

FAST DIAGRAMMING: A TECHNIQUE TO FACILITATE DESIGN ALTERNATIVES



Gershon Blumstein
EDS, Warren, Michigan

Gershon Blumstein is a Senior Engineer for EDS responsible for providing Quality Function Deployment, Value Engineering (VE), Trade Studies and Risk Analysis, and Design For Excellence for GM's Small Car Group. He also has experience in Program Management, Concurrent Engineering, and Manufacturing. Gershon has published more than twenty technical articles and has been the recipient of ACE's Cost Engineer of the Year, and the Taguchi Quality Award.

ABSTRACT

The objective of this paper is to explain how to use the information generated from the FAST (Functional Analysis System Technique) diagram and to choose the best alternative that meets the requirements defined in the Technical or Customer FAST.

- Focuses function to be met by optimally satisfying the stated functions in such areas as customer needs, engineering/manufacturing specifications, marketing, and serviceability
- Demonstrates that the chosen alternative satisfy the functions of the FAST diagram
- Assures that sufficient information for decision making is provided
- Helps document the understanding of the desired functions for each element of the FAST diagram
- Assists in identifying areas for improvement
- Increases the quality of decisions
- Provides a competitive advantage

WHAT IS A DESIGN ALTERNATIVE STUDY?

The Design Alternative Study is modeled on a modified Kepno Trego Analysis Technique. This study is a structured analytical method that:

- Objectively identifies, defines, and evaluates alternatives
- Analytically presents, evaluates, and weighs decision information
- Ensures that the selected alternative best meets the Technical or Customer FAST's functional requirements.

This study considers pragmatic decision factors and interacts with other Design Alternative Studies and key issues that must be resolved.

You may decide to use this type of application of VE because it:

- Promotes objective evaluation and selection of the optimum alternative

HOW TO CONDUCT A DESIGN ALTERNATIVE STUDY

One of the most critical decisions in the planning of any system is the selection of the best conceptual design with which to proceed. The rest of this paper deals with how to conduct a Design Alternative Study.

STEP ONE -- DEFINE THE SCOPE

The subject of the Design Alternative Study and the reasons for performing the study is the starting point for identifying and defining the functions used to evaluate the alternatives. The key points to be considered when defining the scope are:

- Who is affected by the decision?
- How important is the decision?

- Who has the authority to make the decision?
- How much time will the study take?
- Have the alternatives been developed?

STEP TWO -- ASSEMBLE AND EMPOWER THE TEAM

Managers whose people are involved in the Design Alternative Study should become familiar with the process. This helps them understand the need for the team's process, structure, and discipline. Also management must commit the necessary resources to get the study done properly. If the Design Alternative Study becomes a part of the established process, the chance for success and value to the organization becomes measurably increased. Managers who take an active role by attending the study and supporting the Design Alternative Study results, add measurably to the probability of the study's success and value to the organization.

These are some points to remember:

- The team needs to represent those impacted by the decision
- The team leader selected should support the facilitator
- The team must reach agreement on their decision processes such as what constitutes consensus
- Much of the actual work occurs inside the meetings.

STEP THREE -- TRAINING THE TEAM

If training is necessary to empower the team, please review the different steps identified in this paper with the team that will be performing the Design Alternative Study.

STEP FOUR -- ESTABLISH FUNCTIONS

At this point, the team must use Functional Analysis (Technical or Customer FAST diagrams) to define the reasons for having a product feature or explain the need it fulfills. The first word must be an action verb that describes what function the system does. The second word must be a noun describing the object which the action verb performs to or with. For example, to apply a primer, the manu-

facturing plant wanted to Eliminate Drips, Maintain The Current Supplier, and Add No New Technology. The list of these functions is used in later steps to help determine the best solution when eliminating the other possible alternatives.

STEP FIVE -- PRIORITIZE FUNCTIONS

The next step is to establish weights for the functions and record the weight for each function. To assist in developing weights, the team can use the following techniques: Analytic Hierarchy Process, Delphi, Pair-Wise Comparison, or Banding. I have had the most success using the Banding process. The team then decides the value of each function using a numerical grading process. The scale can be one through five, one being a low priority for a particular function and five being a high priority for that function.

Eliminate Drips	5
Maintain Supplier	4
No New Technology	1

CHART I -- PRIORITIZE FUNCTIONS

STEP SIX -- DETERMINE ALTERNATIVES

There are a number of different methods to identify the alternatives used in the Design Alternative Study. Any method that is used should include the following elements:

- Identify the appropriate set of viable alternatives
- Limit the set of alternatives to the available resource
- Clearly define and determine the uniqueness of each alternative
- Prescreen each alternative
- Document the eliminated alternatives
- Define time and cost constraints
- Achieve agreement on the alternatives

		Alt 1	Alt 2	Alt 3
Eliminate Drips	5			
Maintain Supplier	4			
No New Technology	1			

CHART II -- ALTERNATIVES

The team needs to reach a consensus and understand each alternative.

STEP SEVEN -- SCORE ALTERNATIVES

The team, under the direction of a facilitator, evaluates each alternative against each function. Within the context of the Design Alternative Study, one of the key principles is to establish relative performance among the alternatives under the study. Alternatives should be rated against each other for each function. This can be done as simply as rating each alternative. A score of one is the worst relative rating for that function, a score of nine is the best relative rating for the function, and a score of three is the neutral point.

		Alt 1	Alt 2	Alt 3
Eliminate Drips	5	1	3	3
Maintain Supplier	4	9	1	3
No New Technology	1	3	3	3

CHART III -- SCORE ALTERNATIVES

STEP EIGHT -- CALCULATE

The next step is to calculate the score for each alternative using the following formula:

- $S = W \times R$ -- Where W is equal to the weighting assigned to each function and R is the relative rating of a particular alternative
- Total the score for each alternative
- Note the highest scoring alternative(s)

		Alt 1	Alt 2	Alt 3
Eliminate Drips	5	1	3	3
Maintain Supplier	4	9	1	3
No New Technology	1	3	3	3
		44	23	30

CHART IV -- CALCULATE

STEP NINE -- ASSESS SENSITIVITY

A sensitivity analysis must be made to determine the value of the results. This is especially important where performance estimates are developed without the benefit of operational data. The deliverable of a sensitivity analysis is to clearly understand the reasons for the sensitivity, and begin to formulate a root cause approach to provide a robust resolution to the key issues for the study. It is also important to understand the relationships between these alternatives and the functions in these sensitive areas, and determine how and why these impacts occur.

To assess sensitivity:

- Change the weights of the functions
- Record the new total score and compare it to the original scores
- Note whether there are significant changes in the new total score compared to the original score, and what those changes are

The key factor is to determine if the alternative with the highest score originally, still remains the highest scoring alternative. If this is not the case, the alternative(s) are sensitive to the weightings for the particular function that was changes.

		Alt 1	Alt 2	Alt 3
Eliminate Drips	5	1	3	3
Maintain Supplier	4	9	1/9	3
No New Technology	1	3	3	3
		44	23/55	30

CHART V -- ASSESS SENSITIVITY

STEP TEN -- RISK ANALYSIS

Uncertainty will exist when the team implements the best alternative identified in the Design Alternative Study. The purpose of the Risk Analysis is to identify and manage the elements of uncertainty. The Risk Analysis is not to eliminate all uncertainty about the success of all desired outcomes but provides a method to identify the various elements of uncertainty that must be controlled by management instead of managed by the organization.

This methodology assigns value to the management of those elements based on their severity of occurrence and the probability of their occurrence.

The first step is to brainstorm all the possible risks that must be controlled if the alternative identified in Step Seven is implemented. The next step is to assess those risk items using the following formula:

$S = SV \times P$ -- where SV is equal to the severity of each risk item. The rating is one through five. One is a low severity ranking, and a five is a high severity ranking.
P is the probability of each risk item occurring. A score of one is a low relative rating for the risk to occur, and a score of nine is a high relative rating for the risk to occur, and a score of three is the neutral point.

The last step is to prioritize the risks according to their scores. The risks should be ranked from the highest score to the lowest score.

STEP ELEVEN -- PRESENT TO MANAGEMENT

The output of a Design Alternative Study is a summary report of the selected optimum alternative that provides all of the information needed to communicate why the alternative was chosen. All of the information on all of the alternatives and the risk analysis should be included.

CONCLUSION

The Design Alternative Study leads a team through a controlled convergence to the optimum alternative. The following summarizes how a team should execute the methodology:

- Identify the functions that an optimum alternative shall have
- Weigh the importance of each function
- Establish guidelines for rating each function
- Score each alternative relative to each other, based on the weight and rate of each function
- Total the scores to find the best alternative
- Assess the sensitivity to ensure that the chosen alternative has been selected without using a function that has been inflected with personal bias
- Determine the risk associated with the best alternative
- Document the entire process and relay the information to management in a summary presentation

The benefits of the Design Alternative Study are:

- Minimize subjective evaluation
- Provide sufficient information for making decisions
- Document and apply lessons learned
- Encourage continual improvement
- Establish a baseline for future development
- Encompass a balanced set of criteria
- Support and facilitate Concurrent Engineering
- Encourage proactive work ethics instead of reactive behavior
- Reduce overall risk through planned control

The ultimate result of a Design Alternative Study is not the selection of an optimal design, but the documentation and communication of the process. The reasons for not selecting certain alternatives and how certain functions were valued over others in an evaluation of alternatives should also be included.

REFERENCES

1. Snoodgrass, Thomas J., CVS and Kassi, Muthiah, CVS (1968) *Function Analysis The Stepping Stones to Good Value*: Madison, Wisconsin. University of Wisconsin Systems.

2. Gose, Vernon L., (1987) *Managing Risk Systematic Loss Prevention For Executives*: Englewood Cliffs, New Jersey. Prentice Hall.
3. Kepner, Charles H., Tregoe, Benjamin B., (1981) *The New Rational Manager*: Princeton, New Jersey. Princeton Research Press.