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Designation: ~~E2013 – 12~~ E2013 – 20

Standard Practice for Developing Functions, Constructing FAST Diagrams, and Performing Function Analysis During Value Engineering (VE)/Value Analysis (VA) Study[1]

This standard is issued under the fixed designation E2013; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers a logical structure for the function analysis of a ~~building project~~project, product, or process.

1.2 This practice provides a system to ~~identify unnecessary costs of a project.~~identify, define, and clearly communicate the purpose of a project, product, or process and the associated elements of the project, product, or process.

1.3 This practice covers the relationship between the functions that must be satisfied and the resources for a project, product, or process to accomplish those functions.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses ~~are mathematical conversions to inch-pound units that~~ after SI units are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions
E833 Terminology of Building Economics
E1557 Classification for Building Elements and Related Sitework—UNIFORMAT II
E1699 Practice for Performing Value Engineering (VE)/Value Analysis (VA) of Projects, Products and Processes
E2103/E2103M Classification for Bridge Elements—UNIFORMAT II

[1] This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.81 on Building Economics.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the ~~standard's~~standard's Document Summary page on the ASTM website.

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3. Terminology

3.1 ~~*Definitions:*~~ *Definitions—*

~~3.1.1 For definitions of terms used in this practice, refer to Terminologies E631 and E833.~~For definitions of general terms related to building construction used in this practice, refer to Terminology E631; and for general terms related to building economics, refer to Terminology E833.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *basic function, n*—a primary purpose or action of a project, product, or process.

3.2.1.1 *Discussion—*

A basic function establishes the specific purpose for which something exists and answers the question "what must it do?".

3.2.2 *function, n*—the intent or purpose that all elements of a project, product, or process is expected to satisfy.

3.2.3 *function analysis, n*—the process of identifying, classifying, and prioritizing functions for value improvement.

3.2.4 *function analysis systems technique (FAST), n*—a structured tool used to identify, classify, and analyze functions.

3.2.5 *function cost, n*—the cost of an element or set of elements to satisfy a specific function.

3.2.6 *function worth, n*—the lowest utilization of resources to satisfy a specific function.

3.2.7 *higher order function, n*—it represents the specific goals or needs for which the basic function exists.

3.2.8 *lower order function, n*—this function is typically the input to the project, product, or process study. It is outside the scope of the study.

3.2.9 *secondary function, n*—an action or set of actions that enhances the satisfaction of the stakeholders' needs and desires.

3.2.9.1 *Discussion—*

Secondary functions define how the basic functions are being accomplished.

3.2.10 *sell function (aesthetic function), n*—an action or set of actions that enhances a work function.

3.2.11 *stakeholders, n*—anyone who is responsible for or affected by the budget, construction, maintenance, or operation of the project, product, or process.

3.2.11.1 *Discussion—*

Stakeholders include, but are not limited to, developers, owners, users, planners, contractors, designers, architects, engineers, value analysts, and cost professionals.

3.2.12 *value, n*—an expression of the relationship between the function that must be satisfied and the resources it takes to accomplish that function.

3.2.12.1 *Discussion—*

The function is measured by the performance requirements of the customer and resources are measured in terms of cost, materials, labor, time, or other attributes required to satisfy that function.

3.2.13 *work function (use function), n*—an action or set of actions that satisfies a basic function.

4. Summary of Practice

4.1 This practice is used during the function analysis phase of the value methodology as required for the VE/VA of a project, product, or process (see Practice E1699).

4.2 This practice provides an organized approach ~~for determining~~ to understand and communicate the needs and desires of the

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stakeholders ~~during the Value Analysis (VA) of a project. These needs and desires are used in developing the functions of the project.~~in terms of the functions to be accomplished by the project, product, or process.

~~4.2 This practice establishes a logical procedure for allocating cost to each function.~~

4.3 ~~Function~~ This practice establishes a procedure for measuring the function cost of the project, product, or process elements. Function cost analysis helps design professionals ~~justify the value of their concepts.~~ to establish strategies to arrive at the desired value. It also provides the stakeholders with a justification of their investments.

5. Significance and Use

5.1 As part of the VE/VA study, perform function analysis after the collection of relevant information and prior to the identification of alternatives.

5.2 This practice provides a specific understanding of what must be accomplished and provides the basis for stimulating the creative phase of the value methodology. This is accomplished by naming and analyzing the functions and using the functions of the VE/VA study to generate ideas and alternative solutions.

5.3 This practice establishes a communication format through which all stakeholders can understand the project, product, or process.

5.4 This practice ~~establishes a communication format through which all stakeholders can understand, analyze, revise, and agree on the purposes of the project. This practice~~ presents a method by which ~~stakeholders'~~stakeholders' needs and desires are compared to the cost to satisfy those needs and desires. ~~This is done by identifying the low preference/high cost functions and high preference/low cost functions. These data will be used in the value analysis study as a basis to create alternative solutions.~~

5.4.1 Function cost data help the user identify the alternatives and their functions that are highly valued with respect to their cost, thereby targeting opportunities for increasing value.

5.4.2 Targeting is done by identifying the low preference/high cost functions and high preference/low cost functions. These data will be used in the VE/VA study as a basis to create alternative solutions.

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5.5 This practice helps ~~stakeholders, which include developers, owners, users, planners, contractors, architects, engineers, value analysts, cost professionals, and anyone who is responsible for the budget, construction, maintenance, or operation of the project.~~stakeholders to formulate a strategy to maximize values.

5.6 ~~A practice on performing value analysis of buildings and building systems and other constructed projects, Practice~~ Functions ~~E1699, has been published. As part of the value analysis study, perform function analysis after the collection of relevant information and prior to the identification of alternatives. Function Analysis Systems Technique (FAST) data helps the user identify the alternatives that are highly valued with respect to their cost.~~are also used to define criteria to compare alternatives.

6. Procedure

6.1 Function analysis ~~consists of five sequential steps: (~~is practiced as part of ~~1) select a building component, (2) define the needs and desires (functions),~~the VE/VA study (see Practice E1699~~(),3) classify functions, (~~ as shown in~~4)~~ Fig. 1~~allocate cost to each function, and (.5) analyze the importance and expected performance level of the functions.~~

6.2 ~~*Selection of a Building Component*—For cost-effectiveness, select building components that offer a significant opportunity for improvement of performance, reduction in cost, or both.~~Function analysis can be practiced as a standalone activity to gain a better understanding of the needs and desires of the subject being analyzed.

~~6.3 *Definition of Needs and Desires (Functions)*—Define each significant need or desire of the stakeholders in two words using an active verb and a descriptive noun. The two-word definitions are the functions of the project.~~

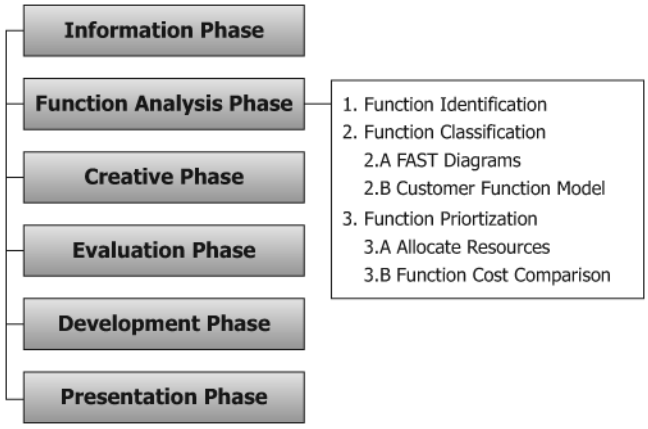

FIG. 1 ~~Function Analysis Systems Technique (Technical FAST)~~Phases in VE/VA Study

~~6.4 *Classification of Functions*—Categorize the functions of the building component as basic (essential to meet the stakeholders' needs) or supporting (enhances the satisfaction of the stakeholders' needs and desires).~~

~~6.5 *Distribution of Cost to Functions*—Divide cost of each component into smaller sections based on the specific use of the project and distribute cost to each function.~~

6.3 ~~*Analysis of Functions:*~~ The function analysis phase, as shown in Fig. 1, consists of three steps: *(1)* Function Identification, *(2)* Function Classification, and *(3)* Function Prioritization. The three steps and their various parts are: *(1)* Function Identification—select a project, product, or process, or any associated element, feature, or subsystem, define the needs and desires, and identify the functions being accomplished to satisfy those needs and desires; *(2)* Function Classification—*(2a)* use the FAST tool to classify the functions, and *(2b)* use the Customer Function Model to classify functions from the customer's point of view; *(3)* Function Prioritization—*(3a)* allocate resources/cost to each function, and *(3b)* analyze the importance and expected performance level of each function.

~~6.6.1 Analyze functions through a structured logical format called Function Analysis Systems Technique (FAST). FAST is a diagramming technique which specifically illustrates the relationships and interrelationships of all functions within a specific project using a "How-Why" logic pattern. There are two FAST variations.~~

6.3.1 ~~One variation, known as Technical FAST, develops a critical path to define the basic needs of the project. This diagram helps the user calculate the ratio of total cost to critical functions.~~FAST diagramming classifies functions in a logical, structured format. This helps the VE/VA practitioners to identify and add missing functions. In addition, this approach gives a broader perspective of the purpose. For major group elements, this approach helps to sort out their importance.

~~6.6.2.1 Technical FAST diagramming is effective in a specific situation or element within a project. The situation or element is an assembly or a portion of a construction design. Terms or functions are oriented to technical activities. A Technical FAST diagram has a specific structural form (Fig. 1).~~

~~6.6.2.2 There are four important concepts in a Technical FAST diagram:~~

~~1. "How-Why" Logic Questions~~

~~2. Scope Line~~
- ~~Higher-Order Function~~
- ~~Basic Function~~
- ~~Required Secondary Functions~~
- ~~Causative Function~~

~~3. Critical Functions~~

~~4. Supporting Functions~~
- ~~Design Objectives~~
- ~~All-The-Time Functions~~
- ~~Caused-By/Same-Time Functions~~

6.6.2.3 Function analysis requires analyzing why a function exists and how a function satisfies other functions to complete the link between them. This "How-Why" logic assures that all the required functions are listed in the FAST diagram.[4]

6.6.2.4 Begin the Technical FAST diagramming with a higher order function of the project and two scope lines. All functions that the selected element fulfills are bounded by the two scope lines. The basic function is on the right of the left-hand scope line, and the higher order function is on the left. The purpose of the element or project for which a FAST diagram is developed is the higher order function. The relationship between the higher order function and the basic function is determined by asking "Why" the basic function candidate performs as it does. The answer should be the higher order function. The logic check must be completed by asking "How" the higher order function performs. The logical answer must be the basic function candidate. It is still necessary to confirm the required secondary function to the left of the right-hand scope line. When the "How" question is asked of this function, the answer will be an outside function candidate. The outside function is called the *causative function*, since it really starts the critical functions.

6.6.2.5 Determining the basic function often requires selecting functions from the list of suggestions and applying the "How" and "Why" questions. If the "Why" question is answered by another identified function, that function is the next candidate for the basic function. The function to the right becomes a required secondary function. Once the basic function is verified, the remaining required secondary functions are identified. This group makes up the *critical functions*.

6.6.2.6 The last group of functions is *supporting functions*. There are three types. The first type, *caused by* or *same time* functions, connects directly to a critical function. These functions result from the performance characteristics of particular critical functions and act as modifiers. The second type, *all-the-time functions*, modifies two or more of the critical functions. The third type, *design objectives*, represents specifications that are added to the design, often by the stakeholder or group that is developing or operating the process.

6.3.2 The second variation, known as Task-oriented FAST, creates distinct functions for stakeholders' concerns and is always headed by four primary functions: (customer function model classifies functions from the customer's point of view. The customer function model is especially effective in the planning/conceptual phase when1) assure dependability, (developing a project,2) assure convenience, (product, or process.3) satisfy stakeholders, and (4) attract stakeholders.

6.6.3.1 The Task-oriented FAST diagram logically displays the stakeholders' needs and desires (see Fig. 2). Task-oriented FAST diagramming is especially effective in the planning or conceptual phase. Use conceptual layout and building plans to develop these FAST diagrams.

6.6.3.2 There are four parts to the Task-oriented FAST diagram:

1. Task
2. Basic Functions
   - Primary
   - Secondary
3. Supporting Functions
   - Assure Dependability
   - Assure Convenience
   - Satisfy Stakeholders
   - Attract Stakeholders

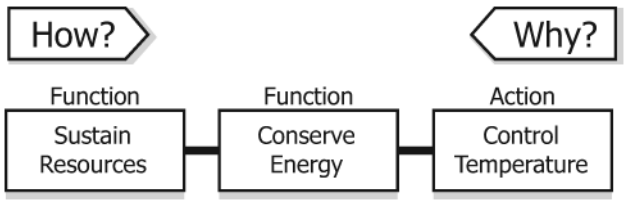

FIG. 2 Function Analysis System Technique (Task-Oriented FAST)Actions to Functions
FIG. X1.1 Median Slope
FIG. X1.2 Concrete Guardwall
FIG. X1.3 Alternative Guardrail
FIG. X1.4 Components and Functions

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4. Classify Functions
- Primary
- Secondary
- Tertiary

6.6.3.3 The first step is to determine the task. The task satisfies the overall needs of the stakeholder. Establish a scope line just to the right of the task. Functions that answer "why perform the task" lie outside of the scope.

6.6.3.4 The second step is to separate the identified functions into basic and supporting functions. Basic functions are those which are essential to the performance of the task. Without the primary basic functions, the project or process will not work.

6.6.3.5 The third step is to group the remaining functions into the four primary supporting function groups. Supporting functions play an important role in a building. Structural engineers, for instance, concentrate primarily on the basic functions, with heavy emphasis on the primary supporting function *Assure Dependability*. Mechanical engineers and electrical engineers pay more attention to the supporting function *Assure Convenience*, while architects' ideas satisfy the basic and supporting functions *Satisfy Stakeholders* and *Attract Stakeholders*.

6.6.4 *Assure Dependability*—Any function that assures dependability has at least one of the following attributes:

6.6.4.1 Makes the elements of the project stronger or more reliable or effective,

6.6.4.2 Makes it safer to use,

6.6.4.3 Lengthens the life of the parts or minimizes maintenance cost, or both, and

6.6.4.4 Protects the environment.

6.6.5 *Assure Convenience*—Any function that assures convenience has at least one of the following attributes:

6.6.5.1 Modifies the basic function to make it convenient to use,

6.6.5.2 Enhances spatial arrangements,

6.6.5.3 Facilitates maintenance and repairs, and

6.6.5.4 Furnishes instructions and directions to stakeholders.

6.6.6 *Satisfy Stakeholders*—Any function that satisfies stakeholders has at least one of the following attributes:

6.6.6.1 Modifies the basic function to satisfy the individual desires,

6.6.6.2 Makes the stakeholders' life more pleasant; for example, minimizes noise, and

6.6.6.3 Makes the element appear to be better in the opinion of the stakeholder, but not necessarily in the opinion of the designer. (Sometimes these opinions are reflected in the standards and specifications of a particular agency/owner.)

6.6.7 *Attract Stakeholders*—Any function that attracts stakeholders and has at least one of the following attributes:

6.6.7.1 Emphasizes the visual aspect (sight) or other senses, and

6.6.7.2 Projects a favorable image (that is, trademarks or endorsement by public figures).

6.6.8 The fourth step is to classify the functions as primary, secondary, or tertiary.

6.6.8.1 The link between the task and basic functions is the sequence of the logical question "How-Why." The "How-Why" concepts must work between the selected task and the primary basic functions. These primary basic functions are interdependent and both are essential to the performance of the task.

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6.6.8.2 Once the primary basic functions have been identified, the question "How" can be asked of each of the primary basic functions. Functions that answer the question "How" will be found in the expanding branches. These are the secondary basic functions. There must be two or more secondary basic functions to justify branching from the primary function.

6.6.8.3 In a similar manner, the secondary supporting functions branch to the right from the primary supporting functions when the question "How" is applied. Again, there must be two or more secondary functions to justify branching.

6.6.8.4 This rule also affects further branching off to the third (tertiary) level. Usually, the tertiary level completes the branching basic functions. The end of the branching is obtained when the hardware description or action is the noun of the function. The branches must also satisfy the "Why" question in the opposite direction, that is, logic check.

6.6.9 *Cost Estimate:*

6.6.9.1 Obtain cost estimates for the proposed building components and related sitework. Classification E1557 provides a useful format for allocating cost to functions.

6.6.10 *Function Cost:*

6.6.10.1 Most components of a building have more than one function to satisfy. Distribute cost of each component to each one of these functions, proportionate to their time cost. Use the elemental format, UNIFORMAT II, for the development of cost estimates. This expedites the completion of function costs. Allocate all life-cycle costs, including first cost, operation cost and maintenance cost.

6.6.10.2 When cost is distributed to all functions, review the total distribution. In the Technical FAST, the ratio of total cost to the cost of critical functions is defined as the value index. In the Task-Oriented FAST, the ratio of the total cost to the Basic and Assure Dependability functions is defined as the value index. The value index varies from 1.5 to 6.0. As this ratio gets higher, the opportunity to reduce cost is higher for the selected component. A value index of 1.5 means a very basic design with minimum cost of supporting functions. If most of the total cost is spent on critical functions, the value index is approximately 1.5. The construction of a fast food restaurant, for example, will have a value index around 1.5, whereas a luxurious restaurant may have a value index much higher than the fast food restaurant.

6.6.10.3 In Task-Oriented FAST, the ratio of basic to supporting functions indicates how basic the project or component is designed. Opportunity to improve value depends upon the understanding and willingness of the stakeholders to accept the findings and change the ratios to fit the intent of the project. Cost distribution for the type of building affects the four supporting functions. Table 1 shows the highest cost function for each of the several types of buildings. In an industrial building, major spending occurs in order to make the building dependable. In a public building such as a train station, major spending will occur in order to make the facility convenient to use; that is, elevators, escalators, stairs signage and corridors.

6.6.11 The team should calculate function cost as follows:

6.6.11.1 Review each building component for its functions and allocate cost accordingly,

6.6.11.2 Summarize all costs of each function, and

6.6.11.3 Compute percentage of function cost and list in the FAST diagram.

6.6.11.4 The attached appendixes consist of two case studies. The first is Appendix X1, a Technical FAST diagram case study that shows the method of the function cost distribution in detail. The second is Appendix X2, a Task FAST diagram case study that uses similar function cost distribution of the elements.

6.6.12 *Function Preference:*

6.6.12.1 Designers gather information to understand the needs, desires and constraints of the project. However, the stakeholders may change their opinion after the project is designed and cost is distributed. Utilize questionnaires/surveys, focus groups, public information meetings or public hearings, and measure preferences as they relate to function cost.

6.6.12.2 For each function, measure and tabulate the function preference of the project.

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TABLE 1 ~~Highest Cost Function Group~~Function Analysis Worksheet

Subject:____

Basic Function: ______________________ (Verb, Noun)

Higher Order Function: ______________________ (Verb, Noun)

Component	Resource (cost, space, time, etc.)	Function Verb	Function Noun	Function Type[A]	Resource % Allocation
~~High Cost %~~	~~Type of Building~~				
~~Assure Dependability~~	~~Industrial building~~				
~~Assure Convenience~~	~~Public buildings (for example, train stations, libraries, and schools)~~				
~~Satisfy Stakeholders~~	~~Any building where more decision makers or stakeholders are involved~~				
~~Attract Stakeholders~~	~~Museums, city halls, monuments~~				

[A] Basic, Secondary (Required, Unwanted), Higher Order, Lower Order.

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6.3.3 ~~*Analyze the Functions and Identify Mismatches*—Compare function cost and function preference.~~Function cost analysis quantifies function analysis. ~~Table 2 shows four possible combinations of cost/preference. If the cost of a function is high and the stakeholder thinks its importance is low, the result is a mismatch (Type A in~~ It provides a system to identify and eliminate unnecessary costs with low need and retain the elements that have necessary costs with ~~Table 2). On the other hand, if the cost of a function is low and the stakeholder rates its importance as high, a high value is achieved and the stakeholder has a match (Type D in~~high need. In this way, individual elements and the entire project, product, or process can be ~~Table 2). These are the two extremes of the cost/preference measurement.~~analyzed.

~~6.6.14 Use value analysis to propose and develop redesigns to reduce or eliminate Type A combinations. Employ value analysis~~

TABLE 2 Illustration of Cost/Preference Combinations

Type of Combination	Function Cost	Function Preference	Function Value
~~Type of Combination~~	~~Function Cost~~	~~Function Preference~~	~~Function Value~~
~~A~~	~~High~~	~~Low~~	~~Mismatch (Mandatory Value Analysis) (VA)~~
A	High	Low	Mismatch Mandatory (VA)
B	High	High	Candidate for VA
~~C~~	~~Low~~	~~Low~~	~~—~~
C	Low	Low	...
D	Low	High	Match

~~to develop alternatives to reduce the cost of Type B combinations while maintaining high-preference functions. Maintain the Type D combinations since it is a match. Determine if the Type C combination with low cost is worth further analysis.~~

6.4 This practice addresses the three function analysis steps contained in any VE/VA study. The VE/VA team can perform those parts of the function analysis steps as appropriate to the scope of the VE/VA study. The effort to utilize some or all of the parts depends upon the detail of information provided by the owner/client, the amount of time allocated to the study, and the number and level of expertise of the VE/VA team members.

6.5 Function analysis develops functions that will facilitate the development of alternatives specific to the purpose of the project, product, or process. This approach provides the stakeholders with appropriate alternatives that can be implemented. In this practice, individual elements are analyzed.

7. Function Identification – "How-Why" Logic

7.1 Function analysis is critical to the VE/VA process. Its key activities differentiate the VE/VA process from other problem-solving or improvement practices. Function analysis is the process of identifying what must be accomplished as opposed to how it is to be accomplished. During this phase of the VE/VA job plan, functions are identified that describe the reasons for expected outcomes of the project, product, or process under study.

7.2 Function analysis develops the functions and allocates resources to each function. Using these data, the user can define the worth of a specific function.

7.3 This identification and naming convention of functions promotes a better understanding by limiting the description of a function to an *active verb* that operates on a *measurable noun* to communicate what work an item or activity performs. This naming convention also helps multidisciplinary teams to build a shared understanding of the functional requirements of the project, product, or process.

7.3.1 Select an element of a project, product, or process and subdivide into sub-elements. Define functions of each sub-element, and then assemble the functions for analysis. This approach is applicable when project elements or a product or process is given. This approach answers the question:

What does it do?

Since all costs are for functions, for cost effectiveness, select elements that offer a significant opportunity for improvement of performance, reduction in cost, or both. This approach is applicable if elements are defined or available.

7.3.2 Another way of naming functions is to use the stakeholders' needs and desires and convert them into functions. This is applicable at the planning stage where the project, product, or process details are not developed. This approach answers the question:

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What should it do?

7.3.3 When elements are not developed, use the second approach of stakeholder preference. List the needs and desires of various stakeholders. The stakeholders include the owners, users, and another group affected by the project, product, or process. Most of the needs will come from this other group. Also include the desires of the other stakeholders.

7.4 When both elements and stakeholder preferences are available, make use of both approaches.

7.5 Define each element or each significant need or desire of the stakeholders in two words using an active verb or descriptive verb and a measurable or quantifiable noun. The two-word definitions are the functions of the subject being analyzed. Some of the functions are based on the stakeholders' needs and desires.

7.5.1 Functions should not be the description of a process, product or project element and should not be an action. Functions behind any action or description can be derived by utilizing a critical path of how-why logic.

7.5.1.1 As an example, a stated function "Control Temperature" is an action. When a question is asked "Why do you Control Temperature?", the answer is to "Conserve Energy."

7.5.1.2 The how-why logic path will expand this action to function; Conserve Energy or Sustain Resources. This is possible by testing with a why question. The answer to a why question of an action or description will yield a function. See Fig. 2.

7.5.2 Quantify functions when practicable. It should be measurable so that its benefit can be weighted.

7.5.3 The two-word function definition should describe specifically *what* the subject does. The verb and noun usage should be as specific as possible. It is also important to understand the context or specifically how the subject is being used.

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7.5.4 Appropriate functions, which are general in nature, offer opportunities to expand possibilities. In the above example "Control Temperature" limits options. However, conserve energy can be achieved by controlling temperature, adding insulation, using energy efficient appliances, as well as other means.

7.5.4.1 In the example of "Conserve Energy," one of the actions is "Control Temperature," and one of the secondary functions is "Comfort Occupants." This practice requires the function to be specific. The specific function will lead to different alternatives or actions. If the secondary function, "Comfort Occupant," is changed to "Comfort Clients" or "Comfort Elderly," the action may change from "Control Temperature" to "Control or Manage Temperature." The noun "occupants or clients or elderly" results in the change in the definition of value. Customer/user profile is required to define functions and their classification.

7.5.4.2 The how-why logic also helps to develop functions at various levels. Those different levels of functions result in various alternatives. Control temperature leads to alternatives; manually control temperature, automate temperature control (fixed each day, vary on weekends). Conserve energy can be accomplished by temperature control, insulated walls, insulated windows, lower ceilings, recirculation of air, direction of window placement, building materials of the wall.

7.6 *Categorize Functions:*

7.6.1 Categorize the functions of the subject as basic or secondary. Basic functions are essential to meet the users or stakeholders' needs for the subject being analyzed. They represent the specific purpose for which a project, product, or process exists and conveys a sense of need.

7.6.2 Secondary functions enhance the satisfaction of the users or stakeholders' needs and desires. They define how the basic functions are being accomplished. There are two types of secondary functions, work functions, and sell functions.

7.6.3 All costs in a product, process, or project are to accomplish two types of functions—work functions (needs) and sell functions (desires).

7.6.4 Work functions are also referred to as use functions. Users expect an element to perform certain actions. For example, a building design is expected to "Sustain Resources." It is based on *how* the basic function "Sustain Resources" was chosen to be accomplished. One of the work functions is "Conserve Energy."

7.6.5 Sell functions are also referred to as aesthetic functions. An element of a project, product, or process/service is to please the user or customer. The objective behind these functions is to satisfy the users' desires. Sell functions are secondary functions.

7.7 *Role of Functions in Job Plan*—Needs and desires of the stakeholders are used to define functions. Functions and cost are compared. This information is the basis for the creative process where ideas are generated for each function. Also, functions are used to develop criteria for evaluation of the creative ideas. See Fig. 3.

8. Function Classification - FAST Diagrams

8.1 Functions define the purpose of an element or part of the element. Function analysis can be performed with just functions. FAST diagramming helps to relate various needs and desires and give a total perspective of an element of a project, product, or process. The how-why logic helps to locate missing functions of the element. A FAST diagram is a strategic map that helps to communicate the overall purpose of the project, product, process, or element. One should understand the importance of each component of the diagram. In addition, it should be simplified to help understand and focus on the issue. Functions are derived from the constraints, needs, and desires of stakeholders. Various components of the FAST diagram place these constraints, needs, and desires of the project, product, or process in the FAST diagram.

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8.2 Function analysis is a tool to define functions. This section describes how to classify the functions.

8.3 Classify the functions through a structured logical format called function analysis systems technique (FAST). FAST is a diagramming technique that specifically illustrates the relationships and interrelationships of all functions within a specific project using a how-why logic pattern.

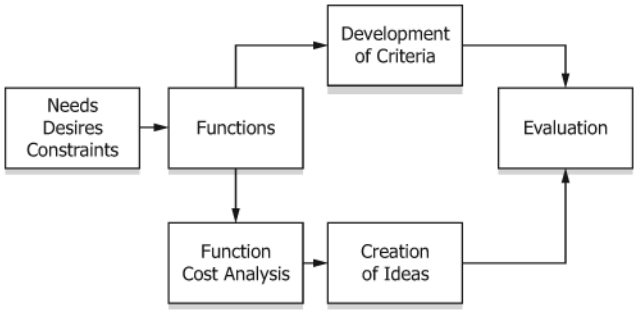

FIG. ~~X1.53~~ ~~Function Cost Distribution~~Role of Functions in Job Plan

~~**FIG. X1.6 Function Analysis Systems Technique (Technical FAST)**~~

~~**Guardwall as Designed**~~

~~**FIG. X1.7 Metal Plate Guardrail ($40 000)**~~

~~**FIG. X1.8 Concrete Wall Footing ($60 000)**~~

~~**FIG. X1.9 Revision of the Median**~~

~~**FIG. X1.10 Alternative Barrier Functions**~~