC03.3
1.1.1.2.2.2.1 Test hours	M	SC17.2, SC20.6
1.1.1.2.2.2.2 Test rate ($/hr)	M	SC17.2
1.1.2 Multiple Cost types	L	SC19.1
1.1.2.1 Baseline costs for internally purchased parts	H	SC16.8, SC15.4, IN23
1.1.2.2 Target (should) cost	H	NJ03, IN23
1.1.2.3 Current / LPP cost	L	SC16.7, IN09, IN23
1.1.2.4 Standard cost	M	SC16.5, IN09
1.1.2.5 Estimated (forecasted) cost	H	IN23
1.1.2.5.1 Price forecasts over a time period (18 months minimum)	H	IN01, NF26
1.1.2.5.1.1 Time based	H	NF01, IN37, SC03.5
1.1.2.5.1.2 Volume based	H	NF01, IN37, SC03.5
1.1.2.5.1.3 Cumulative volume based	H	NF01, NF02, IN37, SC03.5, SC14.1
1.1.2.5.1.4 Cost at system x (10th, 50th, 100th, etc)	H	NF08
1.1.2.5.1.5 Project related cost savings for a system	M	FI10, IN39
1.1.2.5.2 Supplier quote (this is really 3rd party data)		
1.1.2.5.2.1 Quoted Price	M	SC02.1, SC15.2
1.1.2.5.2.2 Approval records	M	SC02.1
1.1.2.5.2.3 Need details of pricing for assemblies	M	SC02.2
1.1.2.5.3 Negotiated cost with effectivity date (i.e. preferred supplier quote)	M	IN38, SC16.6, SC15.3
1.1.2.5.4 Source of estimate	M	NJ06
1.1.2.5.5 Quality (source) of data used as basis for estimate (i.e. drawing on a napkin vs released engineering drawing)	H	NJ07
1.1.2.5.6 3-level cost estimate for costs (i.e. landed costs)	M	NJ01, SC03.4
1.1.2.5.6.1 95% confidence cost		
1.1.2.5.6.2 75 – 95% confidence cost		
1.1.2.5.6.3 > 50% & < 75% confidence cost		
1.1.2.5.7 Comments	M	IN05
1.1.3 Receipts		
1.1.3.1 Source (3rd party or internal)	H	IN08
1.1.3.2 Transaction data (Part #, PO #, PO Line, Qty, Supplier, Price, Receipt date)	H	SC07.2, IN08, SC16.4
1.1.4 Demand (capture internal and external separately)	H	SC13.1

APPENDIX C (continued)

Business Requirements for Procurement Cost Management System

Requirements	Priority	Reference to Detailed Requirements Worksheet
1.1.4.1 Open order quantity	H	FI02, SC13.2, IN18, SC13.4, SC13.7
1.1.4.2 Planned order quantity	H	FI03, SC13.3, IN18, SC13.4, SC13.7
1.1.4.3 Material usage requirements	M	FI04
1.1.4.4 Ability to update demand quarterly, monthly or weekly	H	IN26
1.1.5 On-hand inventory (held for Teradyne)	H	SC21.1, SC22.1, FI01
1.1.6 BOMs (Bills of Material)		
1.1.6.1 BOM detail for outsourced products (i.e. ability to look at BOM structure for assemblies that have been outsourced)	H	NF04, NF21, NJ02, SC20.4
1.1.6.2 Effectivity dates for BOM changes (i.e. ECO effectivity dates)	M	IN33, SC20.3
1.1.6.3 Pending ECOs impacting material, labor, test, etc. costs	M	SC20.1
1.1.7 Manufacturer (OEM) for parts purchased from distributor	M	IN36
1.1.8 Commodity Management Ownership for Part		
1.1.8.1 Cost management responsibility (i.e. is part managed by 3rd party or Teradyne)	M	SC04.1
1.1.8.2 Cost sharing rules (i.e. Does Teradyne or 3rd party get cost savings? For how long?)	M	SC23.1
1.2 Central repository for cost data	H	FI09, IN11
1.2.1 Repository for data in sections 1.1 and 1.2		
1.2.2 Includes NPI cost data	M	NJ13
1.2.3 Includes 100% of parts	H	IN06
1.3 Archive historical data		
1.3.1 Standard costs (material, labor, material OH, etc.)	H	FI05, IN24
1.3.2 Make vs buy costs for an assembly that is outsourced		
1.3.2.1 Material cost	M	NF20, SC15.1,SC17.3, SC05.1
1.3.2.2 Labor cost	M	SC17.3, SC05.1
1.3.2.3 Test cost	M	SC17.3, SC05.1
1.3.3 Cumulative volume (to understand price breaks)	H	NF02
1.3.4 Catalog demand by master planning schedule date	M	SC13.5
1.4 Ability to make adjustments to costs	H	IN02, NF19
1.4.1 Receipt price		
1.4.2 Cost goals		
1.4.3 Baseline cost		
1.5 Data elements provided to 3rd party suppliers		
1.5.1 Contract pricing for parts managed by Teradyne	M	SC10.1
1.5.1.1 Price		
1.5.1.2 Supplier		
1.5.1.3 P.O. #		
2 Decision Support / Analytics		
2.1 BOM compare		
2.1.1 Identify quantity / part "adds"	H	NF14
2.1.2 Identify quantity / part "deletes"	H	NF14
2.1.3 Identify cost changes unrelated to adds and deletes (i.e. price changes)	H	NF14
2.1.4 Compare 2 versions of the same BOM	H	NF14, IN03, IN28
2.1.5 BOM can be at system, assembly, sub assembly level	H	NF14
2.1.6 BOMs can be selected by effectivity date	M	NF23
2.2 TAM (total spend) compare		
2.2.1 Identify volume changes	M	IN13
2.2.2 Identify price changes	M	IN13
2.2.3 Net change capability for demand / MPS (Master Planning Schedule)	M	SC13.5
2.3 Measure actual performance vs. forecasted performance / goals to highlight areas to focus on for cost down work	H	IN16, SC11.1

APPENDIX C (continued)

Business Requirements for Procurement Cost Management System

Requirements	Priority	Reference to Detailed Requirements Worksheet
2.3.1 Material cost		
2.3.2 Labor cost		
2.3.3 Test cost	M	SC11.3
2.3.4 "Other" cost	M	SC11.4
2.3.5 MMU cost	M	SC11.2
2.3.6 Report by commodity	M	SC11.5, SC12.1
2.3.7 Report on system (product)	L	SC11.7, SC12.1
2.3.8 Report on assemblies	M	SC11.6
2.3.9 Report by strategy (e.g. LCR)	M	SC12.1
2.3.10 Report by supplier	M	SC12.1
2.4 Measure gaps between cost estimates and cost budget (target)	H	NJ08
2.5 PPV (Purchase Price Variance) - Internal and 3rd Party		
2.5.1 PPV cost	M	SC06.4, FI07
2.5.2 PPV submission records	M	SC06.1
2.5.3 PPV approvals	M	SC06.2
2.5.4 PPV causes	M	SC06.3
2.5.5 PPV report summaries	M	SC06.5
2.6 IPV (Invoice Price Variance)	M	FI07
2.7 Maintain links between "new" parts and the parts they replaced	M	IN35
2.7.1.1 Ability to do cost comparisons when product options are re-packaged	M	NF15
2.8 Simulation		
2.8.1 Flexible Configuration of BOMs	H	IN27
2.8.1.1 Need Engineering BOM capability in pre-MRP stages	H	NF11
2.8.1.2 Ability to manipulate BOM configurations	H	NF22
2.8.1.3 Capture all configurations that are booked/shipped	H	FI08, NF13, NJ09
2.8.1.4 Ability to modify target system and restate cost down metric	M	IN17
2.8.1.5 Multiple level BOMs	H	IN34, SC01.1
2.8.1.6 Ability to perform "what-if" analysis (scenarios)		
2.8.1.6.1 Price and BOM changes	M	IN14
2.8.1.6.2 Cost implications of assemblies vs. piece-parts	H	NF06
2.8.1.6.3 Cost impact of changes in sales forecast, business plans, slot plan, lot size etc.	H	NJ04, SC09.1, NJ05
3 Infrastructure		
3.1 Data transfer		
3.1.1 Export to Excel	H	IN10, IT03, NF09
3.1.2 Import from Excel	H	IT06
3.1.3 Ability to transition smoothly from off-line spreadsheets to ERP	M	NJ14
3.2 Data integration		
3.2.1 Update price forecast with blanket price data in Oracle PO	H	IN07
3.3 System Architecture		
3.3.1 Security		
3.3.1.1 Multiple Levels of security	H	IT07
3.3.1.2 Security for 3rd party data	H	IT17
3.3.2 Interface		
3.3.2.1 Efficiency of data entry	H	IT01
3.3.2.1.1 Reduce manual requirements for BOM initialization	M	IN32

APPENDIX C (continued)

Business Requirements for Procurement Cost Management System

Requirements	Priority	Reference to Detailed Requirements Worksheet
3.3.2.1.2 Mass update capability (e.g. ability to load spreadsheet with price forecast data)	H	IN04
3.3.2.2 Independent data screens (windows) in single session	H	IT02
3.3.2.3 Web-client user interface	M	IT14
3.3.3 3rd Party Data Exchange		
3.3.3.1 Ability to import data from 3rd party suppliers	H	IT18
3.3.3.2 Ability to export data to 3rd party suppliers	H	IT18
3.3.4 Scalability		
3.3.4.1 Number of concurrent users	H	IT16
3.3.4.2 Ability to support up to 100 users	H	IT15
3.4 Performance		
3.4.1 Quick system response time	H	IT08
3.4.2 System availability 24 x 7	M	IT09
3.4.3 Maximum data loss is 24 hours	H	IT10
3.4.4 Maximum down-time is 3 days	H	IT11
3.5 Support		
3.5.1 Ongoing software support and upgrades	M	IT13
3.5.2 On-line user-guide that documents basis for cost and metrics definitions	H	IN19
3.5.3 Interactive "help" and "FAQ" for users	M	IT12
4 Reports		
4.1 Report Generation		
4.1.1 Standardized reports that can be user-modified to target desired information	M	IN20
4.1.2 Customizable reports (ability to filter, sort etc.)	H	IT04
4.1.3 Ad-hoc reporting capability (user can create own reports)	H	IT05
4.2 Data validation, monitoring and compliance		
4.2.1 Exception reports – user alerted to potential problems, variances	M	NF16, FI11
4.2.2 Audit trail to record last change to price forecasts and adjustments	M	IN12
4.2.3 Price Forecast Rules Violation Testing	M	IN40
4.3 Drill down capability		
4.3.1 Users can drill down to see detailed data on pre-defined reports	H	IN15
4.4 Report cost down that is negotiated but has not had receipts yet	M	NF24
4.5 Graph cost over time		
4.5.1 System (product) rollup	H	NJ11
4.5.2 Piece part cost curve	H	NJ11
4.5.3 Commodity		
5 Strategy		
5.1 Method for achieving desired outcome		
5.1.1 Cost Down strategy tracking	H	IN25
5.1.2 Ability to store 4W1H (who, what, when, where, how) records for cost reduction	H	NJ10
5.2 · Sourcing Plan Support		
5.2.1 Split Buy Capability	H	IN29
5.2.2 Capture sourcing status (single vs. multiple sources vs. sole source)	H	NF12
5.2.3 Manufacturing strategy should be determined early and captured in system, to understand Total Cost of Ownership	H	NJ15
6 Indirect Spend		
6.1 Ability to handle items without part numbers and/or at a commodity/supplier level	H	NI02
6.2 Ability to the use same metrics as for "inventory" costs	H	NI01
6.3 Ability to import 3rd party data (e.g. P-Card, Travel)	L	NI03

APPENDIX D: CHECKLIST FOR SCREENING SOFTWARE VENDORS

	Criteria			Target Values	Company X Rating
Business Requirements	Data	3rd Party Data Exchange		5	
		Visibility into 3rd Pary Piece-Part Costs		5	
		Integration with ERP - Inventory Position (in-house and at 3rd party)		5	
	Decision Support Systems	Flexible Configuration of BOM data		5	
		Engineering BOM capability (pre-MRP stage)		5	
		BOM Compare Capability		5	
		Develop Price Forecasts (parts)		5	
		Multiple Cost Types (BaseLine, Current, Future, Should Be Cost)		5	
		Multiple material cost types (freight, duty, labor)		5	
		Simulate Cost Impact of changes in forecast, price etc.		. 5	
		Ability to make adjustments to actual results and baselines		5	
		Demand Update Capability		5	
		Drill Down Capability in standard reports to get details		5	
	Reports	Ability to create Ad-hoc Reports		5	
	Strategy	Focused Means / Strategy Tracking		5	
		Indirect Spend		5	
Vendor Viability	Revenue	<50 M is cutoff		> 100 M	
	Full Time Employees				
	Public/Private			Public	
	Years in Existence			> 5 yrs	
	If private, years left based on Burn Rate			> 2 yrs	
	Market Description (PLM, PDM, Point Solutions)			e.g. PLM, PDM, Point Soln Cost Mgmt, Spend Mgmt, SRM)	
	Market Share claimed			> 20%	
Infrastructure	Multiple Levels of Security			Yes	
	Number of users and scalability			40+	
	Compatibility	OS			
		DBMS			
		% install base with Oracle ERP		> 20%	
Cost of Ownership	NRE	S/W	Price Schedule	*Description (e.g. Site licensing, $/seat)*	
			Cost ($)	*Range of values*	
			Implementation $	*Range of values*	
		H/W	Cost ($)	*Range of values*	
	Ongoing	Maintenance Support (% of S/W		*Range of Values*	
Reference	Company Name				
	Contact	Name			
		Phone Number			
	Favorable	For internal use only		Yes	
	Biz. Achievements				
	Comments				

APPENDIX E: COMPARISON OF SOFTWARE VENDORS

	Vendor X		Vendor Y	
	Most Likely Cost	Most Likely Duration (weeks)	Most Likely Cost	Most Likely Duration (weeks)
Evaluation Phase				
Internal Resource Expense	$ 267,500.00	18	$ 267,500.00	18
Negotiation Phase				
Internal Resource Expense	$ 5,625.00	2	$ 5,625.00	2
Implementation Phase				
Software and Maintenance	$ 2,015,000.00		$ 852,500.00	
Hardware	$ 50,000.00		$ 125,000.00	
Training	$ 22,500.00		(included in ext. resources)	
External Resources	$ 1,560,000.00		$ 973,000.00	
Travel and Entertainment	$ 234,000.00		$ 145,950.00	
Internal Resources	$ 487,500.00		$ 487,500.00	
Implementation Total	$ 4,369,000.00	30	$ 2,583,950.00	30
Grand Total	**$ 4,642,125.00**	**50**	**$ 2,857,075.00**	**50**
Internal Resources	$ 760,625.00		$ 760,625.00	
Out-of-Pocket	$ 3,881,500.00		$ 2,096,450.00	
Some numbers disguised				