

Value Engineering an Effective tool for Failure Analysis-A Case Study

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ABSTRACT

What has been stated implies that even in very advanced and competent companies, unnecessary costs are being generated. Further, that if we are to remedy this condition we must make a different approach in which both the functions and their costs are considered together to provide an overall improvement in value with benefits to both the user and the supplier of the product. In value engineering practice, areas of poor value are identified by analysis and studied at a very early stage in the design cycle, and at various stages right through manufacture to distribution and operation. At each stage the overall effect of any change is considered.

INTRODUCTION

What is VALUE? Basically, it is a form of measurement which most people use every day when they are spending their own money. For most things we buy, we make comparisons between alternatives and relate what we get to what we pay. What we get embodies FUNCTIONS which can be specified in terms of technical performance, reliability, life, appearance, maintainability, safety, weight, etc. Value is measured by the relationship of these functions to the cost of providing them.

Value engineering does not question the manufacturing methods, although these are ultimately considered. Instead it questions

the concept- the means by which the necessary functions are performed. For example not "how do we best machine a radius" but "what is the function of the radius". In different ways it asks these basic questions:-

What is it?

What does it do?

What does it cost?

What else will do the job?

What will that cost?

To illustrate this difference in approach case study can be explained, Leaving to one side the organization and direction of the overall value programme, which is explained in subsequent sections, the elements of value engineering can be adequately explained under six headings.

- STEP1: Selection
- STEP2: Information
- STEP3: Analysis
- STEP4: Teamwork
- STEP5: Implementation
- STEP6: Attitudes

Methodology-Assisted with Automobile Case Study

• STEP1 (SELECTION):

Value engineering need not be applied to everything. Products, assemblies, Components and systems selected for study should result

from a careful analysis of the costs, quantities produced, future sales life and technical complexity. The areas selected are those which should yield the greatest results for the suitable least time and effort and with

the minimum risk. Rear Axle Carrier is selected for value engineering Analysis to reduce failure as shown in fig 1,

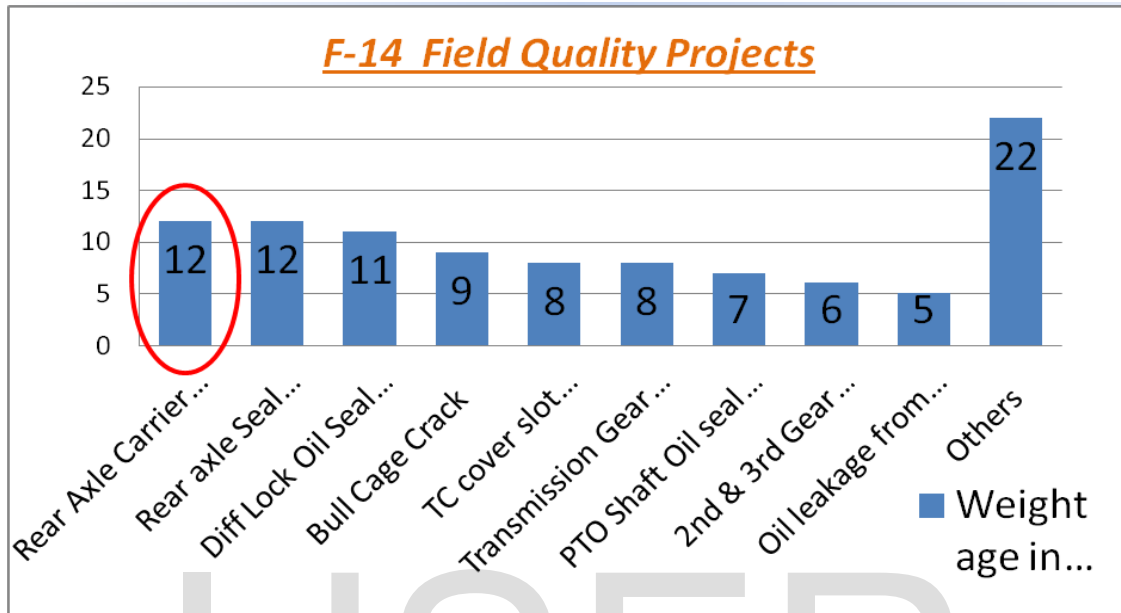


Figure1. Rear Axle carrier failure on wetland X- tractors

• **STEP2 (INFORMATION)**

Difficulty is experienced in most companies in collecting adequate information on the subjects to be studied. Information is, of course, an essential ingredient and time must be allowed for the relevant costs, specifications and requirements to be collected, analyzed and prepared ready for the use of the designer or team. This is usually the task of a skilled value engineer or co-coordinator, who is frequently the only full-time person involved.

In this phase the scope of the study is established and the necessary costs and other information are collected, analyzed and prepared by the co- coordinator, often in conjunction with the engineer or designer. It is also during this phase that the necessary functions are described and the areas of high

cost or poor value identified by cost analysis and function/cost analysis techniques.

Wet Land models are largest selling tractor models in domestic market for X-Tractors (80%). These models are designed to cater specifically for south region market requirements in India for various applications.(E.g. Puddling, Reverse ploughing).But also, Tractor facing field failure problems in the Rear Axle Carriers used in these models. As this is a structural part, any failure causes a good amount of financial loss, productive time loss to customer (Farmer). Also as a X- Brand Tractors are facing stiff cost pressure from competition in the market so product cost has also become big concern for business growth & sustaining position in the dynamic market. Rear axle location is shown in **fig.2** as below also **fig.3** explains failure in rear axle.

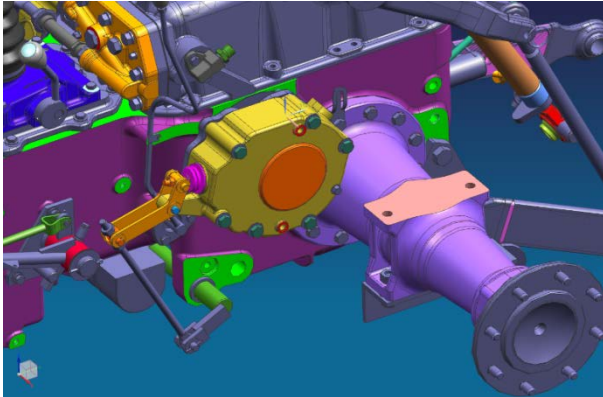


Figure 2. Location of Rear Axle Carrier on Tractor

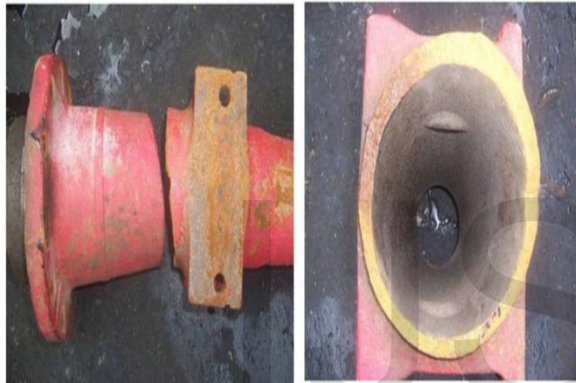


Figure 3. Failure Photographs of Rear Axle Carrier

• **STEP3(ANALYSIS)**

The analysis of information takes two basic forms in value engineering: Cost Analysis and Functional Analysis. These two forms are used extensively either separately or in combination (Function/Cost Analysis) to select items for study, and during the course of the studies, to indicate significant cost areas in the product or assembly.

COST ANALYSIS is the most usual preliminary to selecting and fixing the scope of a study. The individual costs of the component parts of the subject are tabulated to an appropriate degree of detail. From such an analysis of an assembly or system the areas or individual items which appear to be

of disproportionate cost and offer potential for study and improvement, can be selected. Functional Analysis requires accurate definition of the functions performed by the subject under investigation. Properly to understand the subject, the definition of functions must be lucid and precise. So for this reason it is considered desirable to describe a function by two words, a verb and a noun. For example, a pencil "makes mark" or a bolt may "join parts".

FUNCTION/COST ANALYSIS is one of the most potent weapons in value engineering's armory. It is particularly valuable in the study of complex subjects as an aid to the designer and quite separately as a means of Poor value is locating areas of poor value in the overheads sector and in some indicated administrative procedures. by analysis Functional cost analysis requires proper training and practice, but it can briefly be explained as follows:- Each part of a system may contribute to more than one function, or looked at another way, each function will have a number of parts contributing to its cost. For given case study functional analysis is required to reduce failure, possible causes which helps to identify failure are as mentioned below,

Possible Causes:

- 1) Material Specification Not Ok
- 2) Hardness not proper
- 3) Microstructure of material not ok
- 4) Improper loading
- 5) Assembly not ok
- 6) Radial clearance in assembly
- 7) Wall thickness not ok
- 8) Insufficient Design strength

• **STEP4 (TEAMWORK)**

The element of teamwork in value engineering is not intended as a Substitute for individual skills. However, there are

clearly many occasions when the requirements and knowledge of different disciplines should be considered in parallel at an early stage in the design or re-design. A team may be used formally and meet at regular intervals, as is often the case when examining existing products, or less formally and as circumstances demand when controlling the cost of a new scheme or product. The effectiveness of value engineering teamwork results from using the people combining who are normally concerned with the product and concentrating their skills collective abilities and experience in a free but orderly manner on the selected improves problem and its information. The composition of a typical team engaged on a results new engineering design project might be:-

- Research/Development Engineer.
- Design Engineer. Team
- Production/Methods Engineer.
- Cost Estimator.
- Value Engineering Co-ordinator.

Marketing, Finance, Purchasing, Quality Control, Service and other specialists might be opted as required to deal with specific problems, as may be a customer or supplier. It should also be said that a team member who knows little or nothing of the product but is a creative person can be an advantage to the team. The composition of each team will differ according to the nature of the project under study. The members should be of sufficient seniority to be able to speak authoritatively for their respective departments and see that any actions Agreed to are carried out. They will not be engaged full time on the project, but will integrate the work with their normal duties. They would be responsible for making investigations between meetings, of any points arising which affect their specialist fields. It is probable that most organizations will appoint a value engineer or a small group to manage and co-ordinate the various value activities. The coordinator is a very

important member of each team. He will be responsible for guiding and organizing the work of the team, for collecting and analyzing information, running some meetings, progressing the work allocated to team members and Maintaining proper controls and records. It is his job to see that results are achieved. One Italian company calls him an "Animator"!

Different Teams Involved:

Based on study of failed parts and team discussion with experts, following probable causes in different manufacturing team identified.

- 1) Wall thickness less (quality Team)
- 2) Material Specification not Ok (Material Team)
- 3) Insufficient Design Strength (Design Team)

• STEP5 (IMPLEMENTATION)

This step will depend on the nature of the proposal. In the case of an existing product, assembly or component, the value engineering coordinator will progress the introduction of the idea through normal Channels and, if necessary, arrange for further team meetings to deal with any problems which arise. For new products, the designer or draughtsman will be responsible for incorporating the changes into the new design in the normal way. In given case study probable causes got studied and based on that study hypothesis implemented for the given area, these hypothesis are explained below.

Testing of Hypothesis:

During the testing of the hypothesis - for some probable causes, simulation tests were conducted and for others, in-process audits were conducted.

Probable Cause 1: Wall Thickness

Less

Design specifications of the Wall thickness is shown in table 1

Table 1. Wall thickness Design Data

SR No.	Part No	Section Length (mm)	Wall Thk Actual (mm)	
			Min	Max
1	A	150	8.7	14.3
2	B	165	8.9	12
3	C	160	9	13
4	D	160	8.7	14.8
5	E	160	9.5	14.5
6	F	150	9.8	13.5

Thickness on drawing 9.7 +/- 1.25

Wall Thickness found Ok as per drawing specification. Hence failure could not be due to less wall Thickness.

Hypothesis is invalid

When all ideas have been recorded, each is reviewed in turn and briefly explained. An assessment of the relative cost of each is made on the assumption, at this stage, that the idea is practicable. Other factors, such as weight, reliability, proximity to patent, are sometimes included in this first part of the evaluation, but cost is mostly used. The purpose of this preliminary cost rating is to establish the sequence by which the various ideas are to be studied by the team in their effort to find the lowest cost means which will perform the required functions satisfactorily.

The team then makes a systematic assessment of the overall advantages and disadvantages of each low cost idea.

Attempts are made to overcome or minimize the disadvantages and any action to do this is recorded. Having taken cost and function into consideration, the lower cost solutions which are best from all point of view, are selected for further development.

During training, team members are made aware of the disadvantages of knowing that "something cannot be done", also that ideas are not the privilege of any particular group or skill. The team then makes a systematic assessment of the overall advantages and disadvantages of each low cost idea The outcome in terms of performance and cost will be prepared and circulated if necessary

Probable Cause 2: Material Specification not Ok

Material Specifications checked in Laboratory as shown in table 2.

Table 2 Material Specification

Level of Users	Remarks
Level 1	Rear Axle Carrier (Casting)
Level 2	Microstructure Gray cast iron structure predominantly pearlite-ferrite 30%-35%
Level 3	Ok

The Material specification found OK as per Laboratory report

Hypothesis is invalid

Probable Cause 3: Insufficient Design Strength

CAE analysis is done to validate existing Component design. Fig.4 shows CAE analysis High stresses in zone in which failures were occurring. Thus existing carrier design was incapable to take the loads coming onto carrier.

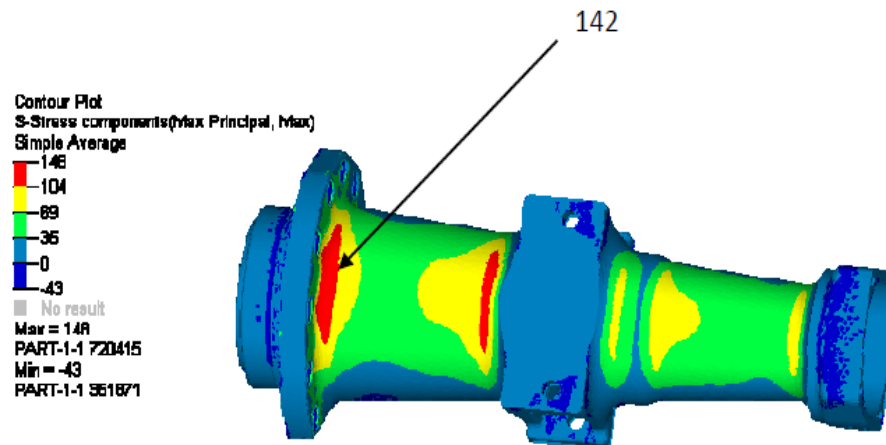


Fig.4 CAE Stress analysis on rear axle of Tractor

Thus Hypothesis is valid

- **STEP6 (ATTITUDES)**

The outcome in terms of performance and cost will be prepared and circulated if necessary. Information collected during the study will be examined with a view to extracting useful cost and other data for future reference. A systematically maintained record of value engineering project data is of great assistance in reducing the work load of future studies, and also for reference purposes by design and estimating departments. Reference has been made to the various causes of unnecessary cost and to the Team fact that these are mainly the result of negative attitudes and fears. One of

training and guidance can bring about at the operating level must be a reflection of similar attitudes from senior management. Result of study shows that different

the work advantages of the team approach and the procedures mentioned above is that engenders it helps to break down many of the fears and inhibitions which prevent so many confidence people from thinking creatively and making their best contribution. The team approach makes everyone feel that they are involved in the business, and by coming into contact (sometimes in larger organizations, for the first time) with people of different skills, experience and point of view, feel that an enrichment of their daily work has taken place. The positive attitudes with proper

principals have to improved for a particular team and studied them in detail, Design of rear Axle should improve properly using these principals. the results for failure of the

axle and also governing design principal when simulated on TRIZ software shown in Table 3. Design team can improve all such principal to reduce failure.

TRIZ Results:

Table 3. TRIZ software results

Item	Results
Parameter to improve	Strength
Undesired results	Weight of Stationary object
Principals to improve	40 Composite materials 14 Shapes 27 Cheap disposable 1 Segmentation

Conclusion

These six elements have been used to briefly illustrate the basic principles or value engineering. There are, of course, many other details which require explanation for those in the actual studies.

These arguments suggest:-

I. That the decisions made prior to production/process planning largely control works cost.

II. That better cost and other information should be provided as a service during the design process.

III. That the cost problem cannot be solved by any one discipline and that Effective corporate team work and communications are necessary for its control.

Clearly, a procedure which will meet these requirements must provide cost information and other facts, must question everything of significant cost and must encourage new

ideas to be put forward and considered in a positive way by all those involved with the product and its cost.

Principals involved in attitudes are explained below as there features are responsible for reduction of failure of rear axle of the shaft.

Principle 40: Composite materials

- Change from uniform to composite (multiple) materials.
- Composite epoxy resin/carbon fibre golf club shafts are lighter, stronger, and more flexible than metal. Same for airplane parts
- Fiberglass surfboards are lighter and more controllable and easier to form into a variety of shapes than wooden ones.

Principle 14: Spheroidality – Curvature

- Change in shape of objects Change in cross section of parts has effect on its strength
- Use arches and domes for strength in architecture.
- Use rollers, balls, spirals, domes.
- Spiral gear (Nautilus) produces continuous resistance for weight lifting.
- Ball point and roller point pens for smooth ink distribution
- Go from linear to rotary motion, use centrifugal forces.
- Produce linear motion of the cursor on the computer screen using a mouse or a trackball.
- Replace wringing clothes to remove water with spinning clothes in a washing machine.
- Use spherical casters instead of cylindrical wheels to move furniture.

Principle 27: Cheap short-living objects

- Replace an inexpensive object with a multiple of inexpensive objects, comprising certain qualities (such as service life, for instance).
- Use disposable paper objects to avoid the cost of cleaning and storing durable objects. Plastic cups in motels, disposable diapers, many kinds of medical supplies.

Principle 1: Segmentation

- Divide an object into independent parts. Replace mainframe computer by personal computers. Replace a large truck by a truck and trailer. Use a work breakdown structure for a large project
- Make an object easy to disassemble Modular furniture, quick disconnect joints in plumbing
- Increase the degree of fragmentation or segmentation Replace solid shades with Venetian blinds Use powdered welding metal instead of foil or rod to get better penetration of the joint

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