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BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Secretary Of Transportation

Value Engineering Has The Potential To Reduce Mass Transit Construction Costs

The Urban Mass Transportation Administration (UMTA) could achieve substantial savings by applying value engineering to the design of federally funded rail and bus construction projects. Value engineering, a cost-control program, assures that a project's required function is met at the lowest cost consistent with performability, reliability, and maintainability.

Although UMTA provides billions of dollars annually in capital grants to transit authorities, it has no formal program to control costs and not enough regional engineers to assure that mass transit projects are constructed at the lowest cost. Instead, UMTA has an informal peer review program to control costs on new, primarily heavy rail projects.

GAO recommends that UMTA establish a value engineering program for transportation construction projects and suggests how the program should be implemented.

GAO/RCED-83-34

DECEMBER 29, 1982

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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION

B-209932

The Honorable Drew L. Lewis
The Secretary of Transportation

Dear Mr. Secretary:

This report discusses and demonstrates the potential of value engineering to reduce construction costs on capital grants provided by the Urban Mass Transportation Administration and suggests ways to assure a more prudent and cost-effective use of Federal mass transit funds. We made our review because of our Office's continuing interest in the use of value engineering as a means to help reduce Federal acquisition and ownership costs.

The report contains recommendations to you on page 28. As you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the Senate Committee on Governmental Affairs and the House Committee on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

In addition to the committees mentioned above, we are sending copies of this report to the Director, Office of Management and Budget, interested congressional committees, and to your Assistant Secretary for Administration.

Sincerely yours,

J. Dexter Peach
Director

GENERAL ACCOUNTING OFFICE
REPORT TO THE SECRETARY
OF TRANSPORTATION

VALUE ENGINEERING HAS THE
POTENTIAL TO REDUCE MASS
TRANSIT CONSTRUCTION COSTS

DIGEST

Millions of dollars in Federal, State, and local construction funds can be saved by applying value engineering to the designs of construction projects funded by the Urban Mass Transportation Administration (UMTA).

GAO made this review to determine (1) how effective value engineering would be when applied to heavy rail and bus construction projects and (2) if value engineering could produce greater savings than UMTA's peer review on one aspect of a proposed subway station.

Value engineering is a systematic, multidiscipline approach designed to optimize the value of each dollar spent. To accomplish this goal, a team of architects/engineers identifies, analyzes, and establishes a value for a function of an item or system. The objective is to satisfy the required function at the lowest cost consistent with the requirements of performability, reliability, and maintainability. As a management tool, value engineering complements rather than replaces other cost-reduction and/or cost-control techniques.

During two value engineering training workshops arranged by GAO in cooperation with the Corps of Engineers and the American Consulting Engineers Council/American Institute of Architects, teams of professional architects and engineers identified potential savings in capital costs on two UMTA-funded projects. Projects selected by GAO for value engineering were typical of projects funded by UMTA. One team made recommendations that would reduce costs about $3.1 million, or 18 percent, on the bus layout of a subway station. Another study team identified savings of over $900,000, or about 15 percent, on a bus maintenance building. In this instance the transit authority plans to implement recommendations that will reduce costs by about $364,000, or about 6 percent. The authority is considering other value engineering recommendations which, if implemented, would further reduce project costs. The remaining

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recommendations were rejected as infeasible. (See pp. 12 and 16.)

UMTA officials and representatives of several architectural/engineering firms that have designed UMTA projects believe value engineering has the potential to reduce construction costs if (1) it is performed early during the design phase by experienced staff and (2) the resulting recommendations are implemented in a timely manner to prevent construction delays. (See p. 24.)

Value engineering has been used successfully by several Federal agencies with construction programs. Agency officials emphasized the need for strong, active top management support as a primary factor for a successful program. Three agencies GAO visited reported cumulative project cost savings from \$235 million to \$7.4 billion. One agency claimed that 143 value engineering studies costing about \$15 million have produced savings of \$235 million, a return of \$16 for each \$1 spent for value engineering. (See p. 26.)

Value engineering can also reduce costs during construction. Value engineering incentive clauses in construction contracts encourage contractors to suggest changes in methods or materials and share in resultant savings.

HOW MASS TRANSIT PROJECTS ARE DESIGNED AND REVIEWED

Most transit authorities that receive UMTA funds lack the technical expertise to design projects. To obtain this capability they hire architectural/engineering firms. Because the firms design facilities to satisfy transit authorities' requirements, the cost to construct the facilities may be greater than necessary. (See pp. 23 and 24.)

The design plans are evaluated by UMTA regional engineers for cost effectiveness, safety, and technical feasibility. However, UMTA officials and architectural/engineering representatives acknowledge that UMTA does not have enough engineers to adequately review designs. In addition, the engineers have many other responsibilities that preclude them from performing adequate reviews. (See p. 19.)

In response to its lack of in-house technical expertise and engineering credentials, UMTA in 1979 introduced an informal peer review program in an attempt to control costs, but only on selected new, primarily heavy rail transit capital projects. The peers, mostly experts in the transit industry, review the concept or design of a proposed project and make cost saving recommendations based on their collective experience and judgment. Unlike value engineering, peer review does not include use of a job plan, analysis of the functional requirements of a system before recommendations are made, or use of formal criteria and guidelines. (See p. 25.)

UMTA adopted peer review because headquarters grants management officials were familiar with the program's concepts. They believed that by using chief engineers' expertise on transit authorities, UMTA could resolve its problems discussed above. UMTA believes that peer reviews held during the conceptual and informational stages of project development have saved millions of dollars in construction costs. (See pp. 2 and 22.)

UMTA NEEDS EFFECTIVE COST CONTROLS

For fiscal years 1965-81, UMTA has provided about $18 billion in capital grants to local transit authorities to construct and rehabilitate rail and bus facilities--about $7.5 billion for rail and $1.5 billion for bus projects. The remaining funds were used to purchase rolling stock and equipment and for similiar purposes. In fiscal year 1981, obligations for UMTA capital programs totaled about $2.9 billion; about $866 million was used for bus and about $2 billion for rail projects.

Considering the magnitude of these funds in a time of rising costs and budgetary constraints, it is essential that projects be constructed at the lowest cost. GAO believes that UMTA needs a more effective cost-control program that can reduce rail and bus project construction costs. Value engineering can significantly reduce construction costs as demonstrated in the workshops and by several Federal agencies that use it.

GAO recommends that UMTA implement a value engineering program for construction projects. In implementing the program, the Administrator should:

--Appoint a full-time program manager for value engineering activities who reports to the UMTA Administrator.

--Apply value engineering early in a project's design on all UMTA-funded construction projects exceeding $2 million.

--Share with the grantee the cost and savings of value engineering in proportion to its participation in project costs.

--Assure that value engineering is performed by a private architectural/engineering firm not participating in the project.

--Retain final authority for approving and disapproving value engineering recommendations.

--Ensure that construction contracts include a value engineering incentive clause.

GAO further recommends that UMTA limit its peer review program to the conceptual and informational phases of major construction projects and complement it with value engineering during the early design and construction phases of such projects.

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Department of Transportation comments were not received within the time allowed and to evaluate and include the comments would have delayed issuance of the report without significantly improving its accuracy. The Massachusetts Bay Transportation Authority and the Santa Cruz Metropolitan Transit District did not submit comments on the report although they were given the opportunity to do so.

Contents

ABBREVIATIONS

EPA	Environmental Protection Agency
GAO	General Accounting Office
MBTA	Massachusetts Bay Transportation Authority
OMR	operations, maintenance, and replacement
SCMTD	Santa Cruz Metropolitan Transit District
UMTA	Urban Mass Transportation Administration
VE	value engineering

CHAPTER 1

INTRODUCTION

The goal of the Urban Mass Transportation Administration (UMTA), an agency in the Department of Transportation, is to improve urban life and environment through mass transit systems that provide safe, fast, attractive, and convenient service as efficiently and economically as possible. To accomplish this, UMTA provides transit authorities with operating assistance and capital grants. Capital grants enable transit authorities to construct or rehabilitate rail and bus facilities and acquire rolling stock.

UMTA CAPITAL ASSISTANCE

The UMTA Act of 1964, as amended (49 U.S.C. 1601), and the Federal-Aid Highway Act of 1973, as amended (23 U.S.C.), established grant programs for UMTA capital assistance--Sections 3 and 5, Interstate Transfers and Federal-Aid Urban Systems. Section 3 provides loans and discretionary grants for constructing and extending rail systems, constructing rail and bus facilities, and acquiring rolling stock. Section 5 provides limited funds for construction. The Interstate Transfer Program allows States to transfer funds from nonessential segments of the interstate highway system to construct transit facilities. The Federal-Aid Urban Systems Program allows States to support either urban highway or mass transportation capital construction projects.

UMTA funds 80 percent of the capital costs under the UMTA act and 85 percent under the Federal-Aid Highway Act. Grants are distributed to State and local transportation authorities in response to project requests submitted to and approved by UMTA regional offices. UMTA regulations require that grant funds be spent prudently and with maximum effectiveness.

Funds for the UMTA program are provided annually. For fiscal years 1965-81, UMTA has provided about $18 billion in capital grants to local transit authorities to construct and rehabilitate rail and bus facilities--about $7.5 billion for rail and $1.5 billion for bus projects. The remaining funds were used to purchase rolling stock and equipment and for similiar purposes. In fiscal year 1981, obligations for UMTA capital programs totaled about $2.9 billion; about $866 million was used for bus and about $2 billion for rail projects. For fiscal year 1982, proposed obligations total about $3.9 billion, including grants for operating assistance.

HISTORY AND GROWTH OF VALUE ENGINEERING

The concept of value engineering (VE) is a byproduct of material shortages during World War II. These shortages led to the creation of innovative material and design alternatives. It was found that, in many instances, the alternative approach functioned as well, or better, and cost less. From this beginning, an analytical discipline evolved which challenged the proposed way of doing things and systematically searched for less costly alternatives. Commonly known as value engineering, it is sometimes termed value analysis, value control, value improvement, or value management.

VE is a systematic, multidiscipline, creative, and organized approach designed to optimize the value of each dollar spent. Using systematic techniques, the required function of an item is identified and analyzed and a value is established for that function. The objective is to satisfy the required function at the lowest cost consistent with the requirements of performability reliability, and maintainability. VE is a management tool that complements rather than replaces other cost-reduction and/or cost-control techniques.

VE can be applied during any phase of a project--from conception to completion. According to the Society of American Value Engineers, the optimum time to use VE is during the early design stage because once standards and criteria have been established, architects'/engineers' decisions have the greatest impact on total cost (see app. I). Performing VE early in the design phase has other advantages: the prospects for implementing changes are greatest at an early stage and the effects on implementation costs and the construction schedules are less. The cost of performing VE depends on the size and complexity of a project. Historically, the cost has been between 0.1 and 0.3 percent of total project costs.

VE is used by many private industries, local and State agencies, and Federal agencies such as the U.S. Army Corps of Engineers, the Environmental Protection Agency (EPA), and the Department of Defense. Since 1954, at least 14 Federal agencies have used VE.

GAO has a longstanding interest in the use of VE as a means to help reduce Government acquisition and ownership costs and has issued several reports, as shown in appendix II.

UMTA's PEER REVIEW PROGRAM

Most transit authorities hire architectural/engineering firms to design construction projects. The designs are subsequently evaluated by UMTA engineers for cost effectiveness and technical feasibility. In recognition of its lack of in-house technical expertise and engineering credentials, UMTA, in 1979, established a peer review program in an attempt to reduce costs on selected new, primarily heavy rail transit capital projects. UMTA adopted peer review because headquarters grants management officials were familiar with program concepts. They believed that using a transit authority chief engineer's expertise could address UMTA's problems, as discussed above. The program draws on the knowledge available within the transit industry to assist UMTA and transit authorities through either a cost-reduction effort or the transmittal of first-hand, practical data obtained from transit experience.

The reviewers, generally chief operating engineers, are drawn from those transit systems that best lend their collective expertise and experience to the particular project reviewed. The project reviewed may encompass the entire range of rapid transit design and operation activities from planning to the finished design. At the time of our review, peer reviews were not performed on bus construction projects such as garages or stations.

UMTA provides the reviewers with a list of items to be reviewed and necessary data such as design plans and specifications. The reviewers subsequently meet for about 2 days to obtain additional information from transit authority officials and/or their architectural and engineering consultants and make specific cost-saving recommendations. Generally, such recommendations result in eliminating items or changing materials based upon the reviewers' subjective expertise and judgment. To date, the majority of peer reviews have been held during the conceptual phase of project development.

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of this review were to determine (1) how effective VE would be when applied to heavy rail and bus construction projects and (2) if VE could produce greater savings than UMTA's peer review on one aspect of a proposed subway station. This review was made according to generally accepted government audit standards.

To accomplish our review objectives, we arranged to have two UMTA-funded capital projects--one aspect of a subway station of the Massachusetts Bay Transportation Authority's (MBTA's) Orange Line relocation project and the Santa Cruz, California, Metropolitan Transit District's (SCMTD's) bus maintenance and operations building--value engineered during two VE training workshops.

We selected transit projects representative of the types funded by UMTA, to compare savings resulting from peer review and VE on an aspect of a subway station and to determine the feasibility of applying VE to bus construction projects. The bus project was also selected because the Office of Management and Budget has deferred new construction on heavy rail projects until the economy improves. Therefore, UMTA's immediate future emphasis will be on constructing bus-related facilities.

We informed the UMTA headquarters Office of Grants Management that we planned to use VE workshops to accomplish our review objectives. UMTA did not object to our methodology.

VE was performed for us by the Corps of Engineers and a group of professional architects and engineers from private industry. The Corps periodically trains its engineers in VE techniques through workshops. The Corps agreed to value engineer the bus layout of an MBTA subway station during one of its workshops. This station had been examined previously by UMTA's peer review program in 1979. The Corps workshop was conducted by two experienced VE instructors. Mr. William Kelly, the principal instructor, has 22 years experience in designing military and civil works projects and is a registered professional engineer and a certified value specialist. 1/ He also is a member of the Society of American Value Engineers. In 1973, he was made a Corps VE officer. 2/ The other instructor, Mr. Frederick Suhm, holds degrees in mechanical engineering, engineering management and economics, and management science. He is a Corps VE officer and is a certified value specialist through the Society of American Value Engineers.

A second VE workshop was sponsored by the American Consulting Engineers Council and the American Institute of Architects. The study team, composed of a professional architect and engineers from private industry, value engineered a proposed bus maintenance and operations facility to be constructed in Watsonville, California, by the SCMTD.

The instructor, Mr. Alphonse Dell'Isola, is an internationally recognized VE authority and is a registered professional engineer in Massachusetts, the District of Columbia, and Puerto Rico. He is the author of the book entitled "Value Engineering in the Construction Industry" and coauthor of "Life Cycle Costing for Design Professionals." Currently, he is a vice president of the value management division of a large architectural/engineering firm that has participated in almost 500 VE studies for Federal agencies; State, municipal and foreign governments; and large corporations. In addition, he has been a VE instructor in over 190 workshops. He is also a member of the Society of American Value Engineers and is a certified value specialist.

1/A title awarded by the Society of American Value Engineers upon completion of a 40-hour VE course and 2 years of VE experience.

2/VE officers are responsible for participating in, conducting, supervising, and managing VE studies in a Corps region or district.

The potential savings that were identified during the workshops were achieved despite shortcomings associated with having the projects evaluated during workshop training. For example, one major constraint the participants encountered was a lack of time. They had only one week to learn VE methodology, familiarize themselves with the project designs, and apply their learning to the project. Also, the two transit authorities involved in the studies were unable to send representatives to the workshops who could have provided detailed information to the VE study teams. Consequently, some costs had to be estimated.

We also made a projection of the potential impact that VE could have on UMTA-funded construction projects. The projection is based upon an estimated percentage of budget reductions that could be achieved if the Department of Transportation applied VE to its construction programs.

We interviewed officials at UMTA headquarters and UMTA's Boston and San Francisco regional offices. We also interviewed VE headquarter officials at Federal agencies that have VE programs--the Corps, EPA, the Department of Defense, and the General Services Administration.

We interviewed representatives of seven architectural/engineering firms that have experience in designing UMTA projects to determine if VE was being applied to such projects and to obtain their views on the feasibility of applying VE to UMTA projects. We also discussed with UMTA headquarters officials and representatives of the firms visited whether UMTA regional engineers adequately evaluate project designs to identify cost savings. The firms visited were Bechtel, Inc., San Francisco, California; CHK, Inc., Silver Spring, Maryland; Daniel, Mann, Johnson & Mendenhall, New York, New York; Foster Engineering Co., San Francisco, California; Greenhorne & O'Mara, Inc., Riverdale, Maryland; Kaiser Engineers, Oakland, California; and Parsons Brinckerhoff Quade Douglas, Inc., New York, New York.

We discussed various cost-control techniques with the American Institute of Architects, American Society of Civil Engineers, American Academy of Environmental Engineers, National Academy of Engineers, National Society of Professional Engineers, and representatives of the architectural/engineering firms visited.

We also discussed the workshop results with MBTA officials in Boston and their consulting engineers; SCMTD officials in Santa Cruz; and UMTA officials at headquarters and regional offices in Boston and San Francisco. We met with SCMTD and the San Francisco regional engineers to discuss which VE recommendations SCMTD planned to implement. Finally, two Society of American Value Engineers officials analyzed UMTA's peer review process and compared it to VE.

The Department of Transportation, the Massachusetts Bay Transportation Authority, and the Santa Cruz Metropolitan Transit District were given the opportunity to submit comments on the report. However, the Department's comments were not received within the time allowed and to evaluate and include the comments would have delayed issuance of the report without significantly improving its accuracy. The Massachusetts Bay Transportation Authority and the Santa Cruz Metropolitan Transit District did not submit comments on the report.

CHAPTER 2

VALUE ENGINEERING CAN REDUCE TRANSIT COSTS

The amount of Federal funds required to develop and improve the Nation's urban mass transportation systems calls for establishing better cost controls to assure that such funds are spent prudently and with maximum effectiveness as required by UMTA regulations. Reductions in project costs can result in substantial savings, permit a wider distribution of Federal funds for constructing projects, expedite improvements in urban transportation systems, and enable local transit authorities to more easily finance their portion of transit projects.

Value engineering, as demonstrated in the workshops on two UMTA projects selected for review, identified significant potential cost savings. One study team identified about $3.1 million in potential savings on one aspect of a subway station that was originally designed to cost about $17 million. UMTA's peer review panel had previously examined the same aspect of that station. Their recommendations totaled about $334,000 in savings. The other team identified over $900,000 in savings on a $6.2 million bus facility. Moreover, the estimated cost 1/ to perform these studies--$53,500 and $40,000, respectively--when compared to potential savings was insignificant. For example, the relation of potential savings to estimated costs that would have been incurred to perform the VE studies shows that each dollar spent on VE produced a potential estimated savings of $59 on part of the subway station and $23 on the bus facility. Further, VE has the potential to reduce the 80-85 percent Federal share of rail and bus construction costs by about $42 to $70 million for a single year.

We provided officials of each transit authority with workshop results. We discussed the feasibility of implementing the VE recommendations with bus project officials. We did not discuss the feasibility of implementing the recommendations on the subway project because the station was about 90 percent designed when the VE study was performed. Any changes in the station design could have resulted in costly construction delays. The studies and transit officials' comments are discussed below.

MBTA's ORANGE LINE RELOCATION PROJECT

Between August 1978 and December 1980, UMTA awarded MBTA approximately $354 million to relocate the southwest portion of the Orange Line. The total project cost was initially estimated at

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1/Also includes cost to implement value engineering recommendations.

about $600 million but has since been revised to about $900 million. The project will relocate about 4.7 miles of the Orange Line to a railroad right-of-way and include five tracks--two for rapid transit and three for commuter and intercity rail--and will result in the construction of nine new stations, a 500-car parking facility, a new street, and 23 bridges.

In March 1979, UMTA requested that MBTA evaluate cost-effective means and methods of controlling the project budget. Beginning in April 1979, the MBTA project staff, coordinating engineers, and design engineers identified several aspects of the project that could be eliminated or modified. Their efforts according to an UMTA peer review official, resulted in reducing project costs by an estimated $40 million.

As part of its project cost-control efforts, MBTA examined several aspects of the Ruggles Street subway station. The total estimated cost of the station was about $17 million. As a result of eliminating or modifying several station components, MBTA initially reduced station costs by about $1.4 million. In one instance, for example, MBTA reduced the width of a 56-foot wide bus roadway by 12 feet and eliminated materials under the roadway, reducing station costs by $300,000 and $34,000, respectively.

To further reduce costs, the Ruggles Street station was peer reviewed in October 1979. At that time the station was about 30 percent designed. The reviewers included four chief engineers from transit authorities and railroads, a regional planner, and a retired chief engineer from a private construction firm. They reviewed three aspects of the station and, based upon their collective experience and judgment, suggested that the designers

--reduce the height and width of the overpass,

--simplify the bus layout by reducing the width of the bus roadway by 12 feet and eliminating material under the roadway as suggested by MBTA, and

--utilize a different bus loading design.

The savings resulting from these suggestions were about $1.8 million. The savings attributed to reducing the width of the roadway and eliminating the materials were about $334,000.

<u>VE study vs. peer review</u>

To demonstrate if VE could be applied to heavy rail projects and produce greater savings than UMTA's peer review, we arranged for the Corps to value engineer one aspect of the Ruggles Street station that had been previously peer reviewed. The bus layout was originally designed so that buses would enter and depart the station via a 700-foot long, 56-foot wide roadway around most of the station. (See figure 1 on p. 10.) Bus passengers would be discharged at one of two bus platforms located one level beneath the pedestrian concourse--the walkway providing access to the rail systems. To reach the concourse, bus passengers would take escalators. To reach the commuter rail or subway system station, passengers would then take escalators down to the platform areas. The Corps value engineered the bus layout in February 1982. (The results are shown in figure 2 on p. 11.) At that time, the station was about 90 percent designed. To compare the savings resulting from value engineering and peer review of the bus layout, we provided the VE study team with most of the data that was available to the reviewers, such as 30 percent completed design plans.

Value engineering techniques are applied through the use of a job plan. The job plan establishes an approach for performing the VE study in five consecutive phases:

--Informational phase. Study team members become familiar with the design and select areas with the greatest potential for significant savings for further study.

--Speculation phase. The team develops ways through creative thought processes to achieve the same basic function of the items selected for study.

--Analytical phase. The team screens the ideas generated in the previous phase and selects the best for possible implementation.

--Proposal phase. The team prepares final written recommendations for the cost-reduction alternatives.

--Report phase. The team summarizes the results of the study, recommends specific action, and requests implementation approval from responsible officials.

Following the phases in the job plan, the VE study team identified a potential of about $3 million, or about 18 percent, in savings as compared to $334,000 saved during peer review. These savings could be achieved without reducing the primary or required function of the bus layout. Table 1 on page 12 summarizes the VE recommendations and potential estimated savings.

Figure 1

RUGGLES STREET STATION
(before value engineering)

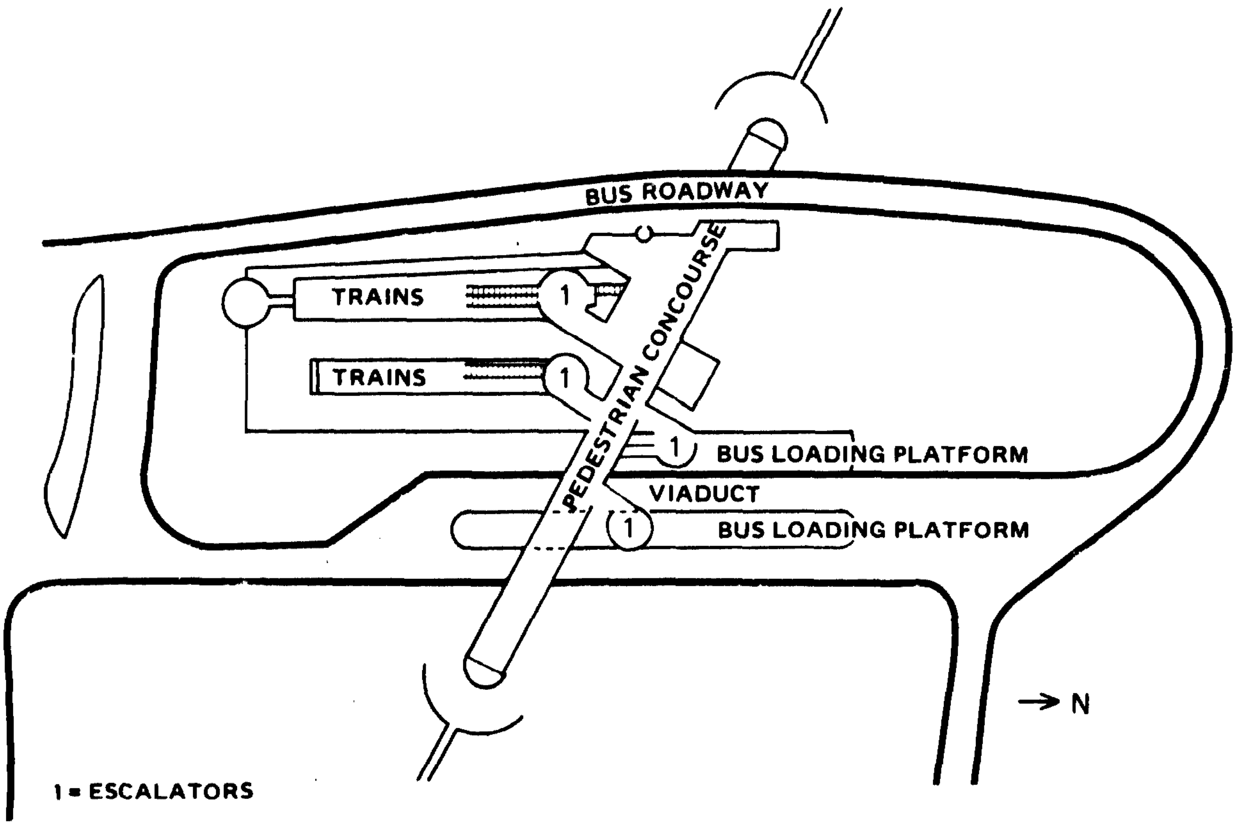

Figure 2

RUGGLES STREET STATION
(after value engineering)

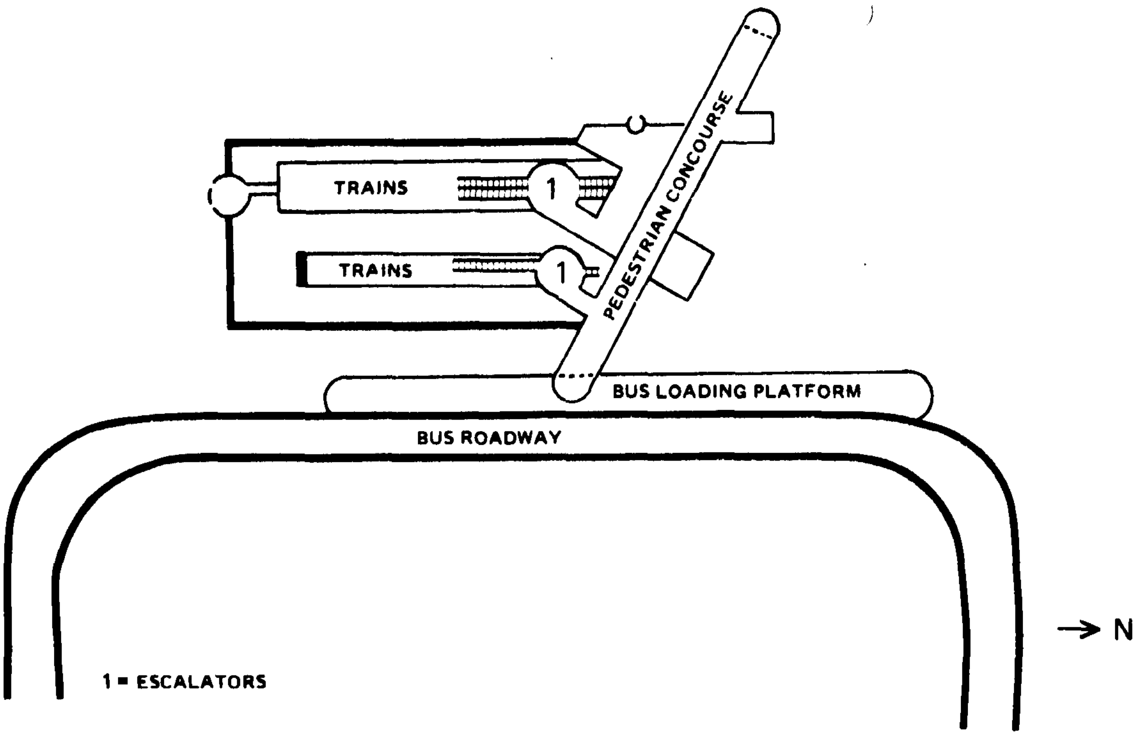

Table 1

VE recommendations	Estimated cost savings
Eliminate west bus ramp and roadway system	$1,880,477
Eliminate north and south bridges	531,200
Eliminate two bus waiting areas	410,000
Reduce the length of a pedestrian concourse	100,000
Reduce concrete thickness for bus platform	137,017
Eliminate excavation by raising bus platform to same level as pedestrian concourse	334,269
Total estimated gross savings	3,392,963
Less additional costs (note a)	
Increase width of bus platform	(61,491)
Construct bus platform roof	(134,000)
Estimated gross savings less additional costs incurred	3,197,472
Estimated cost of study (note b)	(53,500)
Total estimated net savings	$3,143,972
Ratio of estimated capital savings to estimated cost of study	59:1

a/Additional costs are those incurred by adding items to the project.

b/If the study had been performed by a private value engineering team, the cost would have been slightly greater.

In completing the job plan the VE study team, which consisted of structural, civil, and electrical engineers, initially analyzed the station designs and other data. This information served as the basis for identifying the basic or primary functions of major components of the bus layout and subsequently for generating proposed alternatives. For example, one alternative was to combine and raise the bus passenger loading areas to the same level as the pedestrian concourse.

During the next phase, the team analyzed the alternatives. For example, in relation to the alternative discussed above, the team listed such advantages as station users, including the handicapped, having a better and more direct access to the station and trains. In addition, excavation, concrete, and steel costs would be reduced. The disadvantages were that walk-in passengers to the station--18 percent of total station users--would have to cross bus lanes and traffic congestion would be increased.

During the next phase, the team assessed the technical feasibility of selected or surviving alternatives and obtained information such as choice of materials, cost estimates, and projected ridership data from the project consulting engineers. By analyzing the functional requirements of the bus layout, the team questioned the need for a 700-foot long bus roadway around the station. They believed that the length of the roadway could be reduced considerably if the buses arrived and departed only from the west side of the station and at the same level as the pedestrian concourse. Additional advantages were that two escalators, the bus viaduct area, and two bus platforms could also be eliminated. Further, the team analyzed ridership projections and frequency of buses and trains during peak hours of operation. Their computations showed that a single station entrance could handle the flow of passengers. The team then computed the length and width of the bus platform and the roof over the platform. (See figure 2 on p. 11.)

In conclusion, the VE study team believed that their recommendations retained the primary function of the original bus layout--to collect people--and reduced station costs by about $3 million, about 10 times greater than the savings proposed by the peer review.

Views of agency officials

We submitted the VE recommendations to MBTA, its consulting engineers, and an UMTA headquarters peer review official. In commenting on the recommendations, the consulting engineers and the peer review official stated that the VE recommendations were technically feasible and could be implemented except for community objections to changes in the design of the station. However, the objectives of our performing the study, as previously mentioned, were only to determine if VE could be applied to the project and could produce greater savings than peer review. In addition, we recognize that because the station was about 90 percent designed when the VE study was performed, it would not be practical to substantially revise the station designs because of cost increases due to construction delays.

MBTA disagreed with the results of the study. However, two of its comments were not applicable. These dealt with recent MBTA efforts subsequent to the peer review to reduce station costs or design constraints. They did not address the merits of

VE compared to UMTA's peer review conducted under similar conditions. MBTA's specific disagreements included a charge of an erroneous VE assumption, failure to recognize station context and urban design considerations, pedestrian access to the station, and community opposition.

Erroneous VE assumption

MBTA stated that the VE report contained an erroneous assumption about existing site conditions and grades--specifically, that to keep the busway down low under the pedestrian concourse as originally designed would require a great deal of excavation at an estimated cost of $334,269. MBTA pointed out that the existing site ground elevation is already close to the elevation proposed in the current design for the bus pickup area. Thus, almost no excavation is required.

MBTA's comments did not refer to the validity of the VE recommendation which was based on the 30 percent design plans when MBTA proposed to build a roadway under the pedestrian concourse requiring a great deal of excavation work. Rather, MBTA evaluated the validity of the VE recommendation--raise the roadway to the same level as the pedestrian concourse--as compared to the present design, which is about 90 percent complete. In our view, this is not a valid comparison.

Failure to recognize station context, urban design considerations, and pedestrian access

The study team recommended that the bus platforms be raised to the same level as the pedestrian concourse. In making this recommendation, the team recognized three disadvantages--pedestrians would have to walk across bus lanes, access to the station would be restricted, and traffic would be more congested--and offered a solution. According to a VE study team member, because more than 80 percent of the station's users will be bused to and from the station, the remaining users could gain access to the station through the use of walkways and traffic lights.

MBTA said that the study team did not address the way pedestrians enter and leave the station. It noted that the recommendation to elevate the platform would mean that station users from several nearby housing developments would be severely constrained by having only one access to the station. A VE study team member subsequently reviewed station plans and other appropriate project documentation and concluded that the recommendation would not severely constrain station users' access but would cause a slight inconvenience.

Community opposition

The MBTA said it could not eliminate the bus roadway and elevate the bus platform to the pedestrian concourse because the community supported the original design and would object vehemently to any changes. MBTA's comments are not criticisms of VE but an identification of a constraint. In our opinion MBTA, because of community opposition, is faced with a dilemma--saving money versus appeasing local community desires for station requirements. Under such conditions, MBTA could use VE to justify the less costly alternatives. However, we recognize that because the station design is almost completed, it would not be practical to implement the VE recommendations. Again, our objectives in performing the study were only to determine if VE could be applied to a heavy rail project and could produce greater savings than peer review.

SANTA CRUZ BUS FACILITY VE STUDY

SCMTD plans to construct a bus operations and maintenance facility in Watonsville, California. Budgeted at $5 million, the facility was originally designed to cost $6.2 million and was to provide about 57,000 square feet of building space and parking for 135 buses and about 200 other vehicles.

Because of concerns over project costs, SCMTD officials agreed to have the project value engineered by professional engineers and/or architects during an American Consulting Engineers Council/American Institute of Architects-sponsored VE training workshop. We selected this UMTA-funded project for VE because UMTA does not peer review or value engineer bus facilities although it provides millions of dollars annually--about $1.5 billion through fiscal year 1981--for bus projects.

As a result of the study, the team developed recommendations that, if implemented, would reduce the project's capital costs by approximately $945,000, or about 15 percent. In addition, operations, maintenance, and replacement (OMR) costs would be reduced by over $400,000, or about 6 percent. Table 2 lists the VE suggestions, estimated cost savings, and estimated costs to perform the VE study and implement the recommendations. Table 3 lists those VE recommendations and estimated cost savings that SCMTD plans to implement.

Table 2

VE recommendations	Estimated cost savings Capital	OMR
Reduce area lighting	$200,000	$100,000
Reduce pavement area	138,600	-
Combine wash, fuel, and steam cleaning buildings	140,000	-
Reduce landscaping/ irrigation	48,000	-
Reduce drainage system	40,000	-
Reduce size of overhead doors	3,300	-
Reduce number of skylights	67,000	-
Substitute pre-engineered/pre-fabricated building	215,000	
Redesign building	93,000	330,000
Total estimated gross savings	944,900	430,000
Less estimated study and implementation costs	40,000	-
Total estimated net savings	$904,900	$430,000
Ratio of estimated capital savings to estimated cost of study	23:1	

Table 3

To be implemented	Capital	OMR
Reduce area lighting	$200,000	$100,000
Reduce pavement area	138,600	-
Reduce number of skylights	25,000	-
Total	$363,600	$100,000
Ratio of recommendations SCMTD plans to implement to estimated study/implementation costs	9:1	

In addition to those savings listed in table 3, SCMTD plans to reduce the facility's landscaping, irrigation, and drainage, although not as much as recommended in the VE study. Further, it is considering reducing pavement thickness as suggested in the VE report. However, because these changes are still under consideration, the actual savings could not be quantified.

The rationale behind the VE team's recommendation to substitute a pre-engineered, prefabricated, and redesigned building for the structure as now designed provides an example of how VE methodology is applied.

The building, as currently designed, is a combination one- and two-story structure with masonry exterior walls, metal floors, and a flat roof. Administrative offices and some lounges, classrooms, and conference rooms are located on the first floor. Maintenance will be performed in two shop areas that are 30 feet high. Lounges, dayrooms, and training rooms would be located on the second floor. The building provides 57,200 square feet of space.

The VE study team reviewed the facility's design plans and other documents and determined that the building's exterior enclosure was costly and contained many aesthetic items. In addition, the potential for expansion, as required by SCMTD, was limited because the two shop areas--where expansion must occur--are closely bordered by a river on one side and private property on the other.

The VE study team followed the prescribed sequence of steps in the job plan and developed the following VE recommendations:

--Parapets, skylights, masonry walls, and sun control fins were determined to be for aesthetics and could be eliminated or replaced by less expensive materials that performed the same function.

--Analysis of the original design versus other designs using such criteria as initial cost, maintenance, aesthetics, and salvage value showed that a pre-engineered, prefabricated structure with a combination of masonry and metal walls provided the most value.

--Relocating first-floor offices onto the second floor and substituting a sloped roof for the flat roof would increase interior building space, decrease exterior space, and provide more area for expansion. Also, a sloped roof costs less to construct and maintain than a flat roof.

--Substituting prefabricated metal panels for masonry block on second-floor walls is feasible because they cost less and are aesthetically acceptable. Masonry walls would be retained on the first floor where maintenance operations occur. Damaged masonry walls resulting from such operations cost less to repair and maintain than metal panels.

--Locating restrooms next to each other to consolidate plumbing would reduce initial costs.

Accordingly, the VE study team recommended a pre-engineered and redesigned building, utilizing prefabricated metal panels for the second-story walls while retaining masonry walls on the first floor, consolidating plumbing, eliminating some skylights, and replacing the flat roof with a sloped one. If SCMTD had implemented these recommendations, initial cost savings of about $307,000 and OMR savings of $330,000 would have resulted. Also, interior building space would have increased from about 57,000 to 61,000 square feet. Finally, because the redesigned building would be smaller, it could be relocated farther from the river/private property, allowing better expansion potential.

SCMTD officials rejected this VE recommendation. They told us that the cost benefits of a pre-engineered and prefabricated building had been examined early in the proposal stage, and although initial costs would have been reduced, OMR costs would have increased.

POTENTIAL IMPACT OF VE IN UMTA

UMTA, as previously mentioned, obligated about $2.9 billion for rail and bus projects in fiscal year 1981. Funds for capital projects are generally used for purchasing land and equipment, acquiring rolling stock, and construction, but construction costs for rail and bus projects are generally not separated from other project costs. However, an UMTA Transportation Program Specialist estimated that 50 percent or about $1.4 billion of UMTA's funding was used for rail and bus facility construction in fiscal year 1981. According to Mr. Dell 'Isola, the Department of Transportation could achieve a 3- to 5-percent budget reduction in construction program costs if it used VE. Therefore, applying this estimate to the estimated $1.4 billion above shows that VE has the potential to reduce UMTA's share of construction costs by about $42 to $70 million for a single year.

CONCLUSIONS

The VE workshop results prove that value engineering can reduce costs on UMTA-funded heavy rail and bus facilities and is more effective than UMTA's peer review program. A VE study team identified over $3 million in potential savings on one aspect of a subway station. Similar cost-reduction efforts by MBTA and UMTA's peer reviewers on this aspect of the station produced only $334,000 in savings. A VE study of a bus facility identified over $900,000 in potential savings. The transit authority plans to implement several VE recommendations that will reduce project costs by over $360,000. Further, if value engineering had been applied to UMTA construction projects, the fiscal year 1981 Federal share of costs could have been potentially reduced by an estimated $42 to $70 million.

CHAPTER 3

UMTA NEEDS A BETTER COST-CONTROL PROGRAM

In view of the limited resources available to address mass transit problems, it is essential that every effort be made to assure that funds are used prudently and with maximum effectiveness. Because UMTA and most transit authorities have neither sufficient technical capability nor expertise to adequately review designs to assure that facilities are cost effective, UMTA may be incurring greater costs than necessary. To address these problems, UMTA has a peer review program to control costs on new, primarily heavy rail projects. It appears that such reviews are more effective when performed during the conceptual and informational phases of project development.

INADEQUATE REVIEW OF PROJECT DESIGNS

UMTA's regional engineers are required to evaluate proposed transit project designs for technical feasibility, cost effectiveness, and safety. However, according to an UMTA regional administrator, a regional engineer, a headquarters peer review engineer, the former Acting Director of the Grants Management Division, and representatives of several architectural/engineering firms, UMTA does not have enough regional engineers to adequately perform design reviews.

An October 1980 UMTA report, 1/ prepared at the request of the UMTA Administrator, stated that although UMTA funds some of the largest public works programs in the country, it has never assumed a stewardship role for the engineering involved. The report found that UMTA lacks a policy defining its oversight responsibilities in major construction projects. Further, regional engineers who perform design reviews are hampered by inadequate guidance and review criteria and are frequently unable to adequately review proposed plans and designs. Regional engineers also have other work to perform and cannot concentrate totally on the larger projects. The report concluded that UMTA needs additional experienced, technically qualified, industry-respected engineers, particularly if it is to pursue a more aggressive approach in reviewing engineering activities during the early phases of major construction projects. This report was formulated from an analysis of UMTA documents and interviews with UMTA staff, including regional administrators and engineers and headquarters peer review officials.

According to an April 1981 UMTA report 2/ developed through contact with 10 percent of UMTA staff, and as two UMTA officials

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1/"Study of Feasibility of Establishing On-Site Management Teams."

2/ "Working Group Final Report."

previously noted, UMTA's emphasis is on "getting out the bucks." The former director of UMTA's Grants Management Division and a peer review official told us that the agency does not exert pressure on transit authorities to change designs to reduce costs. For example, during our meeting with UMTA region IX engineers and SCMTD officials to discuss the VE recommendations they plan to implement, the regional chief engineer told us that UMTA does not direct transit authorities to design construction projects at the lowest cost because the agency's emphasis is primarily on providing grant funds.

According to the former Acting Director of Grants Management, UMTA's 22 regional engineers 1/ are responsible for reviewing numerous projects and performing other duties related to those projects. He further stated that design reviews are generally cursory and therefore do not always lead to the most cost-effective facilities. As an example, region I has two engineers who were responsible for 157 grants as of June 1982. UMTA's share of these project costs is about $1.7 billion.

Other responsibilities of the regional engineers include, in part,

--providing engineering and project administration assistance to transit authorities regarding construction techniques and solutions to problems,

--monitoring projects by reviewing quarterly progress reports submitted by transit authorities and conducting onsite reviews of each capital grant to ensure that project progress has been reported accurately,

--determining if contract specifications permit free and open competition, and

--determining if grantees are in compliance with third-party contract guidelines.

In April 1982, we reported 2/ that all UMTA regions had problems monitoring projects because of understaffing. The UMTA project managers discussed in that report are the regional engineers who are responsible for reviewing and evaluating the project designs discussed above.

1/Actual number of engineers as of May 1, 1982. One position is vacant.

2/"Better Adminstration of Capital Grants Could Reduce Unnecessary Expenditures on Mass Transit Projects" (CED-82-22, Apr. 20, 1982).

UMTA's EFFORTS TO REDUCE COSTS

In 1979, UMTA introduced peer review in response to (1) its lack of in-house technical expertise and engineering credentials to control costs on large rapid transit construction projects and (2) the extent of Federal participation in such projects. The peers, experts in the transit industry, review project data and subsequently meet for about 2 days to make cost-saving recommendations based on their collective experience and judgment. Peer reviews have been performed only on new, primarily heavy rail projects. However, the Office of Management and Budget has deferred the construction of new rail and extension projects except those that are funded through the Interstate Transfer Program. An UMTA headquarters peer review official believes that bus facilities may also be peer reviewed in the future.

Through June 1982, 18 peer reviews had been conducted on six proposed rail projects as follows:

Project	Project phase of development
Boston:	
Red Line	Design
Orange Line	Design
Portland:	
Track	Informational
Maintenance, shop, & yard	Informational
Los Angeles:	
Operations	Conceptual
Vehicles	Conceptual
Train control	Conceptual
Ways and structures	Conceptual
Power	Conceptual
Architecture	Conceptual
Communications	Conceptual
Fire protection	Conceptual
Shops and yards	Conceptual
Safety	Conceptual
San Francisco:	
Rail car specifications	Informational
Dade County:	
Stations	Informational
Track	Informational
Organization	Informational

As the table shows, most peer reviews have been conducted during the conceptual or informational stages of project development.

Conceptual stage peer reviews assure that transit authority officials' ideas about specific aspects of the proposed project are correct. For example, during one conceptual stage peer review, the reviewers noted that the proposed location of a train storage yard would not be functional with regard to ease of operation. Accordingly, the yard was relocated. Informational stage peer reviews are held to collect data on various design specifications. Cost estimates are not prepared until the design phase.

Although UMTA has no formal guidance or criteria on when and how a peer review should be conducted, an UMTA peer review official believed that correcting transit authorities' misconceptions during the conceptual stage of development has reduced costs by millions. However, UMTA could not document such savings because cost data had not been developed for the projects at the time the reviews were conducted.

As mentioned above, UMTA peer reviewed two transit projects during the design phase. These were the only reviews where cost savings could be validated. According to UMTA, the peer review program resulted in savings of about $8 million with a potential for an additional $7.5 million savings on one project and about $42 million on another project. Our review of these two peer reviews, as discussed below, shows that the actual savings were far less than claimed by UMTA.

Red Line extension project

UMTA's peer review of MBTA's Red Line--a heavy rail extension project--took place in April 1979 when the project was 80 percent designed and one-third constructed. The project is estimated to cost about $574 million. The reviewers examined background data and design documents and met with UMTA and MBTA consulting engineers. Subsequently, they made 31 suggestions with a total potential savings of about $15.5 million. Our review of the 31 suggestions showed that two of the recommendations were fully implemented and two were partially implemented for a total savings of about $319,000. According to MBTA's Red Line project manager, the peer review was held too late to implement the majority of peer review recommendations. Further, a draft letter from MBTA's Assistant Director of Construction Administration and Development stated that restrictive environmental impact statement requirements, community agreements, redesign time and costs, and an increasing inflation rate mitigated against implementing the recommendations.

Orange Line relocation project

MBTA's $900 million Orange Line relocation project, as discussed previously, was peer reviewed in October 1979 when it was about 30 percent designed. According to UMTA, as a result of the peer review process, project costs were reduced by $42 million.

To determine the effectiveness of peer review on this project, we reviewed peer review data. We found that several months before the peer review meeting, UMTA requested that MBTA project staff review the project to reduce or control costs. As a result of that cost-control effort, MBTA reported savings of $40 million. Many of the cost-saving recommendations made by MBTA were included on the agenda provided to the UMTA peer review panel for review. Therefore, when the reviewers subsequently met with MBTA, they were advised that many of these recommendations had already been implemented as part of MBTA's project cost-reduction efforts.

An UMTA headquarters peer review official agreed that $40 million of the $42 million in reported project cost savings directly resulted from MBTA's cost reduction program and not the peer reviewers' suggestions. He advised us that MBTA's cost-savings recommendations were included with UMTA's savings estimates because the fact that the authority was aware that the project was to be peer reviewed led to its cost-savings effort. We do not agree. Although the authority's cost-reduction program was in response to UMTA's concerns that the Orange Line's costs would exceed budget, the peer reviewers were not involved with this effort. Therefore, only about $2 million in estimated savings resulting from the peers' suggestions can be attributed to the peer review.

VE NOT USED IN TRANSIT FACILITY DESIGNS

Transit authorities are responsible for planning, designing, constructing, and maintaining UMTA-funded facilities. According to UMTA peer review and architectural/engineering firm officials, most transit authorities do not have the engineering capability to prepare and review design plans and supervise the construction of new or rehabilitated bus maintenance and operations facilities, garages, and subway systems. To obtain this capability, authorities hire architectural/engineering firms. However, according to officials at the firms we visited, most firms do not use the value engineering process.

The professional services provided by these firms generally include

--preparing the Federal financial assistance grant application;

--preparing design plans, specifications, and cost estimates;

--supervising facility construction; and

--representing the grantee/transit authority whenever necessary.

A basic task of the architectural/engineering firm is to design a facility that minimizes costs subject to the limitations and standards imposed by UMTA, States, and municipalities. Most constraints, however, are imposed subjectively by the designers' engineering expertise. The constraints include safety, reliability, aesthetics, ease of operation, desirability, and State and local building codes.

The firms design a facility that satisfies the transit authority's requirements. During design, alternatives are identified and evaluated on the basis of performance, cost, and other considerations such as aesthetics. The authority selects the alternative that best meets its needs. This may include selecting a more expensive, overly aesthetic subway station over a less costly station to satisfy neighborhood desires. Although VE is not used, the firms monitor project progress against budgetary and time schedules. If costs exceed budget estimates, the project may be scoped down to reduce costs.

VE HAS THE POTENTIAL TO SAVE MILLIONS IN UMTA CONSTRUCTION COSTS

Two UMTA regional administrators, headquarters peer review engineers, and architectural/engineering representatives of the seven firms we visited believe that VE has the potential to reduce project costs if (1) it is performed early during design by experienced staff and (2) decisions resulting from VE recommendations are made expeditiously to prevent delays in the project's construction schedule. We also believe, based on the magnitude of funds UMTA has provided to construct rail and bus projects (about $9 billion), that VE has the potential to save millions. (See pp. 11, 16, and 18.)

Further, we believe that our review shows that the VE process can save more project construction money than peer reviews. Although VE and peer review have a similar goal--cost control--the differences between the two are greater than their similarities. Also, our reviews of other Federal agencies using VE show that it has resulted in considerable savings in some agency programs where it has received strong support from agency top management. The program most similar to UMTA's transit construction grants appears to be the Environmental Protection Agency's waste treatment facilities construction grants.

VE can outperform peer review in cutting costs

UMTA's peer review program and VE have a similar objective--to control costs. Significant differences exist, however, between the two processes in scope, methodology, and application. For example, peer review is an informal program, with almost no guidelines or criteria. It is used on a limited, ad hoc basis. Reviewers' recommendations are based solely on their collective experience and judgment. VE, on the other hand, is a formal, systematic, creative, and organized approach to assure the lowest total costs--capital and OMR. To reduce costs, a multidiscipline study team utilizes a systematic VE Job Plan. In a VE Job Plan, cost modeling and functional analysis 1/ are used to identify major cost elements and areas for potential savings. Each suggestion is then evaluated on a cost/worth basis and evaluated against total capital and OMR costs.

In comparing VE to peer review, the UMTA Associate Administrator for Transit Assistance stated that VE and peer review have the same goal--to modify the existing design to produce a better and less costly product. However, beyond that goal, the processes are uniquely different.

Two Society of American Value Engineers officials analyzed the peer review process and compared it to VE. They concluded that the only similarity between the two techniques is the use of multidiscipline teams. Further, peer review does not use cost modeling to identify major cost elements and areas for potential savings as is done in a VE study. Rather, peer review appears to be a cost-cutting technique accomplished by eliminating items or changing materials based upon individual, subjective expertise. This process addresses downgrading materials and eliminating items rather than a creative development of alternatives to perform the needed functions. The officials believe that using VE techniques in a peer review study would have increased the number of alternatives to be considered, resulted in a quantitative evaluation of these alternatives, and produced substantially more savings. The peer review official believed that (1) VE can be applied to UMTA-funded construction projects, (2) VE would have to be contracted out because UMTA regional engineers have a heavy workload, and (3) VE and peer review can complement each other.

How other Federal agencies use VE

VE was first used on Federal construction projects by the Navy in 1954. Since then, about 14 agencies that build facilities or finance them have incorporated VE in the design and/or construction of such facilities with varying degrees of success.

1/A technique for identifying and describing the functions of an item in a general way so that some functions can be eliminated and other functions combined.

Three agencies--EPA, the Corps, and the Department of Defense--have successful VE programs. Reported cumulative savings in reduced project costs resulting from VE performed during design were $235 million at EPA and $7.4 billion at the Department of Defense. 1/ EPA reported that during its program's 5-year history, 143 VE studies, costing about $15 million, have reduced project costs by 4.5 percent, or an average return of $16 for each $1 invested in VE. 2/ The Department of Defense's VE program reduced project costs by $825 million in fiscal year 1981. The agency's return was $29 for each $1 spent.

VE during construction

VE also has the potential to reduce project construction costs. Value engineering incentive clauses in construction contracts encourage participation by contractors and subcontractors. The clauses enable a contractor and/or a subcontractor to share in savings resulting from changes they suggest in methods or materials which do not detract from the utility of the project. The Corps, for example, reported that VE change proposals during construction have resulted in cumulative savings of $27.7 million.

Federal agencies use various formulas for sharing savings with contractors. Under the Corps' program, the contractor retains 55 percent of net savings from approved changes. Under EPA's program, on savings of less than $1 million, the contractor retains 50 percent and EPA and the grantee share the remainder in proportion to participation in project costs. On savings over $1 million, the contractor receives 20 percent of the savings plus $300,000. EPA and the grantee share the remaining savings on a proportional basis.

VE program management

In a prior report on VE, 3/ we noted that establishing a VE program does not, in itself, assure an effective approach to cost control. Officials at Federal agencies with successful programs emphasized then, as did Corps, EPA, and Department of Defense officials during this review, the need for strong, active top-management support of a VE effort generally, including

--issuing an affirmative policy statement on VE and

--assigning a full-time program manager to direct the program.

Lack of agency support seriously impairs the effectiveness of a VE program. For example, from 1972, when the General Services Administration established a program, through 1979, the

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1/Includes Corps savings.

2/Includes the cost of VE studies and implementation costs.

3/"Potential of Value Analysis for Reducing Waste Treatment Plant Costs" (RED-75-367, May 8, 1975).

Public Building Service reduced construction costs on Federal facilities by $43.4 million. Since then, the program has produced no additional savings. According to the former Director of the Cost Management Division, the continued operation of a VE program is at the discretion of the Public Building Service Commissioner. Due to the lack of continuity in Public Building Service top management and a general lack of understanding of VE concepts, the program has received little or no support. As a result, he stated that the program is no longer viable.

Establishing a program

We examined the VE programs of four Federal agencies. The Corps, the Department of Defense, and the General Services Administration contract directly with engineers and contractors for the design and construction of facilities. Unlike EPA, these agencies have the in-house technical staff to perform VE. Conversely, EPA functions similarly to UMTA. It provides capital grants to grantees for construction, who then award contracts for engineering and construction. Because of these similarities between EPA and UMTA, we believe UMTA needs to consider EPA's VE management practices in its own efforts to establish and incorporate a VE program into its construction grants program.

Under EPA's VE program, waste treatment facilities costing more than $10 million must be value engineered when the design plans are 20-30 percent complete. Larger projects may require more than one VE study. In accordance with EPA's construction grant program regulations, the cost of performing VE is shared by EPA and its grantees. Savings resulting from VE studies are also shared between EPA and grantees in proportion to their participation in project costs. EPA has final authority for approving VE recommendations. Further, EPA's analysis of the program revealed that VE performed by an independent VE firm is more effective than VE done by the firm designing the project. According to two VE experts, UMTA construction projects costing more than $2 to $2.5 million should be value engineered.

CONCLUSIONS

UMTA provides millions in grants annually for transit authorities to construct rail and bus facilities. UMTA's emphasis is on providing the funds required to complete such facilities and not on assuring that they are constructed at the lowest cost. UMTA's efforts to review project designs are hampered by an insufficient number of regional engineers. To correct its problems, UMTA's needs a better, more formal cost-control program that can be applied to both rail and bus capital and rehabilitation projects. VE, as demonstrated in the workshops and by other Federal agencies that use it in their construction programs, has the potential to save millions in UMTA construction costs.

RECOMMENDATIONS TO THE SECRETARY OF TRANSPORTATION

We recommend that the Secretary of Transportation direct the Administrator of UMTA to implement a value engineering program for construction projects. In implementing the program, the Administrator should:

--Appoint a full-time program manager for value engineering activities who reports to the UMTA Administrator.

--Apply value engineering early in a project's design on all UMTA-funded construction projects exceeding $2 million.

--Share with the grantee the cost and savings of value engineering in proportion to its participation in project costs.

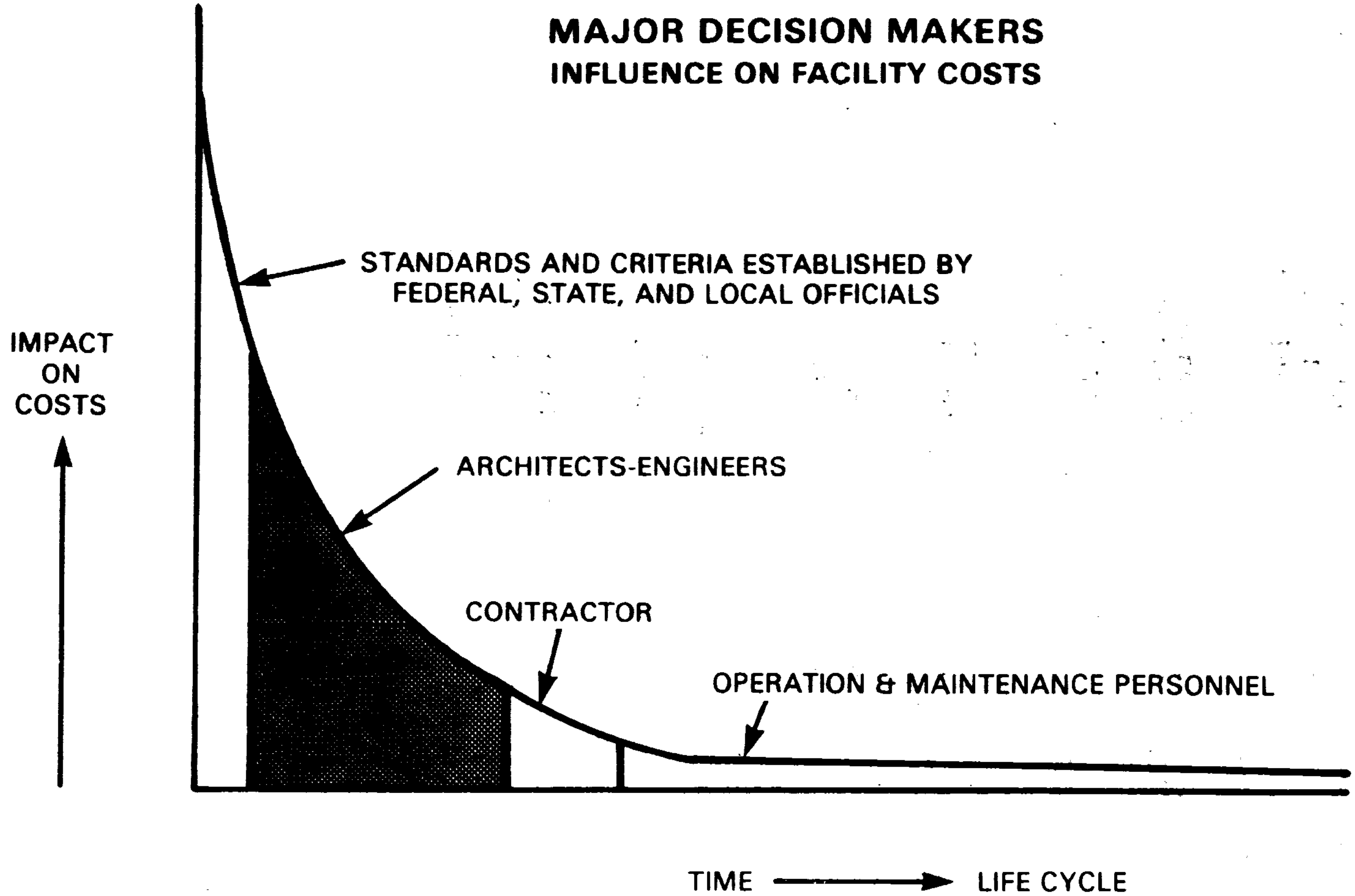
--Assure that value engineering is performed by a private architectural/engineering firm not participating in the project.

--Retain final authority for approving and disapproving value engineering recommendations.

--Assure that construction contracts include a value engineering incentive clause.

We further recommend that UMTA limit its peer review program to the conceptual and informational phases of major construction projects and complement it with value engineering during the early design and construction phases of such projects.

APPENDIX I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IMPACT ON COSTS
ARCHITECTS-ENGINEERS
CONTRACTOR
OPERATION & MAINTENANCE PERSONNEL
TIME
LIFE CYCLE

PREVIOUS GAO REPORTS ON VE

--"Department of Defense Value Engineering Program Needs Top Management Support" (PSAD 78-5, Nov. 16, 1977).

--"Potential of Value Analysis for Reducing Waste Treatment Plant Costs" (RED-75-367, May 8, 1975).

--"Need for Increased Use of Value Engineering, a Proven Cost-Saving Technique, in Federal Construction" (B-163762, May 6, 1974).

--"Value Engineering Program Needs To Be Improved and Reinstated" (B-118779, May 10, 1972).

--"Opportunities for Increased Savings by Improving Management of Value Engineering (Design and Manufacture Simplification) Performed by Contractors" (B-165757, Aug. 25, 1969).

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