VOL. 10, NO 21, NOVEMBER, 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

# IMPLEMENTATION OF FUNCTIONAL ANALYSIS USING VALUE ANALYSIS VALUE ENGINEERING (VAVE)

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**ABSTRACT**

This paper presents one of the tools used in Value Analysis Value Engineering (VAVE) methodology; Functional Analysis and its implementation during New Product Development (NPD) phase. Current vehicle outer door handle has been redesigned through its functions in order to meet customer requirements of having higher value vehicle, by increasing performance while trying to decrease the cost without scarifying the quality, saleability and maintainability. An analysis has been made and discussed using Function Analysis System Technique (FAST) diagram to achieve product optimization. Finally, results obtained are discussed.

**Keywords:** functional analysis, value analysis (VA), value engineering (VE), new product development (NPD), FAST diagram.

## 1. INTRODUCTION

Functional Analysis is a fundamental tool of the design process to explore new concepts and define their architectures. When systems engineers design new products, they perform Functional Analysis to refine the new product's functional requirements, to map its functions to physical components, to guarantee that all necessary components are listed and that no unnecessary components are requested and to understand the relationships between the new product's components. The conceptual design stage in NPD phase is where the role of Functional Analysis is highlighted [1].

## 2. PURPOSE OF FUNCTIONAL ANALYSIS

There are numerous purposes behind the Functional Analysis which can be seen through developing the Function Analysis Systems Technique (FAST) diagram [2]. They are listed as follows:

1. Assuring proper relationships between functions.
2. Provides a good basis for classifying the functions.
3. Arrangement of the functions can help identify missing functions.
4. Clarification of the meaning of function can result from the diagramming of the functions.
5. Finding duplicate functions becomes more evident and marks those that may be eliminated or combined with others with the same result.
6. FAST can help avoid coming up with the right solution to the wrong problem. Thus expecting to possibly reduce the total cost of the products or services.
7. To set the scope of the project undertaking.

## 3. ISSUES TO BE CHECKED FOR FUNCTIONAL ANALYSIS

A. Function
B. Material Specification and Content
C. Material and Manufacturing
D. Standardization
E. Direct Labor Costs
F. Tolerances and Finishes
G. Costs of material

## 4. FAST DIAGRAM

One of the most popular and easiest ways of doing Functional Analysis is through developing the FAST diagram. FAST diagram is a technique that was developed to determine, classify and evaluate functions based on a function block diagram according to the how/why logic. The result is a hierarchy of functions in order of their importance as efforts to achieve a basic function, objective or end result. [2] FAST can be divided into two types; technical FAST diagram and customer FAST diagram. Technical FAST diagram is used to understand the technical aspects of a specific portion of a total product while customer FAST diagram focuses on the aspects of a product that the customer cares about and does not delve into the technicalities, mechanics or physics of the product. Customer FAST diagram is usually applied to a total product [3].

## 5. VAVE METHODOLOGY

The four different segments of VAVE methodology used for this study was enhanced base on the Value Analysis Study Activity Chart (VASAC) [4] which has covered the three out of seven phases from engineering design process; conceptual design, embodiment design and detail design. It is expected that

the existing vehicle outer door handle especially for the 3-door hatchback car can be redesigned base on this methodology. The first two segments were covering the first phase of engineering design process.

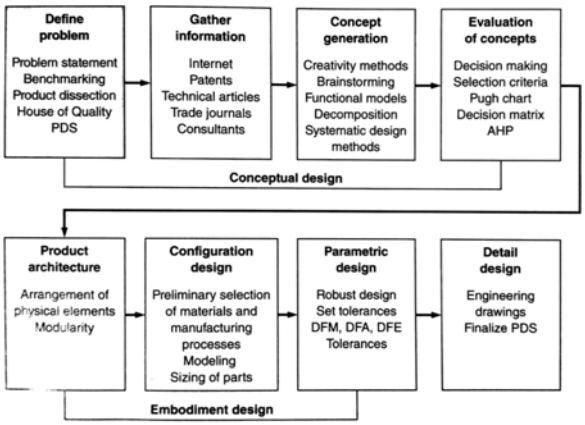


**Figure-1.** Discrete steps in engineering design process from problem definition to detail design. The chief tools or techniques applicable in each step are given [5].

### 5.1. Preparation

Data was collected through set of questionnaire done by the previous study regarding PROTON cars which has taken public as the respondents.

### 5.2. Segment 1

FAST diagrams were developed base on the function analysis made as to come out with a new target cost. Then, data may be collected from the benchmarking and observations for the new concept generation and selection. At the end of segment 1, feasible design can be generated. However this case study only focuses up to the FAST diagram as to show how it can be developed and what are the benefits through this methodology.

### 5.3. Segment 2

Segment 2 is covering the next phase of engineering design process; embodiment design. From the feasible design generated in segment 1, several alternatives can be introduced. These alternatives can be developed through modelling and prototyping. They may then been critiqued based on the Design for Manufacturing and Assembly (DFMA) guidelines as to come out with few feasible models.

### 5.4. Segment 3

Segment 3 is covering the detail design phase of engineering design process. The alternatives need to be further reviewed based on the cost. Current alternative designs cost need to be compared with the previous target cost in segment 1. The final steps from Value Analysis need to be made before the alternatives can be resolved to select and propose for the best model. Selected best model may then be validated before the results can be presented and published.

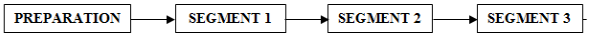


**Figure-2.** An overview of the VAVE methodology flowchart.

## 6. CASE STUDY - VEHICLE OUTER DOOR HANDLE

The company Perusahaan Otomobil Nasional (National Automotive Industry) PROTON is selected for the case study, located in Shah Alam, Selangor, Malaysia. Establish in 1983, PROTON is Malaysia's largest manufacturer of automobiles, and the only full-fledged OEM car manufacturer in Southeast Asia. Its key markets are from the United Kingdom to the Middle East and across South-East Asia and Australia - especially in countries like China, India and Iran - PROTON produces cars to suit a range of customer demands and preferences. It offerings include versatile and reliable four-door family vehicles, two-door hatchbacks for the young-at-heart, luxurious and stylish executive sedans, spacious and affordable multi-purpose vehicles, as well as the world renowned sports cars from Lotus. Most importantly, PROTON models are now developed with Lotus Engineering, offering customers a superior ride and handling experience [6], Hence, this study has applied the Functional Analysis tool to the product manufactured in this industry.

**Figure-3.** Current vehicle outer door handle.

### 6.1. Functional analysis worksheet

**Table-1.** Functional analysis worksheet for the existed vehicle outer door handle.

| PART | QTY | FUNCTION | | PART | | ASSEMBLY | |
|---|---|---|---|---|---|---|---|
| | | VERB | NOUN | * | ** | * | ** |
| Outside handle | 1 | Improve | Appearance | | X | | |
| | | Provide | Surface | X | | | |
| | | Provide | Strength | | X | | |
| | | Improve | Aesthetic | | X | | |
| | | Provide | Protection | | X | | |
| Base portion | 1 | Provide | Movement | X | | | |
| | | Provide | Strength | X | | | |
| | | Hold | Assembly | X | | X | |
| | | Support | Handle | | X | | |
| Grip portion | 1 | Facilitate | Working | | X | | |
| | | Open | Door | | X | | |
| | | Provide | Grip | | X | | |
| | | Provide | Surface | | X | | |
| | | Provide | Strength | X | | | |
| | | Pull | Door | | X | | |
| | | Pull | Handle | | X | | |
| | | Provide | Ergonomic | | X | | |
| Case portion | 1 | Hold | Assembly | X | | X | |
| | | Provide | Movement | X | | | |
| | | Provide | Locking | | X | | |
| | | Provide | Safety | | X | | |
| | | Provide | Strength | X | | | |
| | | Support | Handle | | X | | |
| | | Hold | Parts | | X | | |
| Bell crank | 1 | Provide | Movement | | X | | |
| | | Provide | Strength | X | | | |
| | | Hold | Assembly | X | | X | |
| | | Facilitate | Locking | | X | | |
| | | Tug | Handle | | X | | |
| Spring | 1 | Provide | Movement | | X | | |
| | | Hold | Assembly | X | | X | |
| | | Provide | Stiffness | | X | | |
| Pin | 1 | Hold | Assembly | X | | X | |
| | | Support | Load | | X | | |
| Clip | 1 | Hold | Rod | | X | X | |
| | | Provide | Movement | | X | | |
| | | Provide | Strength | X | | | |
| Clip | 1 | Hold | Assembly | X | | | |
| Counter-weight | 1 | Support | Load | | X | | |

Functional Analysis Worksheet of the existed vehicle outer door handle has been developed as in Table-1. This was the basis for the FAST diagrams development by which the basic (*) and secondary (**) functions of the

part and assembly been ranked according to the particular functions of each components.

### 6.2. FAST diagram

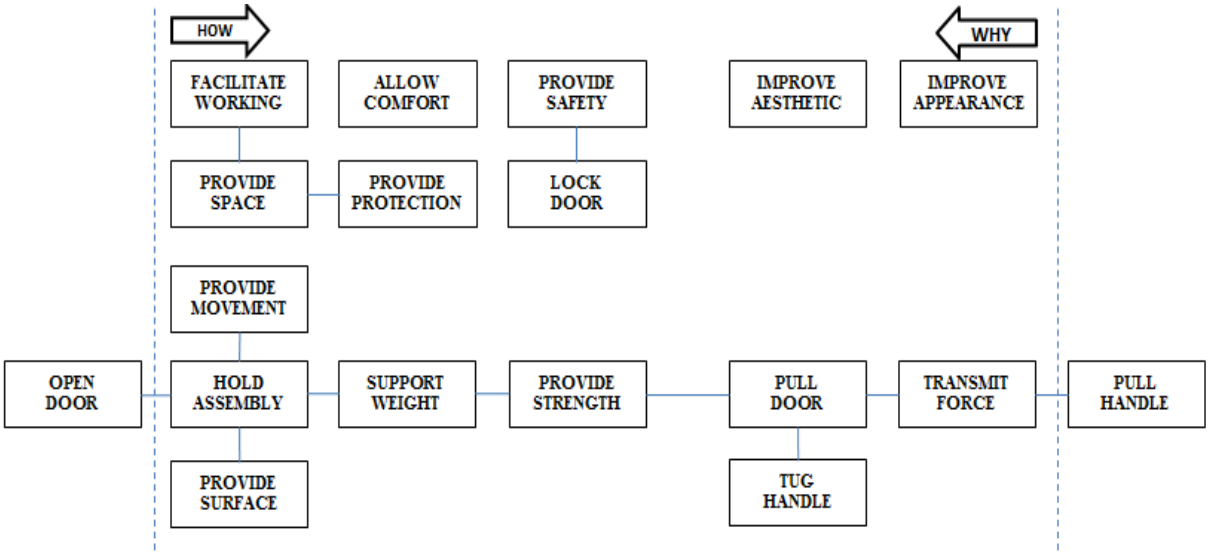


**Figure-4.** FAST diagram of the current outer door handle.

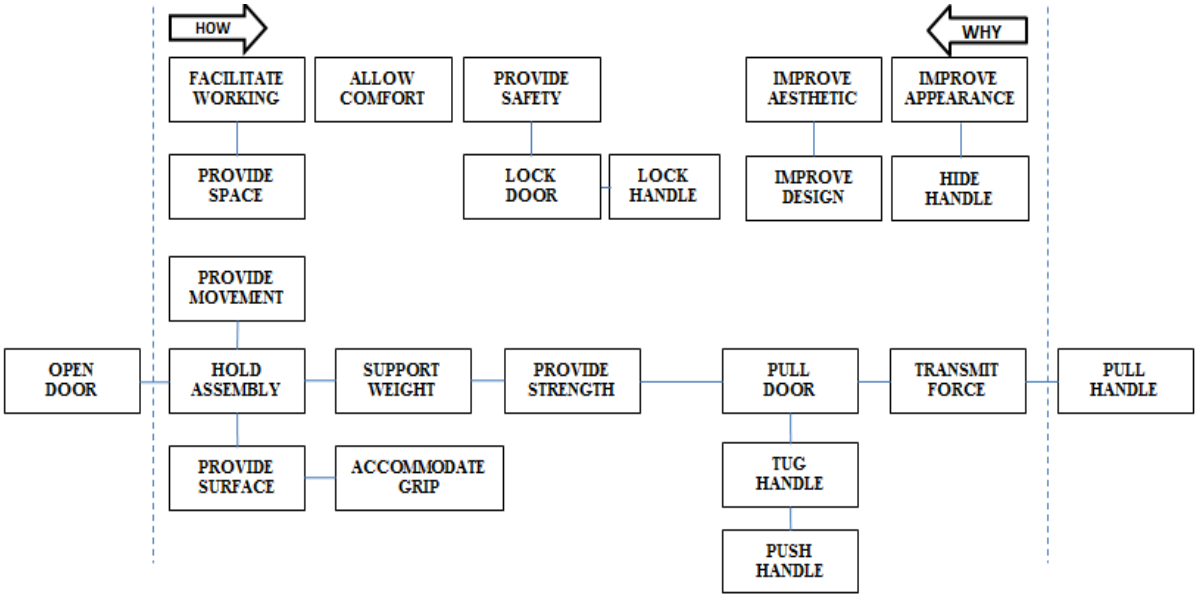


**Figure-5.** FAST diagram of the outer door handle proposed.

## 7. CONCLUSION AND RECOMMENDATIONS

In conclusion, Functional Analysis may be used to enhance product performance while maintaining its intended functions for solving particular problems without scarifying any project requirements for safety, quality, operations, maintenance or environment. FAST diagram applied shows the concept of concurrent engineering which give new opportunities for multidiscipline team to work together at the same time on the basic functions and to set the scope of the project undertaken. It allows the unlimited alternative ideas to be generated for the particular problem solutions within the scope lines, thus developing their potentials.

In the Case Study discussed above, Functional Analysis Worksheet of the existed vehicle outer door handle has been developed which shown in Table-1 as the

basis for the FAST diagrams development. The basic and secondary functions of the part and assembly been ranked according to the particular functions for each components. From the FAST diagram of the proposed idea, we can see that by scarifying one function in the existed model FAST diagram lead the study to have another five new different functions. This will eventually give us the opportunity in the future design to increase the value of the door handle to the customer by mean of functions to be increased while costs to be kept constant or reduced. In future, we can continue the validation analysis for any new design of the outer door handle using VAVE methodology so that the value of the said product can be enhanced.

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