APPLICATION OF VALUE ENGINEERING FOR COST REDUCTION – A CASE STUDY OF UNIVERSAL TESTING MACHINE

Chougule Mahadeo Annappa[1] and Kallurkar Shrikant Panditrao[2]
[1]Principal, A.G. Patil Polytechnic Institute, Vijapur Road, Solapur (Maharashtra), India.
[2]Principal, A.G. Patil Institute of Technology, Vijapur Road, Solapur (Maharashtra), India.

ABSTRACT

This paper presents the basic fundamental of value engineering that can be implemented in any product to optimize its value. A case study of a Universal Testing Machine (UTM) is discussed in which the material, design of components is changed according to the value engineering methodology. In the present case study, it is observed that the unnecessary increase in cost is due to the use of expensive material, increase in variety of hardware items and thereby increasing the inventory and so on. Therefore we have selected some components from UTM i.e Hand Wheel, Range Selector Knob, Top Bearing Bracket Assembly, Dial Bracket, Recorder Gear etc. and we have applied value engineering technique for the cost reduction of these components of UTM. Therefore by Value Engineering technique, Design modification for Dial Bracket and Top Bearing Bracket Assembly, use of alternative less expensive material for Recorder Gears, Range Selector Knob and Hand Wheel is suggested in this case study and thereby which cost reduction is achieved.

KEYWORDS: *Value Engineering (VE), Data collection and Analysis, Job Plan, Speculation and Evolution, Achievement, Universal Testing Machine (UTM).*

I. INTRODUCTION

In 1947, L.D. Miles [4], Design Engineer in G.E.C. USA organized the technique of 'Value Analysis' while attempting to reduce the manufacturing cost of some products. His attempt was to search for unnecessary manufacturing cost and indicate the ways to reduce it without lowering down the performance of product. However in India, VE is mostly associated to any alternative design with the intension to cost cutting exercise for a project, which is merely one of the initial intension of the VE. This paper outlines the basic frame work of value Engineering and present a case study showing the merits of VE in a universal testing machine.

II. DEFINITION OF VALUE ENGINEERING

Value Engineering is the systematic application of recognized techniques which identify the function of the product or service, establish a monitory value for that function and provide the necessary function reliability at the lowest overall cost. The purpose of the Value Engineering Systematic Approach is to provide each individual with a means of skillfully, deliberately and systematically analyzing and controlling the total cost of product. This total cost control is accomplished, in the main, by the systematic analysis and development of alternative means of achieving the functions that are desired and required. The purpose of VESA is well served when the user is able to define and segregate the necessary from the unnecessary and thereby develop alternate means of accomplishing the necessary at a lower cost. Hence Value Engineering may be defined as, "an organized Procedure for efficient identification of unnecessary cost."

III. TYPES OF VALUES

a. Use value - which is based on those properties of the product, which enable it to perform work or service.
b. Cost value - which is based on the minimum cost of achieving a useful function.
c. Esteem value - which is based on those properties of the product, which contribute to pride of ownership.
d. Exchange value – which is based on those properties which make a product valuable for exchange purposes. Examples of the different categories of value are

Table No. 1

Category of 'value'	Examples
Use value	Nail
Cost value	Bus fare
Esteem value	Gold watch
Exchange value	Antique furniture

Six value engineering phases:

1. Information phase
2. Functional analysis phase
3. Speculative phase
4. Evaluation phase
5. Implementation phase
6. Presentation phase

IV. CASE STUDY

In this paper we have discussed a case study of Universal Testing Machine which is manufactured in Balancing Instruments and Equipments Ltd. Miraj, (Maharashtra) since from last 35 years. They are also manufacturing big range of testing machines i.e. Impact Testing Machine, Hardness Tester, Torsion Testing Machine etc. Universal Testing Machine is selected for case study as it is most popular and relatively fast moving product. We have selected following components from Universal Testing Machine and we have applied Value Analysis technique for cost reduction [3] of following components of UTM. The components are

I. Hand Wheel
II. Range Selector Knob
III. Top Bearing Bracket Assembly
IV. Dial Bracket
V. Recorder Gears

Universal Testing Machine

In the present case study it is observed that the unnecessary increase in cost is due to use of expensive material, complicated design, increase in variety of hardware items and thereby increasing the inventory. Therefore by Value Engineering technique, Design modification [2] for Dial Bracket and Top Bearing Bracket Assembly, use of alternative less expensive material [12] for Recorder Gears, Range Selector Knob and Hand Wheel is suggested in this case study and thereby which cost reduction is achieved.

A. HAND WHEEL:

Data Collection & Analysis:

Two main control valves one at right side and other at left side are provided on control panel. The right side valve is pressure compensating flow control valve with integral over load relief valve. Left side valve is return valve which allows the oil in the cylinder to go back during the downward motion of main piston. If this return valve is closed, oil delivered by pump passes through the right side valve to the cylinder and piston goes up. Therefore after studying the function it has been observed that only by rotating the hand wheels these valves can be opened or closed. By keeping same function the material of hand wheel can be changed from cast iron to Nylon.

VE Job Plan:-

Information:

1. What is it? :-Hand Wheel CI (Fig No.1)
2. What does it cost? :-Rs. 400/-
3. How many parts? :- one
4. What does it do? :- To open and close valve.
   (List all functions)
5. How many required?
   Current usage Quantity? :- 90 per year
   Forecast? :- Continue for five years

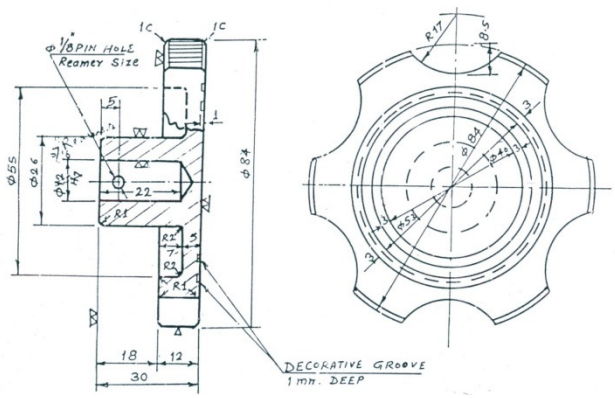


Figure No.1

Speculation and Evaluations:

6. Which (of those answer in Q.4) is the primary function
   :-To open and close valve.
7. What else will do? :- Replace CI Hand Wheel by Nylon Hand Wheel
8. What will that cost? :-Rs. 180.50

Plan:

9. Which alternative way (Q.7) of doing the job show the greatest difference between COST and USE VALUE?
   Greatest offered by : Nylon hand wheel
10. Which ideas are to be developed?
    First Choice : Nylon hand wheel
11. What other functions (work or sell) and specification features must be incorporated?

No.	Factor	Nylon hand wheel
1.	Function	Same as existing
2.	No. of parts	No change
3.	Space Required	Same as existing
4.	Durability	Certainly
5.	Aesthetic	Very Good

We are looking for:

The minimum amount which must be spent to achieve the appropriate USE and ESTEEM factors.

Selling:

12. What do we need to sell our ideas and forestall road-blocks?

a. Model
b. Sketches
c. Full drawing
d. Product cost comparison
e. Capital cost of change
f. Revenue costs of change

Achievement:

With the same function the material of Hand Wheel can be replaced by Nylon

Result of VE Job Plan are:

Die Development Charges / piece = Die Development cost / (No. of considered Yrs. X No. of pieces per year) = 20000/ (5x 90) = Rs. 44.44

Total cost per piece = Die development cost + Material Cost
= 44.44 +140.00 = Rs.184.44 (Say Rs.184/-)

So Net Saving = 400-184
= Rs.216/-

Percentage saving in cost = 54 %

B. RANGE SELECTOR KNOB:

Data Collection & Analysis:

The main function of Selector Knob is to select required load range. By rotating this knob, we can change the cam positions and dial marking suitably. Presently this knob is made from C.I. for which different operations are to be carried out. After studying the function of this knob it has been observed that the material of this knob can be replaced from C.I. to Nylon which is inexpensive, light in weight, corrosion resistance etc.

VE Job Plan:-

Information:

1. What is it? :- Range Selector Knob (Figure No.2)
2. What does it cost? :-Rs. 300/-
3. How many parts? :- One
4. What does it do? :- a. To select the required range.
   b. To change the cam position and dial marking.
5. How many required?
   Current usage Quantity? :- 45 per year
   Forecast? :- Continue for five years

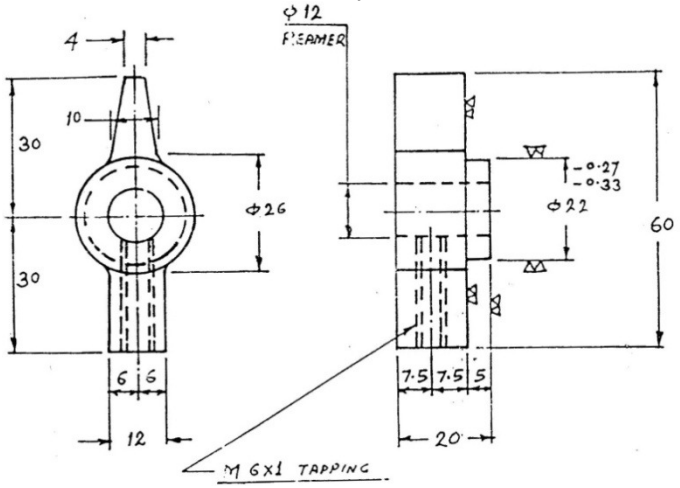


Figure No. 2

Speculation and Evaluations:

6. Which (of those answer in Q.4) is the primary function
   :- To select the required load range
7. What else will do? :- Replace C.I. Knob by Nylon Knob

8. What will that cost? :- Rs. 130/-

Plan:

9. Which of the alternative way (Q.7) of doing the job show the greatest difference between COST and USE VALUE?
   Greatest offered by :- Nylon Knob
10. Which ideas are to be developed?
    First Choice :- Nylon Knob
11. What other functions (work or sell) and specification features must be incorporated?

No.	Factor	Nylon Knob
i	Function	Same as existing
ii	No. of parts	No change
iii	Space Required	Same as existing
iv	Durability	Certainly
v	Other factors	Light in weight, Inexpensive, corrosion resistance etc.

We are looking for:
The minimum amount which must be spent to achieve the appropriate USE and ESTEEM factors.

Selling:

12. What do we need to sell our ideas and forestall road-blocks?
    a. Model
    b. Sketches
    c. Full drawing
    d. Product cost comparison
    e. Capital cost of change
    f. Revenue costs of change

Achievement:

By using Nylon Selector Knob, we can select the required load range and also cam position and dial markings can be suitably changed.
Result of VE Job Plan are:
Nylon Selector Knob:

Die Development Charges / piece = Die Development cost / (Effective Life X No. of pieces per year)
= 10000/ (5x 45) = Rs. 44.44
Total cost per piece = Die development cost + Material Cost
= 44.44 + 80.00
= Rs. 124.44 (Say Rs. 125/-)
So Net Saving = 300 – 125
= Rs. 175/-
Percentage saving in cost = 58.33 %

C. TOP BEARING BRACKET ASSEMBLY:

Data Collection & Analysis:

The lower beam is rigidly connected with upper beam by the two columns and the entire assembly is connected to hydraulic ram a ball and ball set joint which ensures axial loading. The lower and upper beam assembly moves up and down with the ram. This movement is guided at the top side by the bearing sliding round the main screws. In the existing design four guide bearings are provided in each of the two top bearing brackets fixed at the top of upper beam. It has been observed that, when the entire assembly moves up and down with ram, only one or two bearings comes in contact with the main screw. Therefore by keeping same function, the design of existing bearing bracket can be modified.

VE Job Plan:-

Information:

1. What is it? :-Top Bearing Bracket Assembly (Fig No.3 with four bearings)
2. What does it cost? :- Rs.7500/-
   (Details not required yet)
3. How many parts? :- Nine

4. What does it do? (List all functions)
   a. To guide movement of upper and lower beam assemble.
   b. To keep the movement in vertical direction.
   c. To minimize the friction between bracket and main screw
5. How many required?
   Current usage Quantity? :- 90 per year
   Forecast? :- Continue for five years

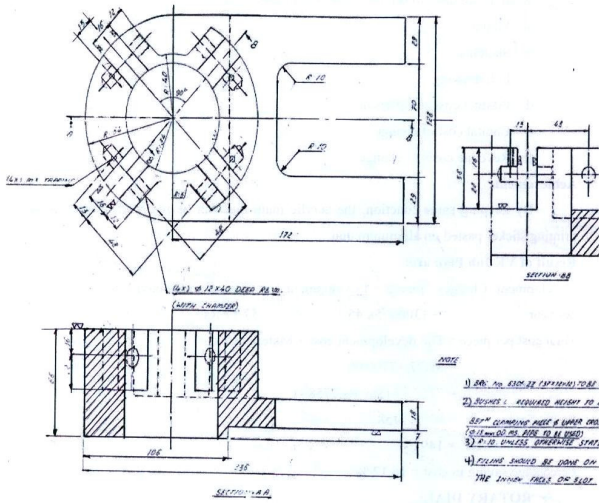


Figure No. 3

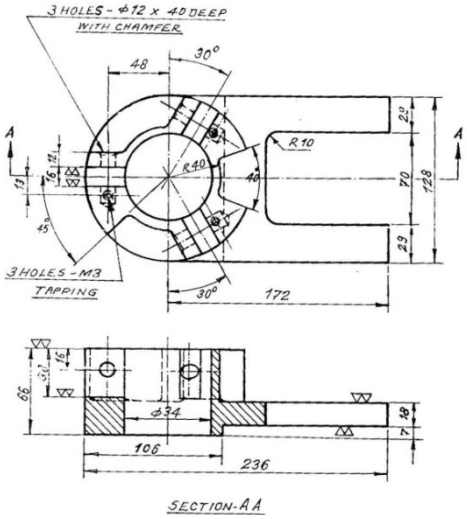


Figure No. 4

Speculation and Evaluations:

6. Which (of those answer in Q.4) is the primary function
   :-To guide the movement of upper and lower beam assembly
7. What else will do? :- Top Bearing Bracket Assembly (Fig. No. 4)
8. What will that cost? :- Top Bearing Bracket Assembly – Rs. 6050/-

Plan:

9. Which alternative way (Q.7) of doing the job show the greatest difference between COST and USE VALUE?
   Greatest offered by: Top Bearing Bracket assembly (with three bearings)
10. Which ideas are to be developed?
    First Choice: Top Bearing Bracket assembly (with three bearings)
11. What other functions (work or sell) and specification features must be incorporated?

No.	Factor	Top Bearing Bracket Assemble (with three bearings)
1.	Function	Same as existing
2.	No. of parts	Reduce to seven parts
3.	Space Required	Same as existing
4.	Durability	Certainly more

We are looking for:

The minimum amount which must be spent to achieve the appropriate USE and ESTEEM factors.

Selling:

12. What do we need to sell our ideas and forestall road-blocks?
    a. Model
    b. Sketches
    c. Full drawing
    d. Product cost comparison
    e. Capital cost of change

f. Revenue costs of change

Achievement:

By keeping same function the design of the existing Top bearing Bracket assembly is modified as shown in drawing no. 5. Result of VE Jon Plan are

1. Saving in raw material cost Rs. 110/-
2. Saving in machining cost Rs. 90/-
3. Saving by reducing one pin Rs. 150/-
4. Saving by reducing one bearing (6301zz) Rs. 1100/-

Total saving by modifying design Rs. 1450/-

Hence percentage saving in this proposal is 19.33 %.

D. DIAL BRACKET:

Data Collection & Analysis:

The main function of dial bracket is to support the outer dial, pointer assembly (reading pointer and dummy pointer) and cover at top. The existing dial bracket is very bulky in design and complicated which is actually not required. The design and shape of existing dial bracket is studied in detail and it has been observed that by keeping same function, the design of the existing dial bracket can be modified.

VE Job Plan:-

Information:

2. What is it? :- Dial Bracket (four arm) (Figure No.5)
2. What does it cost? :-Rs. 9000/-
3. How many parts? :- One
4. What does it do? :- a. Supports inner and outer dial.
   b. Supports cover (Acrylic) on dial.
5. How many required?

   Current usage Quantity? :- 45 per year

   Forecast? :- Continue for five years

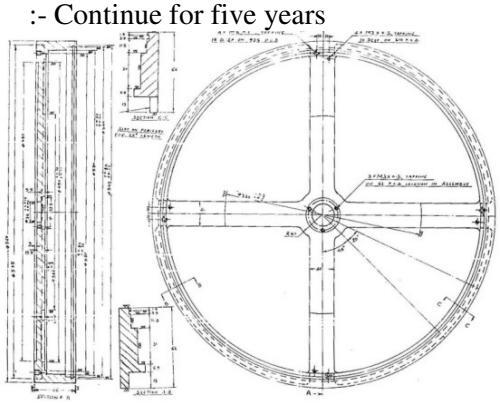


Figure No. 5

Speculation and Evaluations:

13. Which (of those answer in Q.4) is the primary function
    :- supports inner and outer dial and pointer assembly
14. What else will do? a. Two arm dial bracket Fig. No. 6
    b. Three arm dial bracket Fig. No.7
15. What will that cost?
    a. Two arm dial bracket Fig. No. 6 – Rs. 810/-
    b. Three arm dial bracket Fig. No. 7 – Rs. 855/-

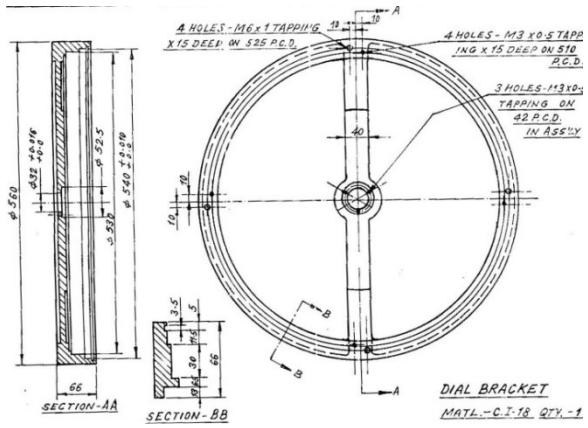


Figure No. 6

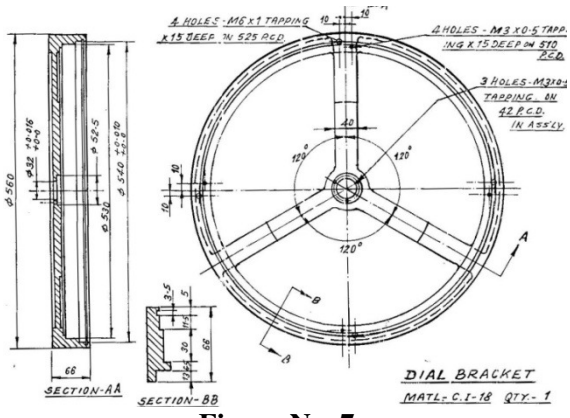


Figure No. 7

Plan:

16. Which two of the alternative way (Q.7) of doing the job show the greatest difference between COST and USE VALUE?
    Greatest offered by : Two arm Bracket
    Second best : Three arm dial bracket
17. Which ideas are to be developed?
    First Choice : Two Arm Bracket
    Second choice : Three Arm Bracket
18. What other functions (work or sell) and specification features must be incorporated?

No.	Factor	Two arm bracket	Three arm bracket
i	Function	Same as existing	Same as existing
ii	No. of parts	No change	No Change
iii	Space Required	Same as existing	Same as existing
iv	Durability	Certainly	Certainly

We are looking for:
The minimum amount which must be spent to achieve the appropriate USE and ESTEEM factors.
Selling: What do we need to sell our ideas and forestall road-blocks?

a. Model
b. Sketches
c. Full drawing
d. Product cost comparison
e. Capital cost of change
f. Revenue costs of change

Achievement: By keeping same function the design of the existing dial bracket can be modified in the following two ways

1. Two arm dial bracket
2. Three arm dial bracket

The design of dial bracket in the first proposal saves the raw material of cost of Rs. 900/-.
Hence percentage saving in this proposal is 10 %.
The design of dial bracket in the second proposal saves the raw material of cost of Rs. 450/-.
Hence percentage saving in this second proposal is 5%.

E. RECORDER GEAR:

Data Collection & Analysis:
The main function of recorder gear is to give the rotary motion to the chart roller and function of the pinion is to give the linear to the rack scale. Presently in the recording unit brass gears are used which are very expensive. After studying the working of recorder unit, it has been observed that, the material of gear can be replaced by nylon, which in inexpensive, light in weight, corrosion resistance etc.
VE Job Plan:-

Information:

1. What is it?:-Recorder Gear and pinion (Fig No.8,9 &10)
2. What does it cost? :- Gear A Rs. 320/- Gear B Rs.520/- Pinion Rs. 550/-
3. How many parts? :- Five
4. What does it do? :- To give the rotary motion to the chart roller.
   (List all functions) To give linear motion to the rack scale.
5. How many required?
   Current usage Quantity:-Gear A 90 per year, Gear B 90 per Year & Pinion 45 per year
   Forecast? :- Continue for five years

Speculation and Evaluations:

6. Which (of those answer in Q.4) is the primary function
   :- To give the rotary motion to the chart roller and linear motion to the rack scale
7. What else will do?:- Replace Brass gears and pinion by nylon.
8. What will that cost? :- Gear A Rs.90/-, Gear B Rs.100/- and Pinion Rs. 120/-

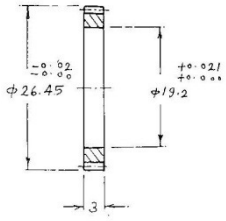


Figure No.8

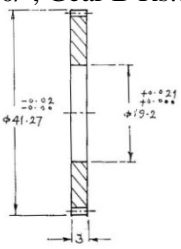


Figure No. 9

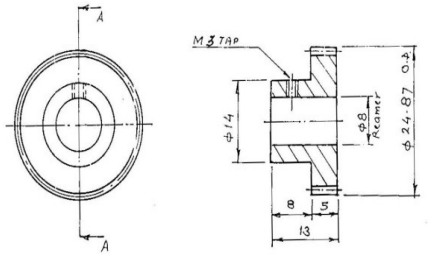


Figure No. 10

Plan:

9. Which alternative way (Q.7) of doing the job show the greatest difference between COST and USE VALUE?
   Greatest offered by : Nylon Gear A, B, and pinion
10. Which ideas are to be developed?
    First Choice : Nylon Gear A, B, and pinion
11. What other functions (work or sell) and specification features must be incorporated?

No.	Factor	Nylon Gear
1.	Function	Same as existing
2.	No. of parts	No change
3.	Space Required	Same as existing
4.	Durability	Certainly
5.	Friction	Negligible
6.	Lubrication	Not Required
7.	Other Factors	Light in weight, Inexpensive, Corrosion Resistance Etc.

We are looking for**:**

The minimum amount which must be spent to achieve the appropriate USE and ESTEEM factors.

Selling:

12. What do we need to sell our ideas and forestall road-blocks?
    a. Model
    b. Sketches
    c. Full drawing
    d. Product cost comparison
    e. Capital cost of change
    f. Revenue costs of change

Achievement:

By using Nylon Gears and Pinion, the motion can be easily given to the chart roller and rack scale.

Result of VE Job Plan are:

i) *Gear A – (Nylon)*

Die Development Charges / piece = Die Development cost / (Effective Life X No. of pieces per year)
= 15000/ (5 x 90) = Rs. 33.33
Total cost per piece = Die development cost + Material Cost
= 33.33 + 5.00
= 38.33 (Say Rs.39/-)
So Net Saving = 320 –39
= Rs. 281/-
Percentage saving in cost = 87.81 %

ii) *Gear B – (Nylon)*

Die Development Charges / piece = Die Development cost / (Effective Life X No. of pieces per year)
= 18000/ (5x 90) = Rs. 40/-
Total cost per piece = Die development cost + Material Cost
= 40.00 + 60.00
= Rs. 100.00
So Net Saving = 520 – 100
= Rs. 420/-
Percentage saving in cost = 80.76 %

iii) *Pinion (Nylon):*

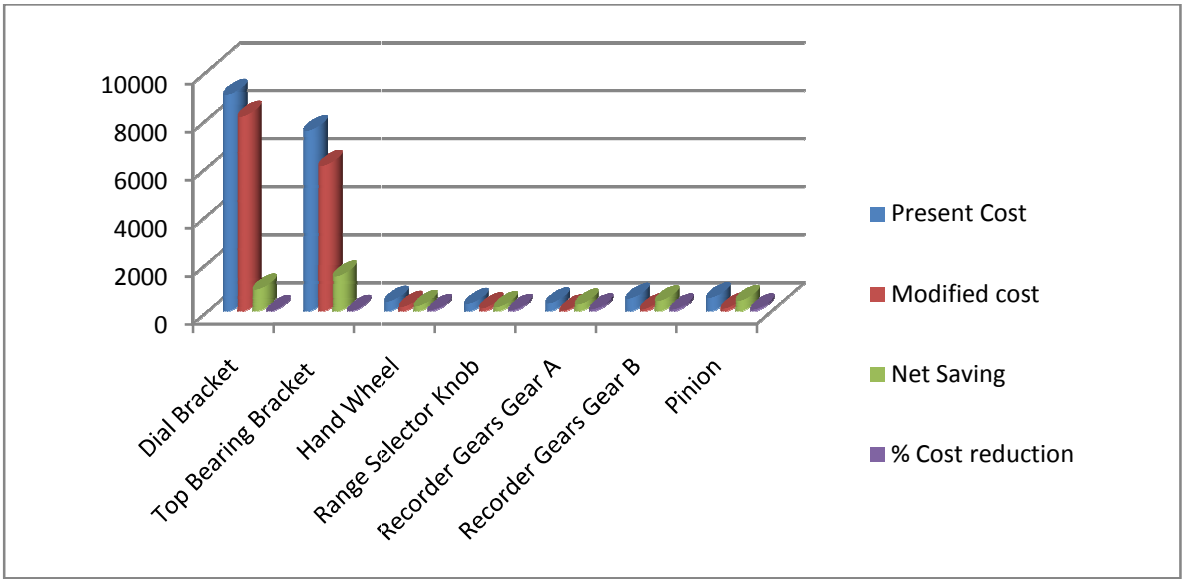
Die Development Charges / piece = Die Development cost / (Effective Life X No. of pieces per year)
= 15000/ (5x 45) = Rs. 66.66
Total cost per piece = Die development cost + Material Cost
= 66.66 + 50.00
= 116.66 (Say Rs.117/-)
So Net Saving = 550 – 117
= Rs. 433/-
Percentage saving in cost = 78.72 %

V. COMBINED RESULT OF SUGGESTED MODIFICATION

Sr. No.	Component Name	Present Cost in Rs.	Modified cost in Rs.	Net Saving in Rs.	% Cost reduction
1.	Dial Bracket	9000	8100	900	10
2.	Top Bearing Bracket Assembly	7500	6050	1450	19.33
3.	Hand Wheel	400	184	216	54
4.	Range Selector Knob	300	125	175	58.33
5.	Recorder Gears				
	Gear A	320	39	281	87.81
	Gear B	520	100	420	80.76
	Pinion	550	117	433	78.72
	Total	18590	14715	3875	20.84

Table No.2

VI. GRAPHICAL REPRESENTATION OF PRESENT AND SUGGESTED MODIFICATION



Graph No.1

VII. CONCLUSION AND FUTURE SCOPE

In the present case study it is observed that the unnecessary increase in cost is due to use of expensive material, complicated design, increase in variety of hardware items and thereby increasing the inventory. Value Engineering is executed in this case study by implementing design modifications and change in materials of components. From the results of the execution of value engineering to the selected components of Universal Testing Machine, we conclude as follows,

- The design modification suggested for Dial Bracket and Top Bearing Bracket Assembly reduces the weight and material requirements which reduces the cost and is clear from Table No.2
- Value Engineering results in use of alternative less expensive and light material. The Recorder Gears, Range Selector Knob and Hand Wheel of brass, cast iron are replaced by Nylon. This results in reduction in weight and cost of component which is clear from Table No.2
- From Table No.2 it is clear that Execution of Value Engineering technique to selected five components only results in net saving of 20.84 %.

Value Engineering is executed in this case study only for five selected component and substantial reduction in cost is achieved. In the similar manner secondary analysis for the remaining components can be made and further cost reduction can be achieved. Also Value Engineering results in the elimination of unnecessary cost by avoiding the unwanted machining of components and minimizing variety of different hardware items which reduces the inventory of hardware and also of the required tools for operation.

The development of additional testing attachments to the existing UTM increases its use value with the addition of some cost.

REFERENCES

[1] Dr. Habil. Ferenc Nádasdi , CVS, Ph.D., FSAVE, College of Dunaújváros Hungary, Dunaújváros, Táncsics M. u. 1/a., "Can Value Added Strategies Enhance the Competitiveness Of Products**?"**

[2] John b. sankey, "The Use of Design Charettes to Enhance the Practice of Value Engineering"

[3] Amit Sharma1, Harshit Srivastava1, ME Research Scholar, PEC University of Technology, Chandigarh (India), "A Case Study Analysis through The Implementation Of Value Engineering."

[4] L.D. Miles "Techniques and Approaches of Value Engineering," A Reference Book.

[5] Don J. Gerhardt, Ingersoll Rand, 800-E, Beaty street, Davison, NC, 28036, "Managing Value Engineering in New Product Development."

[6] P. F. THEW, "Value Engineering in the Electronic Industry"

[7] James D. Bolton, "Utilization of TRIZ with DFMA to Maximize Value."

[8] Fang-Lin CHAO, Chien-Ming SHIEH and Chi-Chang LAI, "Value Engineering in Product Renovation"
[9] Habibollah Najafi, Amir Abbas Yazdani, Hosseinali Nahavandi, "Value Engineering and Its Effect in Reduction of Industrial Organization Energy Expenses"
[10] Dr. Diego Masera, "Eco-design a Key Factor for Micro and Small Enterprise Development"
[11] Hisaya Yokota, "Why Problems Cannot Be Solved and Why VE Is Effective?"
[12] Jin Wang, Lufang Zhang, Xiaojian Liu, College of Art, Zhejiang University of Technology Hangzhou, Zhejiang Province 310032, China, 978-1-4244-5268-2/09/$25.00 ©2009 IEEE, "Material Application and Innovation in Furniture Design."

Short Biography:

Chougule M.A. (Ph.D. Scholar in Mechanical Engg.), Principal, A.G. Patil Polytechnic Institute, Solapur, (India), Date of Birth: 20th April 1965, E-mail: chougulema@yahoo.co.in, Teaching Experience: 24 Yrs., Industrial Experience:2 Yrs.