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HOW ROOT CAUSE ANALYSIS CAN IMPROVE THE VALUE METHODOLOGY

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ABSTRACT

Root cause analysis (RCA) is an important methodology that can be integrated with the VE Job Plan to generate superior results from the VE Methodology. The point at which RCA is most appropriate is after the function analysis and FAST Model have been built and functions for improvement have been chosen. These functions are then subjected to a simple, but, rigorous RCA to get to the root cause of their deficiencies, whether it is high cost/poor value, poor quality, or poor reliability. Once the most probable causes for these problems have been arrived at, better solutions for improvement can be developed in the creativity phase because the team better understands the problems associated with these functions.

INTRODUCTION

John Dewey once said, "A problem well-defined is half solved."[1]

Root cause analysis is any methodology that enables a person to identify less than adequate elements in the control of a system or the performance of a product, process, or service. The definition of a basic function is "the principle reason for the existence of a 'thing'. " Or, another definition is "that function which makes a product, process, or service 'work or sell'."[2] Therefore, if a product or system has failed, then its basic function has failed. Likewise, if there are quality or reliability problems, then identifying the root cause of these problems is paramount to successful and lasting resolution of the problems. The Greek orator, Demosthenes (384 - 322 BC) characterised the root cause of a problem by stating that "Not solving the root cause of the problem is like putting an amateur in the boxing ring…if he is hit, his hands go where it hurts, and his opponent will hit him somewhere else."[3] Value Management is an "intense inter-disciplinary problem solving activity." A well applied root cause methodology will greatly enhance any Value Management effort focused on improving the quality, performance or reliability of and existing product, process or service by generating better understanding of the associated problems and their root cause(s).

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OVERVIEW

Root Cause Analysis results in significant improvements to quality and reliability by focusing the teams attention on the most likely functions that could contribute to these problems, and the most likely causes contributing to poor performance, quality or reliability. Then, the team develops ways to fix these potential causes or ways to fix the problems that have occurred and means to prevent their reoccurrence. It capitalizes on the structured VE job plan to first clearly define the problem in the information phase, and identify the system's basic function(s) and the critical functions required to support the basic function. If a product, process or system is experiencing problems with quality, reliability, or failures, then its basic function has failed. This is where Value Management can be a valuable methodology for solving such problems. This methodology also capitalizes on the very nature of Value Management, as it is an "intense inter-disciplinary problem solving activity."

There are a few minor modifications to the job plan that occur primarily in the Information Phase. These modifications are structured toward determining the root-cause of the problems by isolating the functions that have contributed to the problems, and identifying potential problems that could lead to the problems in these functions. Then, most likely causes of these problems are developed that explain how the potential problems could occur. This adds an additional level of brainstorming and evaluation to the job plan in the information phase geared toward identifying the most likely causes, and root-cause(s) of problems.

EXAMPLE

One excellent example that I have been associated with in which these methodology was tried was a problem that came up when I was working with E-Systems, Inc. (now Moog, Inc.) in Salt Lake

City, Utah.[4] These elevator feel computers were designed and manufactured for the Boeing 737/757 aircraft. This sophisticated electro-hydraulic control module produces a variable hydraulic pressure used to produce resistance, or artificial "feel" in the pitch axis control system that the pilot commands or "steers" the pitch of the aircraft with. Without this very important component, the pilot could not tell how much pitch he was applying to the aircraft and he would be unable to control it.

The problem that developed during final test of the assembly was a serious oscillation in the computer valve. This was a very expensive problem to fix since the feel computers are fully assembled by the time they reach final test. Fixing this problem requires disassembling the feel computer and replacing the offending valve just to find that the next valve might be defective.

In this example the value management team quickly isolated the problem by focusing on the basic function of the valve which was "control pressure." Answering the question, "How does the computer valve 'control pressure'" led to more functions. These functions were then ranked by their level of importance as to how they might be contributing to the problems which was exhibited as oscillation in the valve. Subsequent brainstorming and ranking of the answers as to the **most likely cause** of these problems narrowed the problem down to a small orifice produced by electrical discharge machining (EDM) through the wall of the valve. This hole was responsible for allowing hydraulic fluid to flow from one side of the valve to the other upon a signal from the computer, resulting in a change in direction of the valve stem. The edge of this hole, called the "metering edge" was .0002 in. thick and needed to be very smooth to accommodate a laminar flow through the orifice. Otherwise, the hydraulic fluid would experience cavitation as it flowed over the metering edge of the orifice resulting in the telltale oscillation that had been experienced in the final test of the feel computer.

Once the problem had been isolated to this jagged metering edge, which could not be seen with the current inspection equipment, brainstorming could begin on why this problem existed and how it could be prevented from happening again. **The most likely cause of why the metering edge was not smooth was established to be that the EDM wire was breaking through the hole instead of burning a smooth edge.** This would cause a rough metering edge.

From this information, the team brainstormed potential fixes to the problem. This brainstorming occurred in the traditional manner and numerous good ideas surfaced. These ideas were grouped into categories that included design changes, process changes, training and operator aids, and new inspection equipment.

METHODOLOGY

Experimentation with this approach to problem solving has lead to several key modifications to the VE job plan, primarily in the Information Phase that enhance the over all results of any VE, or Value Management study. Once a FAST model has been constructed to describe the system, various methods can be employed to identify the functions that require improvement. Note that improvement can be in any dimension including cost, quality, reliability or performance. Ranking of the functions that require improvement occurs next. Information on the performance of the functions can be gathered before the workshop, or, captured during the information phase.

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One example I am currently involved with is a project dealing with how to improve quality performance at the INEEL. Here, information on deficiencies has been captured in a company wide database. A FAST model has been constructed and the functions have been mapped to a representative sample of these deficiencies. (Note: A deficiency may have more than one function mapped to it.) A Pareto analysis, ranking the functions according to the number of "hits" each receives. This technique then yields a prioritized list of functions that need to be improved. The team then will concentrate on the 20% of the functions that represent 80% of the "hits" resulting from each deficiency. The next step in this process is to identify potential causes as to why these functions are not functioning properly. Gathering of human factors information, interviews with employees involved, and review of circumstances surrounding the initial deficiencies will be explored. Then, this information will be linked back to the functions and brainstorming improvements will take place and alternatives developed that will lead to improvements to quality performance.

Alternatively, if data such as this doesn't exist, information can be obtained from the experts on the team as to what functions are experiencing the problems, and why these problems might be happening. Then, scoring the functions as to their contribution to the observed problem(s) can take place. Then, the functions can be ranked according to their score. This brings us to the point of brainstorming creative solutions to fix the performance of these functions.

IDENTIFYING IMPROVEMENTS

Once function analysis and FAST Modelling of the problem have occurred, functions requiring improvement are identified as described above. In this example, the FAST model of a process

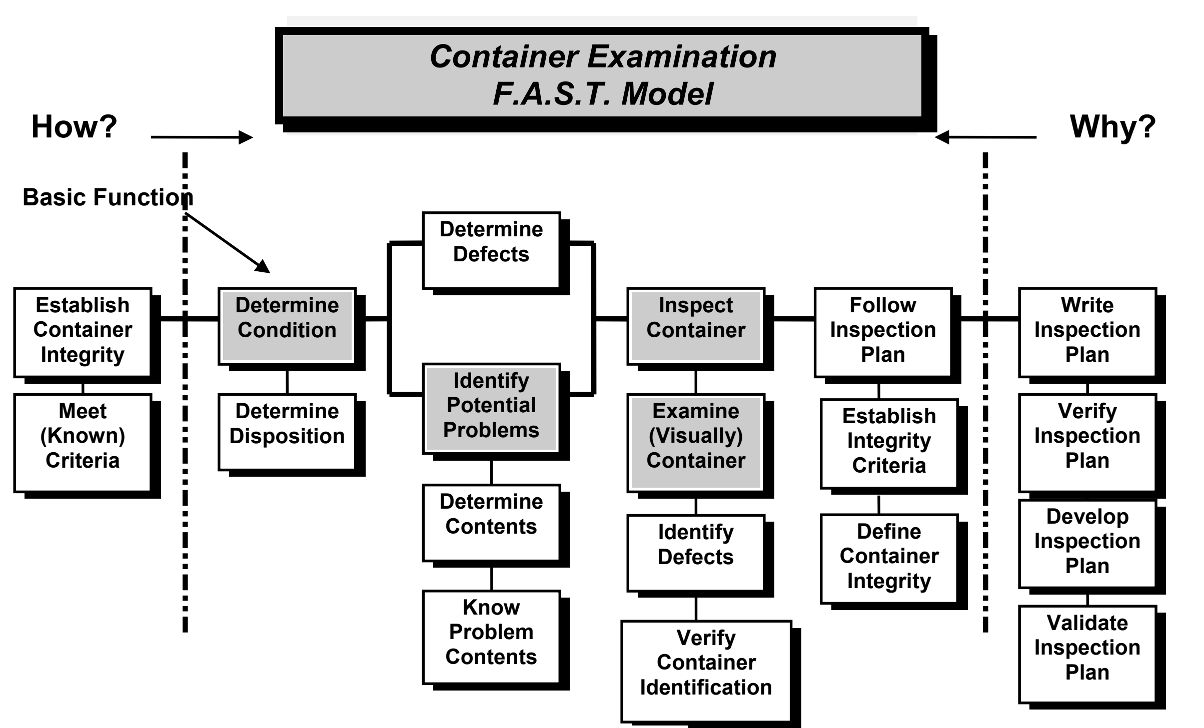

Figure 1

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called "Container Examination" (figure 1) is used for illustration. The basic function “determine condition” is chosen to illustrate how a simple root cause analysis process is applied to develop solutions to improving the performance of this function. Figure 1 illustrates the FAST Model a team developed to isolate the functions that were contributing to the inadequacies of an inspection process. The shaded functions were those determined by the team contributing to the less than adequate performance of the basic function.

By brainstorming ideas as to what problems might occur with the function "Determine Condition", and their most likely causes, the team developed a prioritized list of most likely causes of the problems. This list formed the basis for brainstorming ideas of how to improve the basic function. Over 80 ideas for improvement were identified using this process which fell into categories of both short-term and long-term recommendations.

Figure 2 illustrates the brainstorming and scoring of “Potential problems that can occur with **‘Determine Condition’**’, the basic function.

Problems scoring higher than 6 were evaluated in the next step of this process where these problems were grouped into categories. Then, asking the question, “what could cause these problems to occur?” lead to the basis for the most likely causes of the problems. In this example, the most likely causes of the problems are shown in figure 3. Note the problems are listed in bold print and the possible causes are listed below each problem.

The most likely causes formed the basis for brainstorming improvements to the process. This is a departure from root cause analysis where one is trying to identify the primary cause of failure. However, I have found identification of the most likely causes of problems with the functions focuses the team’s attention on the most needed improvements.

This process greatly facilitates, and focuses the brainstorming effort. It could be pursued for each of the functions identified as needing improvement. However, as in this case, if time is limited performing the process on the basic function may be adequate. The brainstorming process in this case netted 83 ideas that were highly focused toward improving the basic function “**determine condition**.” Evaluation in the form of rating and eliminating the lower scoring ideas was performed. Then, the remaining ideas were fit into 8 different categories. Both short-term and long-term recommendations were identified which will significantly improve the drum examination and inspection process.

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Problems that can occur with "Determine Condition"

Potential Problem	Score
~~Incorrect Container ID~~	~~1~~
~~Incorrect Contents~~	~~5~~
~~Inaccurate Determination~~	
~~Deterioration After Inspection/Damage After Inspection~~	~~2~~
Inadequate Procedures	**10**
Inadequate Equipment	9
~~False Positive Reading for Excessive Thinning~~	
Inadequate Training	**10**
[Poor] Human Factors [Interface] - Ability to see contents, position container, etc.	7
~~Environmental Conditions (Degradation after inspection)~~	~~2~~
Management Pressure to Perform	6
~~Inadequate Quality Checks~~	~~2~~
Inadequate Inspection Criteria	**10+**
Subjective Inspection Criteria	9
Poor Container Condition hampers inspection	7
Time - Availability - 5 min./drum, 1 min. for inspection	6
Poor Weather/Environmental Conditions - Human Factors	8
Work Station Too Cold/Hot (Not Heated/Cooled)	8
Time of Day	8
Time of Week	8
Time of Month (Beginning/End)	8
Overtime/Schedule (4 - 10s)	8
~~Conflicting Requirements~~	~~2~~
Poor Inspection Process	8
Poor Data	5

Figure 2

MOST LIKELY CAUSES

- **Inadequate Procedures**
  - Results Not Tested/Verified
  - Writer of Procedure is not familiar with process
  - Vague Text
- **Inadequate Training**
  - Trainers have not had direct experience with the inspection process.
  - Inadequate Training Materials:
    - ⇒ Poor Illustrations
    - ⇒ Field Examples Poor
    - ⇒ Materials not definitive enough
  - Little, or no, actual training performed
  - Go/No-Go criteria is not clearly defined to operators.
- **Inadequate Inspection Criteria**
  - Too vague
  - Driven by Management Goals
  - Unclear goals and objectives available for development of criteria.
  - Too little quantitative measures and performance parameters.
  - Condition could not be assessed.
  - No measurement of wall thickness...**etc**.
  - Internal Blistered paint was [illegible] considered a problem

Figure 3

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SUMMARY AND CONCLUSIONS

Root Cause Analysis combined with function analysis and the Value Management methodology is a powerful tool for resolving system failures and designing improvements in performance of any process, product, service or organization.. Its application results in significant improvements to quality and reliability by focusing the team's attention on the functions that are contributing most to the problems, and the most likely causes of these problems. Then, the team develops ways to improve these root causes of the problems, and ways to fix the problems that have occurred along with means to prevent their reoccurrence.

The process capitalizes on the structured VE job plan to first clearly define the problem in the information phase, and identify the system's basic function(s) and the critical functions required to support the basic function. There are some additional steps added to the information phase designed to identify the problem functions and identify the most likely causes of these problems with the basic function and selected supporting functions. However, the time to perform this analysis is time well spent as this approach facilitates the brainstorming of superior ideas for improvement in the creativity phase. This is because the team has fully analyzed the most likely causes of the problems with the functions this into superior ideas for improvement.

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1. Kaufman, J. Jerry, CVS-Life., *Value Engineering for the Practitioner* (Third edition), North Carolina State University, 1990, p.7,

2. Ibid, p.7,

3. Demonthenes, Greek Orator, first *Philippics* warning against aggression by Philip, 351 BC.

4. Wixson, James R., CVS-Life., *Value Managed Failure Analysis, 1997 SAVE Proceedings*, Seattle, WA, May 1997, p.276 - 283,

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