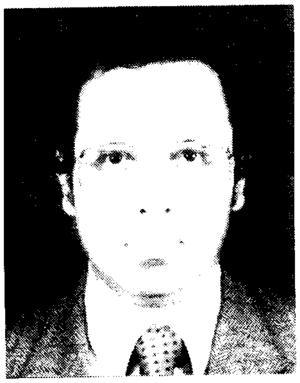
Value Engineering with Suppliers: A Proactive Approach

Nazmul A. Qureshi, P.E
Applied Materials, Austin, Texas



Nazmul (Naz) A. Qureshi is a seasoned Manufacturing and Cost Management professional with over 18 years of experience in the areas of cost estimating, value engineering, cost reduction, productivity improvement, project management, and concurrent engineering in diversified manufacturing environment. Currently he is employed in Applied Materials as a Value Engineering Project Manager. He has gained substantial expertise in value engineering functions dealing with ceramic, quartz, graphite and various ferrous and non-ferrous materials. He is a registered Professional Engineer in Industrial Engineering from the State of California.

ABSTRACT

Value Engineering process uses an organized approach to identify opportunities to eliminate or reduce non-value added costs from products or processes while assuring that quality, reliability, performances meet or exceed requirements. This paper is a collection of a few case studies of VA/VE efforts that were initiated in a semiconductor tool manufacturing company and successfully implemented in collaboration with the suppliers. The key point mentioned in this paper is to use simple and commonsense tools to make a significant cost savings for your company.

The important thing to learn here is that all organized efforts and right focus on an issue can bring success in the organization. In each project, highly pertinent elements of value analysis were applied in reaching the desired results and expectation of the company.

Three case studies illustrated in this paper are small parts, made out of low carbon steel, ceramic (aluminum nitrite) and fused quartz parts used in the semiconductor processing tools. In each case study pertinent value analysis techniques were used to reach the most cost effective solution.

Each case study follows the following format:

- Definition of the part/process problem
- Tools used for alternate solution
- Tests/validation conducted
- Net savings or improvement captured

To successfully implement any VE project in your organization, the first step is to identify the problem with the help of your customer. If you can obtain their support in identifying the problem and a few alternate solutions, you have won half the battle. The second important thing is to look around beyond your organization to obtain better solutions to the problems facing the organization. We have seen that suppliers who have expertise in their own organization can provide useful ideas for meaningful solutions of your problems. These ideas once carried through can be very valuable to your own organization.

This paper has illustrated the various steps that you need to go through to implement VE solutions successfully.

SUCCESS STORIES

Case-I
Magnet Pole Piece

Problem definition:
Pole pieces are used on each side of a magnet, going into the slots of magnet clamp ring used in the robot assembly (Figure 1.0). Sixteen magnet assemblies are required for the upper magnet ring another sixteen for the lower vacuum magnet ring.

A total of sixty-four (64) pole pieces are needed for this assembly. The function of the pole pieces is to direct the magnetic flux lines in one direction in order to achieve maximum magnetic field strength. Therefore, one of the important properties of the pole piece material is low permeability.

Pole pieces are made in metal injection molding (MIM) process under the existing method by an outside supplier. The process was labor intensive and prone to quality problems. The dimensions of pole pieces are critical and need to be hold on consistent basis.

Metal injection molding process failed to hold these tight tolerances on a consistent basis. Also, the density variation due to this process was a major concern for poor performance of magnetic field.

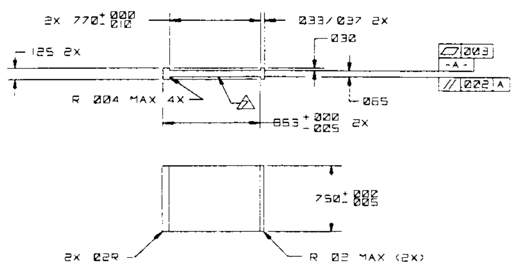


Figure 1.0

Tools used for alternate solution:
A team consisting of Manufacturing Engineer, Product Engineer, Supplier Engineer, and Value Engineer brain stormed on the issue and came up with two different manufacturing processes for evaluation. These are (a) powder metals, and (b) machining of bar stock. Machining was considered to be most desirable process due to consistency of material density. But considering the high cost of machining, other Value Engineering opportunities were pursued.

An organized approach was taken by the above mentioned team members. A major tool of VA/VE process is to "look beyond your organization." A few suppliers were contacted and their manufacturing processes were reviewed by the team. Suppliers were given a target of 30% cost reduction goal from the current cost. At the very beginning of the project, suppliers were informed of our concept of "should cost" price. "Should cost" does not mean cost plus profit margin. It means market price minus profit. In other words, "should cost" means all that our customers can afford to pay for the part to make a viable business. It is important to realize that suppliers need to meet customers' "should cost" price through VA/VE activities.

Machining process of bar stock was critically reviewed using VA techniques. Finally, the VA team came up with a cost effective process known as "cold forming and machining."

Tests conducted:
A detailed analysis of performance of pole pieces made in the existing process (MIM) along with other two processes were conducted. Magnetization curves (BH) were developed for the test samples for all the three processes under consideration. The four-quadrant magnetization curve was measured on each of the two samples up to the maximum available field of 10,000 Oersteads. Results showed that pole pieces made in powder metal process exhibited worst BH curve (Figure 3.0). The existing MIM process showed acceptable magnetization curve (Figure 2.0), but this process was relatively costly and prone to other quality problems. Cold roll forming and machining process produced the best quality with higher flux density (B) in the most cost effective process for this part (Figure 4.0).

Net Savings:
The process of cold forming of bar stock to near-net-shape and machining to exact dimension on a CNC milling machine proved to be the most cost effective method resulting 33% cost reduction compared to MIM process. Total savings achieved was $225K in one year (Table- I).

Case - II
Ceramic Chuck

Problem definition:
Electrostatic ceramic chuck with embedded electrode is a one of the best technological breakthroughs for a particular semiconductor fabrication process. Tape casting of aluminum-nitride was selected as the appropriate manufacturing process to make the ceramic chuck. Customers liked the product because of its excellent reliability and performance. But high cost of this product was a barrier for market penetration. Engineers from the product group along with the supplier worked over two years to develop the best manufacturing method (BKM) for this part. Prototype cost of the complete ceramic chuck with bellows assembly was over $30K per unit.

Tools used for alternate solution:
The Value Engineering group reviewed the manufacturing processes of the supplier in order to perform a "should cost" analysis of the part. "Should cost" analysis is a systematic cost analysis tool which takes into consideration process steps, materials, yield factors, labor, tooling, overhead

cost, and profit margin. Cost reduction of ceramic chuck and the bellows assembly was a great challenge for the team. The key factor in the accuracy of "should cost" analysis lies in the accuracy of mapping the current processes steps. Each manufacturing process steps were challenged at the supplier's facility and non value-added tasks were eliminated.

A series of negotiation meetings were held with the suppliers and they were asked to meet the price as determined in the "should cost" analysis. Finally, contracts were signed with two suppliers to bring the price down to less than $15K. Through VA/VE approach, we were able to achieve over 50% cost reduction for this part.

Net savings:

Total cost avoidance for this part was over $8 million based on 1000 units of annual usage. This was possible due to proactive participation of Suppliers along with the Value Engineering group to solve common problems.

Case - III

Preclean Chamber Pin

Problem definition:

Preclean chamber in one of the critical process steps in physical vapor deposition (PVD) systems in semiconductor fabrication. It uses six small quartz pins to hold the wafer in position during preclean process. The existing pins are made out of fused quartz which goes through costly labor intensive manufacturing processes. This is a consumable item and costs per part is $12.50 per piece. The objective was to find a material with the same physical and chemical properties as fused quartz at a lower cost so that cost of ownership (COO) can be improved.

Tools used for alternate solution:

The physical and chemical properties of the current materials were entered in a spreadsheet and an extensive research was carried out to find similar material at a lower cost.

Suppliers were contacted who had expertise in materials such as plastic, ceramic, glass and quartz. The two primary requirements of the property for the replacement material were: reduced particle generation and low dielectric constant (less than 4.0).

Two types of materials were short listed from a list of ten materials. These are (i) polybenzimidazole (PBI), (ii) vespel sp-1. The material properties of these materials were very close to the properties of fused quartz.

Tests conducted:

Two process matrices were run on a system for a preclean chamber. The first matrix was run with the standard quartz pins. The second matrix was run with the new pins made out of PBI material. The RF power constants were set to 400. Two wafers were etched with standard quartz pins. The chamber was vented and the new pins (PBI material) were installed. Various process parameters such as DC bias, etch rate, and uniformity were used to compare the PBI pins to the quartz pins. A least square model was run for analysis. According to the analysis, PBI pins made no significant difference to the DC bias measurement (Table-II). The etch rates and uniformity differences were observed and recorded in Table-III and IV.

Net Savings:

Preclean chamber pin has a high annual usage. Cost reduction achieved was 75% by switching to the PBI pins. Net savings to the company is over $281K per year. Details of cost savings achieved are shown in Table-V.

Conclusion:

The above success stories of Value Engineering group in my company are only a few out of many performed on a regular basis. VA/VE is a unique problem solving system for designing high-quality products at a low cost. Design and Manufacturing engineers have started recognizing the importance of VA/VE in product improvement and cost reduction efforts.

Case I and II discussed above have already been implemented. Case III is currently in the process of implementation.

Lessons Learned:

Variations between supplier's cost and "should cost" can be significant due to one or combination of the following reasons:

- Suppliers may not be using best known method (BKM) which leads to high cost
- High-cost manufacturing steps are not considered in the "should cost" analysis
- Suppliers have not adjusted the price for the current volume production
- Suppliers have not developed cost models -- quotes are prepared based on "guesstimates."

As the "should cost" model was presented to the suppliers which is a better analytical tool than traditional estimating practice, it helped us to conduct the negotiations more professionally and smoothly.

Table - I: Cost savings achieved for Pole Piece for Case I

Part No. 0020-XX, Rev. A Current Process: MIM	Part No. 0020-XX Rev. B New Process: CRF&M	Description: Pole Piece	Platform: Centura	Kit: HP Robot
Current cost	New Cost	Unit Savings	EAU	Total Savings ($)
$2.25	$1.50	$0.75	300,000	$225,000.00

Table - II: DC bias comparison for Case III

Plasma Power	Bias Power	Quartz Pins	PBI Pins
450	150	59	59
600	200	59	56
750	250	56	54
200	100	126	123
400	200	105	104
600	300	102	101
200	200	263	263
300	300	242	247
400	400	234	236
150	300	502	508
150	450	483	486
225	450	674	682

Note: Table-II provides a comparison of the DC biases. The choice of pins make no difference to the DC biases.

Table- III: Etch rate comparison for Case III

Plasma Power	Bias Power	Quartz Pins	PBI Pins
450	150	309	225
600	200	412	312
750	250	507	403
200	100	164	113
400	200	405	337
600	300	630	551
200	200	294	241
300	300	504	441
400	400	714	641
150	300	316	267
150	450	417	357
225	450	559	485

Note: Table-III presents a comparison of the etch rates with the new pins and the quartz pins. The etch rates with the new pins are considerably lower than the etch rates with the quartz pins.

Table- IV: Uniformity comparison for Case III

Plasma Power	Bias Power	Quartz Pins	PBI Pins
450	150	2.4	3.9
600	200	5.7	4.6
750	250	4.0	4.1
200	100	1.9	2.3
400	200	2.1	2.1
600	300	3.2	3.0
200	200	2.7	2.7
300	300	2.4	2.1
400	400	2.3	2.2
150	300	6.6	6.9
150	450	8.4	9.0
225	450	4.6	4.8

Note: Table- IV provides a comparison of the uniformity between new pins and quartz pins. The new pins (PBI) neither improve nor degrade the uniformity.

Table -V: Cost savings achieved for Preclean Chamber Pin: Case III

Part No. 0020-ZZZ, Rev. A Current Material: Quartz GE-124	Part No. 0020-ZZZ Rev. B New Material: PBI	Description: Preclean Chamber Pin	Platform: Centura &Endura PVD	Kit: Preclean Chamber
Current cost	New Cost	Unit Savings	EAU	Total Savings ($)
$12.50	$3.11	$9.39	30,000	$281,700 .00

Figure 2.0: BH curve of Pole piece
for MIM (existing) process

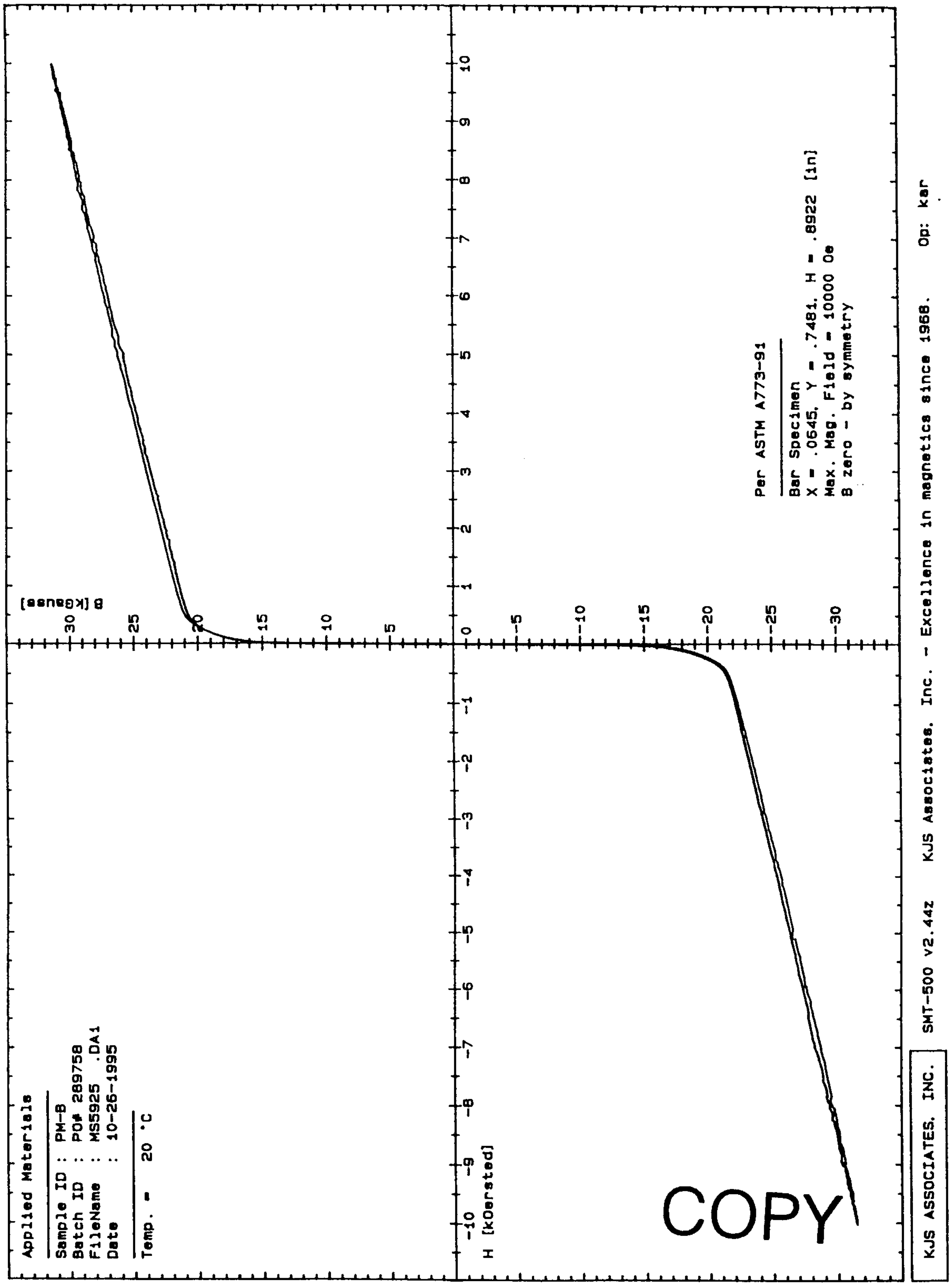


Figure 3.0: BH curve of Pole piece
for powder metal process

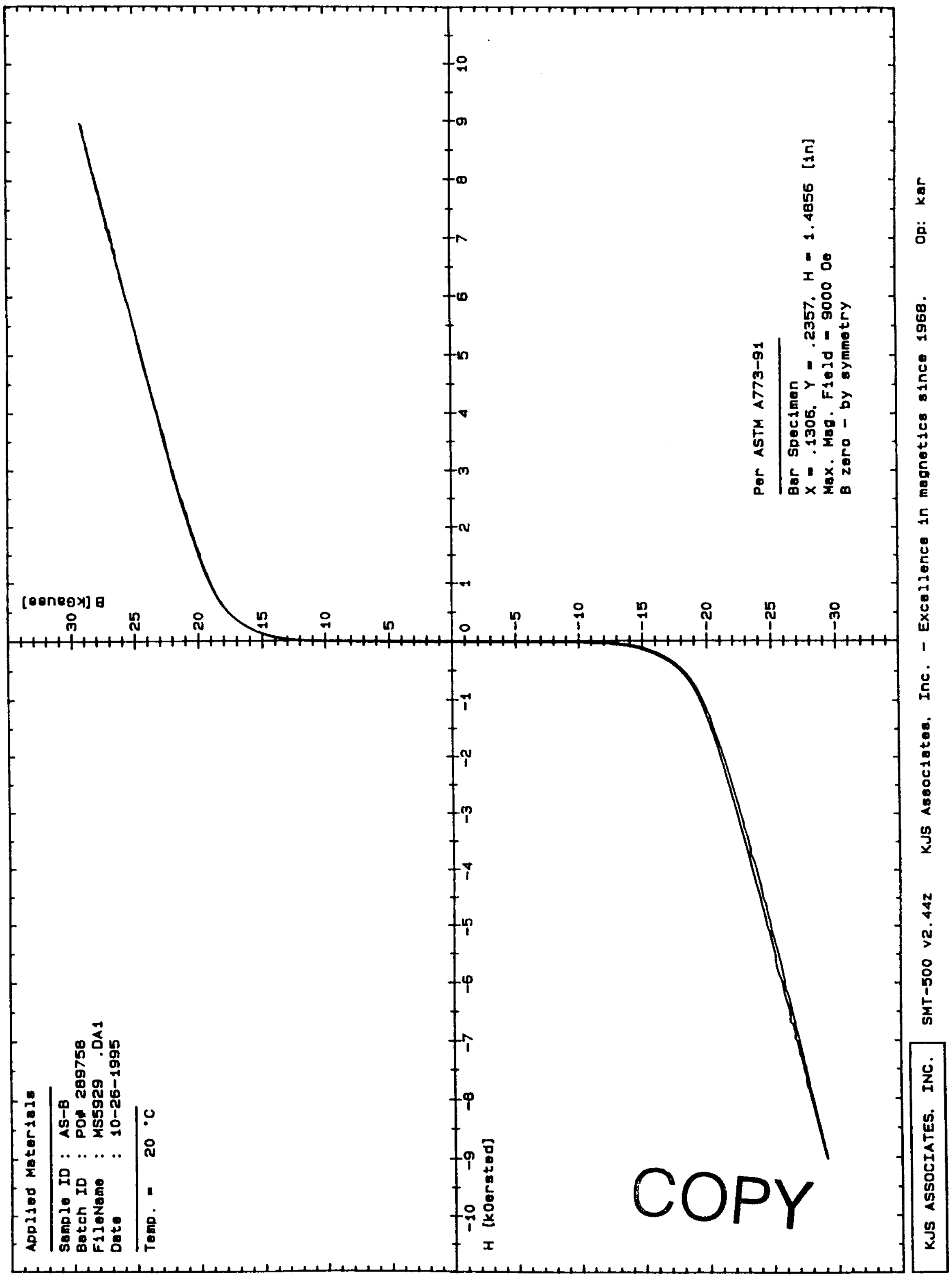


Figure 4.0: BH curve of Pole piece for "cold forming and machining" process