STRUCTURED COST REDUCTION

Value Engineering by the Numbers

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Abstract:

This paper presents a systematic methodology for assessing product cost improvement opportunities; in particular, the paper applies this methodology to electro-mechanical products. This paper explains how to identify cost drivers, redesign and substitute parts, manage vendor selection and contracts, and reexamine product features.

1. Introduction

The need for cost reduction is growing as more companies struggle with global competition and the faltering economy. One way that companies can regain control over their costs is not only to assess these costs, but also systematically classify and identify product costs. Using a systematic approach to perform cost reduction not only yields cost improvement but provides decision-makers with the trade-offs involved in achieving these reductions. The methodology we propose is a version of Value Engineering (VE) and has been used successfully at Hewlett Packard (Compaq Computer Corp., & Digital Equipment Corporation) for a number of years.

The modified value-engineering method requires careful data collection and analysis, product cost identification and redesign and implementation. These steps can be outlined as follows:

- Create an efficient database with relevant data; error check
- Identify the product cost drivers
- Identify the wider cost environment (e.g. overhead)
- Apply VE techniques
  - Redesign
  - Decrease Existing Component Cost
  - Component Substitution
  - Re-Source/Out-Source
  - De-Feature
- Implement

2. Why do you need a structured method to quickly lower product cost?

Companies need to have a systematic method to help lower product cost for several reasons. Many times requests to reduce product cost result from external factors and require quick response. In fact, these requests can often appear to be ad hoc. Reasons for the request vary. A competitor introduces a lower-priced product and thus squeezes your product’s margins. Overly enthusiastic sales forecasts fall below expectations and product revenues barely cover fixed costs. Even more common, a supplier raises its price and these costs cannot be passed along as price increases to your customers. Having a systematic method for looking at costs means that a cost database and benchmarks exist. The time necessary to analyze a product's cost can be reduced. Moreover, as design changes increase the efficiency of both the product and its manufacture, identifying new cost reductions becomes more difficult. Opportunities for cost reduction can be overlooked without careful, systematic analysis.

3. Preparation Step 1: Gather the Data

The first step in systematically evaluating cost should be to gather up all the relevant data. Relevant data at a minimum includes the cost of every part in the product. In addition, the data should include all bills of material (BOM), standard costs, tooling agreements and where used on quantity lists and quotes. This data enables you to answer questions about BOM/part, quantity errors or about vendor quote quantities/price breaks. Without the baseline data, it is often impossible to get the root of why parts costs are the way they are and when they can be reduced.

This data should be gathered and placed into a well-organized database and should be archived as the 'base case'. Costs tend to be dynamic. Component costs, BOMs and product attributes change. If possible, the best time to capture data that is considered to be a 'base case' is after a program review or when the major standards for a product have been set. This helps to minimize problems with stale prices or obsolete components creeping into the analysis. It also minimizes the problem of data synchronization errors creeping into the analysis. Care should be taken to avoid this. If fact, prior to implementing your cost savings ideas, good practice suggests that you should run a second dataset in order to be certain the cost savings you propose are still valid and cost effective. Finally, after implementing your cost savings ideas, a third dataset should be created to document the savings.

4. Preparation Step 2: Check for Errors

Consider the typical part count for a high-end server, over 14,000 parts representing over 700 distinct part types. Tracking all the parts, quantities, costs and auxiliary information can lead to numerous small errors that magnify with product volume. With today's leaner organizations, and automated systems, fewer eyes look at the cost data. Fortunately, Electronic Document Interchange (EDI), automated material systems like SAP[1] and MRP/ERP[2] help reduce total error rates by assuring correct translation of data between the various enterprise entities. Unfortunately, if bad data makes it through the input filters, it has a tendency to acquire a life of its own. The "Garbage In, Garbage Out" loop becomes "Garbage In, Gospel Out."

Most of the data errors we have encountered were due to obsolete or stale cost data and system errors. For instance, common errors include:

- The latest BOM is not on file.
- The vendor quotes were based off the wrong revision.
- Cost data had not been updated on the system.
- A change to a lower level part or its cost has not rippled through the analysis.
- Incorrect part costs were the result of an automated cost system that replaced a zero by a rote algorithm because the system cannot function with a zero.
- ERP software that could only handle whole numbers. For example, quantities such as 0.75 feet of gasketing were estimated to the next higher buy quantity.

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[1] SAP = Systeme Anwendugen, Produkte in der DatenVerarbeitung or Systems, Applications, and product in Data Processing a trademark of SAP AG, http://www.sap.com

[2] MRP/ERP = Material Requirement Planning/Enterprise Resource Planning – pioneered by Joseph Orlicky.

Since the advent of enterprise level information systems, we have seen such errors reduced by about 70%. Many remaining errors occur because of a lag between a lower level change and its reflection on the bottom line. Currently, we find a small but consistent level of errors ranging from 0.5-1% for volume production product and up to 5% for a new product. Once these errors invade the system, they tend to persist. Careful checking for data errors is a crucial step in establishing baseline data.

Careful proofing can eliminate many of these errors. We prefer to group together like parts and their costs and then identify those that appear out of line. We have also found that checking for cost differences against previous databases or catalogs on the net[3] can also be fruitful.

Our experience has shown that the effect of error correction on the bottom line is somewhat mixed. In the volume production phase, both over and under estimates of cost occur and have a tendency to cancel one another out on the bottom line. Highlighting the occasional egregious error makes this exercise worthwhile. On the other hand, in the new product phase, with its higher reliance on estimated and initial quotes, error elimination exercises yield better results.

5. Preparation Step 3: Identify the Product Cost Drivers

The best place to find cost savings is where the most cost is being consumed. This statement appears to be obvious and yet many organizations do not know where most of the cost of a product occurs. The most expensive part is not necessarily the cost driver of a product. The most cost correlates with the highest extended cost.

Extended cost considers not only a part unit's cost but the part quantity being employed.

Extended Cost = Part Unit Cost x Quantity Used

Our experience has been that a fairly low cost part can end up being one of the largest cost contributors to a product because so many units were used in the design. For example, a grommet costing less than a dollar would normally not be thought of as a major cost driver. However, in a server rack design, this part appeared 28 times. By using an injection-molded plastic part instead, not only was part cost reduced, but assembly time was cut as well. The total savings was quite large.[4] In addition, the replacement was so successful that other products began using the part, increasing savings further.

In addition to extended cost, it is important to understand the cost environment of the part. A structured, indented BOM should be constructed and expanded down to the lowest practical level. Performing this analysis identifies what costs roll up under each subassembly. Magnify this by the number of times that a subassembly is used and you may find effective cost savings.

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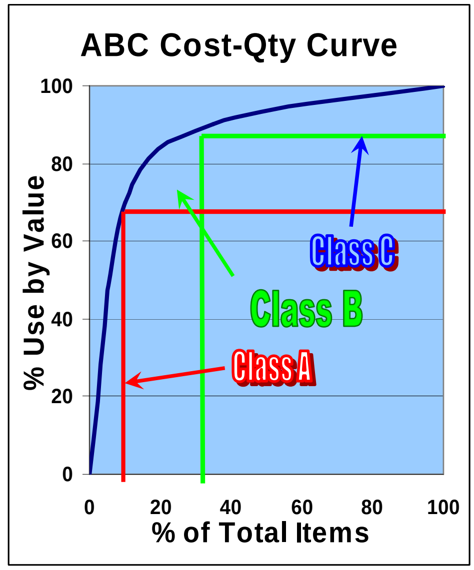
[3] For electronic parts we have found several of the big national distributor web sites to be a good resource such as: Arrow http://www.arrow.com , DigiKey http://www.digikey.com, Mouser http://www.mouser.com , Avnet http://www.avnet.com/em , Future Electronics http://www.futureelectronics.com and Newark Electronics http://www.newark.com

[4] Maniscalo, Michelle. "No Such Thing as a Trivial Part." *Injection Molding* (October, 2000), pp. 47-48.

After calculating extended cost, one should perform an ABC analysis. This analysis sorts the cost into three categories by their percentage contribution to the total cost:

- **A class** items which represent about 10-15% of the total parts count but account for 70% of the total product cost
- **B Class** items which represent the next 20% of the total parts count and the next 20% of the total product costs (for a total of 90%
- **C Class** items which represent 70% of the total items, but only about 10% of the total cost.



The ABC/Pareto analysis should be run down to both the purchased part level and the identifiable component level for the following reasons:

- **Down to the purchased part level**
    - o This is the level the company buys at and represents the level with the best current cost information since you know how much the companies pay.
    - o This is the level you can change the fastest.
- **Down to the identifiable component level**
    - o This is the level of lowest atomic cost.
    - o It may be also be the same as the purchased part level

      -or-
    - o It may also form the basis of the purchased part level.

In order to create the ABC analysis, the extended cost on each purchased part and identifiable component should be computed and the results tabulated and sorted by descending cost contribution.

In a slight modification to the classic ABC analysis, we usually place dividers in the list at the 50% and 90% total cost points. Given the preponderance of either very high or very low value parts on most mechanical and circuit assemblies, we have found it more advantageous to restrict the A Class to fewer part types by limiting the class to 50% of total cost. This ends up roughly doubling the size of the B class but there are usually still a fairly limited number of entries in that class. The bottom 10% or Class C parts remain the most numerous and of the least cost consequence unless they are used in more than one design or product within your product environment.

The table below contains an example of this type of analysis on a sample electrical assembly:

Figure 2: A Sample Module ABC Analysis

Part	Description	Qty	Cost	Ext Cost	% Total	Run %	
VA	Module Value Add	1	$9.120	$9.120	5.2%	5.2%	Top 50%
Part 1	PWB,14L	1	$36.100	$36.100	20.4%	25.6%	
Part 2	CONN,HEADER 200P	1	$20.620	$20.620	11.7%	37.3%	
Part 3	CONN,BACKPLANE POWER	5	$3.950	$19.750	11.2%	48.4%	
Part 4	CONN,HEADER 80P	2	$8.240	$16.480	9.3%	57.8%	Mid 40%
Part 5	HEADER, 154 POSITION	4	$3.580	$14.320	8.1%	65.9%	
Part 6	CONN,HEADER 80P	1	$8.580	$8.580	4.9%	70.7%	
Part 7	CONN HEADER 80 PIN PRESSPIN	1	$8.540	$8.540	4.8%	75.5%	
Part 8	HEADER, 154 POSITION	2	$3.700	$7.400	4.2%	79.7%	
Part 9	HEADER, 154 POSITION	2	$3.550	$7.100	4.0%	83.7%	
Part 10	HEADER, 133 POSITION	2	$3.050	$6.100	3.5%	87.2%	
Part 11	CONN, HEADER 154 POSITION	2	$2.540	$5.080	2.9%	90.1%	Low 10%
Part 12	HEADER, 154 POSITION	2	$2.100	$4.200	2.4%	92.4%	
Part 13	CAPACITOR, CHIP, 47 MFD 1	14	$0.210	$2.940	1.7%	94.1%	
Part 14	HEADER, 133 POSITION	1	$1.950	$1.950	1.1%	95.2%	
Part 15	CONN,SHROUD 110 POSITION	4	$0.396	$1.584	0.9%	96.1%	
Part 16	CONN,SHROUD 154 POSITION	4	$0.396	$1.584	0.9%	97.0%	
Part 17	CONN, SPACER, 154 POSITION	4	$0.370	$1.480	0.8%	97.8%	
Part 18	CONN, SPACER, 133 POSITION	4	$0.360	$1.440	0.8%	98.7%	
Part 19	CONN, SHROUD 133 POSITION	2	$0.396	$0.792	0.4%	99.1%	
Part 20	CONN CODE KEY	5	$0.150	$0.750	0.4%	99.5%	
Part 21	CONN SPACER, 133 POSITION	2	$0.360	$0.720	0.4%	99.9%	
Part 22	CAPACITOR, CHIP 22 MFD	6	$0.016	$0.096	0.1%	100.0%	
Part 23	RESISTOR, SMT, 330.0	4	$0.002	$0.008	0.0%	100.0%	

In this example,

- 3 part types comprise the top 50% of the cost (13% of the part types) Class A
- 7 parts types comprise the mid 40% of the cost (30% of the part types) Class B
- 13 part types comprise the bottom 10% (57% of the part types) Class C

This is fairly typical for modules assemblies. Mechanical assemblies in our experience generally feature fewer class C parts, and a larger share of Class B parts.

Once you have generated this phase of the analysis, you have a cost prioritized list for investigation.

6. Preparation Step 4: Understand the wider cost environment

As a corollary to the product cost analysis, one should also fully understand the cost environment for the product. The final product cost to a business unit is the sum of the direct product cost and a large number of indirect costs and allocations, i.e. overhead. Except for the highest volume producers and product, direct product cost is a small fraction of the sales price or even the internal business unit product cost.

The problem with indirect costs, such as sales & marketing expenses and R&D expenses or general allocations, is that most of them are fixed and/or period expenses that are charged back to the product on a per unit basis. In a perfect world, cost accretion and expensing to an appropriate product cost would be tightly coupled. The reality is there are many grey areas, subject to interpretation. Expenses common to more than one product or business unit have to be apportioned. That apportionment is usually done according to rules that meet the reporting/information needs of the organization.

Our experience has shown that there is a fair amount of spreading of overhead that is done inappropriately:

- Where expenses are assigned to your product that were not incurred by your product.
- Where costs are spread evenly across business, volume or products without a relationship to how they are incurred.

Internal cost shifting to reallocate overhead does occur and can be shifted to make a product look better. This does not imply that the health of the organization has improved. One can argue, however, that in the long run, by more accurately assigning cost, expense problems will be better recognized and dealt with appropriately. Understanding the overhead structure can help to identify perverse incentives that may affect later decisions. Being aware that there are many factors outside of material cost that can adversely affect your product cost is important.

7. The VE Method Hierarchy

To reduce costs we use a modified form of Value Engineering. Value Engineering or "the Value Method" was a problem solving methodology developed by Larry Miles[5, 6, 7] at General Electric in the 1940s. Value Engineering[8] is described as a systematic approach to analyze and improve the value in a product.

The formal creative-team approaches in the classic VE are very useful but they tend to be time intensive because they require the formation of a team of decision-makers. We propose a number of techniques to lower product cost before resorting to classic VE. They include:

- Redesign – The classic value engineering approach involves re-design to reduce parts count, simplify assembly/test, and use lower cost parts. This method, often called "cost avoidance", yields the biggest result when initiated at the beginning of the project. Avoiding cost before the first revenue ship (FRS) is easier than decreasing cost afterwards.

- Existing Component Cost – The fastest, least intrusive way to decrease product cost is to decrease how much you are paying for parts. On common components this may be done by renegotiation, or sourcing through a different vendor.

- Component Substitution – The second fastest method is to substitute components. In the best case scenario, an equivalent part with lower cost replaces an existing component. More likely, an existing part is replaced by a lower quality component with lower cost but that still meets design and quality assurance goals. Determining what is the lowest cost part is a dynamic process since prices change constantly.

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[5] Techniques of Value Analysis and Engineering by Lawrence D. Miles 2nd edition, McGraw Hill Text (1972)

[6] See also: http://www.wisc.edu/wendt/miles/refcenter.html Lawrence D. Miles Papers Collection.

[7] See also: http://www.value-eng.org

[8] Also known as: Value Analysis (VA), Value Management (VM), Value Planning (VP), and Function Analysis (FA)

- Re-sourcing/Out-sourcing – Custom parts and manufacturing sites can be re-sourced or out-sourced to a lower cost producer.

- De-Featuring – Another fast method of lowering cost is to examine what features and options are really valued by customers and offer only those which make economic sense.

7.1. Redesign

Redesign yields the largest amount of cost reduction especially when started early in the design process. At the first revenue ship, the product design becomes frozen. Engineering changes require re-qualification and they impact product launch dates. Redesign is the quickest method for cost reduction because it occurs in parallel with the engineering design effort. Value engineering at this stage is really Design for Manufacturability and Assembly (DFMA). DFMA has been shown to yield significant results when used from the beginning of a project. One study that looked at 117 product development projects has shown average reductions for part count of 54%, part cost 52%, assembly cost 45% and material cost 32% by using DFMA early on in the project. [9] Other studies have shown that the first 5% of engineering design effort locks in 75- 85% of the total product cost.[10]

When the design is mature or beyond FRS date then a more classic value engineering method is used. This method involves calling together an action team. The team consists of representatives from design, manufacturing and test engineering, purchasing, materials, product management, quality control, support engineering, field service and others as needed. We then begin the formal process of evaluating cost which includes:

- Isolating the product into functions (or value-pairs)
- Brainstorming solutions that will satisfy the functions.
- Evaluating the total cost and benefits or each proposed change.
- Creating action plans to implement the solutions that have net benefit.
- Obtaining agreement and following through with the implementation.

A team, with members senior enough to affect decisions, will yield decisions quickly. Even under the best circumstances, not all decisions can be implemented immediately because recommendations require design effort and engineering re-qualification.

7.2. Decrease Existing Component Cost

The fastest and least intrusive way to decrease your product cost is to pay less for the material you are already purchasing. Reducing material cost can be achieved by renegotiations with an existing supplier or sourcing through a lower cost supplier.

In order to identify a better deal, it is best to establish what you should be paying. For a common part, one can simply look part costs up in catalogs or use discount/volume modeling in order to get a good idea of what prices should be. Identifying what custom parts or assemblies should cost is more difficult. Cost Estimating tools like Boothroyd & Dewhurst's DFMA[11] or SEER-

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[9] Manufacturers Say They Cut Product Cost by Half Using Design for Manufacturing and Assembly." *DFMA Newsletter* (April, 2000).

[10] McDonnell Douglas Helicopter, Motorola, Ford and Rolls-Royce, and British Aerospace Industry are four examples. See *Manufacturing Systems*, March, 1988 or W.G. Downey, "Development Cost Estimating" in the report of the *Steering Group for the Ministry of Aviation*, HMSO, 1969 (ref.: D.J. Leech and B.T. Turner, *Engineering Design For Profit*. John Wiley, 1985. Compare also: R.J. Symon and K.J. Dangerfield, "The Application of Design To Cost at Rolls-Royce", Rolls-Royce Limited, Aero Division, Bristol U.K., and Andersen, Kahler, and Lund, *Design For Assembly* IFS (1983) pg. 13.

[11] See http://www.dfma.com/software/DFM.html

DFM[12] can be used to calculate a cost goal for custom parts. The software enables you to establish a target cost for the part by running various scenarios changing volumes, batch sizes, materials and processes to better understand a part's cost.

Once you have established a target cost, you can then begin to negotiate aggressively with your existing suppliers. Often "carrot" approaches like offering partnerships or savings incentives have worked. Other times, "stick" approaches produce better results. In a competitive environment playing one vendor off of another can work.

One of the best ways to reduce part costs is to purchase higher volume. Most supplier costs are very sensitive to volume and lower prices can be negotiated for higher volume. If you can lobby that other designs or products use the same part, volume can increase. In addition, linked volumes and Basic Order Agreements are other ways to negotiate better price. Frequently, if you have enough volume you can approach a manufacturer directly or switch to a supplier willing to meet a better price.

7.3. Component Substitution

This is the second fastest method for achieving savings, because in most cases we are maintaining the three F's – Form, Fit and Function. In this technique there are two similar but slightly different approaches. Parts can be substituted by ones that are same but from a different manufacturer or by parts that are similar but have a slightly lower performance.

7.3.1.Substitution of similar parts

Often for common industry part types, technology and competition gives rise to alternate parts. Many vendors maintain cross-reference tables to help in this substitution. Generally it is a quick check to get another part added to the AVL/QVL[13]. Most parts have several manufacturers. Unless a part is extremely new, it is likely that a cost-reduced copy of the part exists.

7.3.2.. Substitution with lesser parts

Alternatively, an existing part can be replaced with a part that is comparable, but different. In the midst of the design process when you are dealing with a great number of unknowns, it is very common to make simplifying, safe assumptions on the design requirements to minimize schedule risk. Accordingly, many products are over-specified and over-designed which results in higher costs. Usually, you can substitute parts of lower performance, lower tolerance, or lesser quality and still achieve the product requirements without sacrificing quality control.

You have to ask yourself questions and have to take a dispassionate look at what customers really want. Do I really need 30 micro-inch gold plating on connector contacts? Could you possibly use only 20 micro-inch gold plating on the connector contacts? These specific connectors require that circuit boards be removed and then reinserted many times in order to reconfigure the server. How many times would a customer plug and un-plug the circuit board and would there still be any gold left on the connector contacts after multiple removals and insertions. Clearly less gold plating results in a lower cost, but will it affect the connectors' reliability?

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[12] See http://www.galorath.com/tools_dfm-features.shtm

[13] Approved Vendor List/Qualified Parts List

Does the customer really care whether I paint the inside of the enclosure? Does the customer ever look into the machine? Does not painting the inside affect performance? Again this is a customer perception issue with a cost impact. Not painting the inside saves money, and could eliminate some secondary paint masking operations, all of which saves cost.

Do we really need three place tolerances on this fabrication? Many times part tolerances are the defaults that are listed on company drawing formats or are preset in their CAD tools. Careful look at the parts and their interaction with the rest of the product will enable to determine if you need this tight a tolerance. In general looser tolerances are less costly to produce.

7.3.3.. Substitution with greater parts

Occasionally, there are circumstances where using a more expensive part may make longer-term economic sense. This can occur when the cost difference between the two alternatives is low. It also may be true that the more expensive part becomes cost-effective at higher volumes. If a more expensive part can replace several part types, this replacement can also make sense. An example would be the use of 1% tolerance resistors in a design. The higher cost of these resistors is offset by the lower setup cost of not loading two feeders on the placement machine and thus, the easier inspection.

Part substitution is an effective method for reducing product cost. It is important that only robust substitutions be made. You must fully consider the ramifications of the replacement. Is the part a full replacement? Is the design sensitive to some parameter that is not explicitly specified? Part substitution requires generally a confirmation build, but not a full re-qualification.

7.4. Re-sourcing/Out-sourcing

In the majority of corporations, much of manufacturing has already been outsourced. However, keeping an internal manufacturing operation may be warranted for either strategic reasons or to maintain core competencies. Manufacturing internally can also shorten the delay between customer order and delivery or quickly facilitate repair.

If your company does not outsource, you should examine whether the assumptions underlying this decision are still valid. Contract Manufacturers (CM) and Electronic Manufacturing Services (EMS) providers are constantly improving their capabilities as the Manufacturing Services industry matures. When companies first began outsourcing, they could strike “sweet-heart” deals with vendors that wanted to gain your business. Basic game theory implies that a vendor gains leverage once a company has removed its internal manufacturing capability. These days vendors have a more sober appreciation of their strengths and weaknesses.

If your company currently outsources, you should treat the Contract Manufacturer (CM) as any other vendor. You should develop independent models of what each provided service/product should cost and negotiate aggressively to that cost. If your existing provider can’t meet your cost goals and there is no contractual tie that prevents it, investigate using other CMs or EMS. At this time there is quite a bit of over capacity in the world, and there are people who need volume to fill their plants.

If you are looking for a new Manufacturing Services provider, we would re-orient Horace Greeley's famous remark and state, "Go East, young man, go East!".[14] Contract manufacturers in the Far East are offering the best pricing. You should investigate these CMs carefully. Problems with supply chain length, technical complexity, and quality can offset any price advantage.

7.5. De-Featuring

The fourth quick technique we call "de-featuring". Here we examine the product set to determine which features and attributes are really valued by customers. Pre-market customer surveys usually elicit the startling conclusion that customers want every feature possible and want to pay next to nothing for it. Marketing, through focus group and customer visits, will develop a feature-utility function[15],[16] for the market, and give you a good idea of what needs to be in your product to support the desired pricing. The problem is that the analysis and your product introduction are at different points in time, and conditions/customer preferences change. This often leads to problems because your customers aren't buying what you planned to be selling.

To understand what is really being sold, we get the product's sales records and note what configurations and options are selling and which are not. We then correlate that information with the machine standard attributes and determine the relative utility of the features. Based on this information, we can decide whether low value/low preference attributes can be converted from product attributes to product options or dropped from the product menu.

The best example of this appeared a number of years ago when product management and marketing stated that 50-60% of our customers demanded our machines have intelligent Battery Back Up (BBU). Accordingly, the design team worked and embedded an intelligent battery management capability within each power supply that conditioned batteries, provided ride-through capability and orderly machine shut-down at battery exhaustion. The BBU system was elegant and technically sophisticated, but *it was almost never used*. Customers generally needed to keep their entire computer room going through a power event, not just the CPU. As a result, they bought room level Uninterruptible Power Supplies (UPS) and back-up generators, and never used the capability in our power supplies. About a year after product introduction we ended up removing the capability from our standard product and passing the cost savings to the customers. We still kept the intelligent supplies as an extra-cost option for the 10% of our customers who needed this ability.

8. Summary

The techniques described in this paper can yield quick results in product cost reduction and are all variants of the Value Method used in Value Engineering. The key to any 'quick' method is to leave as much of the core product the same changing either the manner in the way it is procured, manufactured, or sold. This circumvents the need for a lengthy or complex product re-qualification.

Opportunities will always exist to improve the cost of any shipped product. The following table summarizes the savings realized on several VE projects we worked on:

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[14] Salt Lake Tribune 15Aug-93 by Harold Schindler – "Everything about Horace Greeley was controversial, including the famous remark: "Go West, young man, go West!" attributed to him in 1853, while in fact he was paraphrasing an Indiana editor's expression of 1851. But it is just as true that if others used the phrase before Greeley, no one heard it. And when Greeley said it, the whole country listened, and thousands acted on it."

[15] Classically done with Conjoint Analysis - see http://www.quickmba.com/marketing/research/conjoint/ for an overview explanation of the method.

[16] See http://marketng/byu.edu/htmlpages/tutorials/conjoint.htm for a tutorial on the methods

Results	Product A		Product B		Product C	
	% of Total Prod Cost	**% of Total VE**	**% of Total Prod Cost**	**% of Total VE**	**% of Total Prod Cost**	**% of Total VE**
Lower Existing Component Cost	1.3%	9.8%	2.8%	7.2%	2.5%	26.2%
Component Substitution	9.1%	68.9%	17.7%	45.4%	0.7%	7.0%
Out-Sourcing /Re-Sourcing	0.3%	2.5%	6.8%	17.5%	1.7%	17.7%
De-Featuring	0.8%	5.8%	5.8%	14.9%	-	-
Redesign	2.5%	18.6%	5.8%	14.9%	2.5%	26.0%
Total Product Savings	**13.3%**		**39.0%**		**9.6%**	

The first project was a post new-product introduction. In the year following product launch, we reduced product cost by over 13% using the techniques previously described. As you would expect most of the savings were the result of component substitution. Efforts at re-sourcing and out-sourcing were not as fruitful for this product because it has a limited product life remaining.

The second VE project began prior to product introduction. We had wider latitude in making changes because the design was not frozen. Thus, we reduced the projected product cost by nearly 39%. Here re-sourcing and out-sourcing provided much higher savings.

The last project was one that required extensive compliance testing and agency certifications. As such, de-featuring was out of the question, and component substitution was limited to non-critical parts that would not trigger a requirement for re-qualification. In spite of these constraints, we still reduced costs by 10%.