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Requirements Analysis In The Value Methodology

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REQUIREMENTS ANALYSIS IN THE VALUE METHODOLOGY

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BIOGRAPHY

Alison Conner is a Staff Engineer at the Idaho National Engineering and Environment Laboratory (INEEL) with 12 years experience in Systems Engineering and Value Methodology. Currently, her primary responsibility at the INEEL to support the initiative to integrate the Research and Development organizations with Operations organizations at the INEEL. She is a graduate of Montana College of Mineral Science and Technology with a B.S. in Engineering Science and has been a Certified Value Specialist since 1997. She has presented papers on Value Engineering, Productivity Improvement, and hydropower-related topics at various professional conferences.

ABSTRACT

The Value Methodology (VM) study brings together a multidisciplinary team of people who own the problem and have the expertise to identify and solve it. With the varied backgrounds and experiences the team brings to the study, come different perspectives on the problem and the requirements of the project. A requirements analysis step can be added to the Information and Function Analysis Phases of a VM study to validate whether the functions being performed are required, either regulatory or customer prescribed. This paper will provide insight to the level of rigor applied to a requirements analysis step and give some examples of tools and techniques utilized to ease the management of the requirements and functions those requirements support for highly complex problems.

INTRODUCTION

The Value Engineering (VE) Job Plan applied at the Idaho National Engineering and Environmental Laboratory includes the following phases:

Phase 0: Preparation and Planning (define scope, objectives, and deliverables)
Phase 1: Information (identify costs, requirements, specifications, include requirements analysis)
Phase 2: Function Analysis [develop Function Analysis System Technique (FAST) diagram, cost function and requirements function relationships]
Phase 3: Creativity (perform brainstorming, and other creativity techniques)
Phase 4: Evaluation (complete trade studies, Kepner-Tregoe, and other techniques)

Phase 5: Planning (perform cost-benefit analysis, risk analysis, etc.)
Phase 6: Presentation (develop reports and management presentations).

The phases that will be addressed in more depth will be Phases 1 and 2, the Information and Function Analysis Phases.

Through the completion of a structured requirements analysis activity (defined below), this paper will attempt to demonstrate the considerable benefit a requirements analysis can provide to the outcome of a VE study.

INFORMATION PHASE

During the Information Phase of the Job Plan pertinent facts and information are gathered to ensure all the team members are working with the same level of knowledge concerning the project. Securing all the facts can be one of the most difficult efforts to accomplish but one that may provide the greatest value to the project if completed thoroughly. Included in gathering the facts are identifying the appropriate specifications, requirements, and costs of the project.

The following definitions are provided for clarity and will be used throughout this paper:

> A specification is a document that contains requirements that have been agreed apply to the project.
>
> A requirement is: (1) A characteristic that identifies the accomplishment levels needed to achieve specific objectives under a given set of conditions. (2) A binding statement in a document or in a contract.
>
> Requirements are of three basic types: functional, performance, and constraint. A functional requirement specifies: (1) The necessary task, action, or activity that must be accomplished, or (2) what the system or one of its products must do. A performance requirement specifies how well the system or one of its products must perform a function along with the conditions under which the function is performed. A derived requirement is: (1) A requirement that is further refined from a primary source requirement or from a higher level derived requirement. (2) A requirement that results from choosing a specific implementation for a system element.[1]

REQUIREMENTS ANALYSIS TECHNIQUE

Often times, the requirements definition ends with just listing the applicable "required documents" or specifications and identifying specific customer needs or requirements. Through the application of a structured requirements analysis, a better understanding of the true set of requirements can be established, validated, challenged, if appropriate, and documented. Also with the completion of a structured requirements analysis, the functions of the project can be validated against the requirements to demonstrate that the correct functions are being performed.

A definition of requirements analysis is:

> The determination of system or project specific characteristics based on analysis of customer needs, requirements and objectives; missions; projected utilization environments for people, products and processes; and measures of effectiveness. Requirements analysis assists the customer in refining their requirements in concert with defining functional and performance requirements for the system's primary life cycle functions. It is a key link in establishing achievable requirements that satisfy needs.

There are many techniques and strategies for performing requirements analysis on a given project. Three suggested strategies include: (1) freestyle, (2) cloning, and (3) structured analysis. A team can select one of these strategies for use throughout a project in all phases or move from one strategy or set of strategies to another as the project matures. The phases of a project, referred to here, include Conceptual, Development, Implementation, and Closure. Depending on the experience of the project team and the phase to which the project has matured, the strategy most appropriate for the team at that time will be defined.

For example, in the conceptual phase the only specifications imposed are high-level contractual and regulatory requirements. A team of very experienced people in the particular type of project under analysis could use the freestyle strategy and identify the list of applicable high-level, driving requirements. In reality, this team of experienced individuals using freestyle are more likely relying on specification formats each has used through years of working with similar projects. Since a formal specification standard or structure is not used, this team's approach could be considered freestyle.

Freestyle carries with it the risk of possible incompleteness due to lack of rigor in the analysis process. It requires very experienced individuals familiar with the customer's needs and is not suggested as the only requirements analysis approach on a large project.

A project that is already established with a large library of specifications could successfully apply the cloning strategy to perform requirements analysis on a similar project, process, or component. The cloning strategy is a scheme for using an existing document as the basis for another. One cloning approach is commonly referred to as a boilerplate. A specification standard is a document that contains a set of standard requirements applicable to a range of items. A team can select the closest standard to their project and edit it, in accordance with a set of instructions, to fit the new project. Even though a cloning strategy is an acceptable approach to requirements analysis, the recommended approach is a structured analysis.

The third requirements analysis strategy, and the one that will be discussed in more detail in this paper, is the structured analysis. The structured analysis strategy provides an organized, systematic environment within which to decompose a large problem or project into a series of smaller ones, such that the solution of all the smaller ones results in a solution to the larger one. A hierarchy of requirements and traceability is defined through a structured requirements analysis approach. One strength of the structured analysis approach is the benefit in further

validation of the functions identified in the next phase of the Job Plan, the Function Analysis Phase.

FUNCTION ANALYSIS PHASE

The Function Analysis Phase of the Job Plan sets the Value Engineering Systematic Approach apart from all other product improvement or cost reduction approaches. Within the Function Phase, the functions of the project are defined in two words, one verb and one noun, and the relationships of these functions are evaluated. Through this evaluation, basic, secondary, and dependent functions are identified. Also determined are those functions that are present due to specifications, requirements, current design, etc.

Many techniques are used to identify the functional relationships, Functional Flow Block Diagramming (FFBD), Functional Analysis System Technique (FAST), etc. Below is an example of a FAST Diagram applied to the deactivation of a building.

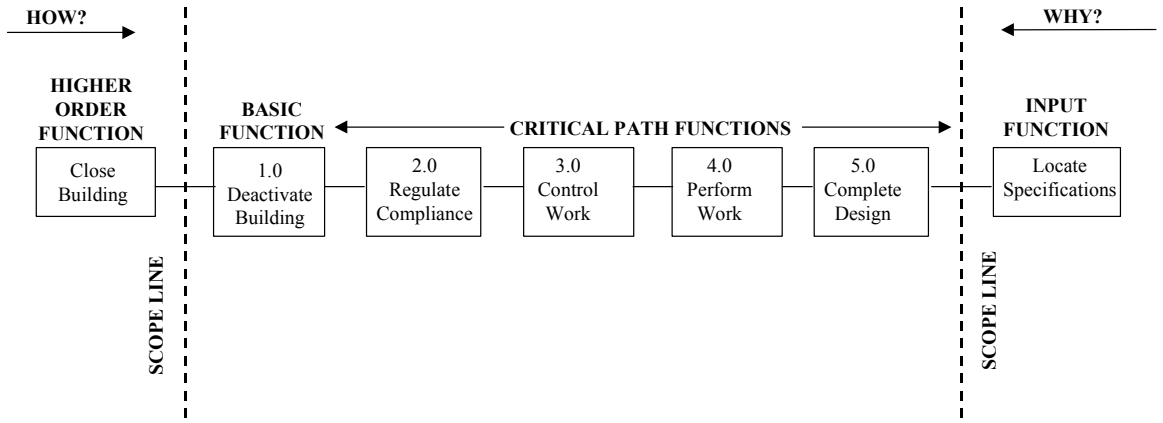

Figure 1. Example of a FAST Diagram on the deactivation of a building.

Figure 1 illustrates the critical path functions identified by the team for this particular project. The functions on the critical path have been numbered for tracking purposes. At this point, the team could take each function on the critical path and break it down further. For this example, only the critical path functions will be addressed.

To validate that the functions identified are required, each function can now be linked with a requirement. This linkage can be documented and traced to the lowest-level functions and requirements. Table 1 illustrates a structured method of documenting the requirements that support the functions identified in Figure 1.

Table 1. Document the requirements.

Function Number	Function	Requirement	Source
1.0	Deactivate Building	The Contractor shall develop and implement a cost effective, prioritized, yet safety conscious and compliant integrated plan for deactivating excess facilities, systems, structures, and equipment that is no longer needed or is no longer cost effective to maintain and utilize.	Contact No. XYZ, Section A, paragraph C
2.0	Regulate Compliance	The Contractor shall perform all activities in compliance with applicable health, safety and environmental laws, orders, and regulations; and governing agreements and permits executed with regulatory and oversight government organizations.	Contact No. XYZ, Section B, paragraph E
3.0	Control Work	Work must be performed to established technical standards and administrative controls, using approved instructions, procedures, or other appropriate means.	DOE Order 414.1A, Quality Assurance, 9-29-99
4.0	Perform Work	All projects shall be completed in compliance with applicable company procedures.	Contact No. XYZ, Section D, paragraph E
5.0	Complete Design	All projects shall be designed in compliance with applicable company procedures.	Contact No. XYZ, Section D, paragraph C

As illustrated in Table 1, a higher degree of function validation can be achieved through the application of a requirements analysis, beginning in the Information Phase and concluding in the Function Analysis Phase. Ensuring that the identified functions are required increases the probability that the most appropriate, cost effective alternative, developed from the required functions, will be developed in the VE study to the satisfaction of the customer.

LEVEL OF RIGOR

The level of rigor applied to requirements analysis and tracking is dependent on multiple circumstances related to the project. As mentioned above, the phase in which the project is currently involved may guide the amount of detail to apply to the requirements analysis and the complexity of the project may also dictate the desired level of rigor to apply. A project in the

Conceptual Phase may only have high-level specifications designated as applicable and available from which to pull requirements, and a Free-style strategy for listing the applicable requirements and specifications may be the only good way to get started in determining the applicable requirements. Whereas a project in the Development Phase that is anticipated to be highly complex, involving many organizations within the company, may be better served by a well structured, easily traceable level of requirements identification and documentation.

TOOLS/TECHNIQUES TO AID MANAGEMENT

Based on the number of requirements and complexity of the project being addressed, there are many software tools and techniques being developed and available to aid in managing potentially large numbers of requirements. If the number of requirements and functions to manage is minimal, a database or spreadsheet on an individual computer would be adequate to provide the documentation and tracking necessary to maintain a traceable, validated set of requirements. If however, the project involves a large amount of requirements, pulled, and traced through many levels of documents and linked to many levels of functions, a software designed specifically to manage the flowdown of requirements and functions may be necessary. Also, if more than one person will be accessing, editing, or reporting the hierarchy of requirements, networking capability may be another criteria to consider when choosing the appropriate management tool.

CONCLUSION

In conclusion, completing a structured requirements analysis, within the Information and Function Analysis Phases of the Job Plan, can be very beneficial to the outcome of the VE study. It will identify the specific functional, technical, and customer dictated requirements applicable to the project, validate the identified functions, on which the most cost effective alternative is based, and document the requirements in a structured, traceable format.

REFERENCES

1. Arthur E. Mudge, CVS, *Value Engineering: A Systematic Approach*, Pennsylvania: J. Pohl Associates, 1989.

2. James N. Martin, *Systems Engineering Guidebook: A Process for Developing Systems and Products*, Florida, CRC Press, Inc., 1997.

3. Jeffrey O. Grady, *System Requirements Analysis*, United States, 1993.

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[1] The definitions were taken from *Systems Engineering Guidebook: A Process for Developing Systems and Products*, page 18.