Function Analysis for Team Problem Solving

Tom Warwick, CVS
Vice President NT Associates
Jupiter, Florida

This document was presented at the 1994 International Conference of the Society of American Value Engineers (SAVE) in New Orleans, LA. It was published in the SAVE Annual Proceedings and is copyrighted (©SAVE, 1994), Permission to upload this document to the LEAP Forum Library has been given by SAVE.
Theodore C. Fowler, CVS, Fellow, SAVE

Tom Warwick, author of many technical papers and recognized for several patents, has directed value studies, seminars and workshops saving hundreds of millions of dollars. He has graduate degrees in engineering from RPI and the University of Florida. Before joining NT, he served as value manager and in other senior positions at Pratt & Whitney.

ABSTRACT

This paper presents an early up-front demonstration of function analysis for team problem solving. It presents a problem solving exercise with three function analysis examples to show that The Way to conduct function analysis is really many ways. This paper is a sequel to a 1993 SAVE Proceedings paper, "Value Assessment of Team Problem Solving."

INTRODUCTION

Function analysis is the principle means for individuals and teams to achieve extraordinary problem solving, outstanding outcomes with superior value.

Function analysis provides a multi-dimensional structure to study, both separately and together, partially or completely, numerous existing and alternative value solutions at many different levels of abstraction.

Most problems have many solutions, so many that they can overwhelm us. The analysis of function, top-down or bottom-up or both, is a systematic disciplined means to better address these many solutions. When function analysis is inadequately performed or is not performed at all, quite often symptoms are solved rather than root causes, real requirements and expectations.

The systematic disciplined analysis of function differentiates Value Engineering (VE) from other problem solving methods. Function analysis understanding and use can be difficult for both VE practitioners and participants.

Before working VE projects, function analysis training and education are essential. Early instruction during the beginning hours of a study, seminar or workshop allows VE practitioners and participants to obviate function analysis difficulties that occur while working live projects.

EXERCISE

A brief introduction of function analysis with a VE study job plan is presented before value program participants perform an up front "ice breaker" problem solving exercise. Because exercise problem solving is similar to live project problem solving, exercise problem solving helps value practitioners to really know and positively respond to individual and team weaknesses and strengths.

For example, not infrequently the exercise approach taken to problem solving by value program participants lacks a needed and thorough function analysis. Problem solving performed under real world conditions sometimes skips VE study job plan steps needed to first analyze, brainstorm and evaluate project functions. The result invariably is a less than satisfactory low value outcome.

Exercise problem solving excites and motivates value program participants. As will be shown, it also can and should be applied to improve individual and team knowledge and use of function analysis.

"Lost at Sea"

With your private yacht slowly sinking after a fire of unknown origin, you are adrift in the South Pacific, "Lost at Sea," approximately 1000 miles south-southwest from the nearest land. You have a serviceable rubber life raft with oars large enough for yourself and crew.

You and crew together have 1 package of cigarettes, several books of matches and 5 one dollar bills. You all also have 15 additional items. The exercise problem to be solved is to rank these 15 additional items by considering their survival value.

Lost at Sea
Survival Items to be Ranked

- Sextant
- Five-gallon can of water
- Maps of the Pacific Ocean
- Small transitor radio receiver
- Shark repellent
- Fifteen feet of nylon rope
- One quart of 160-proof rum
- Shaving mirror
- Mosquito netting
- One case of U.S. Army C rations
- Two-gallon can of oil-gas mixture
- Twenty square feet of opaque plastic
- Two boxes of chocolate bars
- Fishing kit
- Seat cushion (Coast Guard approved flotation device)

Figure 2

Similar Exercises

Other similar problem solving exercises nearly identical to the "Lost at Sea" exercise are available but only the "Lost at Sea" problem solving exercise is presented here.

The other similar problem solving survival exercises, such as "Lost on the Moon," are interchangeable with the "Lost at Sea" exercise. They all require correct ranking of the 15 survival items, performed first by team members as individuals, and then again by team members working together to reach a consensus, a genuine accord by all team members.

Early Up-Front Instruction Essential

As previously mentioned, not infrequently the approach taken by problem solving participants lacks a needed and thorough function analysis. The "Lost at Sea" exercise demonstrates this difficulty early up-front before live projects are worked.

Rather than first determining function and value, VE participants invariably rank the 15 survival items immediately, not withstanding that an instruction review of function analysis and the VE study job plan are given just before starting the "Lost at Sea" exercise. That is, participants skip both function analysis and job plan steps, when problem solving as individuals as well as when problem solving together as team members.

Many new and some veteran value program participants simply do not perform problem solving exercises in a systematic disciplined manner and do not conduct a thorough function analysis. The result is that participants frequently disagree with each other and with the Officers of the United States Merchant Marine who determined the "correct" ranking list for the 15 survival items of the "Lost at Sea" problem.

It is within this real setting of value program participant frustration, following less than satisfactory "Lost at Sea" problem solving exercise results, that value practitioners have an excellent JIT (Just-In-Time) opportunity. It is the time for value practitioners to provide additional "learn by doing" training and education before starting live projects.

At this early stage of a value study, seminar or workshop, function analysis training and retraining is the right thing at the right time to do. The following three "Lost at Sea" function analysis examples are representative of this JIT "learn by doing" approach.

FUNCTION ANALYSIS EXAMPLES

Of the three function analysis examples presented, the first is relatively easy. The next two are more difficult but are more informative. These three function analysis examples analyze, brainstorm and evaluate "Lost at Sea" survival items to reveal their ranked survival value. The three examples demonstrate to individuals and teams alike cardinal requirements and benefits of function analysis for team problem solving.

"Butcher Paper" Documentation

Value program participants are reminded to think before acting. In this case, before value ranking each of the 15 survival items, they are requested to consider many functions required for survival and to document these needed survival functions in a format of active verbs with measurable descriptive nouns.

Judgment is required for ranking. Because suspended judgment improves creativity and free unconstrained associative thinking, immediately ranking functions as they are documented on "butcher paper" is not recommended.

No additional instructions are given other than to request teams organize their own team functions. That is, each value team must assign positions of responsibility to its members such as chairperson, scribe, gatekeeper and presenter. Each team also must review and tailor its own operating norms.

Even though its function analysis frequently is incomplete, "butcher paper" documentation is a "starter" toward more disciplined function analysis problem solving by both individuals and teams. A typical example of this relatively simple function analysis is shown.

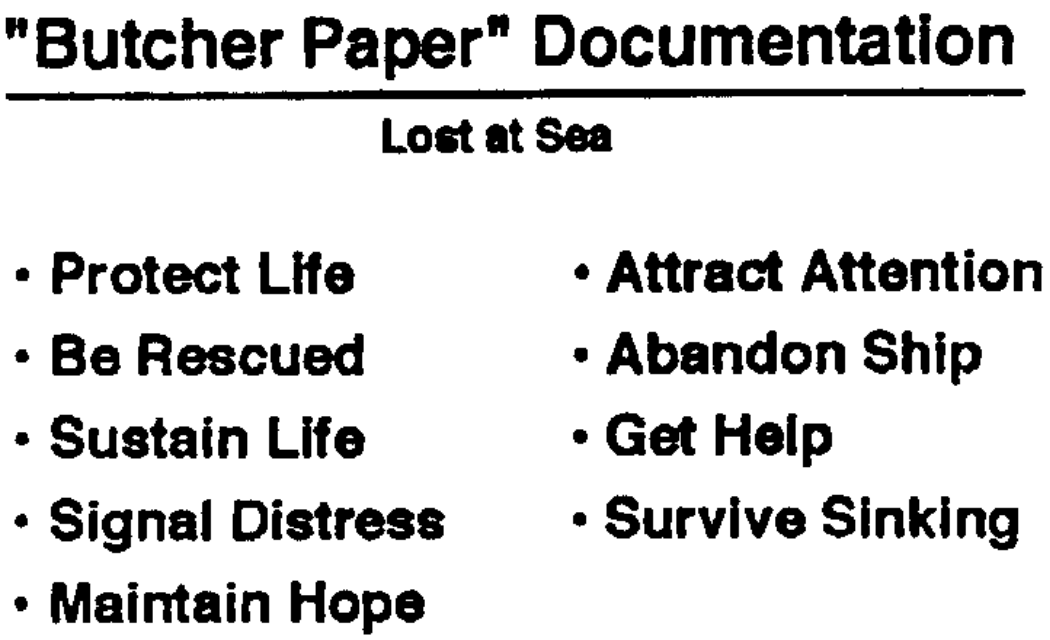

Figure 3

FAST DIAGRAM

Over the years the Function Analysis System Technique has been expanded and improved with many variants making it increasingly complex. However, FAST fundamentals remain deceptively easy:

- "How" reads to right
- "Why" reads to left
- Basic function of a project or product is highest order primary function within scope lines

Having functions documented on "butcher paper" allows both individuals and teams to more rapidly and easily create a FAST diagram. Instructions for FAST diagram creation are simple and concise:

- Identify primary functions
- Identify secondary functions
- Construct FAST diagram

The FAST diagram is an important step for thorough and effective function analysis problem solving by both individuals and teams. It systematically connects and illustrates "How" and "Why" bi-directional interrelationships of many functions. The FAST diagram shown is a typical example.

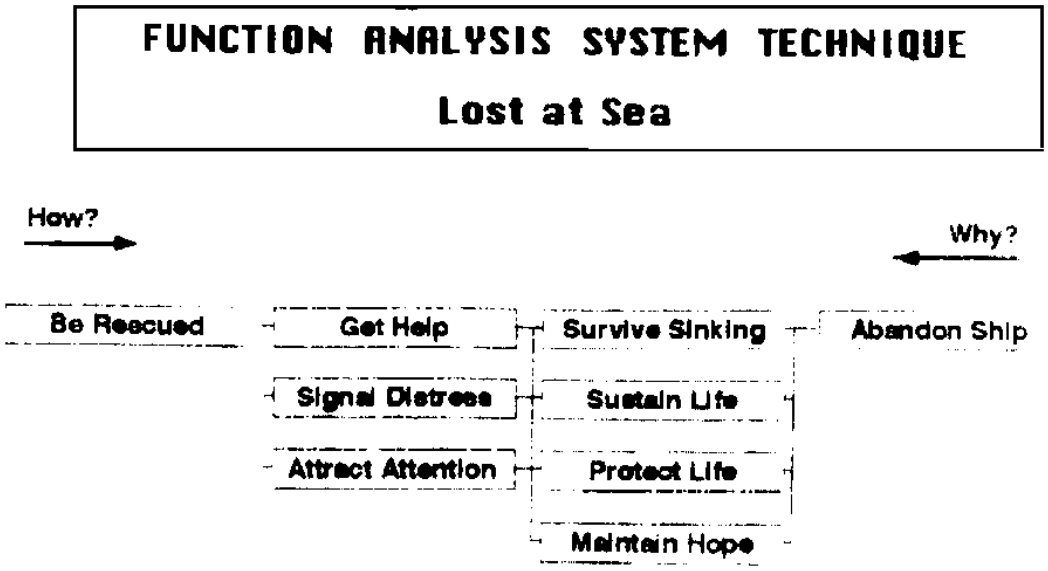

Figure 4

Function Structure Chart

The functions listed by a function structure chart fully meet the primary overall objective of a project or product. Unlike some "butcher paper" documentations and FAST diagrams, a completed function structure chart at each of its function levels captures all the functions required to meet objectives 100%.

A function structure chart offers a "middle-of-the-road" approach to function analysis. That is, constructing a function chart is more difficult than "butcher paper" documentation but frequently is less difficult than a FAST diagram.

Similar to FAST diagram creation, having functions documented on "butcher paper" allows both individuals and teams to more rapidly and easily construct a function structure chart. Instructions for function structure chart preparation also are simple and concise:

- Determine overall function objective
- Identify top-down all level 1 and subsequent functions
- Identify bottom-up all level N and subsequent functions

Function structure chart levels are all equal. No function level is subordinate to another, they are just of different order to each other. Functions listed at each level must add up -- no holes. That is, each function level must be 100% complete as determined by the functions of the levels next to it. While not required by some value practitioners, ranking functions listed at each function level often helps make needed analyses and evaluations better.

A function structure chart frequently has many levels each with a relatively large listing of functions. That is, its structure by design is very open, both broad and deep, to assure a thorough function analysis. Because of this completeness, a function structure chart improves baselining, benchmarking and best composite development and often serves as a template for brainstorming an entire class of projects or products.

A completed function structure chart is an entry point to Value Control. The function structure chart shown is a typical example. (See Table 1)

FUNCTION STRUCTURE

Lost at Sea

Level 1	Level 2	Level 3
Be Rescued	---	---
Get Help	Signal Distress	Mirror
	Attract Attention	Can of Oil-Gas
Survive Sinking	Sustain Life	Can of Water Case of C Rations Plastic Tarp Chocolate Bars Fishing Kit
	Protect Life	Nylon Rope Floating Cushion Shark Repellent 160 Proof Rum
	Maintain Hope	Transistor Radio Pacific Ocean Chart Mosquito Netting Sextant
Abandon Ship	---	---

GUIDELINES

1. Determine primary overall function of the project or product and identify level 1 functions that are required to fully meet the primary overall function objective (tops down).

2. Identify next level [N+1] functions that are required to fully meet each [N] function objective (tops down).

3. Identify individual functions of each part and cost item (bottoms up).

4. Identify next level [N-1] functions that are required to fully meet each [N] function objective (bottoms up).

5. Meld and assign parts and costs to the function structure, refine and rearrange until a complete function structure is created that fully meets requirements and expectations of the primary overall function objective of the project or product (tops down and bottoms up).

Table 1

DISCUSSION

When facilitating value activity, we somehow find lacking sufficient means for achieving and sustaining full utilization of function analysis by independent individuals and by team members problem solving together.

The "new" and the "different" can surface a fear of personal embarrassment that is an ever present VE challenge and function analysis difficulty.

Function analysis is a "new" and "different" technique to many people. Problem solving a benign survival exercise such as "Lost at Sea" offers a relatively safe way to expose, explore and resolve function analysis technical and emotional difficulties that otherwise would not be revealed before live projects are worked.

The three examples presented by the previous section are only typical function analysis examples that might be performed together or separately or in a different sequence. The Way is really many ways. The presented examples and function analysis itself are no exception, they can and may be performed many, many ways.

For example, for brevity and ease of understanding, the presented FAST diagram is incomplete. It lacks scope lines and, unlike the function structure chart, it does not include the 15 survival items, function level N. Both the FAST diagram and the function structure chart incompletely identify the "Lost at Sea" primary overall function objective as "Be Rescued" rather than "Save Life." Also, additional function levels (such as level 4, level 5, ...) are not shown by either the FAST diagram or the function structure chart, Figure 4 and Table 1.

Function analysis sometimes is performed by participants with little or no direct involvement with the value practitioner. That is, the practitioner, "us," outlines how it is to be done and then stands back as participants, "they," do function analysis starting with a clean sheet "zero baseline."

An alternative and frequently more effective "jump start" approach is the value practitioner prepares "stake in the ground" baseline function analyses ("butcher paper" documentations, FAST diagrams, function structure charts, etc.). Then, participants with the practitioner, "we," work in a close direct partnership. Together, we review the baseline and then benchmark and conduct best composite development followed by brainstorming for world class innovation and excellence.

Doing function analysis only one way or another is a disservice to all. Creativity can be stifled by too much or too little mandated procedure; just enough systematic discipline is a needed delicate balance. Function analysis should be taught and done the common sense way or ways that best fit real needs of the particular situation at hand.

CONCLUSIONS and RECOMMENDATIONS

Function analysis with a disciplined VE study job plan is a principle means for individuals and teams to achieve outstanding results with superior value.

A function structure chart might be a "middle-of-the-road" approach to function analysis for many people. It is a good motivator because it directly demonstrates the usefulness of function analysis for completely understanding and solving a problem systematically, front to back, back to front, top-down and bottom-up.

"Butcher paper documentation" is a useful function analysis "starter." It can assist conducting and preparing more difficult function analyses such as the FAST diagram and the function structure chart.

Value practitioners are encouraged to use "ice breaker" problem solving exercises such as "Lost at Sea" since these exercises are a means for JIT "learn by doing." Early up-front problem solving exercises assist value practitioners and participants by providing an opportunity window relatively risk free from personal embarrassment.

Requirements and benefits of function analysis for team problem solving are many and require demonstration and additional training, preferably before starting live projects.

ACKNOWLEDGMENTS

The assistance and encouragement of Bob Bartlett, PE, Consulting Engineer, were most helpful. The interest and comments of Dan Sedam, PE, CVS, Florida Department of Transportation, and Steve Foster, PE, Foster Engineering, are appreciated. The support of Joe Lambert, CVS, Martin-Marietta, also was helpful and is appreciated.

BIBLIOGRAPHY

1. Chaplin, Charlie, *Modern Times*, Magnetic Video, Twentieth Century - Fox., 1936.

2. Korzybski, Alfred, *Science and Sanity*, Fourth Edition, The Colonial Press Inc., 1958

3. Morison, Elting E., *Men, Machines, and Modern Times*, The M.I.T. Press, 1969.

4. Miles, Lawrence D., *Techniques of Value Analysis and Engineering*, McGraw Hill Book Company, 1972.

5. Nemiroff, Paul M., and Pasmore, William A., *Lost at Sea: A Consensus Seeking Task*, Annual Handbook for Facilitators, 1975.

6. Minsky, Marvin, *The Society of Mind*, A Touchstone Book, Simon & Schuster, 1986.

7. Bartlett, Robert L., "Function Value Deployment and Synthesis," *1989 SAVE Proceedings*.

8. Ellegant, Howard, "Back to Basics -- Only Complete Client Centered Function Analysis Makes Legitimate Value Engineering in Construction," 1989 SAVE Proceedings.

9. Fowler, Theodore, C., *Value Analysis in Design*, Van Nostrand Reinhold, 1990.

10. Lambert, CVS, Joseph V., and Megani, CVS, Peter S., and Michaels, Ph.D., PE, CVS, Jack V. and Wood, CVS, William P., Value Institute Incorporated "Value Engineering Workshop," certified by SAVE and accredited by the University of Central Florida, 8-12 January 1990.

11. Barker, Joel Arthur, *Future Edge*, William Morrow and Company, 1992.

12. Bryant, John W., and Daucher, Dale E., and Hannan, Donald, "Managing Value - An Approved Module II Seminar," International Joint Venture by Value Management Associates, East Sandwich, Massachusetts, USA and D.&A.E. Hannan & Associates, Canberra, ACT, Australia, 5-7 May 1993.

13. Lambert, Joseph V., "Why Team Dynamics is a MUST in Value Engineering," *1993 SAVE Proceedings*.

14. Sperling, Roger B., "The PDQ's of FAST: Simplifying Function Analysis for Construction Value Studies," 1993 SAVE Proceedings.

15. Warwick, Tom, "Value Assessment of Team Problem Solving," *1993 SAVE Proceedings*.

16. Bragaw, Louis K., Jr., and Warwick, Tom, "Value Assessment of Changing Technological Innovation,"

Proceedings of the Fourth International Conference - Management of Technology IV, Industrial Engineering and Management Press, February - March, 1994.