# Value Engineering in the Pennsylvania Department of Transportation

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The Pennsylvania Department of Transportation's value engineering (VE) program is presented. How the program started, how it is now administered, and the accomplishments are described. The program has achieved significant savings of more than $10 million per year. Recommendations are aimed at agencies beginning a VE program.

Although it is common knowledge, it bears repeating that transportation and highway agencies throughout the country are trapped between inflation and reduced revenues. Many avenues are being investigated to reduce costs. Many agencies are instituting cost-reduction programs. Some of these programs reduce standards, reduce the size of projects, or otherwise reduce the performance of highway and transportation projects. There is, however, another way to reduce costs, called value engineering (VE). For about 40 years, VE has been recognized as a way to reduce costs without reducing performance.

VE, value analysis (VA), and other similar terms describe (1, p. 9) "an organized action system, attuned to one specific need: accomplishing the function that the customer needs and wants." VE improves quality, but it is more than a quality control system. VE is, at its most basic level, an organized process that ensures that a product meets its necessary function without waste and without extras.

VE is defined by the Society of American Value Engineering as the systematic application of recognized techniques that identify the function of a product or service, establish a value for that function, and provide the necessary function reliably at lowest overall cost. VE is, above all else, systematic. By using a set, well-developed procedure, the VE practitioner can analyze the function of an activity or project and reduce the cost, improve the quality, or both.

## HISTORY

VA was developed as a specific procedure after World War II. During the war, the General Electric Corporation discovered that wartime shortages required substitute designs and materials that often resulted in improved performance at a lower cost. In 1947 Lawrence Miles, a staff engineer with General Electric, was assigned to develop this observed phenomenon into an organized activity that could be applied throughout the company. The process became known as value analysis and was slowly accepted as a valuable tool.

VA was applied to many manufacturing activities and later to construction projects. The U.S. Department of Defense (DoD) was one of the first government agencies to apply VA to major construction projects; VA was applied to shipbuilding and renamed VE. VE has since been applied to many DoD activities.

FHWA has promoted VE for more than 5 years, in which time FHWA, through the National Highway Institute, has sponsored more than 70 VE workshops in some 40 states. Under the program the agency has trained more than 1,500 highway professionals and technicians in the discipline and techniques of VE. An indication of the support for and the worth of VE was evident in the Federal Highway Act of 1982, which requires VE on all projects with a construction cost of more than $2 million.

The Pennsylvania Department of Transportation (PennDOT) has been using VE since early 1979. At that time a single project, the relocation of US-30 near Everett, Pennsylvania, was chosen for a VE study.

This project was a 100 percent federally funded demonstration to show how fast a project could move from concept to completion. It was selected for the demonstration because of the adverse effects of another federal project (the Raystown Dam) on the local highway system.

At the time the estimated cost for the project was fast approaching a $25 million ceiling imposed by Congress. Almost in desperation, FHWA selected VE as the method of reducing the cost of the project. Although it was a back-door approach, this project made many realize that VE could save money without loss of performance.

A VE team was assembled made up of representatives of FHWA, the design consultant, and PennDOT. The team identified about $750,000 in savings. Although not all of the recommended changes were carried out, the results of that pilot study were favorable and a VE program was born.

Soon after the VE effort on the Everett Bypass, FHWA sponsored the first VE conference for state highway officials. The conference, held in New Orleans in 1980, was to begin the federal emphasis of VE in highway design and construction and launched many state efforts into VE. There are now at least eight states that have active VE highway programs; Pennsylvania, Florida, California, and Minnesota are among the most prominent.

## PENNSYLVANIA'S VE PROGRAM

### General Philosophies

Two general philosophies guided the VE program in PennDOT. The department has adopted a multidisciplinary approach to VE and has decentralized the program, relying heavily on the district offices. The multidisciplinary, or matrix-management, approach is vital to the success of a VE program. Varying backgrounds and expertise bring a variety of new ideas to bear on VE studies. VE teams have consisted of environmentalists, urban planners, and even lawyers as well as an assortment of highway designers and engineers. Those who have no direct involvement often bring a fresh viewpoint to the problem, asking the questions that highway specialists do not think to ask.

The other guiding philosophy is decentralization. PennDOT is divided into 11 engineering districts, each responsible for the highways in a geographic area. The districts are decentralized, in that each district is somewhat autonomous in design, maintenance, and construction. Therefore, the districts were given the responsibility of actually performing the VE studies under the guidance of a district VE coordinator. Not only is this in line with the general philosophy of decentralization, but it also eliminates the stumbling block that often exists when ideas and changes are directed from a

central office. The districts originate the ideas and they have a stake in making them work.

Although the program is decentralized, there is a central office coordinator who is given the responsibility of ensuring that the program is successful, that the districts follow the general policies, and that the districts work at keeping the program vital. In Pennsylvania the coordinator is a staff position at a fairly high level, so that top management support is fully given to the program. It cannot be repeated often enough that top management support is essential to the success of VE.

### Program Characteristics

The first administrative step in starting the program was the assignment of a VE coordinator in each engineering district. This is not a full-time position but an assignment to an engineer in an established position. The districts were permitted to assign their own VE coordinators, but they were encouraged to assign those who were known to be creative and who were not locked into traditional ways of thought.

The district VE coordinator is responsible for the successful VE program at the district level. The coordinator works with the design chief to select projects that are good candidates for VE studies, assigns the VE team, and schedules the study. The coordinator is responsible for training district staff in VE principles and practices. He is also responsible for following construction VE proposals to ensure their timely review.

To have a pool of those qualified to take part in VE studies and particularly to have qualified VE coordinators, it is necessary to have an aggressive training program. Three times PennDOT has taken advantage of the federally sponsored workshops to train about 50 people. The workshops are a 40-hr course taught by a certified value specialist (CVS). Anyone with VE responsibilities should attend at least one workshop.

Whenever possible, actual projects should be studied. In this way the students feel that they are contributing to the program and to the savings rather than just doing an exercise. In addition, the savings that result from a workshop can be from 10 to 100 times the payroll costs of the workshop. In Pennsylvania, more than $1 million has been saved in a single workshop.

The department has, through the workshops, built up a pool of about 50 who are qualified to lead VE efforts, and a larger pool has been established by introducing new people to VE through a VE study. Each VE team usually includes one person who has not been exposed to VE and who thus is in an on-the-job training program.

## VE POLICY

### Design

PennDOT policy is to submit all projects with an estimated construction cost of more than $1 million and 10 percent of all projects with a lesser value to the VE study. VE projects are chosen fairly systematically by using the principles of Pareto's distribution.

Pareto's law of distribution states that in any region, a small number of elements (20 percent) contain a greater percentage (80 percent) of the costs. VE takes advantage of this principle, not only for individual studies but for project selection as well.

Large projects with complex features, such as construction of new bridges and expressways, bridge rehabilitation, and major reconstruction, are studied first. The more complicated the project, the greater the chance for major savings. Likewise, the greater the cost of the project, the greater the chance for large savings.

VE is done in the engineering district by a multidisciplinary team. The team conducts an intensive study, usually for 3 or 4 days without interruption. It is important that the team members be totally committed to the study for its duration. Interruptions, other work activities, and so forth, can destroy the effectiveness of the team. An important element of a VE study for a highway project is a field view of the project site.

Team members are chosen carefully from various disciplines, including nonengineering staff, and should be creative thinkers who are not devoted to only traditional ways of thinking. The team must not include the original designer. The designer is used as a resource during the investigation, but the designer naturally wants to defend his design and seldom has a truly open mind with respect to his own project. The team selects a chairman and a recorder, who prepare a report at the end of the study. An oral presentation to decision makers is recommended.

VE studies are done by district staff in the district office. Although this may restrict creative thinking somewhat, because the department team members may have a natural inclination to defend a design developed in their district, this policy increases the acceptance of those changes proposed. The district decision makers do not feel that the changes are coming from an isolated central office and appear to feel less threatened by them.

### Construction

The department also has a contractor VE program, modeled after the U.S. Corps of Engineers program. This is administered through a VE incentive clause in construction contracts.

Contractors are encouraged to submit VE proposals. If a proposal is determined to provide equal performance at lower cost, the savings that result are split equally between the contractor and the department. This results in savings for the department and an additional project for the contractor and often results in ideas that can be used on future projects where the department can get the total savings. There is no limit to the savings paid to the contractor.

An important element of a construction VE program is speed. Contractors' proposals must be reviewed quickly. Contractors are usually on tight schedules, and if a proposal is delayed, it may as well not be submitted.

This does not mean that the review should be compromised. Contractor proposals must meet all of the requirements for a change order. All prices and quantities must be justified, and the final savings depend on the final quantities.

A construction VE program offers a way for an agency to start a VE program quickly; the only effort required is writing a specification and evaluating the contractors' proposals that are received. The actual studies are then done by the contractor.

## ACCOMPLISHMENTS

Table 1 shows the total savings for each year of the VE program since its beginning. The savings have been substantial, and yet the manpower cost is minimal. The estimated manpower cost since 1979 is less than $100,000. The figures shown for construction savings are the department's savings; they

**Table 1. VE summary.**

| Item | Savings ($000s) 1979-1980 | 1980-1981 | 1981-1982 |
|---|---|---|---|
| Estimated design savings | 9,838 | 11,749 | 11,241 |
| Construction savings | 0 | 1,178 | 220 |
| Total | 9,838 | 12,927 | 11,461 |

Note: Number of VE studies is as follows: 1979-1980, 12; 1980-1981, 60; 1981-1982, 60.

should be doubled to show the construction cost reduction.

A VE program is not without its problems. There are the usual problems of acceptance of a new program, especially one the purpose of which is to question established ways of thinking and to question the work of designers. This can be overcome by good top management support of the program. Without top-level support a VE program will not succeed. With top-level support it has a fair chance of success. Pennsylvania has been fortunate, because Thomas Larson, Secretary of Transportation, is a strong supporter of VE and is committed to making the program work.

Another serious problem is acceptance of the program by contractors. Many delays have arisen in PennDOT's construction program because of arguments over prices and costs in a contractor's proposal. A contractor's education program is being planned that will describe the steps that a contractor must follow for the submission of a VE proposal. It will emphasize that a contractor's proposal must be complete and must contain justifiable prices. Proposals that are complete and accurate are evaluated quickly. An important point, to which all agencies adhere strictly, is that a VE proposal is not approved until the contract change order has been approved.

Contractors and others have questioned this policy of strict price justification. They claim that the department is saving money anyway, so why should their prices be questioned? The response is simple. We owe it to the taxpayer to save the maximum amount possible. Otherwise contractors could manipulate the prices so that they got a 60 percent or even 75 percent share of the savings.

## RECOMMENDATIONS

PennDOT's experience can prove valuable to other agencies that would like to start a VE program. The following recommendations may be useful:

1. Obtain top management support. Without this support, creative ideas will be suppressed, and local staff may lack the incentive to continue with the program.
2. Adopt a multidisciplinary approach. Environmentalists, planners, right-of-way specialists, lawyers, and others will bring a fresh point of view on a problem, whereas designers and engineers may, through old traditions, be restricted in their thinking.
3. Let district or regional personnel perform the studies, but with a central guiding policy and support.

## CONCLUSION

VE works. PennDOT has, over the past 2.5 years, saved more than $30 million without reducing performance. A statewide policy has been instituted within the framework of which VE is promoted at the district or regional level. Contractors have been encouraged to join the VE program by adding an incentive clause to construction contracts. VE has even been marketed by using training programs, posters, and pamphlets.

## REFERENCE

1. J.J. O'Brien. Value Analysis in Design and Construction. McGraw-Hill, New York, 1976.

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# Pennsylvania's Inventory Reduction Program

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**In October 1981 the Pennsylvania Department of Transportation (PennDOT) launched a statewide inventory reduction program. Results have been dramatic. In September 1982, 1 year after the start of the program, inventories have been reduced by more than $14 million (30 percent). A description of the underlying causes for excessive inventories at PennDOT, specific remedies that have developed to reduce inventories, the results to date, and actions planned for the future are presented. The methodology includes the use of fairly simple inventory management performance indicators such as turnover ratios, zero-use reports, and inventory values per lane mile to highlight excessive inventories and establish priorities for their reduction. PennDOT's program is especially relevant to other states that have computerized systems but can also be useful to those whose automated systems are in the design stage.**

The purchase of materials and supplies is the largest cost element in a transportation department's highway and bridge maintenance program next to wages and contract maintenance. The private sector has long recognized that the major potential for controlling these costs lies in inventory management. Because of the astronomical costs of financing inventories at today's interest rates, programs to reduce inventories have been placed high on the priority list of private-sector materials management goals.

Consistent with the efforts in Pennsylvania to apply proven business practices to state government, the Pennsylvania Department of Transportation (PennDOT) has concentrated on applying basic inventory management techniques to reduce inventory costs. Clearly transportation agencies faced with dwindling funding levels that do not match even the most basic maintenance needs must recognize the large cost savings potential in reducing excessive inventories.