



Situation Analysis

The first step in the process of innovation

The American approach to systematic innovation—merging the problem-solving methods with a thorough understanding of the customer's needs and the technological capabilities of the industry—accelerates the creation of new, successful products and processes. However, before embarking on the journey to innovation, disciplined preparation can make the difference between success and failure. A clear statement of the problem, a clear understanding of why innovation is needed, and a detailed analysis of the existing system/situation are essential to success.

Usually, an innovation project involves the following steps:

1. Recognition of a need – the functional requirements have been clearly defined and stated; (this is a prerequisite to develop Solved State requirements)
2. Describe the Solved State
3. Generate ideas on how to fulfill the need
4. Develop viable concepts based on generated ideas
5. Develop a design based on the concepts
6. Implement the design

A need can present itself in many forms and shapes. It could be a particular manufacturing or performance issue, or it could be as general as finding a way to reduce cost. What is the normal response to a problem? In many instances, the people responsible for problem solving start generating ideas immediately. Quite often, however, and for various reasons, these very people have limited knowledge about the problematic system.

Let's compare a problem-solving process to a legal case. The US justice system requires withholding judgment until all the facts are known, until all the biases and preconceived notions of guilt or innocence are set aside. We all should display similar discipline when we are faced with a problem in engineering or business. To help a team stay the course in a problem-solving process, one may use the following guidelines:

1. Organize the knowledge about the system/situation
2. Develop a functional model of the system/situation
3. Analyze the model for problem solving ideas

1. Organize the knowledge about the system/situation

Miles [1] recognized the need for functional analysis in problem-solving processes in the 1940s. He also recognized the difference between the intent of

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the design, “what it must do”, and “how it does it”. This is a very important distinction. Miles also developed a list of questions enabling the understanding of intended function.

Since Miles started his work, a number of questionnaires, which address various aspects of the system/situation, have been developed. Some are more effective than the others. The main goal of conducting a questionnaire is to collect as much information about a system/situation as possible in a format conducive to the problem-solving process. One needs to understand the intended functionality, the available resources, and the internal conflicts within the system/situation.

The answers to following questions are helpful:

- What is the name of the system?
- What is the main useful function of the system?
- What is the system structure?
- What is the problem with the system?
- What resources are available to aid problem solving?
- What constraints are placed on potential solutions?
- What has been attempted to solve the problem and why did it not succeed?

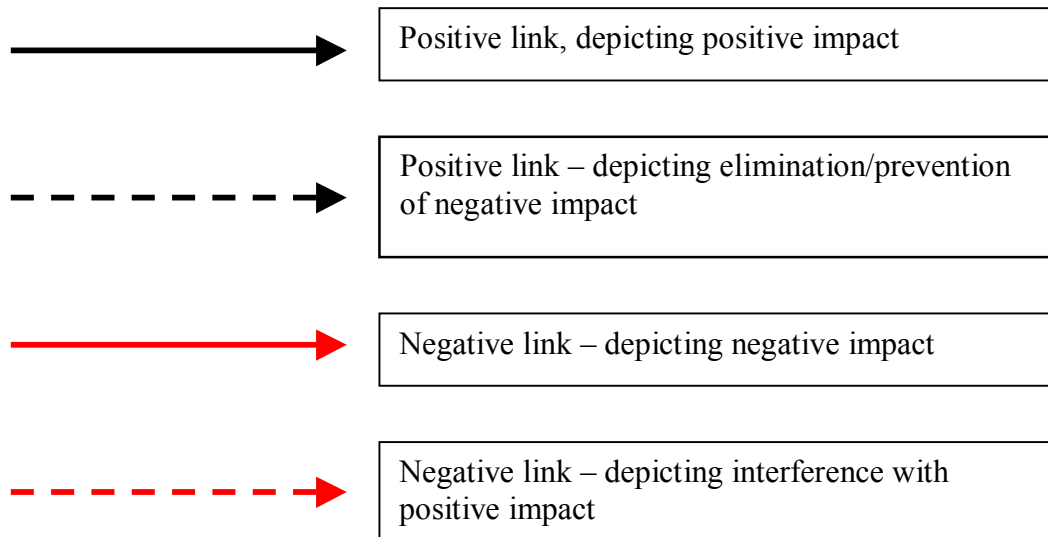
The last question is very important since volumes are written about successes and very little is normally known about failures. However, a failure may be reversed if a necessary resource is located.

2. Develop a functional model of the system/situation

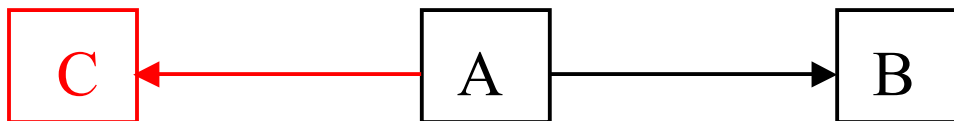
The next step in the process is a functional model of the system/situation. There are a number of different system-modeling techniques in existence today. In the early 1970s, Bytheway [2] developed the Function Analysis System Technique or FAST process. The FAST process supports development of a graphical model that provides the means of communication between the members of a cross-functional team. Here, the system is described on a functional level where the main and auxiliary useful functions are arranged in a cause-effect sequence.

An extension to the FAST diagram is a model which also includes harmful, unintended, functions. Here, the system is described graphically on a functional level where harmful functions are included with the main and auxiliary useful functions in the cause-effect sequence.

In order to build a clear model of the system/situation, we establish the following convention:



Now, let's build a sample diagram:



The useful function **A** produces useful function/effect **B**, and harmful function/effect **C**. A simple analysis of the above diagram reveals some information, which is known, yet is not normally considered. As an example, when turning a piece of metal, a useful function is making the part, and a harmful function is making waste.

How best to transition from a questionnaire to a model? To start with, we need to remember the system approach, which identifies the system, sub-system, and super-system. One may ask, “What does the system approach have to do with building a functional model of the system?” The answer to this question is quite simple: we need to have a very clear picture in our head of where we need to start and where we need to finish. On what level do we want to enter the system to obtain the best results of the model analysis? There is no single answer to this question; each situation will dictate the most fruitful approach. However, there are a few rules that may help in building a model.

First, we need to be at least one level above the level of the perceived problem. For example, when discussing a cooling system in a deep mine, what is the

system? Is it the cooling system? Or is it the mine? I recommend the mine for a simple reason: entering the system on the problem level may result in addressing the symptom rather than the real issue. On the other hand, when looking to develop a new material we need to start on the bottom, physical, level of required functionality. That's where we address the fundamental properties and atomic interactions. At times, we are forced to ask additional questions to clarify the issues which arose in the process of building a diagram. This step of the problem-solving process requires, like the first step, participation of experts in the field of application.

3. Analyze the model for problem-solving ideas

Once the model is ready, it provides a very good basis for problem solving in a team environment. The functional model is an excellent generator of questions, answers to which will help generate ideas on improving the system/situation. Since it is a functional model, it captures useful, intended, functions and harmful, unintended, functions. Thus, the contradictions are easily recognized as a conflict between useful and harmful functionality of the system's segments or components. We can clearly see useful functionality which we can attempt to enhance, as well as harmful functionality which we can attempt to eliminate or reduce. We can now make a well-supported decision concerning the area of the system, which, once addressed, will provide the best return on invested time and other resources.

A simple functional analysis of a ballpoint pen reveals a few additional, unintended, functional capabilities. For example, a ballpoint pen can be used as a weapon. When I described this experience to a friend, he quickly recalled that a ballpoint pen manufacturer produced a batch of ballpoint pens, with housings made from wound wire. A battalion of paratroopers stationed nearby purchased the entire production run. With this knowledge we may then choose to either design a ballpoint pen which can't be used as a weapon or to offer a special design with enhanced weapon functionality. In short, the value of the process/product can be improved significantly when we have good understanding of functional requirements and capabilities.

Conclusion:

Although it is conceivable to improve the system/situation without an in-depth functional analysis, it is a much easier task after we have gained a good understanding of the benefits and ills of the system/situation.

References:

1. Miles, Lawrence D. "Techniques of Value Analysis and Engineering", Second edition. McGraw Hill, Inc., 1972
2. Bytheway, Charles W. "The Creative Aspects of FAST Diagramming", *SAVE Proceedings*, Vol. VI, 1979, pp. 301-312