

What are the Functions of Function Analysis

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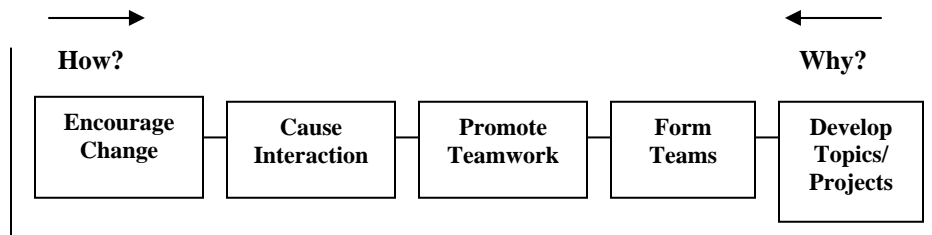
James (Jim) Rains is President of the Advanced Value Group, LLC (AVG). AVG specializes in value engineering (manufacturing, services and construction), competitive tear-down benchmarking and synchronous process improvements (lean manufacturing) in the factory and/or office environment. AVG has extensive expertise in material flow analysis to streamline material handling paths and reduce costs associated with material handling. Training in target costing, which includes Quality Function Deployment and Voice of the Customer is also a part of AVG's long list of services. The services of AVG are performed around the globe. Jim is retired after more than thirty-two years with General Motors. He has served on the SAVE International Board of Directors in several capacities, including President and Chairman. Mr. Rains became a Certified Value Specialist in 1988 and is currently a Life - CVS. He was elected into the SAVE College of Fellows in 2002. He is the Chairman of the Lawrence D. Miles Value Foundation Board of Directors.

Abstract

The heart and soul of value engineering has always been the analysis of function. Lawrence D. Miles the "Father of Value Analysis" stated that, "all the customer wants is function". In the days of Larry Miles, function analysis was part of the Information Phase, however, in recent times the Function Analysis Phase has developed into its own phase of the Value Methodology Job Plan. The purpose of this paper is to explore the reasons for performing function analysis or in other words, "What are the functions of Function Analysis".

This year's conference theme is "SAVE at 50: Celebrating Our Past, Driving Future Value". More than celebrating our past, I am hoping that this paper will better able us to understand our past and what the Value Methodology (VM) is based on. In 2002 my SAVE paper discussed in detail the basic function of the VE practitioner depicted below as "Encourage Change".

The critical path functions described in that paper were:



Many professionals feel that the main purpose or objective of function analysis is to identify the greatest opportunity for value improvement. I agree with this statement. But to me function analysis is the catalyst that promotes or "causes team interaction". This interaction when asked the "Why" question, results in "Encourage Change". Another way of saying this comes from Ted Fowler. Ted prepared a paper that unfortunately he was never able to deliver in full. The title of his paper is "Why Bother With Function Analysis?" Using the thoughts in Ted's paper, he would prefer to replace "Cause Interaction" with "Change Viewpoint". With that in mind I happen to agree with Ted and am now making that replacement. "Cause Interaction" in the full FAST diagram then falls under "Change viewpoint" as a function that happens at the same time as or is caused by "Change viewpoint". In writing this paper the author is assuming that the reader has had some basic exposure to training, practicing and using value engineering.

Description of Function and Function Analysis

The simplest definition of the term function in the value engineering (VE) world is that which a product, process or service must do to make it work and sell. I am not sure of the author of this definition, but I know it has been around for a while, since I first heard this definition in 1980. I am sure the definition gets its roots from the writings of Lawrence D. Miles. Mr. Miles wrote in his book, *Techniques of Value Analysis and Engineering*, that the “customer wants function. He wants something done. He wants something enclosed, held, moved, separated, cleaned, heated, cooled, or whatever under certain conditions and within certain limits; and/or he wants a shape, a color, an aroma, a texture, a sound, a precious material, or whatever to bring pleasure to himself and others. Thus, the language of function is the language of the heart of the problem.” Work functions, or sometimes called use functions, describe how the product works and how it produces use to the customer. Work functions entail some form of action. Aesthetic functions describe the selling features of the product so that it pleases the customer and makes them want to buy the product.

We describe functions, that which a product must do to make it works and sell, in very generic two word connections. The first word is an active verb, and the second word is a measurable noun. Mr. Miles stated, “While the naming of functions may appear simple, the exact opposite is the rule. In fact, naming them articulately is so difficult and requires such precision in thinking that real care must be taken to prevent the abandonment of the task before it is accomplished.” To accomplish this we need to find verb-noun combinations that are abstract and generic in nature. Active verbs describe what is do be done, and measurable nouns describe what the action is being done to. A measurable noun means just that. One must decide the unit of measure for the noun. If none can be determined then a new noun must be created. Once one has a function they should ask three simple questions:

1. Is it exactly what it does for the customer?
2. Is it exactly what the customer wants it to do?
3. Is that exactly what the customer believes he is paying for?

Function analysis is important because it alters the mental path of the user. When we say alter the mental path, we mean that function analysis actually changes the way the user thinks about a particular product. The user no longer thinks about the product and what it is, but rather thinks about what does it do and how else can he do that. This change in mindset is significant.

Steps to Perform Function Analysis

There are four key steps to perform function analysis. The steps are:

1. Random function identification
2. Functional Analysis System Technique or FAST Diagramming
3. Cost to Function Relationships
4. Identify the functions that have the best opportunity to improve value.

Random function identification is the beginning of the function analysis phase. In this step we are doing exactly as the name of this step, we are randomly determining verb-noun combinations that describe the functions of the project under study. For a product design study, I usually have the team list a few functions for the entire product and identify the basic function from this group. Then we explore in detail each component of the Bill of Materials (BOM) and identify the function or functions of each and every part in the BOM. In administrative or in manufacturing process studies you need to start with a detailed description of the process being studied. I like to use a sequence flow chart, but you can also use other forms including value stream mapping. For each step of the process the actual time and elapsed time are important data to work from. In the function analysis phase you take each step of the process and identify all the functions that that step performs. I create the random list for construction projects by taking the detailed cost estimate or the most current cost estimate available. Then by going through each item, just as I do for a product design study the team identifies the functions that each of those costs represent. The random list can become very long, perhaps over 50 functions for even a simple product and much more for complex products. I know too many this seems like a very laborious step of the process and agreed it is. But it is worth it. In Miles’ book and many other texts we can find verb and noun lists that may assist the team in developing the most appropriate and precise functions.

Functional Analysis System Technique or FAST Diagramming takes the function list from above and creates a relationship or what some people call a function logic diagram. Charles Bytheway developed FAST Diagrams in 1964. FAST Diagrams, at first glance, resemble PERT charts or flow charts, but all similarity ends there. FAST Diagrams are FUNCTION-ORIENTED, not time-oriented. They use the functions identified in Step 1 and display them in a “logic format” that deepens understanding of them.

A Technical FAST Diagram has two vertical scope lines, one on the extreme left and one on the extreme right; everything included in the study lies inside them. Therefore, only basic and secondary functions, and design objectives are shown INSIDE them; HIGHER ORDER and ASSUMED FUNCTIONS are shown OUTSIDE them. (Recall: higher order and assumed functions are “givens.”) (The FAST Diagram method noted in this paper is Technical FAST.)

Every FAST Diagram has a CRITICAL PATH crossing horizontally. On this path, running from left to right, lie these functions.

- HIGHER ORDER FUNCTION: Outside the left scope line.
- BASIC FUNCTION: Immediately inside the left scope line.
- SECONDARY REQUIRED FUNCTIONS: Running from the basic function to the right scope line.
- ASSUMED FUNCTION: Outside the right scope line.

On the CRITICAL PATH, the functions are put in order by using a test of HOW/WHY LOGIC, consisting of two questions: HOW?. . . WHY?

- When “HOW?” is asked of any function on the critical path, the answer must be found in the function immediately to the right.

-conversely-

- When “WHY” is asked of any function on the critical path, the answer must be found in the function immediately to the left.

If the order of the function FAILS this two-way test, a function is either MISPLACED or IMPROPERLY DESCRIBED. The template for this FAST diagram is shown in Appendix A.

One of the most important aspects of Function Analysis is the determination of Cost/Function Relationships. It is this technique that identifies where unnecessary cost exists within the study item. Note that not all projects use cost function relationships, however this relationship is the most common. Other projects can be function relationships to time, mass, weight or even a quality metric. Construction relationships to function can be space, profit, revenue, cost per unit of measure or even a LEED metric. The common numerator in all of these relationships is function.

A Cost-Function Worksheet is used to help develop this technique.

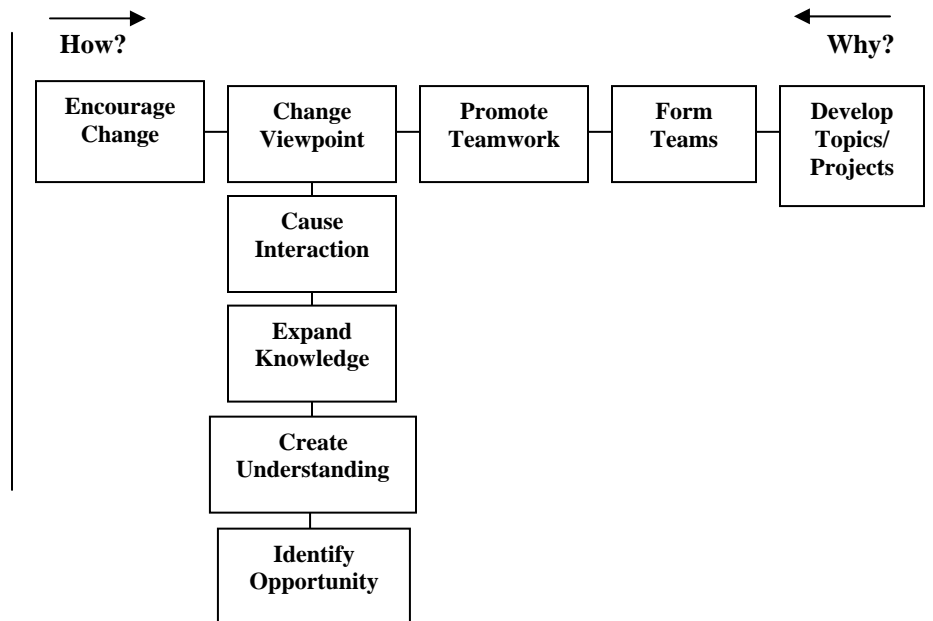
1. Start by listing all functions between the scope lines across the top of the form
2. List the parts or major sub-assemblies down the left-hand side of the form with the associated incremental costs.
3. Check off which function or functions are impacted by each part or sub-assembly.
4. Determine how much of the cost of the part or sub-assembly belongs to each function.
5. Add all columns vertically to determine how much cost is allocated to each function.

Identifying the functions that have the best opportunity to improve value is the final step in the function analysis phase. Per SAVE International, this step is performed by calculating the Value Index. The Value Index is a ratio of function cost to function worth. The function cost was just determined using the Cost-Function Worksheet. Function worth is defined as the lowest cost to perform the function without consequence of failure. In the real world I have found that the formal calculation of the Value Index to be extremely difficult as most companies do not have adequate data to determine the function worth. Thus my method for this segment of the function analysis phase is described later in this paper.

What Are the Functions of Function Analysis?

In my twenty-nine plus years of experience in using value engineering and function analysis I have determined that the best functions that describe function analysis are:

- Expand Knowledge
- Create Understanding
- Identify Opportunity
- Cause Interaction
- Change Viewpoint



So cause interaction, expand knowledge, create understanding and identify opportunity are functions that are caused by or happen at the same time as the function change viewpoint.

Identify opportunity is probably the main reason to perform function analysis. Per SAVE International the objective of the function analysis phase is to identify the functions of the project that have the most opportunity for improvement of value. Remember that value improvement can be a combination of improving function and/or reducing cost. One can also increase function at a greater rate than the increase in cost, to also create a value improvement.

There are a few methods used to determine which functions have the greatest impact on improving value. Basically all methods deal with looking for “value mismatches”, that are that the cost of the function is not approximately equivalent with the value of the function as perceived by the customer. In some situations the cost of the function is too expensive and effort must be made to lower the cost. By contrast in some situations the function performance is inadequate and more cost needs to be added to insure that the function is being performed to meet the expectations of the consumer.

My method is to place all costs from the cost-function worksheet onto the function Post-it notes on the FAST diagram. Then by studying the costs and the placement of those costs on the FAST diagram, along with discussions with the team, we decide together the most appropriate functions to brainstorm in the Creative Phase.

Create understanding happens throughout the function analysis phase. I have had very experienced engineers that have worked on the same project for many years, tell me that after participating in function analysis, they discovered a whole new understanding of the product that they were responsible for. The wonderful aspect of this “new” understanding is that it is a common understanding amongst all team members. When a team works together to create a random function list and a FAST diagram, they created

something as a team. As a team they discussed each aspect of the functions that they created for their product. Thus no matter the technical background of the people participating each person can describe the product in functional terms. Since functional terms are generic and more or less non-technical, a level playing field is created. Also because the entire team participated in creating the function logic diagram there is a buy-in or agreement from all team members of what the project under study does.

Expand knowledge is definitely a function of function analysis as in other phases of the job plan. Everyone on the VE team gains new knowledge on the project that they are working on. The learning takes place through the presentation materials, team discussions and the application of the function analysis process on the project. In the projects that I work on most people are not familiar with functional thinking. Just to learn about functional thinking is a significant learning opportunity for people. This learning gives them a whole new tool that they can continue to use in their business and personal lives. During a workshop a few years ago, I had a lady from the finance department on the team. She had worked for this company for over twelve years. At the end of the workshop she stated, "I learned more about our products in this week, than I have since I started working here." While this particular situation may sound extreme, clearly everyone that fully participates in the VE workshop will gain new knowledge. This knowledge includes but is not limited to advances in the product, both technical and non-technical. The non-technical includes quality issues, cost detail, marketing and sales information, manufacturing and process information and material and supplier information.

Now we get to explore cause interaction. I absolutely love it when I see a team coming together with every team member involved in the function analysis phase. No matter one's background and experience they have a role to play during this process. I have found that the most interesting team interaction occurs at the beginning of the team's effort to create the FAST diagram. As a facilitator, I always tell the team members to get out of their chairs and start to place the Post-it Notes per my lecture on FAST diagrams. Then I sit back and observe their "struggles" to complete the critical path How/Why logic. This interaction continues right on through the remaining of the function analysis phase. It is my opinion that this interaction actually helps create a team, rather than a bunch of people. When this natural team bonding occurs superior results in the remainder phases of the VE job plan also occur. This is by far the greatest intangible benefit of using VE. You may note that on the critical path of functions described above, when we ask the question how do we cause interaction the function to the right is promote teamwork. Now you can see how these two functions go together.

Change Viewpoint

If you believe in my premise that the VM facilitator's main role and basic function is to "Encourage Change", then you must also believe that a change in behavior, attitude and mental thinking must change for that to happen. Otherwise, no change can occur. Human thought patterns must be altered to move into a new direction. We all know that our thought patterns have been developed over a very long period of time, in fact some being formed before we are born. As we continue to grow and learn we become creatures of habit and tend to follow along the same paths, right or wrong. Thus to say that we need to change the viewpoint of a person, we are saying that we are actually trying to alter the way people think and behave. This is very difficult but for successful VM to result, it must occur in the minds of the team members. This is why the entire critical path functions mentioned at the beginning of this paper are important and critically linked together.

Time to Perform Function Analysis

I feel compelled to discuss the time required to perform a proper function analysis. Personally I do not believe in a one or two day workshop. I will do a three day workshop, but only if the team has had a lengthy pre-workshop meeting and that I also feel that the scope of the project has a reasonable chance of being covered in this time period. Over 95 percent of my workshops are at least four days. While working for General Motors we experimented with 2 day workshops. Even with all team members having previous VE experience we found that the results suffered. One of our metrics was savings per team. When our graph depicting that metric showed a negative trend, we discontinued the two day workshop and simply refused to do any workshop less than 3 days. Based on my experience it takes on the average of six to eight hours to complete the function analysis phase.

To quote Ted Fowler: “Essential to the success of the Value Analysis function-based creative-problem-solving system is what has been called the **CHANGE OF VIEWPOINT**. This occurs when the Value Analysis team member considers the function not the part or process which performs the function. The change involves a dramatic broadening of the mental “scenery” of the problem solver. In a properly structured study, the mental images have few boundaries. Much has been written on the advantages of this “functional approach” which broadens the viewpoint of the team members, in turn resulting in far broader range of practical alternatives. This “focus on function” approach was the heart of the original Miles system as illustrated by the following quotation from him; “In search for, and selection of alternatives, attention must be constantly focused on function and not on a material, part, or device as such.”

Summary

We must remember that the function analysis phase is the heart and soul of value engineering. In fact, if we do not do function analysis it is simply not VE. Care and patience must be utilized to properly perform function analysis. Certainly an experienced VE professional with excellent facilitation skills will aid in the proper application of function analysis.

Again to quote Ted Fowler; “Did the definition of FUNCTION change your VIEWPOINT?” Every facilitator needs to remind every team member of this and insure that it happens.

So when we look at the logic path written in the abstract we see that the reason to “change viewpoint” is to “encourage change”. Change must occur to “get positive results”.

References:

Techniques of Value Analysis and Engineering; Lawrence D. Miles, 3rd Edition, Copyright 1989, Miles Value Foundation, p. 25 – 27

“Why Bother With Function Analysis”, Theodore C. Fowler, not formally published

Appendix A
VERB – NOUN LISTING: PRODUCTS

This is only a partial list of verbs and nouns that may be used in describing the functions of a product. The verb describes the action and the noun defines the object of that action. Searching for the most descriptive noun can be difficult and time consuming.

VERBS

NOUNS

| | | | |
|---------------------|------------------|--------------------|--------------------|
| ABSORB | GENERATE | ACCESS | FRICTION |
| ACCESS | GUIDE | AIR | HEAT |
| ACTUATE | IMPROVE | APPEARANCE | IMPACT |
| ALLOW * | INCREASE | BENDING | LIGHT |
| APPLY | ISOLATE | CIRCUIT | MASS |
| ATTACH | LIMIT | CLIMATE | MATERIAL |
| ATTRACT | MAINTAIN | COLD | MOISTURE |
| CIRCULATE | PIVOT | COMFORT | MOTION |
| CONDUCT | POSITION | COMPONENT | NOISE |
| CONNECT | PREVENT | CORROSION | OCCUPANT |
| CONTAIN | PROTECT | CURRENT | PARTS |
| CONTROL | PROVIDE * | DEFLECTION | PATH |
| CONVERT | REDUCE | DIRT | PERFORMANCE |
| CREATE | REGULATE | DRAG | PRESSURE |
| DECREASE | RESIST | ENERGY | STABILITY |
| DIRECT | ROTATE | ENTRY | SURFACE |
| ENCLOSE | SEAL | ENVIRONMENT | TORQUE |
| ENHANCE | SENSE | FLOW | TRAVEL |
| EXTEND | SUPPORT | FLUID | VIBRATION |
| FACILITATE * | TRANSMIT | FORCE | WEIGHT |

We need to avoid using these verbs. Allow, facilitate and provide are what we call passive verbs.

One should also try to avoid using verbs that end with “ize”. If a passive description of a function is suspected, or you need to define a function more actively, then the “rule of thumb” is to transfer the noun you used to the verb and select another noun. For example: “provide support” becomes “support weight”.

TECHNICAL F.A.S.T DIAGRAM

GROUND RULES

