

## Value Engineering Application in Environmental Process Design A Case Study

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### ABSTRACT

This paper presents a case study for applying value engineering (VE) principles and tools to evaluate and improve an environmental remediation process. The study participants used functional analysis to break down the complex process into its functional units, and used brainstorming techniques to generate alternative approaches. The entire VE process (except for the Post Event phase) was performed in two days. Out of the 109 ideas generated, more than 20 were selected at the highest "gut feel index" level for further evaluation. This case study points the way for very focused use of VE by small teams in highly technical areas.

### INTRODUCTION

The development of environmental remediation technologies draws heavily on the fields of chemical engineering, mechanical engineering, electrical engineering and computer science. Due to the limited scope of business in any one treatment technology, designs for equipment tend to be one-of, and do not benefit from the economy of scale of multiple-unit production.

One such treatment technology is Thermal Desorption of Polychlorinated biphenyls (PCBs). Numerous advances in the various fields of engineering listed above present potential opportunities to improve the state of the equipment used to treat PCBs, with a resulting reduction in the cost of treatment. Environmental Chemical Corporation ("Company") is a small business providing environmental remediation services to the federal government. The Company saw the potential for a well-developed and competitive PCB treatment unit, and started to develop it in late 1997; the work hinged on being awarded certain Superfund projects for the EPA.

In 1998, the award of the project was reasonably certain, and the Company moved aggressively to finalize the design of the unit. After the design was finalized, procurement started. At this stage, the Company decided that the design needed a thorough value engineering review to (a) identify operational risk areas; (b) determine any cost savings in fabrication; and (c) make changes in design that would reduce operating cost.

## PROJECT BACKGROUND

The "project" is defined as the design and fabrication of a PCB Thermal Desorption system for the Company.

The system consists of at least three unit processes and 16 unit operations, as well as a large number of mechanical items (pumps, blowers, etc), electrical power issues, and process control items. **Figure 1** shows a simplified process flow diagram for the system. The key criteria for the system were (a) its ability to process a contaminated soil at a minimum (design) flow rate; (b) the absence of any cross-contamination; (c) the ability to pass the "stack test" prior to the start of the treatment operations; and (d) its ability to run continuously with little downtime.

## NEED FOR VE

The inter-disciplinary nature of the design ensured that there was not a single person with all the requisite knowledge to evaluate the entire system. The inter-disciplinary nature also meant that there was not a single, unifying, language used in describing the process - - chemical engineers and mechanical engineers both spoke of a "unit operation" and meant different things!

The authors of this paper were struggling with the issue of an "appropriate" review of the system when they attended a Basic Course in Value Engineering. This system was the ideal project for applying Functional Analysis as a means to simplify all the technical jargon, and to unify engineers and scientists with different backgrounds to work on improving the system.

The project was set up as a traditional seven-step value engineering review<sup>1</sup>, and the next seven sections describe our approach to each of the phases (see **Figure 2**). In this paper we are pointing out those issues that were unusual or compelling, rather than the full application.

## PRE-EVENT PHASE

One of the critical goals of this VE study was to limit the entire process (from the Information Phase to the Implementation Phase, or writing the plan) to two (2) working days. This went against conventional wisdom that at least 3-4 days are needed to do an adequate VE study<sup>2</sup>. In order to ensure the success of

the study, it was important to provide clear instructions and assignments to the participants before the group session started. This aggressive approach does have the potential for negatively impacting the outcome of the study as too much information at this early stage can hinder the production of creative ideas during the Speculation Phase of the study. Therefore it is important to balance the study area and the VE study process.

Pre-event instructions to the VE study participants included a brief (less than one page) introduction to the VE process, the location and time the study would take place, a listing of the participants and their roles in both the project and the VE study. In addition, key project stakeholders were assigned to prepare presentations of the unit functions that defined the VE study. Pre-event planning took approximately 16 work hours by key project participants. We believe this planning phase resulted in reducing the VE study by one full day or at minimum, 56 work hours.

## INFORMATION PHASE

Our experience has shown that the Information Phase of a VE study can become a very time consuming and unproductive event if not managed properly. To ensure that the maximum value for this VE study would be achieved, we felt the Information Phase would need to be carefully planned and time limited. This was accomplished by the VE Team Leader working directly with the person that would be presenting the selected study area of this project.

We also felt that this VE study would be an opportunity to come up with beneficial alternatives to the existing Low Temperature Thermal Desorption (LTTD) design and not a lesson on how to conduct a VE study. We felt that the study group could more quickly learn the VE process through participation. Accordingly, only limited time was used to explain the VE process. The basic ground rules critical to the "brain storming" session were explained, as was FAST diagramming. Those individuals interested in learning more about the VE process were encouraged to contact SAVE International for more in-depth instruction.

The LTTD unit is a complex assembly of mechanical and electronic equipment used to treat PCB contaminated soil in a unique manner. The expedited VE study process required that each study member be able to quickly understand the function of each process unit and also how the various units relate to each other. This was accomplished by having the primary process

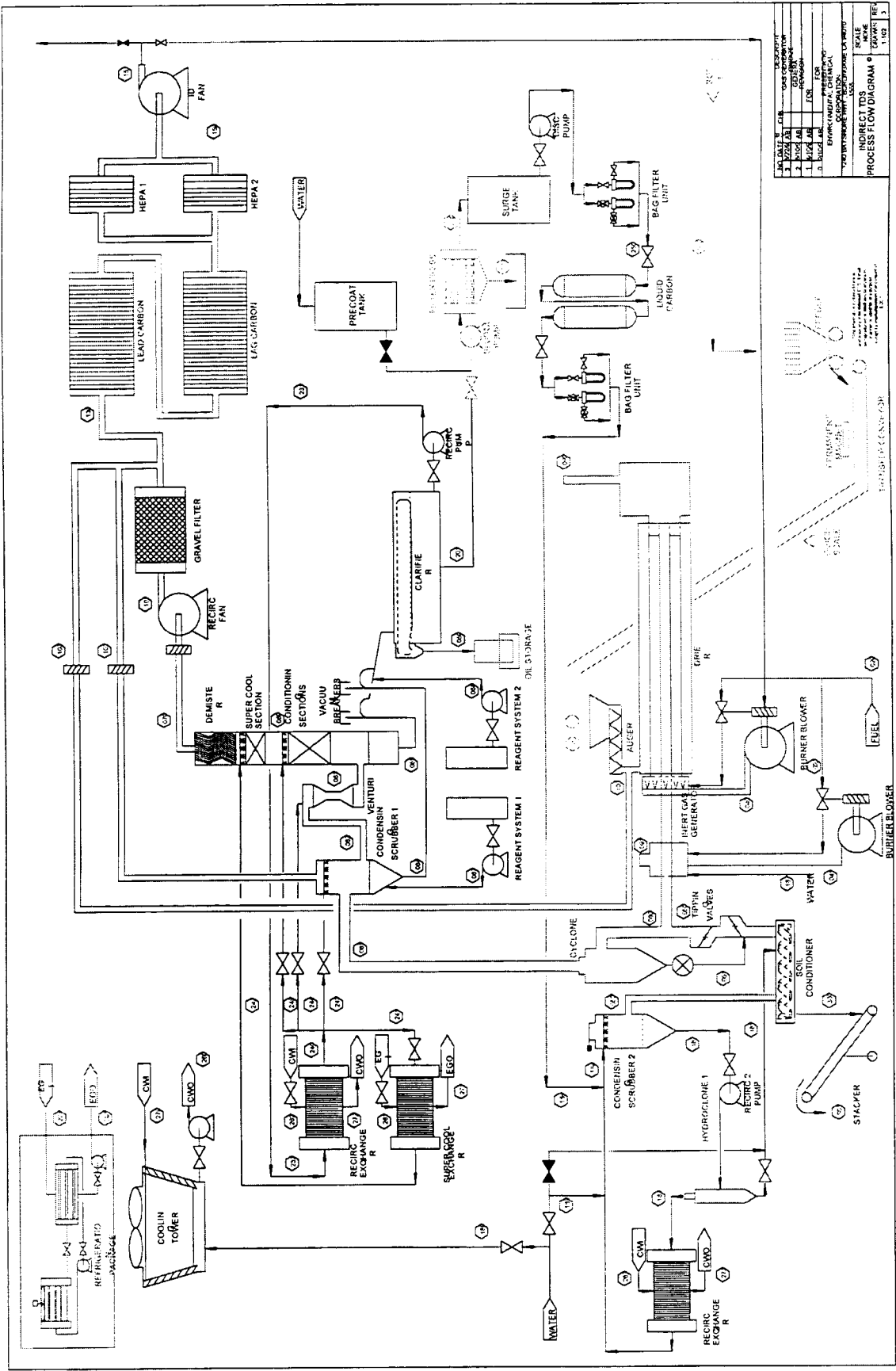


Figure 1. Low Temperature Thermal Desorption Process Flow

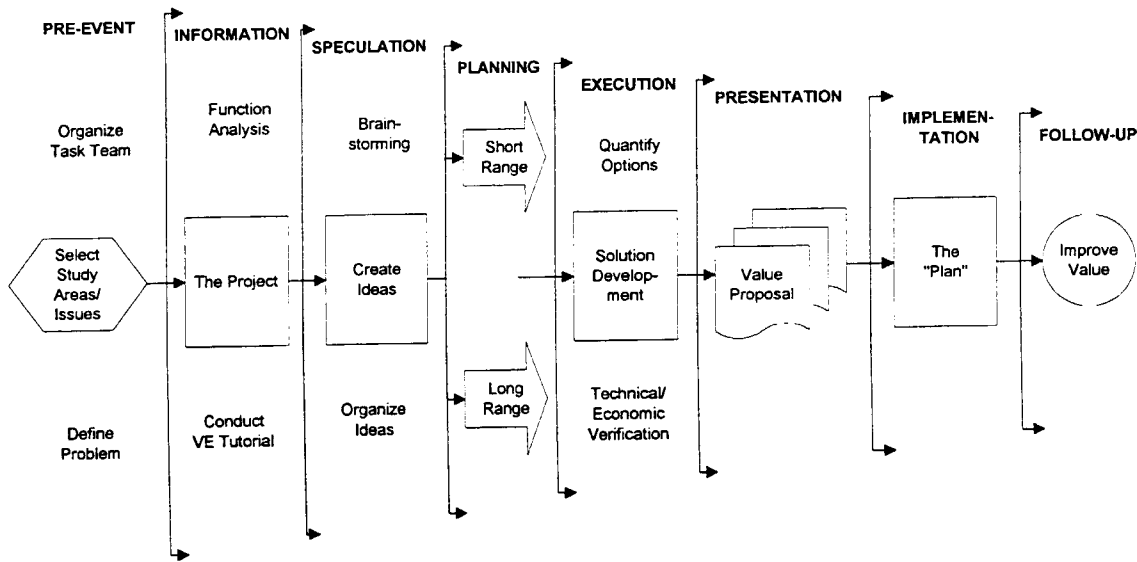


Figure 2: Seven Phase Value Engineering Process

designer prepare a two (2) hour presentation of the elements of the LTTD design. The presentation was supported by a process flow diagram including a mass balance, detailed drawings of specific engineered units, and power requirements by process unit. It is important to note that the designer did not participate in the subsequent Speculation Phase but he was available to answer questions related to existing design of the LTTD system. The study leader was careful to prevent the designer from answering "if we did this what would happen?" questions as this would have lead to the Execution Phase prematurely.

Following the design presentation by the principal designer, the VE study participants prepared a function analysis of the LTTD system which allowed the system to be reduced to a FAST diagram. This is also a critical step in the VE study and must be managed carefully as time can be wasted debating definitions and the difference between basic functionality and complex engineering principles. We found that defining the function using the two word approach (active verb/noun) was a successful way to accomplish this. This process also helped establish a common language within the VE study group, which was made up of multiple engineering disciplines

### SPECULATION PHASE

Brainstorming, the most critical and fruitful part of a VE study, should not be hurried. Therefore, we allowed over 30% of the available time for brainstorming. Careful attention was paid to the

classical rules of brainstorming including no opinions or criticism allowed, and all ideas are accepted and documented. The group was encouraged to build on previous ideas, even if it meant being repetitive. Common ideas were later grouped to eliminate redundancy. The Speculation Phase resulted in the creation of 109 ideas that were then evaluated further in the Planning Phase.

The VE study area included design and operation of the LTTD unit, therefore management issues such as labor and operating requirements were also considered. Several of the proposed improvements resulted in lower operating costs due to a reduction in required operations and maintenance costs.

### PLANNING PHASE

The planning phase simply involved a group analysis of each idea created during the brainstorming session. A Gut Feel Index (GFI) was used to identify those ideas that provided significant improvement to the existing design including reduced operating cost, greater reliability or ease of maintenance. The GFI rating system is shown in Figure 3. The GFI rating system of 1 (no good) to 5 (excellent idea) was used rather than the more common 1-10 system<sup>3</sup>. This resulted in more definitive solutions to the VE study and allowed for a more focused VE Plan.

Using the GFI rating system resulted in 28 ideas having enough merit to warrant further development by the principal designer and his team. The Planning

Phase was also used as an opportunity to focus on those critical - regulated - parts of the design which would have a dramatic impact on the overall operation of the LTTD unit, including air pollution permitting and compliance, water discharge compliance and safety. These elements of the LTTD process could not be compromised and warranted extra attention.

**Figure 3: Gut Feel Index (GFI) Categories**

<u>Rating</u>	<u>Description</u>
5	Excellent idea; MUST develop
4	Good idea; SHOULD develop
3	Not used, in order to prevent "fence sitting"
2	Fair idea; not recommended for development
1	No good!

EXECUTION PHASE

The 28 ideas which rated a 5 on the Gut Feel Index were developed further by the VE study group. Each idea was assigned to individual VE study group members with particular knowledge in the relevant engineering discipline. The team members prepared a detailed description of the VE idea, including a description of the unit process as it exists in the current design, and estimated cost to implement and/or the cost savings.

The VE study group members were encouraged to seek out expert knowledge where needed. The team members were instructed to point out any regulatory compliance and safety consideration associated with the VE idea as these areas are critical to the Company.

PRESENTATION PHASE

For this VE study, the client (the Company) was actively involved in the VE process. Therefore the Value Proposal was presented to the principal designer. This is a departure from most VE study procedures but very appropriate and acceptable in this case. The principal designer was asked to critique each VE idea with respect to the potential for lower cost of construction, greater reliability, lower operating cost, safety and regulatory compliance. The VE team leader encouraged open discussion regarding the merits of each idea so that potential flaws could be identified

early, before the Implementation Phase begins. Of the 28 ideas developed in the Execution Phase, 13 were considered for incorporation into the design. Because of long lead time, some LTTD system components required early procurement. As a result, 8 ideas could not be implemented. The other 7 ideas were subsequently eliminated because a more detailed cost analysis showed them to be economically unviable.

FOLLOW UP PHASE

The follow-up phase is critical to recovering the value of the effort put into the VE. In this case, we had passed on the responsibility of implementing the VE recommendations to the operational managers, the project and program manager of the fabrication project. The authors followed up with them over the next 60 days to ensure that the recommendations were either implemented and the savings documented, or were analyzed and appropriately rejected, and the reasons for the rejection documented.

SUMMARY OF RESULTS

The value engineering process had substantial payback in two areas: functional and economic. In the functional area, it allowed a diverse team of technical staff and managers to interact, and discuss the functionality of each piece of equipment. This has led to a much greater understanding of the LTTD system within the Company, and allowed for a better appreciation of operational risks.

In the economic area, the VE process resulted in implementing five ideas, and operational savings around \$250,000 on the first project alone. These savings are anticipated to be much larger over the life of the equipment.

Further, eight ideas could not be implemented due to the advanced stage of procurement at which the VE was performed. If implemented, these would have had a further positive impact on operational efficiency of the system.

Finally, one of the ideas is being considered for intellectual property treatment, either as a patent or copyright. A final decision on filing has not been made.

**LESSONS LEARNED**

1. **The value of Functional Analysis increases as the technical diversity of the project increases.**
2. **Selection of the team should factor in attitude as well as technical background.**
3. **For "occasional" teams, teach only those tools that are relevant, and focus on the project opportunity and not the tools**
4. **Use only those tools that will work for the project; for this, the VE leader needs to have a thorough understanding of the tools at his/her disposal.**
5. **Don't be constrained by dogma regarding the VE process C experiment with the various elements, such as time requirements.**

**REFERENCES**

1. JJ Kaufman Associates, figure titled, "The Value Plan," Training Handout.
2. Luis M. Venegas, P.E., CVS, and Charles McDuff, P.E., CVS, CCE, "Private conversation with authors," June 12, Washington DC.
3. Lewis & Zimmerman, "Value Engineering Training Workbook," for training held on June 8-12, 1998. (Not page numbered).

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