# LESSONS LEARNED FROM THE CALIFORNIA DEPARTMENT OF TRANSPORTATION'S VALUE ENGINEERING EXPERIENCE IN THE HIGHWAY SECTOR

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## Abstract

Value engineering aims to find innovate, value-adding solutions to projects, processes and services. This paper exhibit the lessons learned from the California department of transportation's value engineering experience in the highway sector. It presents the Caltrans Value Analysis program in detail for this purpose.

Keywords: Value engineering; Highway administration; California
Topic Area: E1 Assessment and Appraisal Method w.r.t. Transport Infrastructure Projects and Transport Activities

## 1. Value engineering history and background

Value engineering is a systematic, team approach to problem solving. Its intent is to find innovate, value-adding solutions to projects, processes and services. Value Engineering evolved out of the necessity to find substitutions for manufacturing materials that became scarce during World War II. In 1954, the U.S. Navy Bureau of Ships became the first agency to apply this analysis process to major construction projects.

In 1959, the Society of American Value Engineers (SAVE) was incorporated in Washington, D.C. to unite practitioners and promote the growth of value engineering. The Society changed its name to SAVE International in 1997. The Society officially defined value engineering as "the systematic application of recognized techniques which identify the function of a product or service, establish a value for that function, and provide the necessary function at the least overall cost. In all instances, the required function should be achieved at the lowest possible life cycle cost consistent with requirements and/or performance, maintainability, safety, and aesthetics."

Escalating construction and maintenance costs, combined with reduced revenues, led to an increased interest in value engineering by state and federal transportation agencies.

## 2. Federal value engineering program impacts

Congress became interested in VE applications to highway projects in the late 1960's. After a series of hearings, Congress included a provision in the 1970 Highway Act (later codified in Section 106 of Title 23, U.S.C.), which permitted the U.S. Secretary of Transportation to require value engineering, or other cost-reduction analyses, on proposed federal-aid highway projects on any federal-aid system.

In 1973, the Federal Highway Administration (FHWA) assigned a VE Coordinator in Washington, D.C. to administer the VE program and to lead that agency's efforts to stimulate interest in value engineering. Shortly thereafter, a workshop in "Value Engineering for Highways" was developed with funding provided by the National Highway Institute (NHI). The NHI has taught VE courses continuously since 1975.

Congress extended the federal value engineering role with the passage of the National Highway Systems Act of 1995. This act included a value engineering provision (later codified in Section 106 of Title 23, U.S.C.) requiring the Secretary to "establish a program to require states to carry out a value engineering analysis for all projects on the National Highway System with an estimated total cost of $25,000,000 or more." FHWA published its regulation (23 CFR Part 627) establishing this program on February 14, 1997.

In addition, the Office of Management and Budget's (OMB) Value Engineering Circular A-131, dated May 21, 1993, provides "Each agency shall report Fiscal Year results of using VE annually to OMB, except those agencies whose total budget is under $10 million or whose total procurement obligations do not exceed $10 million in a given fiscal year." This circular provides the basis for FHWA's request for year-end VE data.

The Federal Aid Policy Guide was revised in September 1998 to include a Chapter 6 "Value Engineering" to provide guidance on the application of Value Engineering in the Federal-aid highway system.

## 3. State highway agency background

In the early 1969 California became the first state to use value engineering in their highway programs. Value Engineering now is a practice in most transportation or highway departments in the United States.

In April 1985, California hosted the fourth national VE conference in San Diego to explore the state-of-the-art practice of VE as it relates to transportation systems. The AASHTO (American Association of State Highway Transportation Officials) Value Engineering Task Force was established as of that date with the following purpose:

- To recognize VE as an element in transportation engineering in the same way other elements have been recognized.
- To provide assistance to the US highway agencies in developing aggressive VE programs.
- To sponsor biennial national transportation-focused VE conferences.
- To formulate a strong AASHTO stand on VE.

In 1997 the "AASHTO Value Engineering Guidelines" were written to promote broad acceptance and use of the concept of value engineering, while providing enough flexibility to enable each state to tailor a VE program to its own needs. In 1999 the AASHTO Value Engineering Task Force updated the guidelines.

**Overview of the Caltrans VA program**

The Value Analysis (VA) Program in the California Department of Transportation (Caltrans), established in 1969, was the first program of its type within a state highway agency in the United States and precedes the Federal Highway Administration's Value Engineering Program. The program operates within in a large state agency with over 20,000 employees operating and maintaining a 15,000-mile state highway system with an $8 Billion budget.

The following is a an overview of the some key features of the Caltrans VA program VA study:

- Continuous, deliberate improvements to make the program current and up-to-date.

- Procedures are documented in policy guidelines and manuals, integrating the VA methodology with its project development procedures providing a systematic way to measure project value.

- A well-defined VA program reporting system that captures the “essence” of the study results.
- A vibrant VA program that is called upon to solve problems for project managers and executive management on major Caltrans project and procedural problems.

## 4. VA program philosophy

Caltrans VA program provides quality assurance on the project management decisions for federally mandated projects. It also utilizes the VA methodology in conjunction with multi-disciplined teams as an external review of the project management decisions and department processes. Highway projects can benefit by a VA review of the project development tasks leading to improvements in project scope, budget and schedule. Caltrans encourages the application of the VA methodology to highway construction projects, products (engineering items), and processes.

## 5. VA program organization & responsibilities

The VA program is staffed by two program advisors in Corporate Headquarters and assisted by regional coordinators, District Value Analysis Coordinators (DVACs). District 4 (Oakland-San Francisco) and District 11 (San Diego) have full-time coordinators, District 7 (Los Angeles) and District 8 (San Bernardino) have half-time coordinator and the remaining DVAC's operate on a part-time basis varying in accordance with the particular District workload and commitment. In addition, the VA Program has been relying on VA consultant services to supply technical team leaders and technical team members since 1990.

The Value Analysis program is managed in the Caltrans Headquarters (HQ) and carried out by District Value Analysis Coordinators in one of the twelve distinct geographic location, labeled Districts.

The HQ VA Program and has the following responsibilities:

1. Setting policy and procedures for the VA program
2. Updating VA reference manuals
3. Developing, coordinating and monitoring the statewide annual VA program
4. Assuring compliance with the federal requirement for VA studies on all federally funded National Highway System projects costing $25 million or more.
5. Preparing and submitting annual reports to FHWA and Caltrans management
6. Monitoring VA studies to assure adherence to the VA methodology
7. Supporting and encouraging the development of expertise in districts for conducting VA studies
8. Reporting statewide results of VECPs (Value Engineering Change Proposals) to the federal government, in cooperation with the Division of Construction. VECPs are changes to the contract documents resulting in changes to the project items with the resulting savings shared 50/50% between the owner and the contractor.
9. Maintaining VA consultant contracts
10. Providing Value Analysis training
11. Providing guidance to the districts on the following:
    - District Annual VA program
    - Independent external peer reviews using VA studies
    - Assistance conducting "life cycle cost analyses"
12. Monitoring the best practices in the value analysis industry
13. Coordinating the nomination and selection of the Annual VA Awards.

14. Auditing the results of the VA Program

Each district (or region) must have a VA Coordinator (DVAC). The coordinator's function is to assure the proper application of VA policies and procedures. The coordinator also monitors and reports district VA studies to district management and to the HQ VA program. The following lists the duties of the DVAC:

1. Coordinate with the VA program on all VA activities
2. Coordinate the development of the district Annual VA program. This includes:
   - Identifying Studies: Highway Project (voluntary and federally mandated), Product and Process Studies
   - Obtaining the district Director's approval for the final VA program
   - Updating the program over the duration of the year as needed
3. Maintain updated VA study target dates and activities
4. Identify and provide a list of qualified team leaders and team members
5. Ensure VA study preparation activities are completed
6. Monitor study activities to assure adherence to the standards as defined in the VA manuals
7. Maintain copies of all completed VA study reports.
8. Be an advocate for the VA program.

Project Managers are responsible for:

1. Identifying highway project to be value analyzed.
2. Ensuring VA studies are conducted on projects which fall under the NHS Value Analysis requirements for federal aid participation
3. Resourcing the VA study into the project work plan
4. Including VA in the project schedules
5. Resolving the implementation dispositions of VA alternatives.

## 6. VA program guidance

The Caltrans VA Program has created several guides with detailed information on how to successfully carry out a VA study. These guides include information on unique Project Scope Performance Measurements employed in the Caltrans VA methodology and can be downloaded from the VA website. The following describes the purpose and contents of these manuals:

*Value Analysis Policy*. The VA Program's official policy is being updated to reflect the changes outlined in these manuals.

*Value Analysis Team Guide* assists the VA study participants in employing the Caltrans VA study methodology over the course of the VA study. The VA team guide includes all of the forms, with instructions, needed to document the VA team activities and the individual VA alternatives. The third edition expands on the Caltrans project performance measures, provides more detail on the study initiation activities and the implementation activities of the VA study.


*Value Analysis Report Guide* outlines the Caltrans VA study report requirements for the VA report writer, including instructions and examples. The third edition separates and details the Preliminary Report, a Final Report and a Study Close-out Section. The study close-out portion provides the VA program with the final statistics for any conditionally approved alternatives that were in the Final Report.

Why were the manuals created?

- Standardization of manuals needed for an organization with over 20,000 employees and 12 Districts separated by up to 800 miles.
- Procedures Manual to assist the District Value Analysis Coordinators (DVACs), especially with the constant changeover in staff turnover averaging approximately every 18 months.
- To provide a "checklist" of activities that need to be completed by the various participants: team leader, team members, team resource advisors, project manager, district value analysis coordinator, etc.
- Elimination of repetitive instructions and advise to the DVACs and to obtain better performance in pre studies activities so as to lead to better study performance.
- Specify minimum requirements that a team leader must carry out on a Caltrans VA study.

These manuals provide the VA Program with the following benefits:

- Minimum study performance standards for VA study participants
- Ensuring compliance with the NHS/VE federal mandate
- Reducing the learning curve for VA Team Leaders, VA Team Members and VA District Coordinators
- Enhances state of the art VA techniques and practices unique to Caltrans, such as project performance measurements
- Establishes implementation procedures.

## 7. Program management details

### Tracking Program Performance

Caltrans has a standardized VA Program reporting system to track multiple program reporting statistics. All VA study findings are reported in a consistent, systematic fashion, which in turn feeds the annual program results shown on **Appendix A**.

### Project Performance Measurements

One of the problems with the VA studies in the department had been the tendency for studies to be "cut-cutting" tools instead of a value-enhancing tool. Since only study costs were reported at the conclusion of the study there was no mechanism to weigh the value of the project costs that were cut against the project scope and project delivery components that accompanied these costs. Therefore the VA Branch developed a tool to do just that. **Appendix B** describes in detail this procedure.

## 8. Integrating VA methodology with the Caltrans project development procedures

**Appendix C** shows how Caltrans integrated the VA methodology within its project development procedures. Caltrans is a large, procedural agency and the methodology needed to be compatible with our "way of doing business". One key feature was the introduction of a Critique Phase between the development of alternatives and the presentation of the study findings. This allowed the project development technical experts to provide and receive input on the study recommendation before they are presented to management and the project stakeholders. For other details on the Caltrans VA Activity Chart see **Appendix C**.

## 9. Implementation procedures

Caltrans implementation procedures are now an integral part of the VA study, as opposed to a "post-study" event. In fact this language "post-study" sends the wrong message to the project development team, therefore the new Caltrans Activity Chart (**see Appendix C**), delineates the implementation activities as the third segment of the "STUDY". See **Appendix D** for the form that must be provided by the Project Manager to close out every VA alternative developed on a Caltrans VA Study.

## 10. Program marketing tools

The VA Program, until recently, was virtually unknown throughout Caltrans. To overcome this deficiency various marketing strategies were employed, including VA awards, presentations and publications. The following awards are presented every year:

- ***E. Darwin Spartz Excellence in Value Analysis Award*** recognizes the excellent application of VE/VA within the Department of Transportation made by Districts, as a whole, or certain individuals that have made significant contributions to the VA Program in a given fiscal year.
- ***Most Outstanding Value Engineering Award*** recognizes outstanding implemented results for a particular VA/VE study done in a given fiscal year.
- ***District Value Analysis Coordinator of the Year Award*** recognizes the important role that the District Value Analysis Coordinator contributes to the success of the Value Analysis Program within the Department of Transportation. The nominations are the District Value Analysis Coordinators from a given District or Region.

## 11. Program results

Table 1, on the following page, shows the improvements in the Caltrans Program over the last three years. What is not shown in the graphs is the overall acceptance and requests to solve problems by Caltrans management and project managers. The results of this deliberate and concerted effort to improve the Caltrans VA Program will pay dividends for many years to come. For the program's results between FY 1996 TO 2003 see **Appendix E**.

## 12. Conclusions

To implement a successful value engineering program in other parts of the world, the Caltrans experience in the highway/ public works sector recommends the following:

- The VE organization must be clearly structured.
- Their VE responsibilities must be clearly delineated.
- VE guidelines and manuals should be developed, used and maintained.
- In-house VE training should being provided.
- Program evaluation and auditing must be provided.
- VE consultants should be utilized..

**TABLE 1: CALTRANS VA HIGHWAY STUDIES RESULTS (FY 2001-2003)**

| CATEGORY | ITEM | 2001 | 2002 | 2003 | TOTALS/ AVERAG |
|---|---|---|---|---|---|
| NO. OF STUDIES | Studies Planned in Given FY | 50 | 53 | 55 | 158 |
| | Studies Started in Given FY | 33 | 23 | 11 | 67 |
| | Reported Studies w/ Implementation Results | 29 | 37 | 30 | 96 |
| | Study Completion Rate | 66% | 43% | 20% | 42% |
| COMPLETED STUDIES SAVINGS | Completed Studies Project Cost (Millions) | $2,067 | $2,394 | $2,650 | $7,111 |
| | Recommended Savings (Millions) | $536 | $373 | $281 | $1,191 |
| | Implemented Savings (Millions)*** | $114 | $0 | $152 | $266 |
| | Average Project Initial Cost Reduction | 5.5% | 0.0% | 5.7% | 3.7% |
| STUDY RECOMMENDATIONS | No. of VA recommendations | 193 | 290 | 187 | 670 |
| | No. of Implemented VA Recommendations | 64 | 75 | 58 | 197 |
| | Implementation Rate * | 33% | 26% | 31% | 29.4% |
| STUDY COSTS/ ROI | Study Costs (Millions) | $1.714 | $1.898 | $1.923 | $3.6 |
| | Return on Investment ** | 67:1 | 0:1 | 79:1 | 49:1 |
| VALUE STATISTICS | Accepted Performance Improvement **** | 11.4% | 12.0% | 8.0% | 10.5% |
| | Accepted Value Improvement | 18.3% | 68.0% | 11.0% | 43.2% |
| | VROI ***** | 320:1 | 923:1 | 182:1 | 475:1 |

only)

** Implemented Savings/ Study Costs (Construction Costs only)

*** Includes conditionally accepted alternatives

**** Project Performance/ Project Costs)

***** VROI - Value Return on Investment ((Accepted Value Improvement / Study Costs)

# Appendix A
## Caltrans Fiscal 2002 Highway Studies Results

| Task Order | 204.183 | 204.191 | 232 | 202.098 | 202.115 | 237 | 238 | | Study Count |
|---|---|---|---|---|---|---|---|---|---|
| Value Analysis Contract No. | 53A0063 | 53A0063 | 53A0063 | 53A0063 | 53A0063 | 53A0063 | 53A0063 | | 7 |
| District | 1 | 1 | 1 | 4 | 5 | 7 | 7 | | |
| EA | 01-324700 | 01-36600K | 19640K | 25620K | 3307U0 | 06247- | 117070 | | |
| NHS (Y/N) | Y | Y | N | Y | Y | Y | Y | | |
| Study Name | SR 101 Roadway Stabilization | Route 101 Eureka Arcata Corridor Improve | Big Lagoon Curve Improvement and Shoulde | Route 80/Ashby Avenue Interchange | SR 46 Widening | VEN 101 Mussel Shoals / La Conchita | I-10 HOV | | |
| Team Leader | Fred Kolano | Fred Kolano | Fred Kolano | Robert | Ginger Adams | Terry Hays | Ginger Adams | | TOTALS |
| **Study Costs** | | | | | | | | | |
| In-House Cost | $24,900 | $19,500 | $27,000 | $21,000 | $21,450 | $28,800 | $30,000 | | $172,650 |
| Consultant Cost | $40,000 | $29,000 | $28,100 | $26,000 | $54,681 | $55,000 | $42,230 | | $275,011 |
| Administrative Cost | $11,413 | $11,413 | $11,413 | $11,500 | $11,413 | $11,413 | $114,130 | | $182,695 |
| Total Cost | $76,313 | $59,913 | $66,513 | $58,500 | $87,544 | $95,213 | $186,360 | | $630,356 |
| **Project Cost** | | | | | | | | | |
| Initial | $45,000,000 | $31,330,000 | $17,003,000 | $18,300,000 | $172,534,500 | $28,030,000 | $278,500,000 | | $590,697,500 |
| **Proposed Cost Savings** | | | | | | | | | |
| Initial | $39,030,000 | $14,265,000 | $4,460,000 | $1,292,000 | $44,108,075 | $14,419,000 | $11,730,000 | | $129,304,075 |
| Subsequent | $0 | $0 | $0 | $0 | $0 | $846,000 | $0 | | $846,000 |
| Highway User | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| **Accepted Cost Savings** | | | | | | | | | |
| Initial | $39,030,000 | $14,265,000 | $4,460,000 | $1,530,000 | $30,022,000 | $14,830,000 | $0 | | $104,137,000 |
| Subsequent | $0 | $0 | $0 | $0 | $0 | $846,000 | $0 | | $846,000 |
| Highway User | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| **Conditionally Accepted** | | | | | | | | | |
| Initial | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Subsequent | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Highway User | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| **Proposed Cost Increases** | | | | | | | | | |
| Initial | $0 | ($3,430,000) | $0 | $0 | ($2,754,600) | $0 | $0 | | ($6,184,600) |
| Subsequent | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Highway User | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| **Accepted Cost Increases** | | | | | | | | | |
| Initial | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Subsequent | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Highway User | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| **Conditionally Accepted** | | | | | | | | | |
| Initial | $0 | ($3,430,000) | $0 | $0 | $0 | $0 | $0 | | ($3,430,000) |
| Subsequent | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Highway User | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| **Proposed LLC (NPV)** | | | | | | | | | |
| Initial (Savings - Increases) | $39,030,000 | $10,835,000 | $4,460,000 | $1,292,000 | $41,353,475 | $14,419,000 | $11,730,000 | | $123,119,475 |
| Subsequent (Savings - Increases) | $0 | $0 | $0 | $0 | $0 | $846,000 | $0 | | $846,000 |
| Highway User (Savings - Increases) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Total Proposed NPV | $39,030,000 | $10,835,000 | $4,460,000 | $1,292,000 | $41,353,475 | $15,265,000 | $11,730,000 | | $123,965,475 |
| **Accepted LLC (NPV)** | | | | | | | | | |
| Initial (Savings - Increases) | $39,030,000 | $14,265,000 | $4,460,000 | $1,530,000 | $30,022,000 | $14,830,000 | $0 | | $104,137,000 |
| Subsequent (Savings - Increases) | $0 | $0 | $0 | $0 | $0 | $846,000 | $0 | | $846,000 |
| Highway User (Savings - Increases) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Total Accepted NPV | $39,030,000 | $14,265,000 | $4,460,000 | $1,530,000 | $30,022,000 | $15,676,000 | $0 | | $104,983,000 |
| **Conditionally Accepted LLC (NPV)** | | | | | | | | | |
| Initial (Savings - Increases) | $0 | ($3,430,000) | $0 | $0 | $0 | $0 | $0 | | ($3,430,000) |
| Subsequent (Savings - Increases) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Highway User (Savings - Increases) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | | $0 |
| Total CA NPV | $0 | ($3,430,000) | $0 | $0 | $0 | $0 | $0 | | ($3,430,000) |
| **Performance** | | | | | | | | | |
| Proposed | 44% | 5% | 14% | 5% | 0% | 11% | 4% | | 14% |
| Accepted | 44% | 5% | 14% | 14% | 2% | 17% | 0% | | 16% |
| Including CA Potential | 44% | 5% | 14% | 14% | 2% | 17% | 0% | | 16% |
| **Value Improvement** | | | | | | | | | |
| Proposed | 978% | 60% | 206% | 14% | 28% | 159% | 8% | | 242% |
| Accepted | 987% | 92% | 93% | 27% | 23% | 149% | 0% | | 229% |
| Including CA Potential | 987% | 92% | 93% | 27% | 23% | 149% | 0% | | 229% |
| **Number of Alternatives** | | | | | | | | | |
| Proposed | 3 | 7 | 1 | 3 | 8 | 2 | 4 | | 28 |
| Accepted | 1 | 2 | 1 | 2 | 4 | 1 | 0 | | 11 |
| Conditionally Accepted | 0 | 1 | 1 | 0 | 0 | 0 | 0 | | 2 |
| Acceptance Rate - | 33% | 29% | 100% | 67% | 50% | 50% | 0% | | 39% |
| Acceptance Rate - Including CA | 33% | 43% | 200% | 67% | 50% | 50% | 0% | | 46% |
| **Project Initial Cost Reduction** | 87% | 46% | 26% | 8% | 17% | 53% | 0% | | 17.6% |
| **ROI (Initial Cost** | 511 | 238 | 67 | 26 | 343 | 156 | 0 | | 165 |
| **VROI (Accepted Value Improvement/Study Costs X 1,000,000)** | 12934 | 1536 | 1398 | 462 | 263 | 1565 | 0 | | 3026 |

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# APPENDIX B

## Caltrans Project Performance Measures

### Introduction

The methodology described herein measures project value by correlating the performance of project scope and delivery to the project costs. The objective of this methodology is to prescribe a systematic, objective approach to study and optimize a project budget, schedule and scope. This serves the transportation community by identifying a quantifiable methodology to effectively analyze and compare the three project management components (scope, schedule and budget) and measure resulting project value.

Project performance measures are an integral part of the Caltrans Value Analysis (VA) methodology and consists of a set of techniques as follows:

- identification of key project (scope & delivery )performance criteria for the project;
- establishing the hierarchy and impact of these criteria upon the project;
- establishing the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts;
- identifying the change in performance of alternative project concepts generated by the study;
- and measuring the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement.

It is important that the project performance criteria be well defined and agreed to by the stakeholders at the start of the study, as they are used throughout the study to identify, evaluate, and document alternatives. Project scope performance improvements are also one of the critical quantifiable results of a Caltrans study. All subsequent references to "project scope and delivery performance" will be abbreviated to "performance". The primary goal of value analysis is to improve project value. A simple way to think of value in terms of an equation is as follows:

$$\text{Value} = \frac{\text{Project Performance (Scope \& Delivery)}}{\text{Project Cost}}$$

Value Analysis has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of overlooking the role that VA can play with regard to improving project performance. Project costs are fairly easy to quantify and compare through traditional estimating techniques. Performance is not so easily quantifiable.

The Caltrans VA Program has developed a unique methodology using a variety of techniques aimed at identifying, defining, and quantifying performance. Once this has been accomplished, the interrelationship between cost and performance can be quantified and compared in terms of how they contribute to overall value.

The direct and active involvement of the project's stakeholders is at the core of this process. The VA team leader will lead Caltrans and external stakeholders through the methodology, using the power of the process to distill subjective thought into an objective language that everyone can relate to and understand. The dialog that develops then forms the basis for the VA team's understanding of the performance requirements of the project and to what degree the current design concept is meeting those requirements.

From this baseline, the VA team can focus on developing alternative concepts that will quantify both performance and cost and contribute to overall project value.

### Methodology

The application of Performance Methodology consists of the following steps:

1) Define the major performance criteria
2) Determine the relative importance of the criteria

# APPENDIX B

**Caltrans Project Performance Measures**

3) Establish the performance "baseline" for the original design
4) Evaluate the performance of the VA alternative concepts
*5)* Compare the performance ratings of alternative concepts to the "baseline" project

The process is summarized by on a Performance Rating Matrix. The performance ratings developed for the VA alternative concepts are entered into the matrix and the summary portion of the Performance Rating Matrix is completed. The summary provides details on net changes to cost, performance and value using the following calculations.

- % Performance Improvement = ΔPerformance VA Alt Set / Total Performance Original Concept.
- Value Index = Total Performance / Total Cost (in millions)
- % Value Improvement = ΔValue Index VA Alt Set / Value Index Original concept.

The stakeholders are asked to validate the Performance Measures and rationale at the Implementation Meeting. The rationale for the numerical rating change for each alternative for each set is developed. The Performance Rating Matrix shows the numerical change for each Performance Measure and alternative set. The Total Performance is calculated by adding the Criteria weight x Performance Rating for each Performance Measure of either the Original Concept or VA Set.

Details of the above described methodology can be found in the Caltrans VA team guide available at: http://www.dot.ca.gov/hq/oppd/value/pdf/teamgde.pdf

**Conclusions**

The development and integration of performance measurements into the value methodology employed on Caltrans studies has improved the effectiveness of the Value Analysis program as applied to highway projects by providing a reliable, integrated method of measuring performance and, consequently, value.

This in turn has allowed the program to more easily discuss implementation dispositions of alternatives, justify alternatives with cost increases, apply more effectively Value Analysis to projects in the earlier stages of project development and to better capture input from participating project stakeholders.

The application of performance measurements within a VA Study neither supplants or reduces the authority of the Project Development Team (notably Design and Environmental units) from developing, analyzing and refining the project scope issue contained in the above two major categories. The intent, of the project (scope) performance measurements , within the context of a VA study, is for the VA Team to address the relevant project scope issues. These may help the project development team, but do not supplant, their role as the final decision makers on the project scope.

The Caltrans approach to project performance yields the following benefits:

- Identifies how the baseline project is meeting performance goals and objectives
- Identifies areas where project performance can be improved through the VA process
- Develops a better understanding of a VA alternative's effect on project performance
- Develops an understanding of the relationship between performance and cost in determining value, which in turn, allows "value" to become the basis of selecting the right project or design concept
- Provides decision makers with a means of comparing costs and performance (i.e., costs vs. benefits) in a way that can assist them in making better decisions.
- Provides a more complete analysis of the project objectives, which can subsequently modeled with a benefit-cost analysis.
- Builds consensus among project stakeholders (especially those holding conflicting views)

# APPENDIX B
**Caltrans Project Performance Measures**

**Project Performance Measures**

**Typical Caltrans Performance Criteria**

# APPENDIX B

**Caltrans Project Performance Measures**

**Caltrans Project Performance Measures Breakdown**

Project Performance Measures explicitly measure the project scope and delivery of a project, providing the project stakeholders the opportunity to effectively compare the three project management components, scope, schedule and budget. Performance Criteria can generally divided between Project Scope components (Highway Operations, Environmental Impacts, and System Preservation) and Project Delivery components.

**Project Scope Components**

**Highway Operation** criteria measure the impacts the highway users and are generally covered in the project's purpose and need. These typically involve, but are not limited to:

- **Traffic Operations** -typically measure in Travel Time between project limits for Highway User). Mainline versus Local Street Operations are commonly segregated in this category.
- **System Compatibility** -integration of the project with the regional transportation system and intermodal facilities. This category also includes non-motorized mobility.
- **Access** (Access to and from the highway and key locations within a community). Vehicular and Non-Motorized are subcategories to consider. Traffic circulation patterns.
- **Highway Safety** - a measure of probability and severity to the highway user and highway maintenance crews). Highway User Safety is customarily measured by Fatality, Injury and Property Damage Only.
- **Construction Related Highway Operations Delays** (Travel time delays during construction)

**Environmental Impacts** criteria measure how the proposed facility impacts its surrounding environment both, in term of the final scope and during construction of the project. Environmental impacts must be addressed per current statutory requirements established in environmental laws and regulations .The environmental impacts imposed by the final project scope as constructed and in place, should be consider the following:

- **Physical Environment –** includes such factors as topography, geology, soils, seismic, paleontology, water quality, hydrology, storm water run off, hazardous waste, air quality, noise and energy.
- **Natural Environment –** includes such factors as vegetation, fish and wildlife, wetlands and other waters of the U.S., special status plants, animals and communities.
- **Special Status Land Use Designations** – includes such factors as floodplains, costal zone, wild and scenic rivers, section 4(f) resources, and section 6(f) properties.
- **Community Issues** – includes such factors as land use planning, farmlands, economic issues, environmental justice and Title VI, relocations, community and public services, traffic, visual and aesthetic resources, and public partnerships.
- **Cultural Resources –** includes such factors as archaeological resources and historical resources.

Construction impacts upon the community during the construction of the facility should be considered, as follows*:*

- **Construction Impacts to the Community –** includes items such as construction noise, dust, business access, water pollution and air pollution.

**System Preservation** criteria measure the sustainability of the proposed facility. These criteria are typically related to maintenance operations or design considerations required to

ensure the facility will withstand natural events. The following major topics could be considered:

- **Maintainability** – a measure of the effort needed to preserve an acceptable level of operations of the facility for the duration of the service life of the facility. Highway roadways typically require maintenance on the traveled way, slopes & drainage, roadside, and traffic guidance as a result wear and tear caused by natural forces and the facility users.
- **Hydraulics -** a measure of the ability to pass floodwaters through the roadway facility's without impacting the roadway facility or the upstream or downstream flow of the drainage facility.
- **Geotechnical –** a measure of ability of the facility to preserve the structural integrity of the soil/ structure and soil/ pavement stable interaction during the service life of the facility..

**Project Delivery Components**

**Project Delivery criteria** measure the potential impact to delivering the project to the stakeholders as proposed.

- **Constructibility Risk** – a measure of the risk that the contractor will not be able to deliver the project scope as defined on the contract documents and the potential for change orders and disputes.
- **Project Schedule -** a measure of the time to complete the project.
- **Project Phaseability** – the ability to build in incremental phases over extended period of time, typically due to incremental amounts of funding or demand.

Typically there are 5-8 key performance criteria that need to be considered for a particular project

# APPENDIX C
## CALTRANS VA ACTIVITY CHART

The VA Activity Chart on the following page summarizes the 15 steps required to successfully complete a VA Study. It begins with *Initiate Study* and ends with *Close Out VA Study*. The activities are grouped in three phases:

- **PREPARATION**
  - **Initiate Study** – Identify study project; define study goals; prepare draft study charter and Task Order Initiation Document.
  - **Organize Study** – Conduct preparation meeting; select team members; finalize study charter and Task Order Initiation Document.
  - **Prepare Data** – Collect and distribute data; prepare cost models; develop LCC model.
- **VA STUDY**

***Segment 1***

  - **Inform Team** – Receive designer presentation; develop performance criteria; visit project site.
  - **Analyze Functions –** Identify basic functions and cost drivers; prepare FAST diagram.
  - **Create Ideas –** List a large quantity of alternative ideas; use group/individual brainstorming.
  - **Evaluate Ideas** – Evaluate all ideas against performance criteria; rank all ideas.

***Segment 2***

  - **Develop Alternatives** – Develop high-ranked ideas into VA alternatives; measure performance.
  - **Critique Alternatives –** Review of alternatives by VA team and Technical Reviewers to develop and ensure team consensus and technical viability. Develop and rate recommended VA alternative set(s).
  - **Present Alternatives –** Give interim presentation of alternatives; prepare preliminary report.

***Segment 3***

  - **Assess Alternatives** – Review alternatives; prepare draft implementation decisions.
  - **Resolve Alternatives** – Resolve dispositions; edit and revise alternatives; summarize results.
  - **Present Results** – Give formal presentation of accepted alternatives.
- **REPORT**

Following the VA Study, the Team Leader assembles all study documentation into the final report:

**Publish Results –** Prepare final VA Study Report; distribute printed and electronic copies.

**Close Out VA Study –** Resolve open conditionally accepted VA alternatives and update the Executive Summary and VASSR. Provide final deliverables to the HQ VA Branch.

The VA Study is complete when the VA Study Report is issued as a record of the VA team's analysis and development work, and the project development team's implementation dispositions for the alternatives. The VA Activity Chart serves as a guide to the VA Coordinator, the VA team, and the Team Leader, as well as the stakeholders, all of whom are participants in VA studies.

This VA Team Guide outlines the steps to accomplish the Study Performance Activities (Boxes 4-13). The VA Report Guide focuses on the preliminary and final report preparation that is identified in Present Alternatives (Box 10) and Publish Results (Box 14) activities. It describes how the Team Leader organizes all of the material generated during the study into a VA Study Report.

# APPENDIX C
## CALTRANS VA ACTIVITY CHART

<table>
<tr><td rowspan="3">PREPARATION</td><td colspan="2"></td><td>INITIATE STUDY<br>➢ Identify study project<br>➢ Define study goals<br>➢ Identify study roles and responsibilities<br>➢ Identify study dates and logistics<br>➢ Begin recruitment of team members<br>➢ Select Team Leader<br>➢ Prepare draft study charter<br>1</td><td>ORGANIZE STUDY<br>➢ Conduct pre-study meeting:<br>➢ Identify stakeholders, decision makers, and technical reviewers<br>➢ Validate team member qualifications and finalize selection<br>➢ Identify data collection<br>➢ Finalize study dates and logistics<br>➢ Update VA Study Charter<br>2</td><td>PREPARE DATA<br>➢ Collect and distribute data<br>➢ Develop construction cost models<br>➢ Develop highway user benefit LCC model<br>3</td><td></td></tr>
<tr><td rowspan="2">VA STUDY</td><td rowspan="1">Segment 1</td><td>INFORM TEAM<br>➢ Review study activities and confirm reviewers<br>➢ Present design concept<br>➢ Present stakeholders' interests<br>➢ Review project issues and objectives<br>➢ Identify key functions and performance criteria<br>➢ Visit project site 4</td><td>ANALYZE FUNCTIONS<br>➢ Analyze project data<br>➢ Expand project functions<br>➢ Prepare FAST diagram<br>➢ Determine functional cost and performance drivers<br>5</td><td>CREATE IDEAS<br>➢ Focus on functions<br>➢ List all ideas<br>➢ Apply creativity and innovation techniques (group and individual)<br>6</td><td>EVALUATE IDEAS<br>➢ Apply key performance criteria<br>➢ Rate each idea<br>➢ List advantages and disadvantages<br>➢ Rank all ideas<br>➢ Assign alternatives for development<br>7</td></tr>
<tr><td>Segment 2</td><td>DEVELOP ALTERNATIVES<br>➢ Develop alternative concepts<br>➢ Prepare sketches and calculations<br>➢ Measure performance<br>➢ Estimate costs, LCC benefits/costs<br>8</td><td>CRITIQUE ALTERNATIVES<br>➢ VA Alternatives Technical Review<br>➢ VA Alternatives Team Consensus Review<br>➢ Update and reevaluate functions and performance measures (if necessary)<br>➢ Group and number alternatives<br>➢ Validate performance<br>9</td><td>PRESENT ALTERNATIVES*<br>➢ Present findings<br>➢ Validate performance measure changes, if necessary<br>➢ Document feedback<br>➢ Confirm pending reviews<br>➢ Prepare preliminary report<br>*Interim presentation of study findings<br>10</td><td></td></tr>
</table>

# APPENDIX C
## CALTRANS VA ACTIVITY CHART

**Segment 3**

**ASSESS ALTERNATIVES****
- Review preliminary report
- Assess alternatives for project acceptance
- Prepare draft implementation dispositions

***Activities performed by PDT, Technical Reviewers, and Stakeholders*

**11**

**RESOLVE ALTERNATIVES**
- Review implementation dispositions
- Resolve implementation actions with decision makers and stakeholders
- Edit alternatives
- Revisit rejected alternatives, if needed

**12**

**PRESENT RESULTS***
- Present results
- Obtain management approval on implemented alternatives
- Summarize performance, cost, and value improvements

**Final presentation of study results* **13**

**REPORT**

**PUBLISH RESULTS**
- Document process and study results
- Incorporate all comments and implementation actions
- Distribute Final VA Report
- Distribute electronic report to HQ VA Branch
- Update VA Study Summary Report (VASSR)
- Provide HQ the Final VA Report in pdf format

**14**

**CLOSE OUT VA STUDY**
*(if conditionally accepted alternatives exist)*
- Resolve conditionally accepted alternatives
- Finalize VA Study Summary Report (VASSR)
- Finalize performance measures
- Finalize VA Report Executive Summary and provide electronically to HQ

**15**

<table>
<tr><td colspan="3">VA ALTERNATIVE IMPLEMENTATION ACTION<br>Project Name</td><td colspan="4">Caltrans</td></tr>
<tr><td colspan="3">TITLE:</td><td colspan="4">NUMBER</td></tr>
<tr><td>RESPONSES</td><td colspan="2">Prepared by:</td><td colspan="4">Date:</td></tr>
<tr><td colspan="7">Acceptance of alternatives denotes intent to implement, based on current information, in the given project development phase (PID, PA&ED or PS&E). It is recognized that future conditions may change this disposition. The validation of disposition and the cost and performance changes for the alternative are required by Caltrans to ensure that the project decision makers agree with the study results. These validated results become the basis for the VA Program reportables.</td></tr>
<tr><td colspan="3" rowspan="2">Technical Feasibility / Validated Performance</td><td colspan="4">DISPOSITION</td></tr>
<tr><td colspan="4">☐ Accept<br>☐ Conditionally Accept<br>☐ Reject<br><br>Validated Performance</td></tr>
<tr><td colspan="3">Implementable Portions</td><td colspan="4"><u>If Alternative is Rejected</u><br>Was rejection due to VA study taking place too late in the project development process to implement the change?<br>Yes ☐ No ☐</td></tr>
<tr><td colspan="3">Validated Cost Savings</td><td colspan="4">Validated Savings<br><br>Project Development Support Cost Savings</td></tr>
<tr><td colspan="2" rowspan="5">Project Development Delivery Impacts</td><td></td><td>No Change</td><td>Reduced by</td><td>Increased by</td></tr>
<tr><td>PID</td><td>☐</td><td>Mo.</td><td>Mo.</td></tr>
<tr><td>PA&ED</td><td>☐</td><td>Mo.</td><td>Mo.</td></tr>
<tr><td>PS&E</td><td>☐</td><td>Mo.</td><td>Mo.</td></tr>
<tr><td>Const.</td><td>☐</td><td>Mo.</td><td>Mo.</td></tr>
<tr><td colspan="7">Other Comments</td></tr>
</table>

# APPENDIX E:
## CALTRANS VA HIGHWAY STUDIES RESULTS (FY 1996-2003)

| CATEGORY | ITEM | FISCAL YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | TOTALS/ AVERAGE |
| NO. OF STUDIES | Studies Planned in Given FY | 84 | 46 | 81 | 53 | 49 | 50 | 53 | 55 | 471 |
| | Studies Started in Given FY | 18 | 26 | 31 | 30 | 26 | 33 | 23 | 11 | 198 |
| | Reported Studies w/ Implementation Results | 18 | 26 | 19 | 25 | 21 | 29 | 37 | 30 | 205 |
| | Study Completion Rate | 21% | 57% | 38% | 57% | 53% | 66% | 43% | 20% | 42% |
| COMPLETED STUDIES SAVINGS | Completed Studies Project Cost (Millions) | $1,292 | $2,069 | $1,823 | $2,040 | $1,420 | $2,067 | $2,394 | $2,650 | $15,756 |
| | Recommended Savings (Millions) | $156 | $512 | $409 | $1,044 | $703 | $536 | $373 | $281 | $4,014 |
| | Implemented Savings (Millions)*** | $104 | $141 | $155 | $117 | $66 | $114 | $173 | $152 | $1,022 |
| | Average Project Initial Cost Reduction | 8.0% | 6.8% | 8.5% | 5.7% | 4.6% | 5.5% | 7.2% | 5.7% | 6.5% |
| STUDY RECOMMENDATIONS | No. of VA recommendations | 117 | 165 | 206 | 296 | 233 | 193 | 290 | 187 | 1687 |
| | No. of Implemented VA Recommendations | 39 | 74 | 56 | 105 | 74 | 64 | 75 | 58 | 545 |
| | Implementation Rate * | 33% | 45% | 27% | 35% | 32% | 33% | 26% | 31% | 32.3% |
| STUDY COSTS/ ROI | Study Costs (Millions) | $0.720 | $2.267 | $1.111 | $1.251 | $1.463 | $1.714 | $1.898 | $1.923 | $12.3 |
| | Return on Investment ** | 144:1 | 62:1 | 140:1 | 94:1 | 45:1 | 67:1 | 91:1 | 79:1 | 90:1 |
| VALUE STATISTICS | Accepted Performance Improvement | Not avail. | Not avail. | Not avail. | Not avail. | Not avail. | 11.4% | 12.0% | 8.0% | 10.5% |
| | Accepted Value Improvement (Performance/ Project Costs) | Not avail. | Not avail. | Not avail. | Not avail. | Not avail. | 18.3% | 68.0% | 11.0% | 32.4% |
| | (Accepted Value Improvement / Study Costs) X 1,000,000 | Not avail. | Not avail. | Not avail. | Not avail. | Not avail. | 320:1 | 923:1 | 182:1 | 475:1 |

* No. Implemented alternatives/ No. of proposed alternatives (Construction Costs only)
** Implemented Savings/ Study Costs (Construction Costs only)