THE INTEGRATION OF THE PERFORMANCE MEASURES PROCESS INTO VALUE STUDIES

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BIOGRAPHY

Mr. Stewart is a professional Value Methodology consultant and is Vice President of Value Management Strategies, Inc. where he is responsible for managing its operations in the Pacific Northwest.

Mr. Stewart has been leading value teams for 15 years and has participated on hundreds of value studies as both a facilitator and project manager for a wide range of projects. He received a Certificate of Recognition from the Federal Highway Administration for his facilitation of the I-215 Improvements project in San Bernardino, California, named "Most Outstanding Study" for the California Department of Transportation in 2001. Most recently, his work on leading the constructability review of the Replacement of the East Span of the San Francisco-Oakland Bay Bridge during the Spring of 2002 was rated first in the category of "Most Innovative VE Study" by AASHTO and received an Honorable Mention overall that year.

ABSTRACT

Value Methodology (VM) has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation and has typically overlooked the positive effect that VM can have on project performance for the sake of cost savings.

The Performance Measures Process was developed in conjunction with the California Department of Transportation over the past several years as a means of developing a better understanding of the effects of recommendations developed in value studies have on project performance. The greatest strength of this process lies in its focus on achieving total value improvement.

This process seeks to measure performance by:

- Identifying and defining key performance attributes
- Determining the relative importance of performance attributes in meeting a project's Purpose and Need
- Developing measurement scales to quantify (or qualify) performance levels
- Comparing performance to cost ratios (i.e., value) of multiple design concepts

This paper will describe how the Performance Measures Process may be integrated into value studies at each stage of the job plan. This paper will also demonstrate how the Performance Measures Process can augment Value Methodology by:

- Building consensus among project stakeholders (especially those holding conflicting views)
- Developing a better understanding of a project's goals and objectives as they relate to Purpose and Need
- Developing a baseline understanding of how the project is meeting performance goals and objectives
- Identifying areas where project performance can be improved through the VM process
- Developing a better understanding of an alternative concept's effect on project performance
- Developing a deeper understanding of the relationship between performance and cost in determining value
- Using value as the basis for selecting the best project or design concept

A Brief History of Performance Measurement

The evolution of the concept of value has been a long one. The philosophical groundwork for the concept of value was first established in ancient Greece by Protagoras, however, our present understanding of the concept did not begin to fully take shape until the 18th century. During this period Adam Smith published *Wealth of Nations*, his landmark economic treatise, while Immanuel Kant's *Critique of Pure Reason* provided the humanistic basis for value – that value is uniquely assessed by the individual. The economic theory of value continued to develop through the early 20th century in Europe and the United States, until in 1947, Larry Miles firmly established the concept of value as a field of study unto itself. In 1961, Miles published his *Techniques of Value Analysis and Engineering*, which laid forth the concept of function as an integral part of value.

Miles' codification of function as a component of value has had far reaching implications within the sphere of human industry. It spurred a new wave of thinking with respect to the value of goods and services. Miles defined value in terms of the relationship of function and cost. This was eloquently stated in his now famous axiom, "All cost is for function."[1] Of equal importance, he stressed that value is established by the user's, or customer's, needs and wants. This basic understanding of value is essential if we are going to set about improving it.

Building upon Miles' theory of value, Carlos Fallon further refined these concepts. Fallon recognized that while function lay at the heart of value, it was the manner in which the function performed that allowed it to be quantified. Through his work with RCA, Fallon developed a methodology for quantifying performance, which he described using the word *utility*. Although Fallon credits numerous philosophers and economists, most notably Daniel Bernoulli and Jon Von Neumann, for developing the concept and mathematical approximations of utility, he appears to be the first to concisely define a practical method for its quantification. Utility, as Fallon describes it, is "the nonlinearity between performance, on the one hand, and the effect of performance, on the other."[2]

In a monograph published for RCA in 1965, Fallon outlined a process, also known as *Combinex*, for measuring the utility of manufactured goods.[3] This process consisted of 1) defining the product's objective; 2) defining key utility factors and related measurement scales; 3) identifying the relative importance of the utility factors; 4) quantifying net value. Fallon's method for weighing the relative importance of utility factors is simple, yet direct – the customer (user) directly assigns them.

David De Marle, provides several simple equations to define value.[4] The first is based upon Miles' understanding of value (Fig. 1).

Figure 1

$$V_{max} = \frac{F}{C_{min}}$$

The next equation is an expression of Fallon's theory of value where the term *utility* is defined as the product of a need and the ability to satisfy that need (Fig. 2).

Figure 2

$$V = \frac{n \ x \ a}{c}$$

Finally, he proposes a simple equation for value that also captures the idea that the customer or user determines value (Fig. 3).

Figure 3

$$Customer\ Value = \frac{performance}{price}$$

Where does the concept of function fit into these notions of value? The equation suggested by Miles states that maximum value is achieved by providing the function for the lowest possible cost. The term "function," as it is commonly understood within the context of value methodology, is defined as the means by which an expressed need or want is fulfilled. I would contend that when we discuss the concept of value, what we are really expressing is a relative measure of how well that need or want is being fulfilled relative to the cost to do so. The "how well" part really refers to the performance of the function rather than of the function itself. I would also suggest that function is tied directly to value such that it provides us a framework for establishing value. It could thus be said that value methodology is a body of knowledge focused on improving *functional value (Fig. 4)*.

Figure 4

$$V_f = \frac{P}{C}$$

In other words: "The value of a function is equal to its performance divided by its cost."

Following Fallon's mathematical approach to the quantification of performance were a number of similar decision-making methods developed by mathematicians. T. Saaty, in his Analytical Hierarchical Process (AHP)[5], breaks a decision into hierarchies through the use of tree maps. It is designed for subjective considerations and utilizes pair-wise comparisons for the weighting of criteria (attributes). A scale of 1 (equal importance) to 9 (absolutely more important) is used. This method uses verbal expressions to help the decision makers to describe the strength of their preferences. The weights are then averaged for each attribute. While not specifically designed to determine value, its applicability in doing so is apparent.

Another methodology developed by W. Edwards is called the simple multi-attribute rating technique (SMART)[6]. This method uses a swing rating method to normalize the weights of various attributes in developing a quantification of value.

Both of these decision-making processes offer useful methods for quantifying and evaluating performance. It is interesting to note that both the AHP and SMART methods consider cost as another facet of performance rather than as the divisor of the value equation as described in the equations presented previously. Cost, as measured in money, is perhaps the most universally understood means for expressing the expenditure of resources to acquire a desired function. Virtually every decision we make in our lives involving the acquisition of goods or services involves money. It is easily quantifiable because it can be estimated with a fair degree of accuracy and cost data is widely available.

Conversely, performance is oftentimes more difficult to quantify because it varies for each function we are trying to acquire. Furthermore, performance is often subjective in nature. Because most functions involve numerous performance factors, it can be difficult to evaluate their relative importance. The methods for quantifying and evaluating performance described above provide various means for achieving this; however, they require specialized knowledge of their application. Furthermore, and most importantly, none of them suggest a means to develop the alternatives that they are designed to evaluate.

Those that are familiar with the application of value methodology are probably well aware of the negative opinions and attitudes held by some with respect to VM. Many of these are associated with the perception that VM is simply a cost cutting technique that readily sacrifices performance for the sake of cost. While much of this criticism can be attributed to a lack of understanding of the process or the misapplication of the terms associated with VM, some of it is warranted.

There is a tendency amongst many value practitioners to emphasize cost over performance. This is understandable for a number of reasons, most of which relate to the prevalence of cost in the decision making process. Cost reduction is often emphasized in value studies because cost is easily quantifiable; cost overruns are pervasive in most business sectors; cost has high visibility in most organizations; cost is directly associated with profit and loss and cost is directly linked to time. Another key factor is the inability of many users, stakeholders, designers and value practitioners to properly define, much less quantify, performance.

The Performance Measures Process

The Performance Measures Process, for lack of a better term, seeks to augment the Value Methodology Job Plan through the application of a number of techniques that place greater emphasis on performance in achieving improved value. This paper details how these techniques can be integrated into the VM Job Plan, from pre-study through implementation. The figure below provides an overview of this integrated approach (Fig. 5).

Integration of the Performance Measures Process with the Value Methodology Job Plan

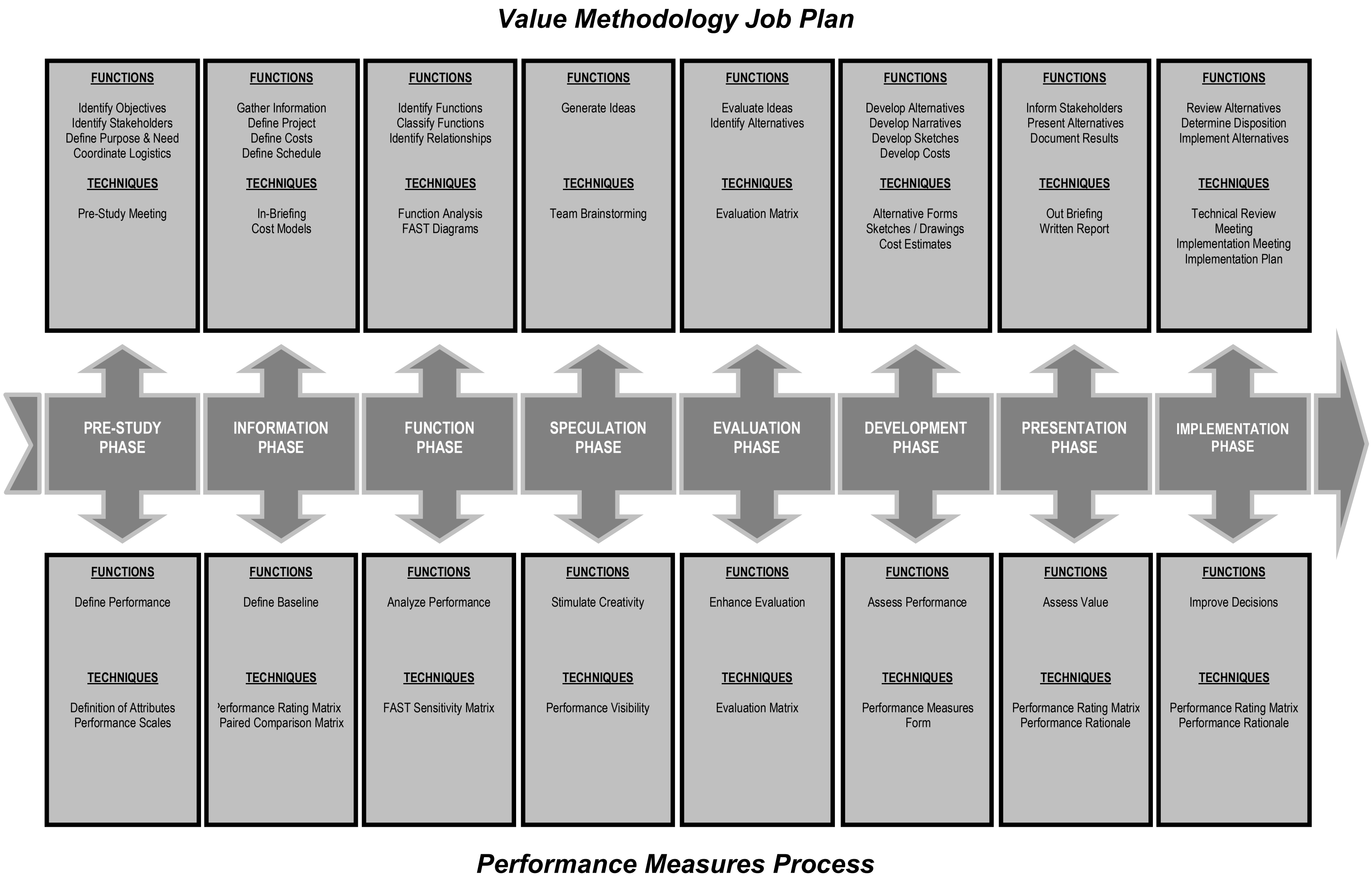

Figure 5

Pre-Study Phase

If it is the appearance of a want or need is what motivates us to seek the means to fulfill it, then it is important for us to first develop a thorough understanding of the want or need before we can develop the means.

Value Methodology should begin at this fundamental level. Function analysis provides us with a powerful technique for developing a better understanding of wants and needs through the identification, classification and organization of functions.

With respect to the sphere of design and construction, most projects include a statement of "purpose and need" as a standard element within the design development process. A well written purpose and need statement should serve as the foundation upon which a design concept is built. Despite the fundamental nature of this, purpose and need statements are frequently taken for granted and are often poorly defined. This can lead to serious problems as the design process progresses, most of which can be linked to disagreements between stakeholders possessing differing perspectives. The reconciliation of the differences becomes increasingly difficult as the project develops. The following is an excerpt from a Federal Highway Administration Memorandum concerning this issue.

> *The Project Development Branch (HEV-11) in its review of environmental impact statements has noted a systematic deficiency in the purpose and need section. In our view this deficiency is particularly critical because it helps define what alternatives must be evaluated and, in some cases, selected in order to comply with the myriad of Federal environmental laws, Executive Orders, and regulations.*[7]

The realization of this problem for projects within the sphere of design and construction has been addressed through refinements to the way in which VM is applied. The U.S. Navy's Naval Facilities Engineering Command developed the Function Analysis Concept Design (FACD) as a way to validate project scope through the application of function analysis at the earliest stages of the design process.

The process I describe in this paper begins with a similar notion of using function analysis to validate a project's need and purpose. Identifying the project's basic and required secondary functions is really all that is needed at the beginning.

Once the basic functions and requirements are understood and agreed upon relative to purpose and need, the next step is to begin the process of defining performance. Performance can be divided into two categories: attributes and requirements. I use the term "attributes" to describe performance characteristics that can possess a range of values while "requirements" are decidedly absolute in nature. Attributes are flexible; requirements are not. A potential solution that does not satisfy a performance requirement cannot be considered. A performance attribute can be further defined by establishing a range of acceptable parameters. Both performance attributes and requirements should be identified at the earliest stage of the VM Job Plan - preferably at the time of the "pre-study" phase.

The Value Team will need to have a clear understanding of both the performance attributes and requirements before moving into the subsequent phases of the VM Job Plan. Performance attributes need to be discretely defined and must not overlap in meaning. Parameters defining the lower and upper range of desired performance should be included as well. Performance requirements should be similarly defined, but more finitely relevant to the actual value of the requirement. The VM facilitator should lead this discussion with the project's stakeholders during a pre-study meeting, preferably in the presence of the Value Team members. Only those attributes identified as most critical in meeting the project's purpose and need should be included. For most projects, I have found that between 4 to 8 performance attributes are usually all that are necessary to do this. The number of performance requirements, however, can vary widely.

Once the performance attributes have been identified and defined the next step is to develop scales that relate to levels of performance that fall within the defined parameters. For the sake of simplicity, I have used a 1 to 10 scale as almost everyone can easily relate to it. A “1” would represent the lowest acceptable level of performance while a “10” would define the maximum amount of performance desired relative to fulfilling the project's purpose and need (Fig. 6).

For non-linear scales, it may be desirable to consider the development of utility curves for each performance attribute to graphically reinforce the logic of the rating scales. Both Fallon and T. Fowler[8] present good models for developing utility curves for this express purpose.

There are two possible methods for calibrating the scales - absolute and comparative. The absolute method is quantitative in nature while the comparative method is qualitative. Absolute scales can be used where quantitative data is readily available. Comparative scales rely upon measurements relative to a known baseline and are useful for performance attributes for which hard data does not exist, are subjective in nature and/or are difficult to quantify within the timeframe of a value study.

Regardless of which type of scale is selected, it is important to define each performance level relative to the numerical ratings. This will become apparent later in the process when it comes time to rate alternative concepts.

Information Phase:

The next step of the process is to identify the baseline concept that will be used for comparative purposes during the VM process. This would normally occur during the Information Phase where the owner and design team present the design concept(s) to the Value Team. At the conclusion of this informational briefing, the facilitator should have the owner and design team select the baseline concept. Frequently, there will be a number of potential design concepts that will be on the table at the beginning of the Value Study and there may not be a “preferred” concept. One of them, however, should be selected as a “baseline” for the purposes of establishing a relative value index from which all of the design concepts, including any additional alternative concepts that are developed during the course of the Value Study, can be compared against.

Attribute	Definition	Rating Scale	Unit of Measure/Quantification
Construction Schedule	A measure of the total time to complete the project from the contractor's Notice to Proceed through the end of construction.	10	Less than 12 Months
	Requirement – Construction must be completed within 36 months.	9	14 – 12 Months
		8	17 – 15 Months
		7	20 – 18 Months
		6	21 – 23 Months
		5	24 Months (Baseline Concept)
		4	25 – 27 Months
		3	28 – 30 Months
		2	31 – 33 Months
		1	34 – 36 Months
Construction Impacts	An approximation of temporary construction issues, including indirect impacts such as noise, vibration, dust, and visual; and direct impacts to traffic such as delays, closures, and detours.	10	No direct or indirect impacts
		9	No direct and minor indirect impacts (i.e., noise, vibration, dust, or visual requiring limited mitigation effort)
		8	Minor direct impacts (i.e., minor traffic delays, occasional temporary nighttime lane closures, etc.)
		7	Minor direct and indirect impacts
		6	Moderate indirect impacts (i.e., noise, vibration, dust, or visual requiring significant mitigation efforts and/or inconveniences to the public)
		5	Moderate direct impacts (i.e., multiple minor traffic delays, lengthy detours, extended temporary night closures, etc.)
		4	Moderate direct and indirect impacts
		3	Major indirect impacts (i.e., noise, vibration, dust, or visual requiring substantial mitigation efforts and/or inconveniences to the public)
		2	Major (i.e., daytime lane closures, etc.)
		1	Major direct and indirect impacts

Figure 6

Once a baseline concept has been selected, the facilitator should lead the owner and design team through the performance rating process. A narrative description relating how the baseline concept will perform relative to each of the performance attributes should be recorded (Fig. 7). Please note that many of the figures in this paper represent partial examples to meet space limitations.

Performance Attribute	Baseline Concept
Construction Impacts	Construction impacts for the baseline concept will be minor in terms of traffic delays. Noise and vibration issue related to pile driving operations may require mitigation. No special construction staging will be required. Construction traffic will be moderate due to the need to haul 40,000 cubic yards imported fill to the site.
Construction Schedule	The baseline concept will require 24 months to construct.

Figure 7

Once statements of performance for the baseline concept have been identified, each performance attribute should be rated on a performance rating matrix using the rating scales that were identified during the Pre-Study Phase. This process should be repeated for any additional design concepts that need to be considered (Fig. 8).

PRELIMINARY PERFORMANCE RATING MATRIX

Bridge Replacement Project

Attribute	Attribute Weight	Concept	Performance Rating										Total Performance
			1	2	3	4	5	6	7	8	9	10	
Construction Impacts		Baseline Concept					5						0
													0
													0
													0
													0
Construction Schedule		Baseline Concept							7				0
													0
													0
													0
													0

Figure 8

Establishing the importance of the various performance attributes relative to the project's purpose and need should next be determined. The paired-comparisons method provides a simple, balanced approach for accomplishing this. It is important to emphasize that these comparisons need to be made within the context of the project's purpose and need statement. When making the paired comparisons, the question might be phrased: "Which of these two performance attributes is more critical in satisfying the project's purpose and need?" Making these distinctions early is important for the Value Team's understanding of the importance of the performance attributes in meeting the project's purpose and need. When the paired comparison has been completed, the results should be reviewed with the group to ensure that there is consistency in logic (Fig. 9).

PERFORMANCE ATTRIBUTE MATRIX

Bridge Replacement Project

								TOTAL	%
Mainline Operations	**A**	A	A	A	A	A	A	6.0	29%
Environment - Natural		**B**	B	B	E	B	B	4.0	19%
Environment - Social			**C**	C	E	C	C	3.0	14%
Constructibility				**D**	E	F	D/G	0.5	2%
Maintainability					**E**	E	E	5.0	24%
Construction Impacts						**F**	F	2.0	10%
Construction Schedule							**G**	0.5	2%
								21.0	100%

Figure 9

The number of votes for each of the performance attributes should be tallied and divided by the sum of the total number of votes possible to develop a percent importance. Alternatively, if greater sensitivity in evaluating the differences between attributes is required, the AHP method of paired comparisons can be utilized. These will then be applied to the performance rating matrix as whole numbers representing relative weights for each of the performance attributes. The 1-10 ratings for each of the performance attributes are multiplied by the attribute weights in order to develop a weighted score.

The results of the performance rating matrix are then summarized using a tabular format. This summary shows the improvement (or degradation) of performance, cost and value relative to the baseline concept. Value is expressed in the form of a value index which is calculated by taking the total weighted performance score divided by the cost (sometimes expressed in thousands or millions of dollars for high cost projects). The value indices for each design concept are then expressed as a percent improvement (or degradation) relative to the baseline concept (Fig. 10). A detailed explanation of the techniques described in this paper is fully documented in previous papers[9] and technical manuals.[10] It is important to emphasize that the facilitator should make it clear that it is the project owner/user that is taking ownership of the performance measurement process. The information that is developed by direct input from the owner/user will serve as the foundation for the evaluation of forthcoming alternative concepts that will be developed as part of the Value Study.

PRELIMINARY PERFORMANCE RATING MATRIX *Bridge Replacement Project*

Attribute	Attribute Weight	Concept	Performance Rating										Total Performance
			1	2	3	4	5	6	7	8	9	10	
Construction Impacts	10	Baseline Concept					5						50
													0
													0
													0
													0
Construction Schedule	2	Baseline Concept							7				14
													0
													0
													0
													0

Overall Performance Alternative	Total Performance	% Performance Improvement	Total Cost ($ millions)	Value Index (P/C)	% Value Improvement
Baseline Concept	518		50	10.4	

Figure 10

Function Phase:

Relating cost to function has been a standard VM practice since the beginning. Function Analysis can be further augmented by also relating performance to function. This can be accomplished using two different methods.

The first method would be applied during the random function identification exercise that typically occurs prior to the development of a FAST (Function Analysis System Technique) diagram. Once a relatively thorough list of functions has been identified and classified in terms basic and secondary functions, the Value Team would consider the relative influence that the functions have on performance. This can simply be expressed in terms of a gross percentage (Fig. 11).

The second method adds a sensitivity matrix below the FAST diagram that relates to performance. The methods for utilizing sensitivity matrices in conjunction with FAST diagrams are well documented by VM practitioners such as Jerry Kaufman.[11] This method provides a highly effective tool for considering the relationship of function, cost and performance. Value Team members will be able to see not only high cost functions, but also performance critical functions. It is at this point that the direct consideration of performance can begin focusing a Value Team's efforts on performance improvement and, ultimately, total value improvement.

Design Element	Function	Type	Performance Attributes	Influence (%)
Deck	Span River	B	Mainline Operations	80%
			Constructibility	50%
			Maintainability	70%
Approach Fills	Extend Roadway	S	Mainline Operations	20%
			Constructibility	5%
			Maintainability	10%
Piers	Support Deck	S	Constructibility	15%
			Maintainability	15%
Foundation	Support Piers	S	Constructibility	30%
			Maintainability	5%
Design Objectives	Mitigate Impacts	S	Construction Impacts	70%
			Environment - Natural	70%
			Environment - Social	40%
	Minimize Detours	S	Construction Impacts	30%
	Maintain Aesthetics	S	Environment - Social	20%
	Accommodate Pedestrians	RS	Environment - Social	15%
	Accommodate Bikes	RS	Environment - Social	25%
	Accommodate Hydraulics	RS	Environment - Natural	30%

Figure 11

Speculation Phase:

Typically, high-cost functions are selected as targets for team brainstorming during this phase. The work done in the Function Phase with respect to performance should have highlighted the performance critical functions, which deserve every bit of attention that is given to high-cost functions.

The performance attributes themselves can also serve as creativity stimulators by incorporating them into questions directed at the Value Team. For example, one might ask: “How could we improve maintainability?” or “”How might we reduce construction impacts?”

In either example, the important thing is that the consideration of performance figures into the creative process as a means of augmenting the generation of ideas.

Evaluation Phase:

It has been my experience that this phase of the VM Job Plan often gets short changed due to time constraints when a thorough, deliberative process is usually needed. The consideration of performance attributes is paramount during this phase in order to ensure that alternatives that may improve performance are thoroughly evaluated.

The evaluation process should consider each idea with respect to the performance attributes. Discussion should focus on the aspects of how the idea would improve or degrade performance relative to the baseline concept. During this discussion, the rationale for each idea relative to performance is documented. This documentation can be very valuable to project stakeholders, even for those ideas which are ultimately rejected, as they provide a very thorough discussion of project issues. Many times, project stakeholders will want to know why an idea was not further developed into an alternative. This conscientious approach should satisfy this requirement.

It has been my experience that ideas are typically discarded on unfounded statements with respect to one aspect of performance. The process described above forces team members to articulate their criticism in an organized way that addresses all aspects of performance, not just those that immediately come to mind. Sometimes it takes additional in-depth discussion before potential performance related benefits reveal themselves.

Performance is evaluated first, followed by cost. When both performance and cost have been considered, a final rating is assigned to the idea. Those ideas offering both cost and performance benefits are ranked most highly followed by those that improve only one or the other (Fig. 12). The "+/-" notation provides a simple means of expressing the degree of improvement (+1 or +2) or degradation (-1 or -2) of the idea relative to the baseline concept. This notation is also applied to cost. These numerical expressions are used solely to assist the Value Team in focusing the discussion and identifying advantages and disadvantages.

IDEA EVALUATION

Bridge Replacement Project

Ideas		Performance Attributes							Advantages	Disadvantages	$	Rank
#	Span River	MO	EN	ES	C	M	CI	PS				
1	Construct trestle adjacent to east side of existing bridge and shift alignment of the new bridge adjacent to trestle	-1	0	+1	+2	0	0	0	• Reduced costs • Reduced visual impacts • Reduced bridge length • Eliminates one trestle	• Requires additional test borings – this may require new or amended permits • Geometry not as desirable	+2	4
2	Shift the east alignment option so that it is directly adjacent to the existing bridge and construct one trestle on the east side of the new bridge	+1	0	+1	+2	0	0	-1	• Reduced costs • Improved geometry • Reduced visual impacts • Reduced bridge length • Eliminates one trestle	• Requires additional test borings – this may require new or amended permits	+2	5
3	Utilize pre-cast segmental construction	0	0	0	-1	0	0	0		• Concerns about transporting pre-cast segments • Limited contractor experience in pre-cast	-1	2

Ranking Scale: 5 = Cost and Performance Improvement 4 = Cost or Performance Improvement 3 = Minor Improvement
2 = Cost and Performance Reduction 1 = Does not Meet Project Purpose and Need

Performance Attributes: Significant Improvement +2, +1, 0, -1, -2 Significant Degradation
MO – Mainline Ops., EN – Environmental - Natural, ES – Environmental - Social, C – Constructibility, M – Maintainability, CI – Construction Impacts, PS – Project Schedule

Figure 12

Development Phase:

During the development of alternative concepts, a statement of performance should be made for each attribute. The addition of a simple form provides an expedient means to record this. Each performance attribute should be considered and the rationale for the change (or no change) relative to the baseline should be noted.

The form I have typically used includes the baseline concept's performance score and attribute weight as well as a space to record the alternative concept's performance score. The change in performance, if any, must be assessed using the scales and must be relative to the affect of the change on the entire project. An alternative may provide a dramatic improvement relative to the project element being considered, however, the overall effect upon the total project may be relatively minor or even insignificant. The rationale should relate to both, however, the performance rating must relate to the total project. This is important to understand as we are ultimately trying to improve the total value of the project as a whole. The cumulative or synergistic effect of multiple alternative concepts on performance is discussed in the Presentation Phase section. The net change in performance for the alternative concept is expressed in a percent format (Fig. 13).

<table>
<tr><td colspan="4" align="center">PERFORMANCE MEASURES
Bridge Replacement Project</td></tr>
<tr><td>TITLE: Shift the Alignment Adjacent to the Existing Bridge</td><td>NUMBER
1.1</td><td colspan="2">PAGE NO.
6 of 8</td></tr>
<tr><td>Performance Attributes</td><td>Performance</td><td>Baseline</td><td>Alternative</td></tr>
<tr><td rowspan="3">CONSTRUCTION IMPACTS:
Eliminating one temporary trestle and reducing construction time would result in a significant reduction in noise and vibration caused by pile driving operations. This alternative concept will create a better balance between cut and fill, thereby reducing construction traffic due to the reduction in off-site haul.</td><td>Rating</td><td>7</td><td>8</td></tr>
<tr><td>Weight</td><td>10</td><td>10</td></tr>
<tr><td>Contribution</td><td>70</td><td>80</td></tr>
<tr><td rowspan="3">CONSTRUCTION SCHEDULE:
No significant change.</td><td>Rating</td><td>5</td><td>5</td></tr>
<tr><td>Weight</td><td>2</td><td>2</td></tr>
<tr><td>Contribution</td><td>10</td><td>10</td></tr>
<tr><td colspan="2">Total Performance:</td><td>500</td><td>510</td></tr>
<tr><td colspan="3">Net Change in Performance:</td><td>+2%</td></tr>
</table>

Figure 13

Presentation Phase:

Following the development of the alternative concepts, the Value Team must next consider how they could be applied to the project in concert with one another. Typically, I will ask the Value Team to develop a number of potential implementation strategies that might be considered. It isn't essential to consider every possible permutation at this point, just a few that seem to be the most logical. Once an implementation strategy(s) has been identified, the Value Team should review each of the alternatives that are a part of that strategy with respect to its impact on performance. It may be that the cumulative effect of several minor performance improvements offered by various alternatives amount to equate to a larger combined performance improvement. The total effect should be recorded on the performance rating matrix based on the revised rating. This approach generally improves the thoroughness of the documentation of the alternative concepts and provides better information for the decision makers. While this information should be included in the discussion of the alternative concept, this process helps to ensure that the relative performance information is captured.

Once aggregate performance ratings have been developed for each implementation strategy, cost, performance and value should be summarized in a manner similar to that described previously for the baseline concept (Fig. 14).

This example provides a cross section of concepts possessing widely differing costs and performance ratings. It is worth noting that in this example, the alternative concept with a minor cost increase and modest performance improvements appears to provide the best overall value solution.

Implementation Phase:

The information developed during the Value Study with respect to performance and value provides the project's decision-makers with additional information in considering all the options. The detailed performance rating rationale generated during the development phase will be of particular benefit in the decision-making process. The consideration of potential implementation strategies within the context of value improvement provides project stakeholders with a means for considering the contribution of both cost and performance in achieving total value.

The project stakeholders can continue to use the performance rating matrix as a means of auditing performance improvements during the implementation of the alternative concepts. A revised matrix can be developed that shows the net benefits of the implemented alternative concepts.

PRELIMINARY PERFORMANCE RATING MATRIX

Bridge Replacement Project

Attribute	Attribute Weight	Concept	Performance Rating										Total Performance
			1	2	3	4	5	6	7	8	9	10	
Mainline Operations	29	Baseline Concept					5						145
		Value Strategy 1				4							116
		Value Strategy 2						6					174
		Value Strategy 3					5						145
		Value Strategy 4					5						145
Environmental - Natural	19	Baseline Concept					5						95
		Value Strategy 1					5						95
		Value Strategy 2							7				133
		Value Strategy 3							7				133
		Value Strategy 4						6					114
Environmental - Social	14	Baseline Concept						6					84
		Value Strategy 1						6					84
		Value Strategy 2								8			112
		Value Strategy 3						6					84
		Value Strategy 4						6					84
Constructibility	2	Baseline Concept					5						10
		Value Strategy 1				4							8
		Value Strategy 2					5						10
		Value Strategy 3				4							8
		Value Strategy 4					5						10
Maintainability	24	Baseline Concept					5						120
		Value Strategy 1					5						120
		Value Strategy 2							7				168
		Value Strategy 3					5						120
		Value Strategy 4					5						120
Construction Impacts	10	Baseline Concept					5						50
		Value Strategy 1						6					60
		Value Strategy 2				4							40
		Value Strategy 3					5						50
		Value Strategy 4					5						50
Construction Schedule	2	Baseline Concept							7				14
		Value Strategy 1						6					12
		Value Strategy 2								8			16
		Value Strategy 3							7				14
		Value Strategy 4					5						10

Overall Performance Alternative	Total Performance	% Performance Improvement	Total Cost ($ millions)	Value Index (P/C)	% Value Improvement
Baseline Concept	518		50	10.4	
Value Strategy 1 (Alts. 1, 2, 5, 7)	495	-4%	47	10.5	2%
Value Strategy 2 (Alts. 1, 2, 6, 8)	653	26%	51	12.8	24%
Value Strategy 3 (Alts. 3, 9, 10)	554	7%	48	11.5	11%
Value Strategy 4 (Alts. 3, 4, 11)	533	3%	50	10.7	3%

Figure 14

Summary

One of the key concepts behind the performance measures process is that the project stakeholders ultimately take ownership of the process. They tend to be predisposed to view alternative concepts that are developed as part of a Value Study more favorably because they know that project performance has been thoroughly considered as part of the process. They also realize that they will have a better basis for considering performance due to the fact that they themselves played an active role in establishing the yardstick for measuring it.

The performance measures process requires project stakeholders to work together in validating the projects purpose and need; identifying performance attributes and requirements; defining performance scales; and identifying the performance and value of the baseline concept. *In experience, this process has continually demonstrated its value as a means of developing stakeholder consensus with regard to issues critical to projects.* The process enlarges everyone's window of understanding while developing a better sense of empathy through the sharing of perspectives.

The performance measures process has been successfully utilized by the California Department of Transportation, as well as other public agencies[12], over the past five years as a means for enhancing their Value Studies. During this time, the process has continued to be modified and improved upon and will no doubt continue to do so.

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