HOW TO SAVE $40 MILLION ON YOUR NEXT WATER TREATMENT PLANT

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ABSTRACT

A value engineering (VE) study on the pre-design of a $165,000,000 water treatment plant in Vancouver, B.C., yielded $40,000,000 in implemented savings (24%) because of the collaborative effort between the owner, designer and VE consultant and VE team. This paper speaks from three different perspectives to describe how this result was achieved. The owner, the designer, and the VE team leader all were instrumental in realising major design modifications and cost savings on this facility. Key reasons for success include the early use of VE, clear objectives and boundaries for the study, a heterogeneous team, complete project documentation, and a three-step implementation process.

INTRODUCTION

The Seymour Filtration Plant was designed to treat 1,000 ml/d of water flowing from the Seymour Reservoir, one of three sources of drinking water for the metropolitan area of Greater Vancouver, B.C., to improve water quality. The Greater Vancouver Water District (GVWD) engaged a consultant engineering design firm to prepare plans, specifications, and cost estimates for the project. After the pre-design phase, the GVWD selected an independent value engineering team and a VE team leader (VETL) to perform a formal VE study of the draft pre-design report for the new plant. The goals of the VE study were to review the design philosophy of the water treatment plant and seek facility design alternatives that would maintain basic functions while reducing unnecessary cost.

This paper speaks with three voices: the owner, the designer, and the VETL. The owner takes the lead and describes how he organized the VE study to yield the optimum results of the VE team effort; the designer and VETL follow with additional comments from their unique perspectives. Taken together the three voices clearly describe how a pro-active owner, a fully involved designer, and a carefully chosen VE team collaborated to achieve a $40 million savings on the filter plant.

THE OWNER'S PERSPECTIVE

How does a water utility like GVWD take advantage of the VE process to save $40 million on the design of a filter plant? The easiest way, of course, is to start with an overly conservative design. From the outset, however, we knew that the design and cost of the Seymour filter plant would be under close scrutiny, as it was (and remains) a candidate for implementation as a Public/Private Partnership project.

As a result, far from being over-designed, the draft pre-design evaluated in this VE study was the product of a carefully structured design process which had already yielded cost reductions at least equal to those later identified by the VE team. For example, an extensive pilot study program determined that a conventional filtration process would effectively meet all of our water quality criteria, and that a pre-treatment step would not be required to deal with the water source's occasional turbidity spikes.

If the design had already been optimized, then how did we manage to find an additional $40 million in savings? We had learned a lot about VE from previous studies on other elements of our drinking water treatment capital works program, and for this study, we consciously set out to maximize the value of the VE process itself. While we were not entirely clear how to set about achieving this, we knew the first task was to establish clear objectives and boundaries for the study.

Establish VE Objectives and Boundaries

In the past, our VE teams sometimes ignored alternative technologies or approaches that we believed were promising, yet embraced other approaches that we already knew were completely unworkable. The VETL would brief the design team and provide opportunities during the week to review progress, yet we frequently found ourselves dissatisfied with the end results of the study.

Upon reflection, we realized the problem was not with the VETL or the study format, but was instead a failure on our part to provide a clear indication of what the study was supposed to accomplish. This time, we identified a number of issues, such as on-site water storage and the cost impact of filter media bed depth, which we wanted to ensure the VE team addressed during the study.

We knew, however, that clear objectives alone would not result in a successful study, so we established equally clear boundaries. Specifically, finished water quality goals were fixed from the outset, and all design alternatives and suggestions would have to meet these goals. In addition, we did not want the study to look at alternate filtration processes because, after nearly two years of intensive study and evaluation, we were very confident that our choice was the most cost-effective.

Study objectives and boundaries were not established at a single meeting, but were developed over time. We knew, however, that putting together a VE team requires a significant amount of advance planning. So at the same time as we were discussing study objectives and boundaries, we began contacting potential VE team members.

Build the Right Team

We had concluded from earlier studies that the more active our role was in selection of VE team members, the more satisfied we were with the results of the study. For this study, we identified and met with the key filtration process VE team members several months prior to the actual study. We

familiarized them with the project by forwarding them technical design memoranda to review prior to sending out the formal VE briefing materials. We then built the rest of the team around this core, bringing in both complementary disciplines as well as local expertise to ensure familiarity with this project's unique problems and opportunities.

In a break from previous studies, we chose to include the designer's cost estimator on the team, since he was the only available candidate with appropriate background and experience. This yielded a surprising but welcome dividend: in past studies, we found that the implementation process frequently stumbled over what was perceived to be overly optimistic cost estimates for VE alternatives. By using the same person to generate both the original and alternative estimates, we ensured that the implementation process could focus on weighing the pros and cons of alternatives instead of arguing over cost calculations.

One potential pitfall of building the team yourself is the inevitable debate over whether you really need a structural (or electrical, or mechanical...) engineer on the team. In this instance, with one eye on the bottom line, we neglected to include constructibility and operations team members. Fortunately, our VETL picked up on this shortcoming in time to add this expertise to the team prior to the start of the study.

In hindsight, we realize that trying to keep VE study costs down by limiting the size of the team was inherently self-defeating. The incremental cost of an additional team member is small when compared to the overall cost of the study, and even smaller when compared to the potential value of the creative ideas generated by the team. This does not mean that more is necessarily better, but instead that the focus should be on building a team capable of realizing the objectives of the study.

Provide Clear Direction to the VETL

Once we had decided what we wanted to accomplish in the study and identified the nucleus of our VE team, we brought the VETL in for a face-to-face meeting. We spent the first part of the day reviewing objectives and boundaries, as well as some of the issues and potential problems that might present themselves during the study. We then discussed the composition of the VE team, and filled in the gaps noted above. We planned the owner's and designer's presentations, and explored options for implementing design alternatives. Finally, we visited the construction site, which allowed the VETL to connect the drawings and specifications with the reality of this particular project.

The meeting went smoothly, and actually finished ahead of schedule, which led us to briefly question whether it was worth the time and expense? The answer is a resounding yes, not only because we were able to articulate our expectations for the study, but also because it provided an opportunity to start building a relationship between the designer and the VETL.

Involve Designer in VE Process

In past studies, the first experience our designers had with the VE process was being grilled by team members at the Day One presentation. This time, we asked the designer to join us for the initial meeting with the VETL. In addition to reviewing briefing materials and study format, the designer participated in the discussions establishing the study objectives and boundaries described above. We wanted to ensure that the study proceeded in an atmosphere of mutual respect, and the only way this could occur was to make the entire VE process transparent to all parties involved.

The designer responded to their inclusion in the process by more than simply cooperating with the VE effort: when they presented their design on the first day of the study, the design team also provided a list of potential cost savings for the VE team to investigate. Many of the design alternatives and suggestions resulting from the study can be traced back to these initial suggestions. The design team also provided support throughout the week, responding to questions and supplying additional information when appropriate.

Even more impressive than the designer's support during the week was their desire to use the VE team's suggestions as a jumping-off point for new creative design alternatives after the study was over. Instead of mechanically adopting or rejecting alternatives, the designer used the study's results to fundamentally reevaluate the filter plant's systems. This is not to say that the VE team and the designer agreed on every point; on the contrary, there were heated exchanges over many of the suggestions. The debate was, for the most part, a healthy exchange of ideas as opposed to a stubborn defense of established positions.

The real benefit, therefore, of bringing the designer into the VE process early was seen not during the week-long study, but instead in the implementation process that followed. In order for

this benefit to be realized, however, we needed to have a clear strategy for incorporating the results of the VE study into the design.

Establish a Formal Implementation Process

The fundamental difference between this study and earlier ones is that, from the outset, we shifted our focus from the VE study to the implementation process. Previous attempts at implementation stumbled for a variety of reasons, most of which we were able to address by establishing clear study objectives, building the right team, and fostering a good working relationship between the VE team and the designer.

Still, if our goal was to increase the value of the project, we had to create a mechanism for integrating results of the study into the design. So with the aid of our VETL, we set out a three-step implementation process and began preparing for it at the same time as we were planning the workshop itself.

1. The first step was to have the VETL expedite production of the draft report and forward it to the designer the week immediately following the VE study. We requested the designer to study the workshop results closely, and start evaluating both the value and practicality of implementing design alternatives and suggestions.

2. The next step was to convene a formal, one-day implementation workshop approximately three weeks after the VE study. Two representatives from the VE team attended, as did the designer and the owner's management team. We believe that in the past, worthwhile design alternatives had been rejected not because they lacked merit, but because we simply failed to understand them. The presence of VE team members at the implementation workshop ensured that VE proposals would get a fair hearing.

   The goal of the implementation workshop was to decide which design alternatives and suggestions could be accepted immediately, which could be rejected, and which would require further study. Items requiring further study were further broken down into those that could be included into the existing design quickly and efficiently, and those that would be assessed at the detailed design. The VETL facilitated the workshop. He was requested not to act as an advocate of the VE team's suggestions, but instead as a facilitator charged with keeping the discussion focused and driving the process to clear decisions.

   Holding a formal implementation workshop was expensive, and added several weeks to the VE process, but we strongly believe it to have been an excellent investment of both time and money. First, it allowed us to quickly clear all of the obviously good or bad VE alternatives off the table without having the designer waste time and money formally studying them. Second, we knew if our efforts resulted in just one more idea being adopted than would have otherwise been the case, the implementation workshop would likely pay not only for itself, but also for the entire VE study.

3. The third step in the implementation process was to have our designer produce a final pre-design report that seamlessly integrated all accepted design alternatives and suggestions, with the exception of those deferred to detailed design. While once again this can be looked at as an expensive and time-consuming process when compared to simply producing a reconciliation report, full integration of VE alternatives allowed us to accurately assess the study's results. Moreover, requesting a fully integrated report allows and encourages the designer to group design alternatives together to realize even greater cost savings.

The Result: $40 Million Saved

So how did we manage to reduce the estimated cost of the facility from $165 million to $125 million when the design had already been optimized? We were aware that we had spent a much greater proportion of time and energy evaluating filtration processes than asking ourselves fundamental questions such as: how much water do we need to treat? How much water do we need to store on site? Do we really need to house our process in a building, or can we leave it exposed to the elements?

A substantial portion of the $40 million in cost savings can be attributed to simply answering these questions. For example, we downsized the plant's capacity, reduced on-site water storage, and removed the roof over a large portion of the process train. Could one not argue, though, that since we were already considering down-rating plant capacity prior to the VE study, the resultant savings should not be attributed to the VE process?

It is true that issues such as plant capacity and water storage requirements were raised prior to the VE study, and were subsequently independently evaluated by the owner, designer, and VE team. It is important to note, however, that these issues may not

have been addressed at all had we not taken advantage of the VE study to re-visit some of the project's fundamental design criteria.

In the end, debating whether the owner, designer, or VE team should take credit for cost savings is a flawed approach to analyzing the impact of the study. For example, on several occasions, the designer was inspired by a VE alternative to develop a solution that resembled neither the original design nor the VE alternative. So who is responsible for the resultant cost savings, the VE team or the designer? Or is it the owner who is flexible and open-minded enough to accept new ideas and approaches?

The correct answer, of course, is all of the above. The fundamental lesson we learned from the success of this study is that by working together before, during, and after a study, the owner, designer, and VE team can increase the value of a project considerably more than they could in acting in isolation. And this is the key to maximizing the value of a value engineering study.

THE DESIGNER'S PERSPECTIVE

As designers we had extensive prior experience of the value engineering process, both through participation on VE teams reviewing projects designed by others and from reviews of our own projects. In each case we had seen significant benefits to the owner in terms of increased value and reduced cost and were fully supportive of the process. We realized that the process could only succeed if the designer recognised the experience and potential of the VE team, retained an open mind to suggested amendments, and made sure that the VE team was provided with a wealth of solid, well-documented information on which to base their ideas. We also knew that there were some aspects of the project that warranted a "second look" and that we should make sure the VE team was aware of these and the issues surrounding them.

Study Preparation

It was important that we fully understood the owner's expectations from the study and how the VETL proposed to ensure that these were satisfied. A study preparation meeting was held with the owner and the VETL to discuss these and to give us an opportunity to advise the VETL as to the information that we could provide to assist the process. Jointly, a study schedule was developed that made sure sufficient time was allocated for us to present all pertinent information to the VE team.

Project Documentation

We knew that the best VE team in the world cannot succeed unless they are given accurate and extensive information. We made sure they were presented with a wealth of information on both the design as it now stood, and the rationale behind the various decisions and selections that had been made to get it to the current point. We provided the VE team with all pertinent reports and design details a week prior to the VE sessions, and also gave presentations on this material on the first day of the process. We made sure that our presentations covered not only the detail of the design, but more importantly, the philosophies behind that design. In our experience with projects in the preliminary stage, it is these basic philosophies that offer the greatest scope for increases in value, and often these need to be revisited once hard preliminary design data and costs are available.

A further vital contribution was the provision of a cost model and database that used the same structure as our preliminary cost estimates. This ensured that costing of VE suggestions by the VE team was conducted on a truly comparable basis. We also made sure that we were available to respond to the VE team during the process and to provide any additional data as might be required to help assess various options.

Cooperation with the VE Team

It is never easy for a designer to have his work critiqued by outside reviewers. Often, concerns about competitors who may be on the VE team can consciously or subliminally affect the process. We knew that it was vitally important that these concerns be discarded. We recognized that our strength lay in supporting the owner to achieve the best end result and to appreciate the value that the VE team could bring to the project. It was important that we adopt the philosophy that this was not a review designed to identify flaws but instead a process to fine tune and optimize the hopefully fundamentally sound approach we had taken to that point.

Full cooperation with the VE team with a common goal of achieving a better product was absolutely essential, not only during the VE study but also afterwards when the VE alternatives were subject to a more detailed consideration by the owner and ourselves.

The Results: A More Cost Effective Design

We knew that our preliminary design had identified the possible cost benefits of revisiting some basic design assumptions for the plant. In particular, the owner's original desire that the facility achieves maximum output during both summer and winter operation warranted a further look. This requirement meant that more conservative design criteria had to be applied to satisfy the challenging winter conditions and resulted in a lot of excess summertime capacity and increased costs.

The VE process presented an ideal opportunity to bring these issues to the table and to undertake some lateral thought as to how the owner's original requirements could be met more cost effectively by utilizing other existing sources. It enabled the VE team to look outside the contractually defined box in which we as designers had been placed and to provide a more cost-effective solution to meeting the owner's objectives.

Other suggestions from the VE team were also reviewed in detail, and our findings were presented to the owner about three weeks after the VE study. We incorporated the more significant of these into the pre-design and also identified promising suggestions that could be better reviewed under the upcoming detailed design phase.

Perhaps the most important result was that the process helped to increase the owner's confidence in the basic approach and the resulting pre-design. In today's atmosphere of extensive political and public focus on large capital projects, it is absolutely essential that the owner has done all he can to justify the project and to ensure that it is provided as cost-effectively as possible, and the VE process provides significant support in these areas. Many of the decisions we had made were revisited and to a large extent supported by the VE team. It gave everyone comfort that we had a sound approach to the project and a solid, supportable foundation from which to move forward.

THE VETL'S PERSPECTIVE

It was a rewarding experience working with the owner and designer on this VE study because of the spirit of collaboration that grounded this effort. We provided the leadership of the team as the VETL, but we also worked closely with the owner to shape the team and the total process, from the study preparation meeting, through the VE study, to the implementation workshop.

The Early Use of VE

The owner elected to perform a VE study early in the project design cycle, using the draft pre-design report as the basis for the study. From past value work we know that using VE early has a greater impact on the design because conceptual design ideas have a greater likelihood of being changed. Even though the water treatment plant had been under study for 1-5 years using a pilot plant to evaluate process alternatives, the application of VE was still at an early design stage. This early use of VE contributed to the success of the study.

Selection and Nurturing of the VE Team

Team member selection was initially aimed at obtaining the three best experts on water treatment, because the owner wanted to validate the treatment process. Because the VE methodology takes benefit from heterogeneous teams, we assisted in this team selection process as it was expanded to include a civil/structural engineer who could develop alternatives for site and facilities concepts. A cost estimator, a construction manager, and a plant operations specialist were included to further broaden the knowledge and experience of the team.

It was a challenge to lead a highly technical seven-person VE team. The presence of three water process specialists could have resulted in an overemphasis on treatment philosophies at the expense of engineering design issues. Through the use of function analysis we encouraged interaction of all team members on a wide range of functional elements. This synergistic effort blurred the boundaries between the technical fields of the team members during creativity and evaluation phases. Later, during development work, each of the experts operated in their unique areas of specialization to develop implementable alternatives.

The spirit of collaboration between the team members and between the owner, designer and VE team helped the team perform at a high level, knowing that their alternatives would be given a fair hearing.

Fostering Communications

Our basic function as VETL was to lead the VE study; however, we had a secondary function to foster communications between the owner, designer and VE team. This was initiated during the study preparation meeting. Also, at mid-study the owner and designer representatives were invited to visit the VE team and observe the listed and ranked ideas that