

EVM.S02

Earned Value on Fixed-Price Projects

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ABSTRACT—This paper is based on lessons learned applying earned value management to projects performed under firm fixed-price contracts. The information is applicable to project teams considering earned value management for fixed-price projects.

Principles and benefits of earned value management do not change. Pros, cons and risks of several approaches to apply earned value management on fixed-price project are presented. Most earned value metrics expose cost. Clear expectations need to be established regarding the earned value information that will be shared with the customer. Performance indices alone provide relatively little information. Metrics, with schedule as the fundamental unit of value [Earned Schedule] is an alternative.

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Introduction

Although Earned Value Management will probably not be required by the customer on fixed-price projects, it is definitely worth including as a core component of the project management approach for its intrinsic benefits. There are some key considerations that must be addressed early, particularly managing the customer's expectations.

The customer may feel that having transferred cost risk to the contractor, there is no value to applying earned value management to the project. The project team may prefer to eliminate earned value if the customer does not require it, especially if they perceive it as an onerous requirement. Yet the benefit of earned value is greatest for the party who has assumed the cost risk – in the case of fixed-price projects – the contractor. And the customer also benefits by when a project is kept on track.

From the customer's perspective, the most visible aspect of earned value will be the reports. A customer who is familiar with standard earned value reports may expect to see a lot of information expressed in terms of cost. This is where the conundrum of earned value on fixed-price projects lies. On fixed-price projects, there are multiple reasons for not sharing cost with the customer and yet earned value reports convey schedule and cost information in terms of value expressed as cost.

Background

This paper is based on lessons learned applying earned value management on fixed-price projects. A state government project priced at 300 million dollars and in its second year of execution is the basis for the findings and recommendations. Earned value was proposed to the customer based on the methodology, processes and tools used by the contractor for cost plus projects and became a contractual requirement. Multiple issues surfaced early in the project, particularly exposing cost on a fixed-price state government contract where project information becomes public information. Multiple alternatives to addressing the issues were identified and evaluated. The focus of this paper is the approaches evaluated, abandoned and used for applying earned value on a fixed-price contract and the pros, cons, risks and benefits of each approach. The approach identified as optimum is currently being used to plan a similar project.

If Earned Value Isn't Required Why Do It?

Earned value is steeped in a history of customers wanting to ensure they get their money's worth on high value cost plus contracts. The ANSI 748 Standard has only a single reference to fixed-price projects:

- "Major or critical subcontractors, normally ***excluding those with a fixed-price contract***, should be required to comply either with the provisions of this standard..." [1]

Most earned value guides similarly exclude fixed-price contracts from earned value requirements:

- "The application of EVM on firm fixed-price, level of effort, and time and materials efforts will be

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optional [at the discretion of the program manager].” [3]

- “Compliance with the EVMS guidelines is not required on some firm fixed-price [FFP] contracts [including FFP contracts with economic price adjustment provisions...” [12]

Other guides discourage the use of earned value management:

- “Only the MDA can grant a waiver allowing application of EVM to a FFP contract” [4]
- “The application of EVM is discouraged on Firm-Fixed-price [FFP] [including FFP with economic price adjustment] contracts, subcontracts, intra-government work agreements, and other agreements, regardless of dollar value.” [9].
- “For firm-fixed-price contracts and subcontracts of any dollar value, the rule [DFARS text addressing EVM policy for DOD contracts, supplements the final FAR rule published at 71 Fed. Reg. 38,238] discourages applying EVM” [13].

While the requirement to apply earned value management has continually expanded within the government sector for high value, cost plus contracts, it is ignored and even discouraged for fixed-price contracts. Earned value, when not required, is often greeted with relief inside the contractor’s organization.

Consider why earned value is required on high value cost plus projects. On cost plus contracts, the customer assumes the lion’s share of risk. Earned value, applied effectively, provides early visibility into cost and schedule performance issues and for that reason is a tool that the customer uses to mitigate their risk. On fixed-price contracts, the customer has transferred the cost risk to the contractor – and earned value is perceived to be less useful. Since the customer’s cost risk is already mitigated by shifting the risk to the contractor – why bother? Result: earned value is not required – and sometimes even discouraged on fixed-price contracts.

If earned value is an effective tool to manage cost risk – wouldn’t it make sense for the contractor to adopt earned value on fixed-price contracts? And yet, many contractors feel like they’ve escaped from an onerous government requirement when earned value is not required. A savvy contractor will quickly realize that when they assume the cost risk they will benefit by using the same cost risk mitigations their customer would have required when the cost risk shoe was on the other foot.

Earned value, as an early warning system -- a management tool for identifying performance issues and impacts early, is well documented. [2] [5] [6] [7] [10] [11] In short, earned value should be part of the risk management arsenal for whichever party has the greatest cost risk.

But Earned Value Exposes Cost!

Earned value, though touted as a model that represents and integrates scope, cost and schedule, uses ‘value’ as the common metric. And value is expressed in terms of currency and maps most directly to budget – cost. Now every aspect of the triple constraint is expressed in terms of cost, making it difficult to share project performance information without also exposing project cost information.

The contractor who is executing a fixed-price project has reasons for not wanting to expose cost:

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- On government contracts, project documents may become public records, exposing cost not only to the customer but to competitors.
- The contractor wants to keep risk built into the price confidential.
- Cost information is sometimes misused, e.g. pressure from the customer to incorporate changes at no extra cost because the customer feels that the contractor has more than adequate funding.
- Cost information is sometimes misinterpreted by the customer. Positive cost variances may cause the customer to feel that they are overpaying, negative cost variances may drive the customer to assume that the contractor is in trouble and trigger customer micromangement.

Naturally reports used in conjunction with earned value focus on earned value metrics expressed in terms of currency. Three parts of the Cost Performance Report [CPR], frequently used in conjunction with earned value management, focus on ‘the numbers’. Format 1 and Format 2 provide current period and cumulative planned value [BCWS or PV], earned value [BCWP or EV], actual cost [ACWP or AC], schedule variance [SV], cost variance [CV], budget at completion [BAC], estimate at completion [EAC] and variance at completion [VAC] by work breakdown structure [WBS] and organizational breakdown structure [OBS] respectively. Format 3 provides cost and schedule baseline data, again in terms of value expressed as cost.

This takes us back to square one. On fixed-price projects, with the customer unconcerned about cost risk, the standard cost performance reports are no longer relevant. The Department of Defense Earned Value Management Implementation Guide, section 2.2.5.6.3.4 CPR Tailoring Guidance for Firm Fixed-price Contracts, states “only the minimal EVM requirements necessary to provide the Government team with the desired visibility into program performance should be applied. Since cost exposure is minimized in a FFP environment, the Government may elect to receive an IMS in order to manage schedule risk.”[4] For CPR Formats 1 and 2, the EVMIG suggests substituting hours or price. [4] The EVMIG goes on to state that Format 3 is optional, Format 4 is not recommended and suggests tailoring or eliminating Format 5. [4]

If information that exposes cost is removed, the Format 1, 2 and 3 Cost Performance Reports must be replaced or revised.

8. PERFORMANCE DATA																			
ITEM (1)	CURRENT PERIOD						CUMULATIVE TO DATE						REPROGRAM ADJUSTMENTS		AT COMPLETION				
	BUDGETED COST		ACTUAL		VARIANCE		BUDGETED COST		ACTUAL		VARIANCE		COST VARIANCE		BUDGET		BUDGETED (14)	ESTIMATED (15)	VARIANCE (16)
	WORK SCHEDULED (2)	WORK PERFORMED (3)	COST WORK PERFORMED (4)	SCHEDULE (5)	COST (6)	WORK SCHEDULED (7)	WORK PERFORMED (8)	COST WORK PERFORMED (9)	SCHEDULE (10)	COST (11)									
a. WBS ELEMENT																			
1.1 - Scope Management	2	924	2,816	2,816	1,892	0	3,156	3,156	3,288	0	-132					11,813	13,067	-1,254	
1.1.1 - Determine proje	3	0	0	0	0	0	184	184	276	0	-92					184	276	-92	

Figure 1—Format 1 Cost Performance Report

6. PERFORMANCE DAT															
ITEM (1)	BCWS CUMULATIVE TO DATE (2)	BCWS FOR REPORT PERIOD (3)	BUDGETED COST FOR WORK SCHEDULED (BCWS) (Non-Cumulative)											UNDISTRIB BUDGET (15)	TOTAL BUDGET (16)
			SIX MONTH FORECAST						ENTER SPECIFIED PERIODS						
			+1 (4)	+2 (5)	+3 (6)	+4 (7)	+5 (8)	+6 (9)	(10)	(11)	(12)	(13)	TC (14)		
a. PERFORMANCE MEASUREMENT BASELINE (Beginning of Period)	10,513	4,517	1,758	2,178	2,202	2,243	2,024	2,178	2,064	2,309	1,609	0	0	0	33,595

Figure 2—Format 3 Cost Performance Report

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So Don't Share the Cost

An obvious solution to avoid sharing cost is to simply not share it. There is nothing in the ANSI 748 earned value criteria that specify report formats or dictate what information is shared with the customer. Note that not sharing cost does not mean ignoring cost. Cost is still a key component of the triple constraint, managing to the budget is still essential to prevent eating into profit or incurring costs. And earned value remains an effective project management methodology for managing cost performance regardless of whether cost information is shared with the customer.

Five approaches for applying earned value on fixed-price projects are described along with their benefits, issues and risks.

Approach 1: Substitute Price for Cost

One obvious approach is to substitute price for cost on fixed-price projects where there are reasons for not sharing cost. Also obvious is the realization that on fixed-price projects, price doesn't change. Substituting price will result in Estimate at Completion [EAC] to remain constant [Figure 3, Item 2] while schedule variances will be exaggerated [Figure 3, Item 1] because they are relative to a constant. Substituting price for cost reiterates what the contract specifies – the price.

Earned Value Metrics

	Period						Cummulative					
	P1	P2	P3	P4	P5	P6	P1	P2	P3	P4	P5	P6
Price	140	210	280	350	280	140	140	350	630	980	1,260	1,400
BCWS	100	150	200	250	200	100	100	250	450	700	900	1,000
BCWP	90	135	180	225			90	225	405	630		
ACWP	110	165	220	275			110	275	495	770		
SV	(10)	(15)	(20)	(25)			(10)	(25)	(45)	(70)		
CV	(20)	(30)	(40)	(50)			(20)	(50)	(90)	(140)		
EAC (Math)	1,020	1,030	1,040	1,050			1,020	1,050	1,090	1,140		
VAC	(20)	(30)	(40)	(50)			(20)	(50)	(90)	(140)		

Earned Value Metrics Using Price Instead of Cost

	Period						Cummulative					
	P1	P2	P3	P4	P5	P6	P1	P2	P3	P4	P5	P6
Price	140	210	280	350	280	140	140	350	630	980	1,260	1,400
BCWS (Price)	140	210	280	350	280	140	140	350	630	980	1,260	1,400
BCWP (Price)	90	135	180	225			90	225	405	630		
ACWP (Price)	110	165	220	275			110	275	495	770		
SV	(50)	(75)	(100)	(125)			(50)	(125)	(225)	(350)		
CV	(20)	(30)	(40)	(50)			(20)	(50)	(90)	(140)		
EAC (Math)	1,400	1,400	1,400	1,400			1,400	1,400	1,400	1,400		
VAC	0	0	0	0			0	0	0	0		

Figure 3—Earned Value Cost and Price Metrics

BCWP [EV] could be adjusted by a price factor. For example, if the profit is 40% of the price, BCWP could be multiplied by 1.4 to adjust the BCWP relative to the price. There are multiple problems with this approach. 'Price' performance will only produce a negative result once the budget plus the profit margin is exceeded. 'Price' performance may drive managing the project to 'price' rather than to budget. The benefit of earned value as an early warning for cost overruns is lost.

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To prevent managing to price, two sets of earned value metrics could be retained – one set based on cost for internal performance measurement and another based on price for external reporting.

Two sets of books will add complexity, may result in conflicting messages that do not add value since price remains constant. For example, the cost and budget of the control account that produces deliverable X is 1 million and the price is 1.2 million. The customer has agreed to pay 1.2 million when deliverable X is completed and accepted. Deliverable x proceeds according to schedule but at 20% higher cost. The cost EAC is forecast to be 1.2 million while the price EAC remains 1.2 million since this is a fixed-price contract. Internally we are reporting a -200,000 VAC and to the customer we are reporting a zero VAC. Assume that EAC for deliverable X is 1.3 million. But the price EAC will continue to be reported as 1.2 million. Price EACs are essentially meaningless. The same information is available simply by looking at the contractually agreed payment milestone table. Nothing new or beneficial is being reported by substituting price for cost but now two sets of books and two sets of reports are required.

If price does not map directly to price milestones, work packages or control accounts, substituting price for cost will require more complex adjustments and the information will be more difficult to interpret. Where price includes a factor for cumulative project risk, there is unlikely to be a control account by control account or deliverable by deliverable cost to price mapping.

Substituting price for cost does not comply with the fundamental earned value principle of integrating cost and schedule by expressing these two dimensions in like units [cost] and then measuring them relative to one another.

Substituting price for cost will protect sensitive and proprietary cost information but the approach adds complexity while providing questionable value.

Approach 2: Substitute Hours for Cost

Another approach is to substitute hours for cost. This approach can quickly become complex due to several factors:

- Not all hours are of equal value. Attempts to convert hours to cost using standard and average labor hour rates may result in erroneous conclusions regarding price and efficiency.
- Not all costs convert directly to hours. Non-labor costs built into the budget will need to be excluded or converted to hours. Excluding non-labor costs may require two sets of reports for each control account with both labor and non-labor cost components. Including non-labor costs will require conversion algorithms which will add complexity and inflate the number of labor hours and impact the average labor costs.
- Project performance information based on labor hours may be distracting, misinterpreted and misused. In one project, the customer interpreted greater than planned labor hours as a risk indicating that the contractor would seek additional funding. The customer pressuring the contractor to limit labor hours while the contractor applies labor to resolve schedule performance issues creates a catch 22 situation.

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- Substituting hours for cost, though not directly exposing cost, does so indirectly while exposing other sensitive information. This approach protects one set of proprietary data by providing different proprietary data. The conversions required increase the complexity of project performance reports.

Approach 3: Keep EV Reports Internal

Another approach is to apply full scale earned value management but not share earned value performance reports with the customer.

This approach protects cost information but another set of reports will be required to provide the customer with schedule visibility.

Approach 4: Report Only Schedule Performance

Reporting just schedule performance will protect sensitive and proprietary cost information while providing schedule information to the customer.

The downside to this approach is when cost data is removed from traditional earned value reports, the reports will be bare. Figure 4 shows a CPR Format 1 report with earned value metrics expressed as cost removed and schedule variance replaced with Schedule Performance Index [SPI]. Substituting SPI for Schedule Variance helps, but expect the customer to want more than SPI, which by itself does not provide predictive information.

8. PERFORMANCE DATA																	
ITEM (1)	CURRENT PERIOD						CUMULATIVE TO DATE						REPROGRAM ADJUSTMENTS		AT COMPLETION		
	BUDGETED-COST		ACTUAL		VARIANCE		BUDGETED-COST		ACTUAL		VARIANCE		COST VARIANCE (12)	BUDGET (13)	BUDGETED (14)	ESTIMATED (15)	VARIANCE (16)
	WORK SCHEDULED (2)	WORK PERFORMED (3)	COST WORK PERFORMED (4)	SCHEDULE (5)	COST (6)	WORK SCHEDULED (7)	WORK PERFORMED (8)	COST WORK PERFORMED (9)	SCHEDULE (10)	COST (11)							
a. WBS ELEMENT																	
1.1 - Scope Management 2	924	816	816	SPI	0	0	1,156	1,156	1,288	SPI	0	132			813	867	254
1.1.1 - Determine proje 3	0	0	0	0	0	0	14	14	76	0	0	62			14	26	12

Figure 4—Format 1 Cost Performance Report with Cost Metrics Eliminated

Approach 5: Report Schedule Performance In Terms of Time – Earned Schedule

A relatively new field stemming from earned value provides an alternative. Earned Schedule uses the same principles as earned value but instead of converting cost and schedule to like units of value expressed as ‘cost’, earned schedule converts cost and schedule to like units of value expressed as ‘time’. [8] [14]

This approach is consistent with earned value fundamentals and addresses the issues with the previous 4 approaches. Earned value performance data will need to be converted to cost for internal, bottom line cost management and to time for external reporting. The ‘cost’ and ‘time’ value are integrated by virtue of being the same information, simply converted to two different units of measurement. Although two sets of reports will be produced, each set is a representation of the same information,

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merely expressed in different units.

Measuring project cost and schedule performance in terms of cost and time has another benefit. In Earned Value, schedule performance metrics, SV and SPI measure the value of the work completed relative to the work planned even when the work is completed late. Earned Schedule provides schedule metrics that provide information about when the work was completed and forecasts of when the remaining work will be completed.

Earned Value on Fixed-Price Projects Approach Summary

	Approach	Pros	Cons	Recommended
1	Substitute Price For Cost	Sensitive and proprietary cost information is protected.	Provides questionable value since price remains constant regardless of cost and schedule performance. Adds complexity and may obscure cost overruns until both budget and profit are exhausted. Deviates from the fundamental earned value principles of using a common metric for representing cost and schedule.	No
2	Substitute Hours For Cost	Sensitive and proprietary cost information is protected.	Exposes labor hours which may also be sensitive and used to infer cost. Non-labor costs do not convert directly to hours resulting in a partial representation of 'value' or requiring conversion techniques that add complexity.	No
3	Keep EV Reports Internal	Sensitive and proprietary cost information is protected.	Alternate reports will be required for the customer resulting in two sets of reports.	No
4	Report Only Schedule Performance	Sensitive and proprietary cost information is protected.	Alternate reports will be required for the customer resulting in two sets of reports.	No
5	Report Schedule Performance In Terms of Time - - Earned Schedule	Sensitive and proprietary cost information is protected. Schedule metrics include 'when' as well as value.	Two sets of reports required traditional earned value for internal use and earned schedule for external use. The reports are based on the same earned value data.	Yes

Schedule Performance Reports

On a fixed-price project, the customer's focus will be schedule performance. For a project where earned value is effectively employed, schedule performance is planned, tracked and reported in terms of value expressed as cost. For example, schedule performance is expressed as the value of the work planned, the value of the work completed, and the difference between the value of the work completed relative to the value of the work planned. Reporting schedule status using standard earned value report formats exposes cost.

One of the idiosyncrasies of earned value schedule performance metrics is that schedule variance

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trends toward zero, even when the work is performed later than planned. Earned value schedule variance [value of work completed minus value of work planned] is mathematically correct but ignores when in real time the work is completed. Work completed earns its value whether completed early, on schedule or late. The earned value schedule performance index performs the same way as schedule variance, trending toward 1 as work is completed regardless of when the work is completed. Earned schedule answers questions about when work was completed and forecasts when work will complete. [8] [14]

On a fixed-price project, with the contractor responsible for cost risk, the customer will turn their attention to schedule performance and risk. After all, from the customer’s perspective, cost is fixed and schedule is variable. Earned schedule metrics can provide schedule information in real time terms and without exposing cost information.

Comparison of Earned Value and Earned Schedule Project Schedule Performance Information

Project Schedule Information	Earned Value	Earned Schedule
Value of work planned	Yes, BCWS [PV]	No, use EVM
Value of work completed	Yes, BCWP [EV]	
Value of work completed relative to value of work planned	Yes, SV and SPI	
When work is planned	No	PD
When work is completed	No	EV[t]
When work is completed relative to plan	No. In fact SV and SPI trend toward 0 and 1 regardless of whether work is completed ahead, on or behind schedule.	SV[t] SPI[t]
When project will complete		EAC[t]

Note that [t] indicates metrics where the value is expressed as units of time.

An earned schedule report, similar to a CPR Format 1 report would provide:

- Planned Duration : the planned duration for each work package expressed in units of time
- Earned Schedule: the number of complete periods plus an incomplete portion
- Actual Time: the number of periods executed
- Schedule Variance: Earned Schedule - Actual Time
- Schedule Performance Index: Earned Schedule / Actual Time
- Estimate at Completion: Planned Duration / Schedule Performance Index

Earned Schedule Performance Data													
Item	CURRENT PERIOD					CUMULATIVE TO DATE					AT COMPLETION		
	Budgeted	Actual		Variance		Budgeted	Actual		Variance		Planned Duration PD	Estimate (time) EAC(t)	Variance (time) VAC(t)
	Planned Duration PD	Earned Schedule ES	Actual Time AT	SV(t)	SPI(t)	Planned Duration PD	Earned Schedule	Actual Time AT	SV(t)	SPI(t)			
WBS Element													
1.1 Design	0	0	0	0		20	20	20	0	1.00	20	20	0
1.2 Develop	0	0	1	(1)	0.00	50	50	60	(10)	0.83	50	60	(10)
1.3 Implement	0	2	1	1	2.00	30	28	36	(8)	0.78	30	39	(9)
Total	0	2	2	0	1.00	100	98	116	(18)	0.84	100	118	(18)

Figure 5—Earned Schedule Report

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Figure 5 shows how schedule information could be reported in a style similar to a Format 1 report. WBS 1.1 was planned and completed in 20 time periods. WBS 1.2 was planned to complete in 50 time periods but was actually completed in 60 time periods. WBS 1.3 is in progress but has exceeded the 30 time periods planned by 8 periods and given the current schedule performance index is forecasted to complete 9 time periods later than planned. The project is forecasted to complete 18 time periods later than the original planned finish date. If the project was planned to complete in December 2009, we can now expect the project to complete in June 2011. Note that [t] indicates metrics where the value is expressed as units of time. For more information on the Earned Schedule metrics included in Figure 5, refer to the table 'Earned Schedule Metrics' below.

Using the same earned value management data used to plan and manage the project, earned schedule data can be calculated to provide real time schedule status and forecasts.

Earned Schedule Metrics

Earned Value	Earned Schedule Equivalent	Earned Schedule Abbreviation	Formula
BCWP [EV]	Earned Schedule	ES	Time at which the amount of earned value [EV] accrued should have been earned including number of complete periods [C] plus any incomplete portion [I].
BCWS [PV]	Planned Duration	PD	
ACWP [AC]	Actual Time	AT	Number of periods executed
SV	Schedule Variance	SV[t]	ES - AT
SPI	Schedule Performance Index	SPI[t]	ES / AT
EAC	Estimate At Completion	EAC[t]	PD / SPI[t]
VAC	Variance At Completion	VAC[t]	PD - EAC[t]

Note that [t] indicates metrics where the value is expressed as units of time.

Summary

Earned value cost performance benefits are most relevant to the party with the greatest cost risk. In cost plus projects that is the customer and precisely why the government requires earned value on high value cost plus projects. On fixed-price projects, the contractor assumes the cost risk and it makes sense that they would want the same cost management methodologies a customer would employ. In other words, contract type does not impact the principles or benefits of earned value management.

On fixed-price projects the customer, having shifted cost risk to the contractor, will focus on schedule. Traditional earned value management reports expose cost while providing no real time project schedule information. Earned schedule can be used to provide project schedule information in terms real time, leveraging earned value information. The customer continues to get the benefits of earned value via the contractor's mitigation of cost risk as well as more meaningful schedule information.

Managing customer expectations regarding this application of earned value is essential. Customers who are familiar with earned value may suggest solutions to applying earned value on fixed-price

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projects that are problematic including substituting price for cost or hours for dollars. Prepare for the use of earned value on fixed-price projects by establishing, reviewing and agreeing on an approach that provides retains the benefits of earned value and provides meaningful information to both the customer and the contractor.

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