

# Challenges Encountered by University Students when Constructing FAST Diagrams

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## Abstract

Function Analysis System Technique (FAST) diagramming is a key component of Function Analysis. It contributes to Value Engineering (VE) teams' understanding of the scope of VE studies and maximizes the number of identified VE alternatives. This paper identified some of the challenges encountered by university students in constructing FAST diagrams. This was accomplished through the assessment of 36 FAST diagrams constructed by 36 students and five FAST diagrams constructed by five teams of 24 students. The assessment found less flaws in FAST diagrams when students work as a team rather than as individuals. The analysis also found difficulties associated with understanding and linking functions in the When logic or same time functions. To overcome this issue, the paper is suggesting the use of a "Function Block" approach to facilitate the understanding and construction of FAST diagrams. The new approach was tested by three teams of 13 students to identify its advantages and disadvantages.

**Keywords:** FAST Diagrams, University Students.

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## INTRODUCTION

In 1965, FAST diagramming was presented by Charles By the way at the Society of American Value Engineers conference. Since then, it has become an indispensable tool for effective Value Engineering (VE) studies. It is used to facilitate the understanding of functions' relationships during the Function Analysis Phase. It helps VE team members to transform their thinking from the items within the VE scope to the functions of these items.

VE is one of the courses provided by the Construction Engineering and Management (CEM) Master Program of King Fahd University of Petroleum and Minerals (KFUPM). Students attending VE are required to conduct VE studies on projects and products and present a summary of their VE studies. Some of the presented FAST diagrams were incomplete. This led to the need to identify the challenges encountered by university students in constructing FAST diagrams and recommending improvements. To fulfill this objective, FAST diagrams of 36 VE studies were assessed. Then, five teams of 5 students each were tasked to each conduct a VE study. The goal was to compare the completion of FAST diagrams constructed individually to the ones constructed by the teams of students.

Finally, the five teams were requested to list the challenges they encountered while constructing the FAST diagrams.

The paper found that FAST diagrams constructed by teams of students are more complete than the ones constructed individually which was expected due to the group dynamic aspects of function analysis. The study also found that in all FAST diagrams there are difficulties associated with the functions in the When logic direction. To overcome this difficulty, the "Function Block" approach was recommended and tested by teams of students. The teams constructed FAST diagrams using Function Block method and identified key advantages and disadvantages.

## FAST Diagramming

FAST diagramming is useful in explaining the functional relationships among items within the scope of a VE study. This approach is also useful in paving the road for the creativity phase, by shifting the attention of the VE team from the items of the VE scope to their functions. In many ways, the mapping of functions facilitates the identification of value improvement opportunities, such as identifying

redundant or unwanted functions. Figure -1 shows the basic components of a FAST diagram.

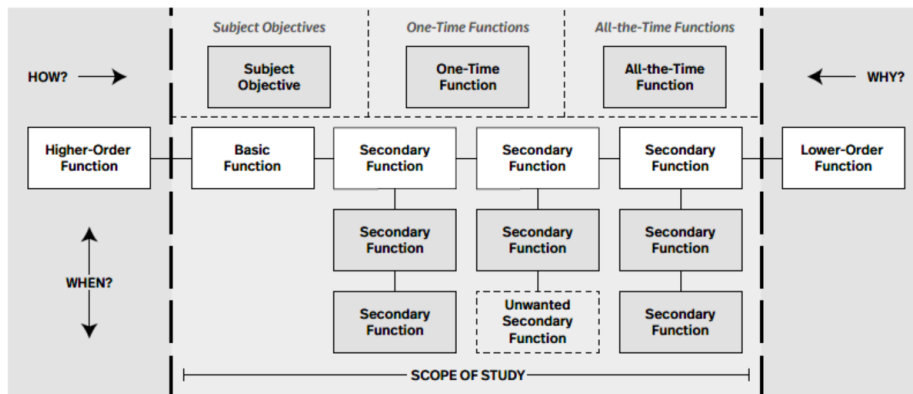


Figure-1: Basic Components of a FAST Diagram [Ref. # 40]

The key components of a FAST diagram and their descriptions follow:

- Basic function: The purpose of the item under study. It is positioned to the immediate right of the left scope line.
- Scope of the VE study: Two vertical dotted lines that bound the item under study.
- Critical path functions: All functions on the How and Why logic are critical path functions.
- Highest order function: The objective of the basic function. It is placed to the left of the basic function and outside the left scope line.
- Lowest order function: The input function of the item under study. It appears outside the right scope line.
- Concurrent functions: All functions on the When logic that take place at the same time of functions on the How and Why logic.

**Study**

An investigation was conducted to identify the challenges encountered by university students in the construction of FAST diagrams. It assessed the FAST diagrams of two groups of students. The details of the two groups follow:

**Group # 1**

- 36 students.
- 36 VE studies [Ref # 1 – 15, 17, 19 – 29, 31 – 34, 37 – 39, 41, 46 & 47].
- VE studies were conducted between September 2019 to June 2021.

**Group # 2**

- 24 students.
- Five VE studies (4 to 5 students per study) [ Ref # 16, 18, 35, 36 & 45].
- VE studies were conducted between September 2021 to December 2021.

The comparison of the FAST diagrams constructed by the two groups is summarized in Figure-2. It shows that students working as teams have more complete FAST diagrams than students working individually. But both groups were similarly challenged with mapping concurrent functions on the When logic direction.

Samples for the FAST diagrams of Group #1 is illustrated by Figures 3 & 4. Also, samples for the FAST diagrams of Group # 2 are illustrated by Figures 5 & 6.

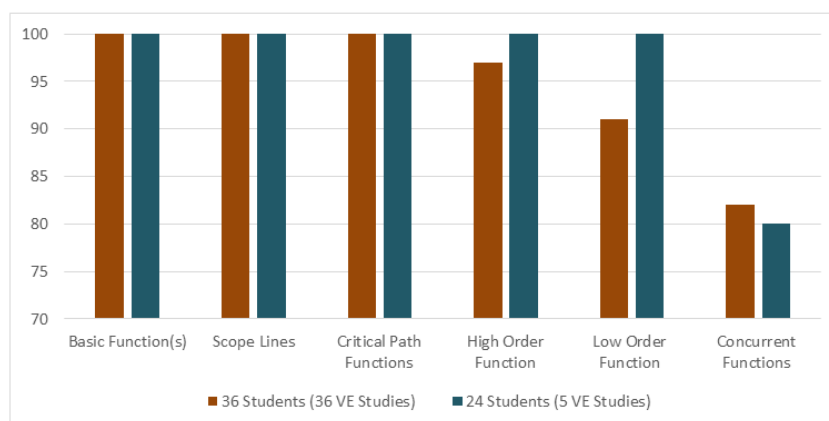


Figure-2: Comparison of Key FAST Diagram Components for Two Groups of Students

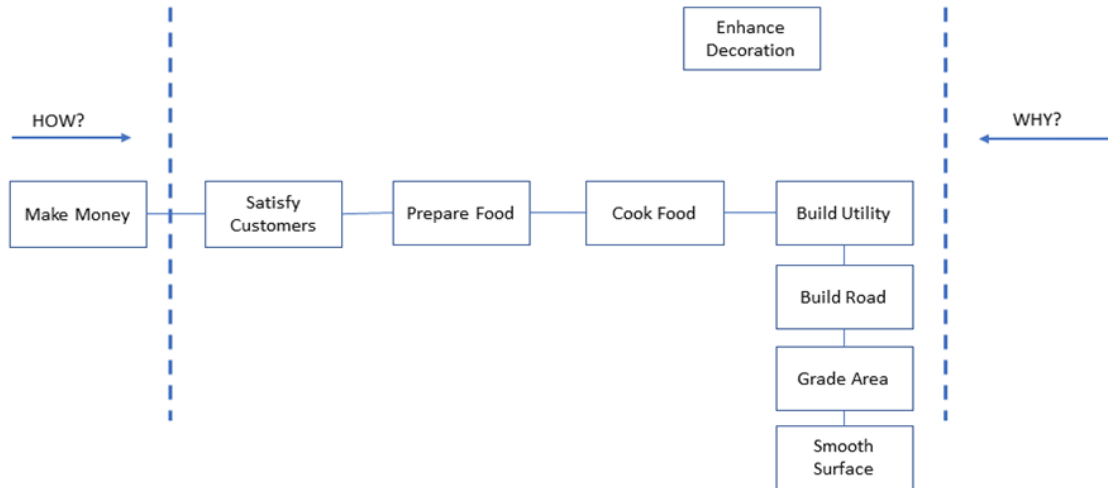


Figure-3: Sample (I) of a FAST Diagram Conducted by a Student [Ref # 21] Regarding a Fast Food Restaurant

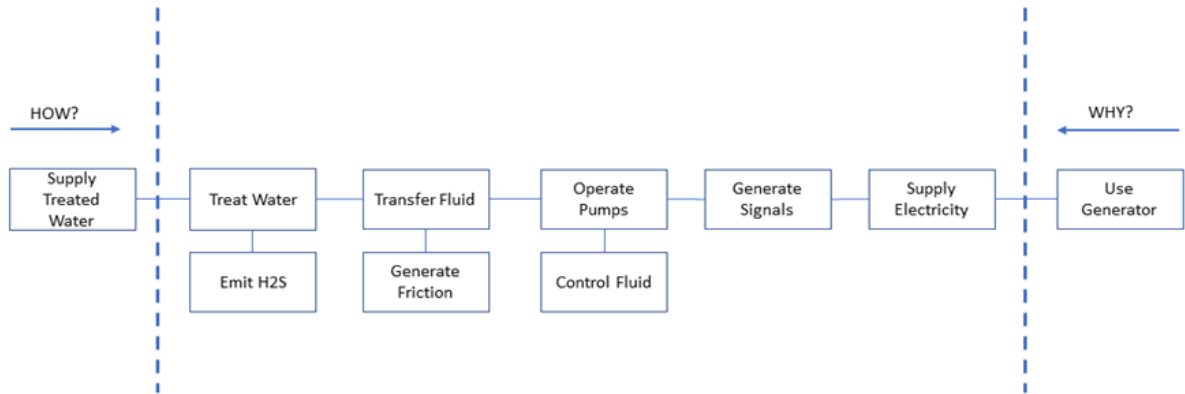


Figure-4: Sample (II) of a FAST Diagram Conducted by a Student [Ref # 31] Regarding a Gas Plant Reverse Osmosis Process

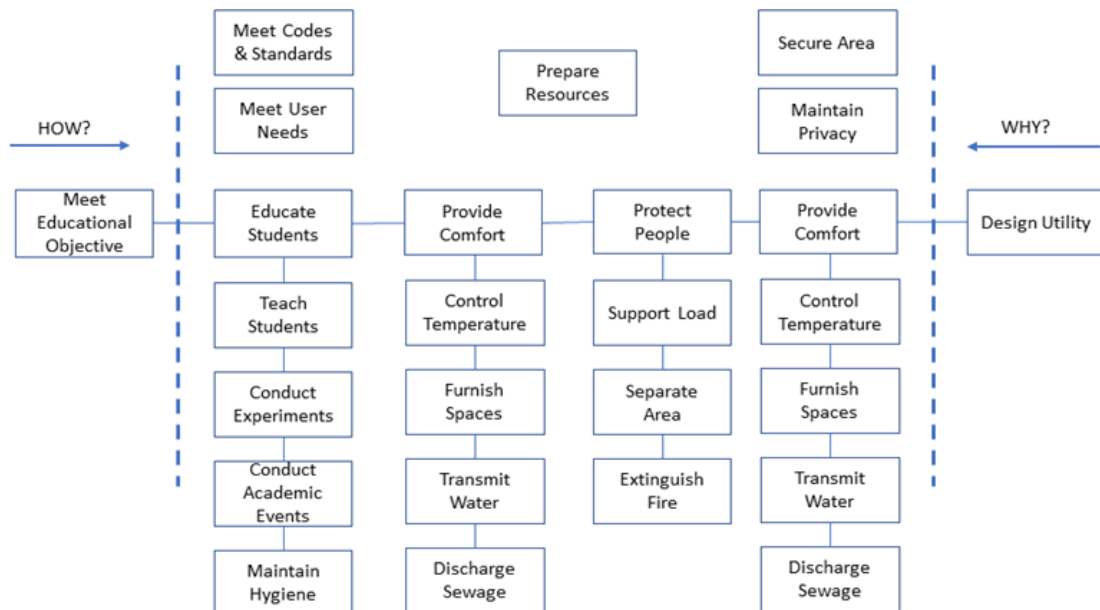


Figure-5: Sample (I) of a FAST Diagram Conducted by a Team of Students [Ref # 16] Regarding the Development of an Educational Facility

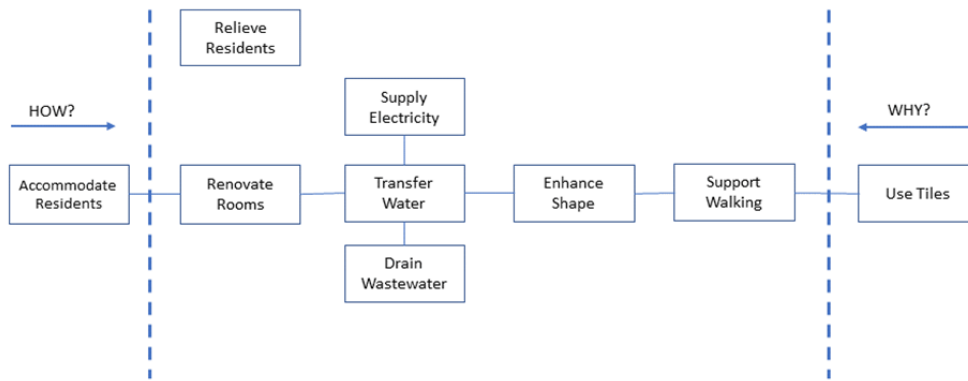


Figure-6: Sample (II) of a FAST Diagram Conducted by a Team of Students [Ref # 35] Regarding the Renovation of a Hotel

A discussion was conducted with Group # 2 to highlight the challenges students encountered during the construction of their FAST diagrams. Feedback received included the following comments and challenges:

- “Identifying basic and secondary functions”
- “Team agreement on FAST diagrams”
- “Identifying functions for FAST diagrams”
- “Fulfilling FAST diagrams’ How – Why logic”
- “Forming functions in terms of Active Verb and Measurable Noun”
- “Defining the scope boundary”
- “Placement of functions in the When logic”
- “Overlapping secondary functions”

The discussion went further to identify the causes that led to the challenges encountered in constructing FAST diagrams. Students came up with the following causes:

- “Different opinions from team members”
- “Intention of FAST diagram”
- “Method of communication”
- “Preparation was incomplete”
- “Limited time for the construction of FAST diagram”
- “Team collaboration”
- “Logic building”
- “Team lack of knowledge and experience”
- “Lack of fluency with FAST diagrams”
- “Understanding what are the most important functions”

The feedback highlighted that FAST diagrams are more complete and easier to construct when the

work of early VE study phases are done properly. FAST diagrams will be more complete when team members are cooperative, detailed scope information is available and functions are clearly defined. More attention and discussion required on the functional logic of FAST diagrams in the Why, How and When logic directions. The results of this feedback led to the recommendation of using the “Function Block” method that has the necessary information to facilitate the construction of FAST diagrams [Figure - 7]. The “Function Block” has the following components:

- Item: The product or project that is being reviewed through the value engineering or value methodology approach.
- Function: A function of the item being value engineered.
- Alternative: The least cost alternative that can accomplish the function of the item being value engineered.
- Function Cost: The cost of the item being value engineered.
- Function Worth: The least cost of an alternative that can accomplish the function of the item being value engineered.
- Value Index: A measure of functions’ potential for value improvement. It can be calculated as function cost divided by function worth.
- Why Function: The function that fulfills the Why logic.
- How Function: The function that fulfills the How logic
- When Function: The function that fulfills the When logic.

Item	Value Index	Alternative
Function Cost		Function Worth
Why Function	Function	How Function
	When Function	

Figure-7: Basic Components of the Recommended Function Block

In March 2022, the recommendation of using function block was tested by three teams of 13 students (4 to 5 students per group). Each team conducted a VE project and was tasked to generate a technical FAST diagram in addition to a FAST diagram using the

function block. Then, the diagrams were discussed and key advantages and disadvantages of the new method compared to the technical FAST diagram were identified. The FAST diagrams of the three teams are illustrated in the following figures

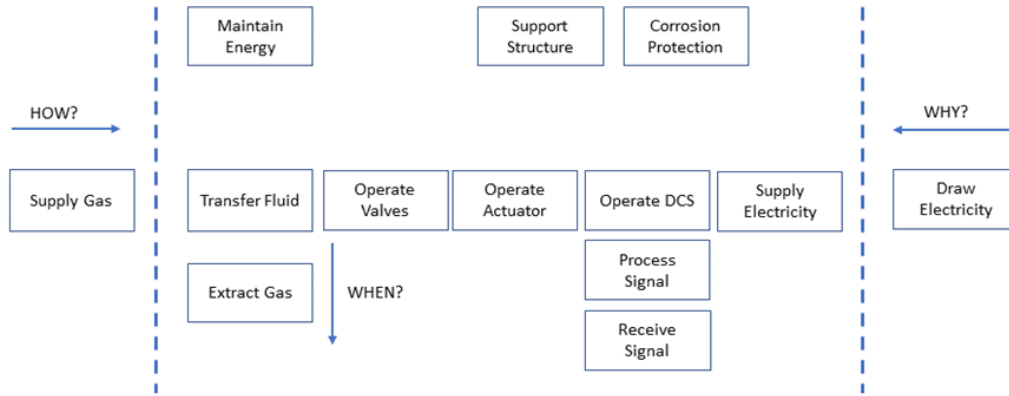


Figure-8: FAST Diagram of a Gas Pipeline Project [Ref # 43]

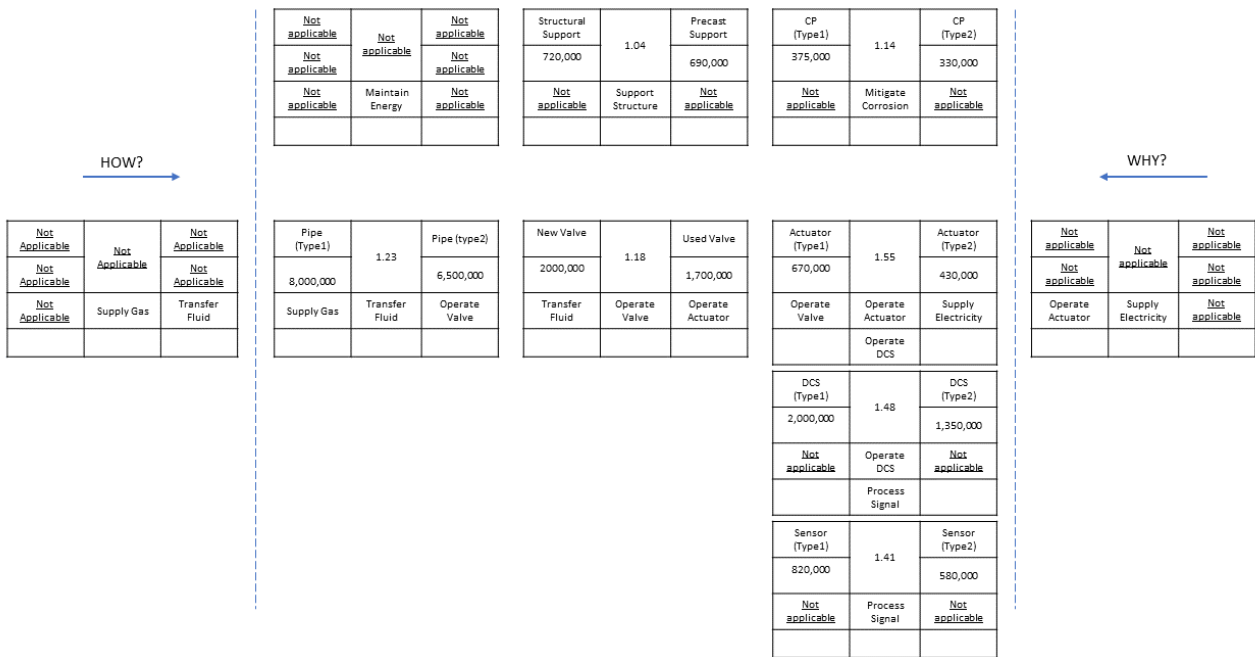


Figure-9: Function Block FAST Diagram of a Gas Pipeline Project [Ref # 43]

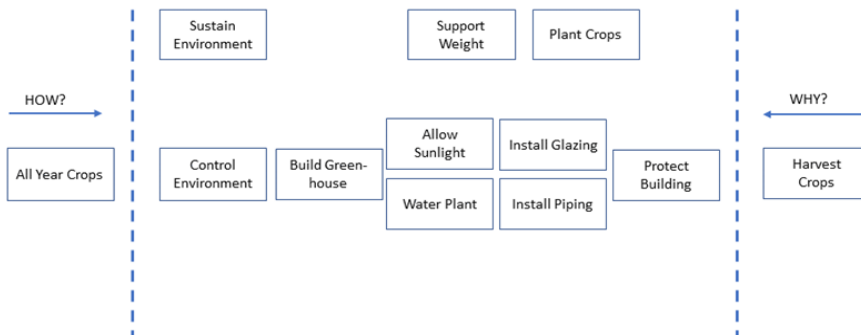


Figure-10: FAST Diagram of a Green House Building Project [Ref # 44]

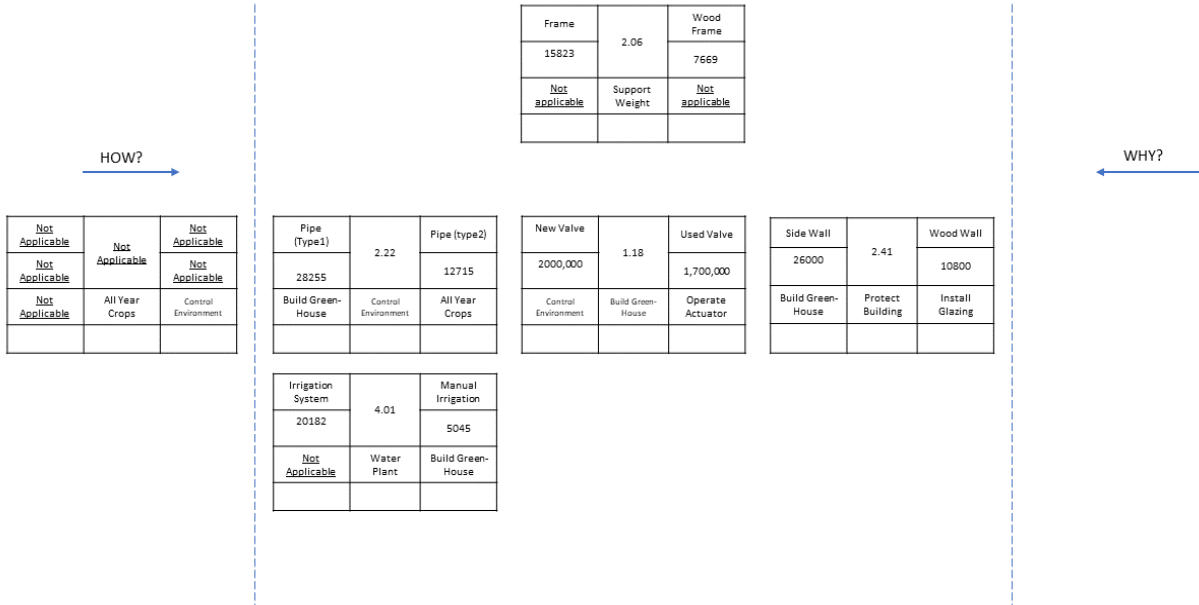


Figure-11: Function Block FAST Diagram of a Green House Building Project [Ref # 44]

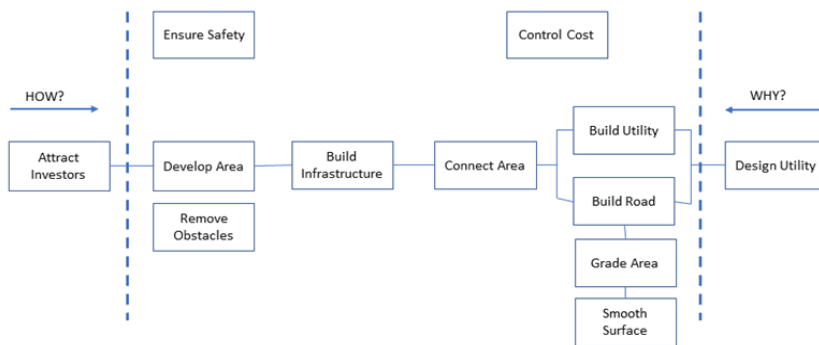


Figure-12 FAST Diagram of an Infrastructure Project [Ref # 42]

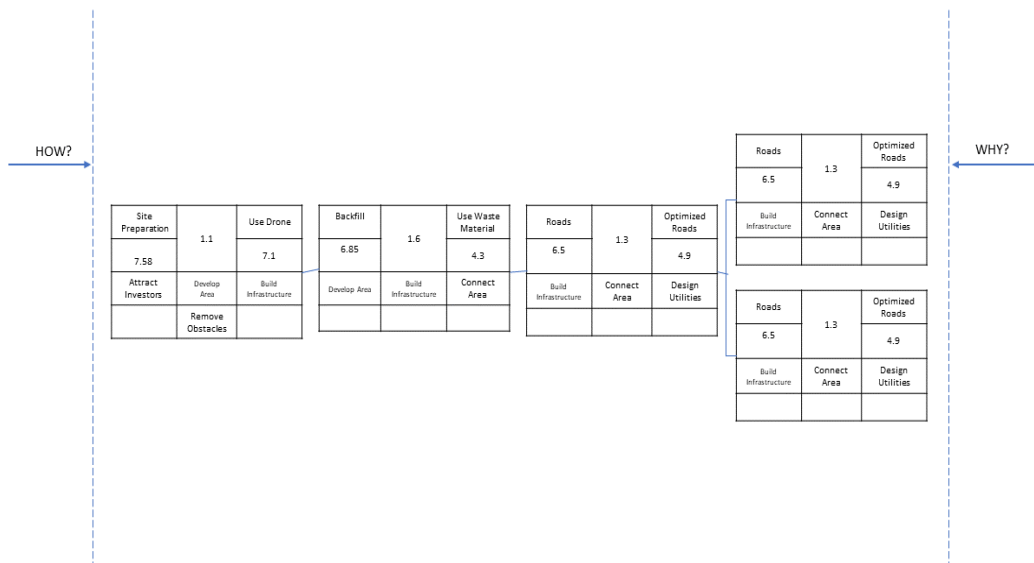


Figure-13: Function Block FAST Diagram of an Infrastructure Project [Ref # 42]

The three teams highlighted the following benefits of using the Function Block method:

- “It summaries all needed information of functions”
- “It integrates the system objective(s), component functions and cost breakdown”
- “It helps to visualize the impact of the secondary and unwanted functions to the overall project budget”
- “It helps to focus on the big cost contributors”

On the other hand, the following disadvantages were underlined by the three groups:

- “It is more difficult for complex projects”
- “It is difficult to represent design function, all time function, one-time function, high order function and low order function”
- “It requires training”
- “It has duplicated information next to each other”

## CONCLUSION

This paper investigated the challenges encountered by university students during the construction of FAST diagrams. There were several identified challenges, such as the definition of functions using an active verb and measurable noun construct and causes such as time constraints. The assessment of FAST diagrams and the discussion with students directed attention towards the logical relationship of functions, especially in the When logic direction. To facilitate the construction of FAST diagrams by students, it is recommended to use the “Function Block” approach. The creation of a function block for each item within the VE scope provides key information that simplifies the logical functional linkage of functions within the scope of VE studies. When tested by three teams of students, it showed promising benefits. However, it is recommended for use in simple scoped projects and for driving functional analysis thinking for university students.

**Biography** Muhammad Al-Ghamdi has more than 20 years of experience and currently works as a Value Management Specialist for Saudi Aramco. He holds a Ph.D. degree in Construction Management and Engineering from Reading University (2000) and has several professional certifications, including: Certified Cost Consultant (2003), Certified Value Specialist (2004), Project Management Professional (2004) and Certified Project Management Office Professional (2021). Muhammad also teaches Value Engineering at King Fahd University of Petroleum and Minerals (KFUPM).

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