

Ch 4 - Forecasting Cost Overruns

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4.0 Chapter Introduction

This chapter will examine methods that you can use to identify, analyze, and resolve contract cost and schedule variances.

Contract Surveillance ([FAR 42.1103](#), [42.1104](#), and [42.1105](#)). While the contractor is responsible for timely cost-effective contract performance, the Government is responsible for maintaining contract surveillance to the extent necessary to protect the Government's interests. Appropriate procedures for identification and analysis of cost and schedule variances should be a part of every contract surveillance plan.

If you are a contracting officer preparing a new contract, consider the information required for effective surveillance of contract performance as you define contract-reporting requirements. If you are the contracting officer responsible for contract administration, determine the contract surveillance requirements based on the criticality of the contract requirement to the Government and the circumstances affecting contract performance.

- **Criticality to the Government.** The contracting officer must assign a criticality designator to each contract following the guidelines in the table below. In general, the more critical the requirement is to the Government, the more attention you should give to contract surveillance, including cost and schedule variance identification and analysis.

Contract Criticality To Government Operations		
Criticality Designator	Relative Criticality	Criterion
A	Most	Critical contracts

	critical.	(including DX-rated contracts), contracts involving unusual and compelling urgency, and contracts for major systems.
B	Moderately critical.	Contracts (other than those designated "A") for items needed to maintain a Government or contractor production or repair line, to preclude out-of-stock conditions, or to meet user needs for non-stock items.
C	Least critical.	All other contracts.

- **Circumstances of the Contract.** In general, the more complex or difficult the contract, the more consideration you should give to contract surveillance. When analyzing contract complexity, consider:
 - **Contract requirements for reporting production progress and performance.** Cost-reimbursement, time-and-materials, and labor-hour contracts typically have stricter requirements for reporting progress and performance than fixed-price contracts.
 - **Contract performance schedule.** Contracts with longer schedules will normally merit closer surveillance, because there is a longer period before late deliveries and other routine indicators will indicate a problem. A contract with an ambitious completion schedule also will normally merit closer surveillance.
 - **Contractor's history of contract performance.** A contractor with a history of overruns or late deliveries will normally merit closer surveillance.
 - **Contractor's experience with the contract supplies or services.** A contractor with limited experience will normally merit closer surveillance.

- **Contractor's financial capability.** A contractor with marginal financial capability will normally merit closer surveillance.
 - **Any supplementary written instructions from the contracting office.**
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4.1 Identifying And Analyzing Cost And Schedule Variances

Uses for Information on Variances ([FAR 52.232-7\(c\)](#), [52.232-20\(a\)](#), [52.232-22\(a\)](#), [52.243-1\(b\)](#), [52.243-2\(b\)](#), [52.243-3\(b\)](#), and [52.243-4\(d\)](#))

Information on variances from cost and schedule projections can provide vital input to many contract administration decisions.

- Information on the contractor's progress toward timely contract completion is important for the administration of any contract. However, it is most important for cost-reimbursement, time-and-material, and labor-hour contracts. For these contracts, the contractor only agrees to put forth its best effort to complete the contract effort within funding, cost, or price limitations.
- Information on contractor cost and schedule performance is essential to negotiating an equitable adjustment that leaves the contractor in the same profit position as it was before the modification.
- Information on cost of the current contract can be a key element in projecting the cost of follow-on contracts awarded before the current contract is complete.

Consider Both Cost and Schedule Variances. To analyze variances, you need to be able to consider contractor cost and schedule variances from initial cost estimates. For example, a contractor in Month 4 of a 12-month contract is tracking perfectly with estimated costs through Month 4. However, the contractor is two months behind schedule. In other words, two months of actual performance have cost as much as four months were projected to cost. If we consider only cost, there does not appear to be a problem. However, if we consider both cost and schedule, there appears to be significant potential for a cost and/or schedule overrun.

Information Sources. You can use information from a variety of sources to monitor cost and schedule performance variance, such as:

- Contractually required cost/schedule analysis and reporting, including:
 - Cost Performance Reports under Earned Value Management System (EVMS) Guidelines; and
 - Cost/Schedule Status Reports.
- Contractually required cost information, including:
 - Contract Funds Status Reports;
 - Progress payment requests;
 - Cost-reimbursement vouchers;
 - Contract progress reports; or
 - Limitation of cost/funds notices.
- Contractor production management reports and analyses, Including:
 - Phase Planning or Gantt Charts
 - Production Flow Charts
 - Program Evaluation and Review Technique (PERT) network analyses
- Progress review meetings
- Observation by Government personnel

Points to Consider in Information Source Selection. The method that you select must be appropriate for the contract. When you have a complex or difficult contract for a requirement with a Criticality A Designator, you should consider contractually mandated analysis and reporting system (e.g., compliance with EVMS Guidelines for a major acquisition). The risk involved will likely merit the additional cost of the required system.

It is unlikely that a requirement with a Criticality C Designator would merit the added cost of any contractually mandated cost/schedule reporting. For low-value low-risk items, you would probably rely on routine observation by Government personnel.

To be effective, the method that you select must provide or permit you to develop:

- A cost baseline upon which the original contract cost was derived (usually the contractor's budget or proposal).
- Actual costs incurred for completed work.
- An estimate to complete.

Earned Value Management Systems ([DODD 5000.2R](#), para. 3.3.5.3, MIL-STD-881, and [DFARS 252.234-7001](#))

[Appendix 4A](#) presents the 32 Industry Standard Guidelines for development and operation of Earned Value Management Systems (EVMSs). Under these guidelines, contract work is planned, budgeted, and scheduled in time-phased "planned value" increments to establish a cost and schedule measurement baseline. Actual cost and schedule performance is then compared to the established baseline.

- **Requiring Compliance.** Requiring contractors to comply with EVMS Guidelines encourages them to use effective internal cost and schedule management control systems, and permits the Government to rely on timely data produced by those systems for determining product-oriented contract status. However, compliance should only be required when contract cost and complexity merit the cost of compliance with EVMS Guidelines.
 - Unless the requirement is waived by the acquisition Milestone Decision Authority (MDA), the DoD requires EVMS Guideline compliance from any firm with a flexibly-priced:
 - System research, development, test, or evaluation contract or subcontract with a value of \$70 million or more in (FY 1996 constant dollars), or
 - System procurement contract with a value of \$300 million or more in (FY 1996 constant dollars).
 - If you are assigned to another agency, consult agency guidance for contracting situations that require contractor compliance with EVMS Guidelines.
- **Stipulating a Work Breakdown Structure.** The framework for EVMS is the Work Breakdown Structure (WBS) and the contractor's baseline plan developed using that structure.
 - The WBS is a product-oriented family tree division of hardware, software, services, and other work tasks which organizes, defines, and graphically displays the product to be produced, as well as the work to be accomplished to achieve the specified product.
 - When you expect that the contract will require the contractor to comply with EVMS guidelines, the request for proposal should require the offeror to provide cost information based on a WBS identified in the solicitation. The offeror can provide more levels of information than required by the solicitation, but the firm cannot provide fewer.

- o The multiple levels of the WBS "explode" the work required down to identifiable work packages that relate costs to specific contract effort. In a common WBS:
 - Level 1 is the entire system;
 - Level 2 identifies the major elements of Level 1;
 - Level 3 identifies the major elements of Level 2; and
 - Each lower level provides increasingly detailed information.

The following table provides an example of a 3-level WBS structure. The example is for a missile system, but the concept can be applied to any large system.

Missile System Work Breakdown Structure, Levels 1-3		
Level 1	Level 2	Level 3
Missile System	Air Vehicle	Vehicle Integration and Assembly Propulsion Vehicle Stages (each stage included in system design) Guidance and Control Equipment Airborne Test Equipment Auxiliary Equipment
	Command and Launch Equipment	Integration and Assembly Surveillance, Identification, and Tracking Sensors Launch and Guidance Control Communications Data Processing Launcher Equipment

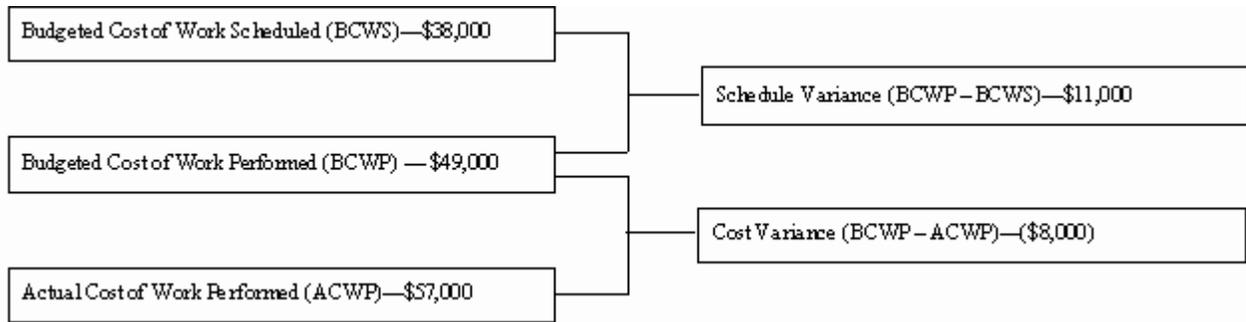
	Auxiliary Equipment
Training	Equipment Services Facilities
Peculiar Support Equipment	Organizational Level Intermediate Level Depot Level
System Test and Evaluation	Development of Test and Evaluation Operational Test and Evaluation Mock-ups Test and Evaluation Support Test Facilities
Systems/Project Management	Systems Engineering Project Management
Data	Technical Publications Engineering Data Management Data Support Data Data Depository
Operational/Site Activation	Contractor Technical Support Site Construction Site/Ship/Vehicle Conversion On-site System Assembly, Installation, and Checkout

Common Support Equipment	Organizational Level Intermediate Level Depot Level
Industrial Facilities	Construction Conversion/Expansion
Initial Spares and Repair Parts	Identified Spares Allowance List (by system grouping or element)

4.1 Identifying And Analyzing Cost And Schedule Variances (cont)

- **Establishing A Contract Cost/Schedule Baseline.** When the contract requires EVMS compliance, a multifunctional Integrated Baseline Review (IBR) should be conducted after contract award. Government participants in the review will normally include engineers, other technical personnel, EVMS support personnel, and program management personnel. Together with contractor representatives, this team will review the contractor's baseline plan for contract performance. This will normally include, work authorizations, schedules, work package budgets, and progress measurement methods.
- **Comparing Actual Cost/Schedule With The Baseline.** Each month during contract performance, the contractor will submit a Cost Performance Report (CPR) that compares actual performance with budgeted performance and establishes a common reference point for identifying variances.
 - CPRs provide key information on:
 - **Budgeted Cost of Work Scheduled (BCWS).** BCWS is the amount budgeted for work scheduled to be accomplished. It is a time-phased expenditure plan, measurable for the current, cumulative-to-date, and contract completion time periods.
 - **Budgeted Cost of Work Performed (BCWP).** BCWP is the amount budgeted for that portion of the scheduled work that was actually performed (i.e., what the contractor planned to spend for the work actually accomplished).
 - **Actual Cost of Work Performed (ACWP).** ACWP is the amount actually spent in the accomplishment of work performed. The amount actually spent includes direct costs (e.g., labor and material) and indirect costs (e.g., overhead and G&A expense).

- o The following example demonstrates how BCWS, BCWP, and ACWP can be used to identify contract cost/schedule variances:



In this example, the contractor is ahead of schedule. BCWP is \$11,000 greater than BCWS. That is almost 29 percent more work completed than was scheduled. However, for the work performed, the contractor is over budget. The ACWP is \$8,000 more than the BCWP. That is approximately 16 percent over budget.

- **Analyzing Reported Variances.** Note that the calculations above identify an area where actual contract costs exceed budgeted costs but do not explain how the variances will affect the total contract.
 - o To permit more detailed analysis, the CPR must present:
 - o An analysis of performance by work breakdown structure (WBS) element.
 - o An analysis of performance by organizational category;
 - o A time-phased contract budgeted cost baseline for contract completion;
 - o A time-phase manpower loading estimate for future contract completion; and
 - o An explanation and analysis of significant variances.
 - o Normally, you will need support from Government technical personnel to review the contractor's analysis and determine the reason for, and the significance of, any cost variance.
- **Example Of Performance Analysis By WBS Element.** The table below presents key CPR information for several elements of the contract WBS.

Cost Performance Report Work Breakdown Structure		
Budget Baseline	Cumulative Cost To Date (in \$000)	Cost At Completion (in \$000)

\$1.5 mil	Budgeted Cost			Variance				
WBS Element	Work Scheduled	Work Performed		Schedule	Cost	Budgeted	Estimated	Variance
1.1	250	250	260	0	(10)	250	260	(10)
1.2	90	85	84	(5)	1	100	100	0
1.3	130	150	155	20	(5)	330	340	(10)
1.4	200	200	185	0	15	250	235	15
1.5	300	310	320	10	(10)	400	415	(15)
1.6	120	120	140	0	(20)	120	140	(20)
Subtotal	1,090	1,115	1,144			1,450	1,490	(40)
Mgt. Reserve						50		50
Total	1,090	1,115	1,144			1,500	1,490	10

Based on the above report, you could make the following observations:

- WBS Element 1.1.
 - Comparison of BCWS, BCWP, and the Cost-at-Completion Budgeted reveals that all are equal and the work under WBS Element A is complete.
 - Comparison of BCWP and ACWP reveals that the element experienced a \$10,000 cost overrun at completion.
 - Comparison of the Cost-at-Completion Budgeted, Estimated, and Variance columns also reflect the \$10,000 cost overrun.
- WBS Element 1.2.
 - Comparison of BCWS with BCWP reveals that the work is behind schedule.
 - Comparison of BCWP with ACWP shows that the contractor is slightly underrunning budgeted cost.
 - Comparison of the Cost-at-Completion Budgeted, Estimated, and Variance columns indicates that the work is expected to be on budget at completion.
- WBS Element 1.3.
 - Comparison of BCWS with BCWP reveals that the work is ahead of schedule.
 - Comparison of BCWP with ACWP shows that the contractor is experiencing a slight overrun of \$5,000 over budgeted cost.
 - Comparison of the Cost-at-Completion Budgeted, Estimated, and Variance columns indicates that the overrun is expected to grow to \$10,000 at completion.
- WBS Element 1.4.
 - Comparison of BCWS with BCWP reveals that the work is on schedule.

- Comparison of BCWP with ACWP shows that the contractor is experiencing an underrun of \$15,000.
 - Comparison of the Cost-at-Completion Budgeted, Estimated, and Variance columns indicates that the underrun is expected to remain at \$15,000 through completion.
- WBS Element 1.5.
 - Comparison of BCWS with BCWP reveals that the work is ahead of schedule.
 - Comparison of BCWP with ACWP shows that the contractor is experiencing an overrun of \$10,000.
 - Comparison of the Cost-at-Completion Budgeted, Estimated, and Variance columns indicates that the overrun is expected to grow to \$15,000 at completion.
- WBS Element 1.6.
 - Comparison of BCWS, BCWP, and the Cost-at-Completion Budgeted reveals that all equal and the work under Element F is complete.
 - Comparison of BCWP and ACWP reveals that the element experienced a \$20,000 overrun at completion.
 - Comparison of the Cost-at-Completion Budgeted, Estimated, and Variance columns also reflect the \$20,000 overrun.
- Subtotal.
 - Comparison of the Cost-at-Completion Budgeted, Estimated, and Variance Subtotals reveals a projected net overrun of \$40,000. Since the contractor had set aside a management reserve of \$50,000, the contract is still within the original Budgeted Cost baseline with \$10,000 of management reserve remaining. There appears to be little need for in-depth technical analysis at this time because the contractor is still within the original Budget Cost baseline and the contract is 76 percent complete.

Cost/Schedule Status Reports ([DFARS 252.242-7005](#)). For flexibly-priced contracts that require close cost/schedule monitoring but do not merit a requirement for full compliance with EVMS guidelines, consider requiring cost/schedule status reporting without requiring EVMS compliance. One example of this type of reporting is the DoD Cost/Schedule Status Report (C/SSR).

- **Requiring Compliance.** When preparing a flexibly-priced contract, DoD contracting officers:

- Must assure that the contract requires the contractor to comply with Cost/Schedule Status Reporting requirements when the contract:
- Supports a major system acquisition;
- Period exceeds 12 months;
- Does not meet the criteria for requiring compliance with EVMS Guidelines and submission of CPRs; and
- Dollar value merits the C/SSR requirement. Application to contracts of less than \$6 million (FY 1996 constant dollars) must be evaluated carefully to ensure that only the minimum information required for effective contract management is required.
- May insert a Cost/Schedule Status Reporting requirement in a contract that does not support major system acquisition, if the need for cost/schedule tracking justifies the requirement.
- **Planning And Reporting.** Under Cost/Schedule Status Reporting, the contractor is required to:
 - Describe its plan for cost/schedule management and reporting;
 - Support an IBR of the contractors cost/schedule baseline, if required by the Government; and
 - Provide monthly C/SSRs analyzing contract performance by WBS element in a format similar to the CPR performance analysis by WBS element. The C/SSR format is similar to the CPR format for analysis of contract performance by WBS.
- **Analyzing Reports.** C/SSR analysis can be performed using the same calculations described above for CPR WBS performance analysis. The reliance that you can place on this analysis will depend on the contractor's plan for C/SSR reporting and the system for gathering the data provided.

Contract Funds Status Report ([DODD 5000.2-R](#), para 6.4.4). For flexibly-priced contracts, you may also consider requiring a continuing detailed report on the status of contract funding. You may require this report in addition to or instead of the type of cost/schedule reporting described above. One example of this type of reporting is the DoD Contract Funds Status Report (CFSR).

t a	i- f i c a t i o n b	c	Total d	e	z e d f	g	z e d h	W o r k i	j	k	o v e r l	m
12. CONTRACT WORK AUTHORIZED (With Fee/Profit) - ACTUAL OR PROJECTED												
		Actual to Date										At Completi on
a. Open Commitments												
b. Accrued Expenditures												
c. Total (12a + 12b)												
13. Forecast of billings to the												

Government												
14. Estimated Termination Costs												
15. Remarks												

- **Requiring Compliance.** When preparing a flexibly-priced contract, DoD contracting officers:
 - Must assure that the contract requires the contractor to comply with Contract Funds Status Reporting requirements when the contract:
 - Supports a major system acquisition;
 - Period exceeds 6 months; and
 - Dollar value merits the CFSR requirement. Application to contracts of less than \$1.2 million (FY 1996 constant dollars) must be evaluated carefully to ensure that only the minimum information required for effective contract management is required.
 - May consider inserting a Contract Funds Status Reporting requirement in a contract that does not support major system acquisition, if the need for cost tracking justifies the requirement.
- **Reporting.** The requirement for Contract Funds Status Reporting should be tailored to the specific contract involved. The CFSR normally required quarterly and must provide enough information for Government personnel to compare the estimate of total funds required to complete authorized contract work with existing contract funding.
- **Analyzing Report Information.** These reports can be combined with cost information from contractor requests for progress payment or cost-reimbursement vouchers to obtain a general picture of contract progress compared to costs expended. If you identify an apparent problem, you should request a technical review of the contractor's physical progress toward contract completion.

Progress Payment Requests ([FAR 32.503-4](#) and [-5](#)). A contractor making a request for progress payments must complete a [Standard Form \(SF\) 1443](#), Contractor's Request for Progress Payment. As part of the request, the contractor must identify total costs to date and estimated additional cost to complete the contract. The estimated additional cost to complete the contract may be the last estimate made, adjusted for costs incurred since the last estimate. However, the contractor must update the estimate at least semi-annually.

- Before making progress payments, you must establish the reliability of the contractor's accounting system and controls. Once you have done that, you may rely on the accounting system and the certification on the SF 1443 when making a progress payment.

- Normally, you should not request an audit of individual progress payment requests. However, you should consider requesting an audit if you have reason to:
 - Question the reliability or accuracy of the contractor's certification on the SF 1443, or
 - Believe that the contract will involve a loss.
- While you may rely on the contractor's accounting system and certification without prepayment review, you must make periodic reviews to determine the validity of progress payments already made or expected to be made. These post-payment reviews must include a number of elements including a determination that the contract price will be adequate to cover the anticipated cost of contract completion or that the contractor has adequate resources to complete the contract. A review of the contractor's actual physical progress should be a part of these post-payment reviews.

Cost-Reimbursement Vouchers ([FAR 52.216-7\(b\)](#)). Under cost-reimbursement contracts, the contractor can submit vouchers or invoices for payment of costs. Unlike the Contractor's Request for Progress Payment, the contractor is not required to submit an estimate of the cost to complete the contract with the cost-reimbursement voucher. However, the vouchers do provide an excellent record of the contractor's costs that can be coupled with other information such as production surveillance and reporting documents to identify potential cost overruns. The record includes:

- Those recorded costs that, at the time of the request for reimbursement, the contractor has paid by cash, check, or other form of actual payment for items or services purchased directly for the contract.
- Costs incurred, but not necessarily paid for, including:
 - Materials issued from the contractor's inventory and placed in the production process for use on the contract;
 - Direct labor;
 - Direct material;
 - Other direct in-house costs; and
 - Properly allocable and allowable indirect costs.
- The amount of progress payments that have been paid to the contractor's subcontractors.
- Contractor contributions to any pension or other post-retirement benefit, profit sharing, or stock ownership plan paid in accordance with contract requirements.

Limitation of Cost/Funds NoticeI. All cost-reimbursement contracts must include a contract clause limiting the Government's obligation to reimburse contractor costs. As shown in the table below, each of the clauses used to limit the Government's obligation also requires contractor notification that total costs are approaching that limit.

Contractor Notification Requirements		
If the contract is...	Then the contract must include the...	Which requires the contractor to notify the Government:
A fully-funded cost-reimbursement contract for other than consolidated facilities, facilities acquisition, or facilities use	Limitation of Cost clause (FAR 52.232-20)	Whenever the Government share of contract costs is expected to... <ul style="list-style-type: none"> • Exceed a stated percentage (normally 75 percent) of estimated contract cost within a stated period (normally 60 days); or • Be either greater or substantially less than previously estimated.
A cost-reimbursement contract for consolidated facilities, facilities acquisition, or facilities use	Limitation of Cost (Facilities) clause (FAR 52.232-21)	Whenever the Government share of contract costs is expected to... <ul style="list-style-type: none"> • Exceed 85 percent of estimated contract cost within the next 30 days; or • Be either greater or substantively less than previously estimated.
An incrementally-funded cost-reimbursement contract	Limitation of Funds clause (FAR 52.232-22)	Whenever the Government share of contract costs is expected to exceed a stated percentage (normally 75 percent) of the amount so far allocated to the contract cost within a stated

		<p>period (normally 60 days).</p> <p>Sixty days before the end of the period specified in the contract schedule of the estimated amount of funds (if any) required to continue timely performance.</p>
A time-and-material or labor-hour contract.	<p>Payments Under Time-and-Materials and Labor-Hour Contracts clause</p> <p>(FAR 52.232-7)</p>	<p>Hourly rate payments and material costs are expected to...</p> <ul style="list-style-type: none"> • Exceed 85 percent of the ceiling price within the next 30 days; or • Be substantially greater or less than the stated ceiling price.

DO NOT expect contractor notification requirements to replace effective contract surveillance! You should be questioning significant variations long before contractor notification. By the time you receive contractor notification, it may be too late for the contractor to take corrective action. In fact, the contractor may fail to provide timely notice despite the contract requirement. There have been many contracts where the contractor did not provide notice until after all contract funds were expended.

Gantt or Phase- Planning Charts. One of the most common techniques for managing schedules for both supply and service contracts is the Gantt Chart (also known as the Phase-Planning Chart). The Gantt Chart provides a graphical representation of the start date, end date, and process time for each phase in the production process.

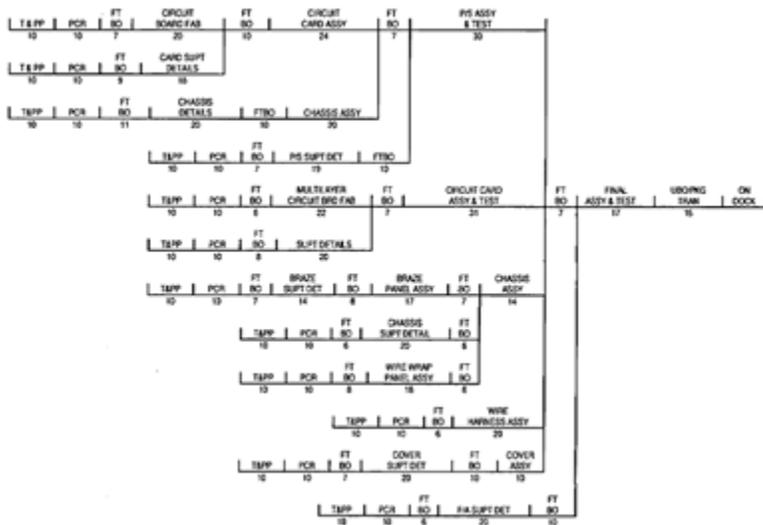
before work begins on the general system concept. If development of the performance specifications took 10 days instead of three, that delay could effect the entire project. The contractor would need to examine ways of shortening other tasks or performing tasks concurrently to meet the required schedule.

If the problems extend the time required to complete an activity on the critical path, the contractor must take action to identify cost effective ways to meet the original schedule. When there is a threat to the contract schedule or cost estimates, you should call upon Government technical personnel to examine the contractor's estimates.

Production Flow Charts. Production flow charts can be developed to more clearly define contract schedules. The production flow chart is developed using the major schedule milestones, production sequence, and projected manpower. The example below depicts the first unit flow chart for production of a new product.

The flow time for each of the assemblies is determined by utilizing the estimated labor-hours, crew sizes, and the operations shifts projected for contract performance.

With the overall sequence of the major activity defined, activities can be scheduled for completion to meet subsequent events which are dependent upon them. Start times for each activity will be determined by estimating when the activity must be completed and the estimated time required to complete the activity.



T&PP - Tools and Production Planning
 PCR - Production Control Records
 FTBO - Flow Time Between Orders
 UBO - Unit Buy Off
 PKG - Package
 Tran - Transportation

All Flow Times are Shown in Days

Using this procedure, the entire schedule can be displayed on a single chart. All organizations can determine at a glance when their responsibilities start, the estimated time required, and the required completion time. The effect of any delay on the overall schedule becomes obvious.

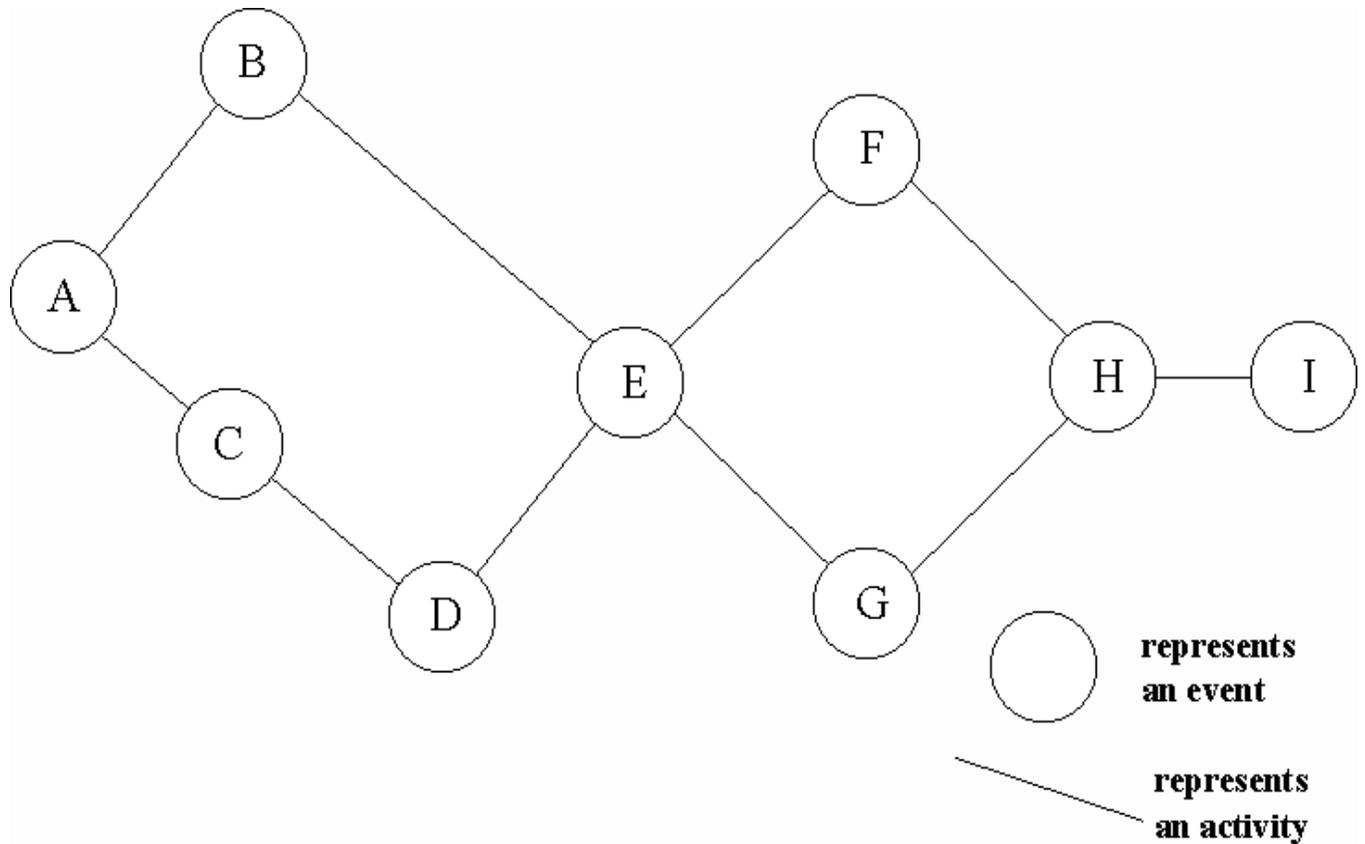
In the chart above, if circuit card assembly and test required 22 days instead of 20, the overall project would not be delayed because of the 5-day flow time between orders. However, if circuit card assembly and test required 40 days because of production problems, contractor corrective action would be necessary to meet the original schedule.

With knowledge of the interrelated activities required for production, Government personnel could raise questions regarding contractor corrective actions. Contractor projected actions could be evaluated for effectiveness and potential effect on cost.

Program Evaluation and Review Technique. The Program Evaluation and Review Technique (PERT) takes the analysis of production flow one step further. PERT permits the contractor to analyze the relationships of all elements needed to complete a project and identify the critical path -- the path that defines the estimated time required to complete the project.

If an element requires more time than estimated, PERT permits analysis of the effect on timely project completion (the critical path). If the increased time required to complete the element does not affect the critical path, no management action may be required. If the completion schedule is affected, PERT permits analysis of alternative corrective actions and the cost associated with each action.

- **PERT Network Structure.** To understand PERT analysis, you must first understand PERT network structure. The PERT network is composed of events and activities.
 - An **event** is a specific milestone that must be reached before a new activity can begin. For example, a foundation must be completed before a contractor can start erecting a building frame. On a PERT chart, events are typically shown as circles or nodes.
 - An **activity** is the work effort over a period of time required to achieve a specific event. On a PERT chart, activities are shown as the lines that connect the event circles, and in effect define the relationships of the activities and events required to complete a project.
 - The figure below depicts a **PERT network**. Network events are labeled with letters (e.g., A, B, C, etc.). The activity that begins at A and ends at B is referred to as AB. Note that activities AB, BE, AC, CD, and DE, all must be completed before Event E can be achieved.



- Activity Times.** The next thing needed to develop the PERT network is information on the length of time to accomplish each activity. PERT uses three estimates of the time required to complete each activity.

$$\text{Activity Time} = \frac{a + 4m + b}{6}$$

Where:

a = Optimistic time -- the completion time if everything goes as well as can be expected.

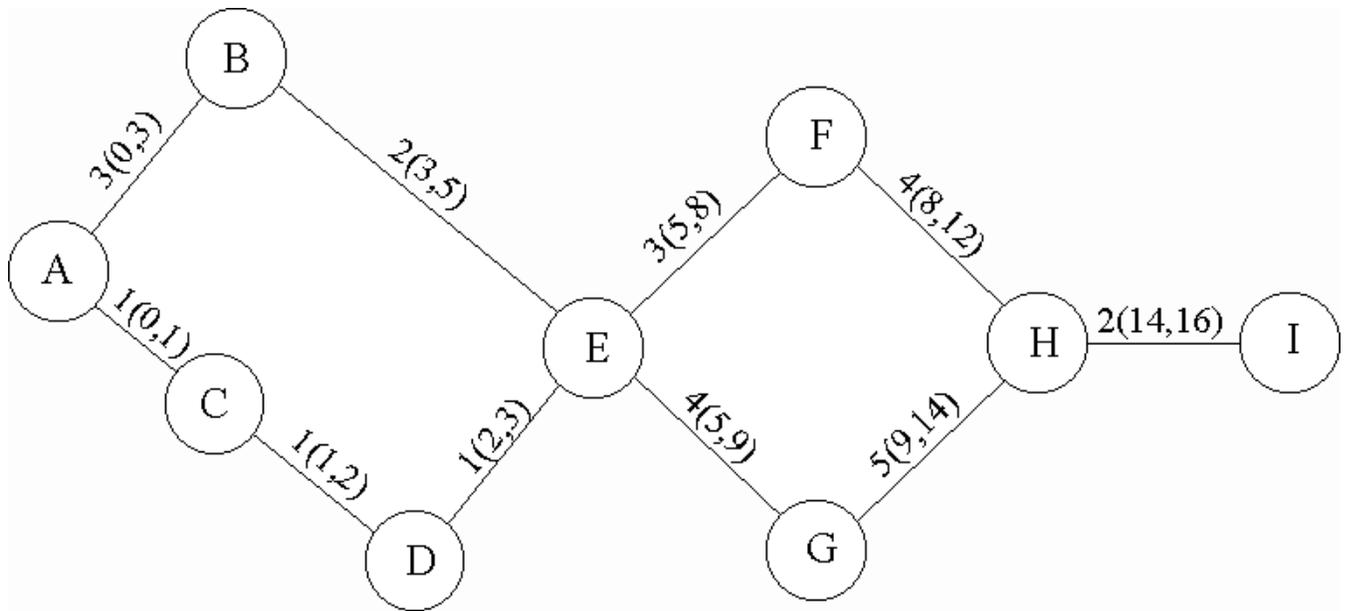
m = Most likely time -- the completion time if everything goes as expected.

b = Pessimistic time -- the completion time if the things that may go wrong do go wrong.

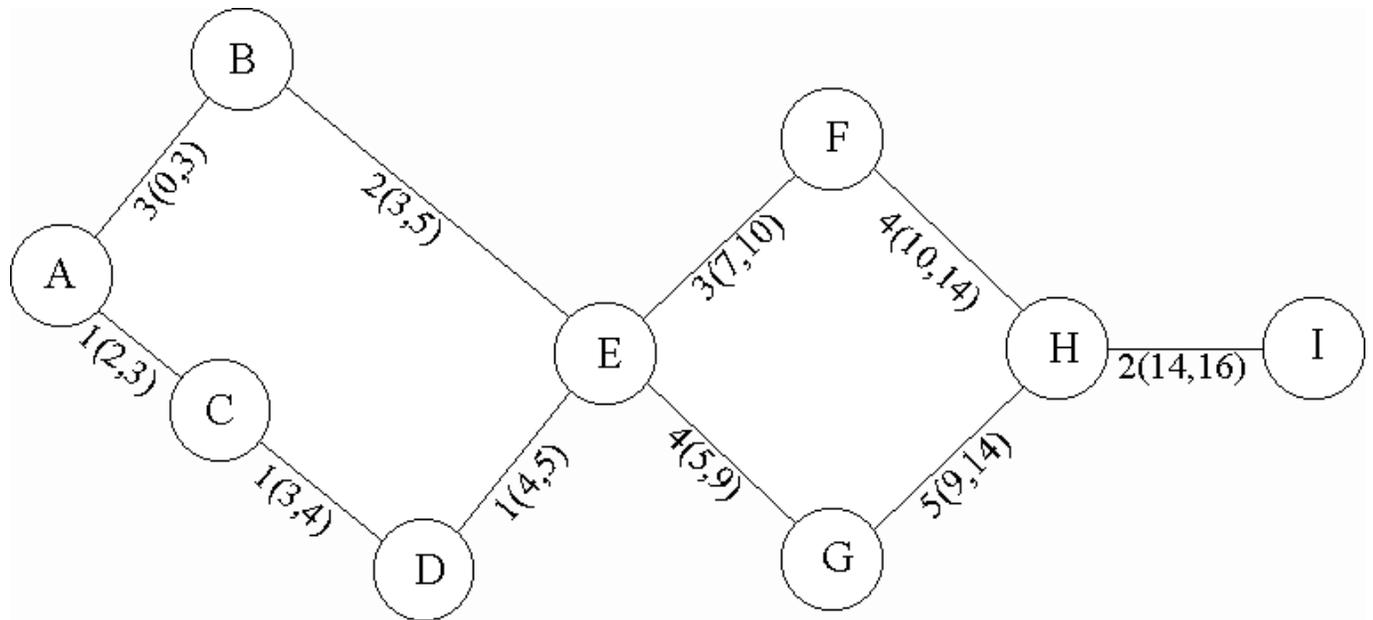
To facilitate analysis and discussion, times for the activities in the network above are delineated in the following table.

Activities and Times Required for Project Completion			
Activity	Length (Months)	Activity	Length (Months)
AB	3	EF	3
AC	1	EG	4
BE	2	FH	4
CD	1	GH	5
DE	1	HI	2

- **Early Start Times.** If you assume that Event A is project start, you can work across the PERT network and determine how long it will take to complete the project. The times developed by working from the beginning to end are known as the Early Start Times or T_e . When reading through the network below, note that:
 - The T_e entries are above the activity lines.
 - The format of the T_e entries is: Length of Time Required to Complete the Activity (Activity Start Time, Start Time Plus Length of Time Required to Complete the Activity). For example:
 - Activity AB reads "3(0,3)", which means the it will take three months to complete the activity, the activity can begin at project start (Month 0), and it will end at the end of Month 3.
 - Activity BE reads "2(3,5)", which means that it will take two months to complete the activity, the activity can begin at the end of Month 3, and it will end at the end of Month 5.
 - When more than one activity ends at an event, the earliest start time for the next activity is the latest time coming into the event. For example, DE is projected to be complete at the end of Month 3, but since BE is not projected to be complete until the end of Month 5, any activities beginning at E cannot start until the end of Month 5.

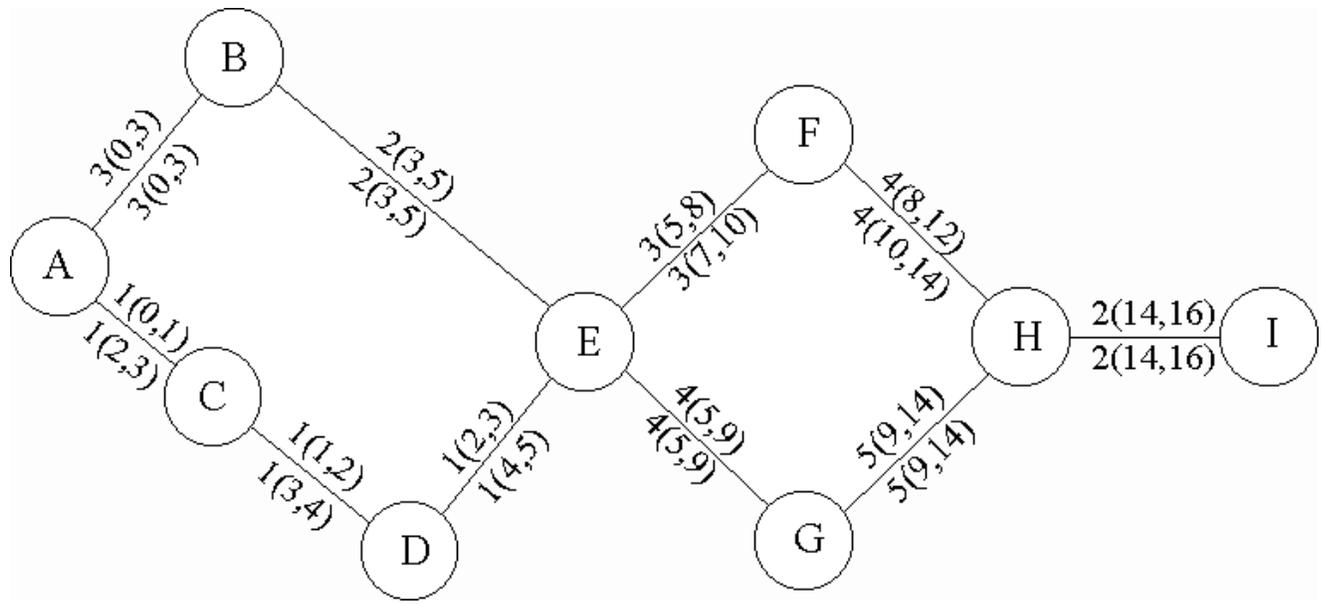


- **Late Start Times.** Based on the PERT network developed so far, the project should take sixteen months to complete. The next step is to determine T_1 or Late Start Times -- the latest time that an event can start and still complete the project on time. The T_1 is calculated the same way as T_e except the calculation is done from the end of the project back to the beginning. When reading through the network below, note that:
 - The T_1 entries are below the activity lines.
 - The format for T_1 is similar to the format for T_e . For example
 - Activity HI reads "2(14,16)", which means that it will take two months to complete the activity. If the activity is to end at Month 16, it must start no later than Month 14.
 - Activity FH reads, "4(10,14)", which means that it will take four months to complete the activity, and if the activity is to end at Month 14, it must start no later than Month 10.
 - When more than one activity begins at an event, the earliest T_1 is used to calculate the T_1 for activities prior to the event. For example, EF has a T_1 of Month 7 while EG has a T_1 of Month 5. The end time used to calculate BE and DE would be the earliest available T_1 or Month 5.



- Critical Path.** Given the information now available, you can identify the Critical Path. The longest of these paths (a-b-e-g-h-I) is sixteen days which is the **shortest** time in which the entire network can be completed. This is called the **critical path** of the network -- the path where the difference between T_e and T_l (slack time) equals zero. The following table and network show the critical path - AB, BE, EG, GH, and HI.

Activity										
	AB	AC	BE	CD	DE	EF	EG	FH	GH	HI
T_e	0	0	3	1	2	5	5	8	9	14
T_l	0	2	3	3	4	7	5	10	9	14
Slack Time	0	2	0	2	2	2	0	2	0	0



- **Cost/Schedule Impact.** With the critical path established, you can consider the impact of any activity time change.
 - Any increase or decrease in the time required to complete any activity on the critical path will increase or decrease the time to complete the entire project.
 - If the time required to complete Activity HI grew from two months to three months, then the entire project time would be increased by one month.
 - If there is a need to accelerate the project schedule, then management knows which activities must be shortened to shorten the project (critical path activities), and can evaluate the cost/schedule trade-offs.
 - For activities not on the critical path, changes do not impact the entire project time.
 - If the time required to complete Activity FH grew from four to five months there would be no increase in total project time because no activities beyond Event H can begin until all activities leading up to Event H have been completed. Activity FH would still be completed a full month ahead of Activity GH.
 - If the time to complete Activity FH were accelerated to three months, again there would be no effect on the time required to complete the project. Activity GI could still not begin until Activity FH is completed.

- **Problem Analysis.** If the problems extend the time required to complete a task, the contractor must determine the effect on the remaining schedule. If timely performance is affected, the contractor must take action to identify cost effective ways to shorten the critical path to meet the original schedule. When there is a schedule or cost risk to the Government, you should request Government technical personnel to examine the contractor's analysis and projected action to correct the problem.

Progress Review Meetings. Regularly scheduled progress review meetings provide an excellent forum for the identification and resolution of contract problems that may affect contract cost and performance. Many contracts include a requirement for periodic review meetings. When there is no contract requirement and you feel that such meetings would be beneficial, consider suggesting an informal review program to the contractor as a forum for sharing concerns, before they become problems.

- **Management Review Meetings.** Management review meetings typically include key members of the contractor and Government contract teams (e.g., program management, contracting, technical, quality assurance, and others).
 - Together, you can evaluate overall contract status, including the identification and resolution of problems that may be affecting contract cost or schedule.
 - The contractor may be required to submit a contract status report prior to each review. Those status reports then become the basis for conference analysis and discussion.
 - You should encourage open discussion to identify problems that may affect contract schedule or cost as early as possible so that action can be taken to resolve them and minimize their effect.
- **Technical Team Meetings.** Periodic meetings between Government and contractor technical personnel provide a forum to discuss technical questions that may affect contract cost and schedule. These technical meetings can be used to supplement or replace the management team meetings described above.
 - As a supplement, these meetings can be used to resolve technical questions too complicated to be resolved at management team meetings.
 - As an alternative, these meetings provide a vital forum for the exchange of information and ideas.

Caution all participants in such meetings that contract changes can only be accomplished through written contract modification. Agreements at the meetings cannot change the contract terms.

- Caution Government personnel not to issue direction to the contractor that is outside their authority under the contract. Remind them that they may be held personally responsible for any unauthorized commitment -- constructive change -- unless the commitment is ratified by the Government.
- Caution contractor personnel to notify the contracting officer immediately of any action by any Government personnel that they interpret as a change to the contract.

Routine Observations by Government Personnel. Even with all the available reports and management analyses, the first indication of potential cost/schedule problems often comes from routine observations by Government technical personnel.

- **Encourage Observation.** Routine observations by Government personnel could identify a variety of indicators of problems affecting timely and cost effective contract performance, such as:
 - Selection of work methods that are not suited to the contract effort;
 - Problems in completing critical tasks or production processes;
 - Inadequate personnel training or experience;
 - Labor unrest (i.e., dissatisfaction that could cause a slowdown in operations);
 - Inadequate tooling or equipment;
 - Excessive work in process inventory;
 - Excessive scrap rates; or
 - Comments about cost/schedule problems made by contractor personnel.
- **Encourage Reporting.** The biggest problem with routine observations as a source of information on potential overruns is that the observations are often not reported to the contracting officer. To benefit from this source of information, you must foster the team concept and make every effort to keep the lines of communication open between yourself, the auditor, and such Government technical personnel as the user, Contracting Officer Representative (COR), Contracting Officer Technical Representative (COTR), Industrial Specialist, or Quality Assurance Representative (QAR). These specialists form the

core of the acquisition team. They approach the contract for different perspectives but with one goal, effective and efficient contract performance.

- **Foster Communication.** By fostering communication between Government Acquisition Team members, you can benefit from the picture that is created when different pieces of the puzzle are brought together.
 - On a manufacturing contract, a QAR notes a large number of rejects from a particular process. At the same time, the Industrial Specialist notes that a shop responsible for that process is not meeting schedule commitments. Together, these bits of information paint a picture of a contractor that has significant quality problems that are affecting production and contract cost.
 - On an engineering services contract, the COTR feels that the Contractor Team Leader has only minimal experience in performing the type of work required by the contract. A Government Project Engineer feels that the Team Leader is putting unreasonable constraints on contractor personnel and these constraints are hampering contract operations. It may be that the contractor's failure to hire a qualified Team Leader is putting the contract schedule and cost performance in jeopardy.
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4.2 Estimating Cost To Complete

Support for Estimating Cost to Complete the Contract. Whenever you suspect a cost overrun, remember that the contracting officer is ultimately responsible for monitoring contractor performance and estimated cost to complete the contract. However, the contracting officer should actively seek support from other members of the Government Acquisition Team.

- Assistance from Government technical personnel is essential in analyzing contract progress to date and estimating the amount of effort required to complete the contract.
- The auditor is the Government expert on contract cost. Audit assistance can be invaluable in verifying the actual contract cost incurred and validating data offered by the contractor to support projections of the cost to complete the contract.
- The requiring activity can provide valuable insight to the analysis process. As the organization responsible for

managing funds, they must be involved in any decision to increase contract price or any decision to modify contract requirements to contain costs.

Procedure for Estimating the Cost to Complete the Contract.

When developing an estimate of the cost to complete a contract:

- Determine the progress toward contract completion to date.
- Determine the cost of the contract work completed to date.
- Determine the reasons for variances from initial estimates.
- Estimate the amount of work remaining to be completed.
- Estimate the cost of the work remaining to be completed.

Progress Toward Contract Completion. Normally, the most difficult element of developing an estimate to complete the contract is determining the amount of work completed to date. It is relatively easy to determine the number of hours worked, wages paid, and material purchased, but those are measures of input --not measures of progress toward contract completion. It is not always easy to determine how these inputs have contributed to completing the work required by the contract.

To determine the work completed to date, you must rely on the sources and types of information identified in the previous section of this chapter:

- Contractually required cost/schedule analysis and reporting;
- Contractually required cost information;
- Contractor production management reports and analyses;
- Progress review meetings; or
- Observation by Government personnel.

Normally, the more detailed the information provided by the data source, the more valuable it is as a basis of estimating the cost to complete the contract. For example, detailed contractor CPR data would normally be more valuable than general contract production management reports, because the BCWS, BCWP, and ACWP data presented in the CPR provide detailed information on the contractor's cost/schedule performance. Contract progress reports typically provide a general overview of contract performance and specific detail only on a limited number of special interest items.

As you analyze available information, you should request support from the using activity and Government technical personnel. They are the experts on Government requirements and

contractor progress. When you request analysis support, establish an "as of" date for the analysis. That date can then be used for the collection of data on both contract work completed and the cost for completing that work.

Cost of Work Completed to Date ([FAR 32.503-4\(b\)](#)). In determining the cost of work completed, rely on contractor submissions and input from involved members of the Government Acquisition Team. Normally, the cognizant auditor plays a key role in evaluating cost information submitted by the contractor. However, others can play key roles, particularly when the contractor has implemented a management system that complies with EVMS Guidelines.

If the auditor has identified deficiencies in the contractor's accounting system, consult with the auditor to determine how those deficiencies may affect the contractor's recording of contract costs.

Determine Reasons for Variances From Initial Estimates. Before you can estimate the cost to complete the contract, you must determine the reason or reasons for the overrun.

- **Gather Information.** Solicit opinions from the contractor and Government Acquisition Team experts concerning the reasons for the overrun. Ask questions such as:
 - Why do actual costs differ from the original estimates?
 - Have circumstances outside the contract affected costs? For example, has a major reduction in business volume increased indirect cost rates and inflated contract costs?
 - Does the Government have any responsibility for the increased costs?
 - What can be done by the contractor and/or the Government to bring costs back into line?
- **Identify The Reason.** The overrun could result from many possible reasons, including:
 - Conflicting interpretations of contract requirements;
 - One or more specific contract performance problems; or
 - Generally poor contractor management of contract operations.
- **Evaluate Current Status.** Evaluate available information to establish whether the situation that caused the overrun has been resolved.

Estimate Amount of Work Remaining. Once you have determined the amount of contract effort completed to date, it is relatively easy to estimate the tasks that remain to be completed. Again, you should request support from other members of the Government Acquisition Team as you perform your analysis. They can provide invaluable support in developing and evaluating both cost and schedule estimates for contract completion.

If the reason for the overrun has been resolved, you can be much more certain of your estimate of the work required to complete the contract. If they have not been resolved, you must consider possible solutions and related risks as you develop your estimate.

Cost of Work Remaining to be Completed. Once you have determined the amount of work remaining and the causes for cost growth, you can estimate the cost to complete the contract. Given this information, estimating the cost to complete the contract is much like estimating the cost of a new contract.

- Select estimating methods and quantitative techniques based on the information available. You can develop estimates using any appropriate method -- round-table, comparison, or detailed. However, as the contractor progresses toward contract completion, you should expect more reliance on comparison and detailed estimates and less on round table estimates
- Consider contract cost history along with other available data in estimate development. For example, where there has been a history of schedule delays and cost overruns, it may not be reasonable to assume that future contract effort will be completed as projected.
- Where there has been a history of schedule delays or cost overruns, it may not be reasonable to assume that future effort will be as projected.
- If there are cost or schedule constraints, develop several cost estimates based on different completion scenarios, such as:
 - Complete contract to original contract specification and schedule requirements.
 - Complete the contract to original specification requirements but allow additional time.
 - Complete the contract to original schedule requirements but reduce contract specification.
 - Adjust both the contract specification and schedule requirements.

4.3 Resolving Potential Cost Overruns

Course of Action. Once the actual cost of work completed and estimates to complete have been identified, a course of action must be determined.

Fixed-Price Contracts. A cost overrun in a firm fixed-price contract, fixed-price economic price adjustment contract (unless the adjustment is based on actual cost), or fixed-price contract with prospective price redetermination contract will not affect contract price. A cost overrun on a fixed-price incentive contract or fixed-price contract with price redetermination may affect overall contract price, but the Government's contract obligation will be limited by the contract ceiling price.

While the effect on contract price will be limited, a cost overrun may have a substantial effect on contract performance. Additional costs will reduce profits and may result in a contract loss. Contractor efforts to control costs may result in decisions that affect the quality of contract performance. Accordingly, with fixed-price contracts, your primary efforts should generally be directed toward:

- Monitoring contract performance more closely to assure that all work is being accomplished in accordance with contract requirements, and
- Considering the need for adjustment in the liquidation rate for any progress payments based on cost.

Cost-Reimbursement Contracts. For cost-reimbursement contracts, you must determine the most appropriate action considering that the Government is responsible for reimbursing the contractor for all allowable costs up to the cost and funding limits established in the contract. The most common alternatives for action include:

- Withhold action until more information is available.
- Provide additional funds/time to complete the contract as is.
- Redefine the contract effort to fit existing funds.
- Allow the contract to continue without change.
- Terminate the contract.

As you determine the appropriate course of action, you should consider contract cost and other factors including:

contract schedule, probable impact of not completing the contract, alternatives to completing the contract (e.g., terminate and reprocure from another source), availability and sources of funding, and many more.

Withhold Action. In situations where your analysis has identified cost or schedule variances, you may wish to stand pat (i.e., take no action until you can obtain additional information).

- Consider this course of action when:
 - You are not sure that the contractor cannot recover from current cost or schedule variances to complete the contract within the original cost and schedule.
 - You are awaiting additional information that may affect contract cost and schedule.
 - A major program management decision is in progress and the decision will affect the action you will take on the contract.
 - Funding is uncertain.
- When you withhold action awaiting more information, inform the contractor. Failure to put the contractor on notice can result in the Government assuming additional liability through constructive consent. Consider the following general steps to put the contractor on notice that the Government intends to withhold action pending further fact-finding:
 - Acknowledge that the Government is considering whether to add funds or increase the estimated contract cost.
 - Point out that the contractor is entitled to stop work when the contract dollar limit has been reached.
 - Admonish the contractor that any work done beyond the dollar limit will be at the contractor's own risk.

Provide Extra Funds/Time to Complete the Contract. When additional funding is available, the need exists, and the increase in cost is justifiable, the most logical course of action may be to continue contract performance following the original contract technical and schedule requirements.

You should consider schedule relief, with or without extra funding, when contract problems have affected the contractor's ability to complete the contract on time.

Consider the following points when implementing a decision to add funds and/or change the contract schedule:

- Obtain necessary approvals for your proposed course of action.
 - If you are planning to increase contract cost, establish the amount of additional funds required and obtain a funded purchase request from the requiring activity.
 - If you are planning to change the contract schedule, obtain concurrence on any proposed delivery date changes from the requiring activity.
- Meet with the Contractor to review contract requirements and verify the remaining tasks, then negotiate the cost/time changes needed to complete the contract.
- Negotiate adequate consideration to the Government for increasing contract cost or revising the contract schedule (e.g., a reduction in potential contract fee).
- Execute and distribute a bilateral contract modification.

Redefine Contract Requirements to Fit Existing Funds.

Redefining contract effort to fit available funds -- sometimes called downscoping -- can be a viable option for research contracts, as well as supply and service contracts with multiple line items. This option is particularly attractive when additional funds are not available, but it can also be employed when the requiring activity determines that marginal elements of the contract are not worth the additional money.

To implement a decision to reduce contract scope, use either a deductive contract modification or a partial termination for convenience. As you decide which one to use, consider the guidance presented in the paragraphs below. However, consult with your agency legal counsel before making a final decision on which approach is appropriate in your situation.

- **Deductive Contract Modification.** In general, you should use a deductive modification when the redefinition of contract requirements is within the scope of the original contract.
 - For example, you can use a contract modification under the Changes clause to downsize requirements in a variety of ways, including changes in:
 - Specifications, drawings, or designs for supplies.
 - Description of services.
 - Method of shipping or packing.
 - Place of delivery or performance.
 - However, none of the Changes clauses available for cost reimbursement contracts provide for changes in quantity. Such changes are normally considered to change the scope of the contract.

- **Partial Termination for Convenience.** In general, a partial termination for convenience is appropriate when the redefinition of contract requirements will change the scope of the original contract. You should use a partial termination when:
 - You are redefining contract requirements by eliminating items from the contract.
 - The redefinition of other requirements (e.g., the description of services) is so substantial as to change the scope of the contract.

Allow the Contract to Continue Without Change. If you select this alternative, allow the contract to continue until funds expire.

- Consider this alternative when:
 - Additional funds are not available but continued contract performance will benefit the Government.
 - Most of the vital elements of the contract will be accomplished within current requirements and funding.
 - The cost of contract redefinition or termination will be greater than the cost of simply allowing the contractor to use available funds and then halting contract performance.
- If you select this alternative, it is absolutely critical that you:
 - Advise the contractor that additional funds will not be added to the contract.
 - Advise the contractor that any contract performance beyond current contract dollar limits will be at the contractor's expense.
 - Not suggest that the contractor perform beyond current contract dollar limits.

Terminate the Contract. If you believe that the Government's best interests will be served by ending the contract immediately, terminate the entire contract for convenience.

Appendix 4A, Earned Value Management System Guidelines

Organization.

1. Define the authorized work elements for the program. A work breakdown structure (WBS), tailored for effective internal management control, is commonly used in this process.

2. Identify the program organizational structure including the major subcontractors responsible for accomplishing the authorized work, and define the organizational elements in which work will be planned and controlled.
3. Provide for the integration of the company's planning, scheduling, budgeting, work authorization and cost accumulation processes with each other, and as appropriate, the program work breakdown structure and the program organizational structure.
4. Identify the company organization or function responsible for controlling overhead (indirect costs).
5. Provide for integration of the program work breakdown structure and the program organizational structure in a manner that permits cost and schedule performance measurement by elements of either or both structures as needed.

Planning, Scheduling, and Budgeting.

6. Schedule the authorized work in a manner which describes the sequence of work and identifies significant task interdependencies required to meet the requirements of the program.
7. Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure progress.
8. Establish and maintain a time-phased budget baseline, at the control account level, against which program performance can be measured. Budget for far-term efforts may be held in higher level accounts until an appropriate time for allocation at the control account level. Initial budgets established for performance measurement will be based on either internal management goals or the external customer negotiated target cost including estimates for authorized but undefinitized work. On government contracts, if an over target baseline is used for performance measurement reporting purposes, prior notification must be provided to the customer.
9. Establish budgets for authorized work with identification of significant cost elements (labor, material, etc.) as needed for internal management and for control of subcontractors.
10. To the extent it is practical to identify the authorized work in discrete work packages, establish budgets or his work in terms of dollars, hours, or other measurable units. Where the entire control account is not subdivided into work packages, identify the far term effort

in larger planning packages for budget and scheduling purposes.

11. Provide that the sum of all work package budgets plus planning package budgets within a control account equals the control account budget.
12. Identify and control level of effort activity by time-phased budgets established for this purpose. Only that effort which is unmeasurable or for which measurement is impractical may be classified as level of effort.
13. Establish overhead budgets for each significant organizational component of the company for expenses which will become indirect costs. Reflect in the program budgets, at the appropriate level, the amounts in overhead pools that are planned to be allocated to the program as indirect costs.
14. Identify management reserves and undistributed budget.
15. Provide that the program target cost goal is reconciled with the sum of all internal program budgets and management reserves.

Accounting Considerations.

16. Record direct costs in a manner consistent with the budgets in a formal system controlled by the general books of account.
17. When a work breakdown structure is used, summarize direct costs from control accounts into the work breakdown structure without allocation of a single control account to two or more work breakdown structure elements.
18. Summarize direct costs from the control accounts into the contractor's organizational elements without allocation of a single control account to two or more organizational elements.
19. Record all indirect costs which will be allocated to the contract.
20. Identify unit costs, equivalent units costs, or lot costs when needed.
21. For EVMS, the material accounting system will provide for:
 - a. Accurate cost accumulation and assignment of costs to control accounts in a manner consistent with the budgets using recognized, acceptable, costing techniques.
 - b. Cost performance measurement at the point in time most suitable for the category of material involved, but no earlier than the time of progress payments or actual receipt of material.

- c. Full accountability of all material purchased for the program including the residual inventory.

Analysis and Management Reports.

- 22. At least on a monthly basis, generate the following information at the control account and other levels as necessary for management control using actual cost data from, or reconcilable with, the accounting system:
 - a. Comparison of the amount of planned budget and the amount of budget earned for work accomplished. This comparison provides the schedule variance.
 - b. Comparison of the amount of the budget earned the actual (applied where appropriate) direct costs for the same work. This comparison provides the cost variance.
- 23. Identify, at least monthly, the significant differences between both planned and actual schedule performance and planned and actual cost performance, and provide the reasons for the variances in the detail needed by program management.
- 24. Identify budgeted and applied (or actual) indirect costs at the level and frequency needed by management for effective control, along with the reasons for any significant variances.
- 25. Summarize the data elements and associated variances through the program organization and/or work breakdown structure to support management needs and any customer reporting specified in the contract.
- 26. Implement managerial actions taken as the result of earned value information.
- 27. Develop revised estimates of cost at completion based on performance to date, commitment values for material, and estimates of future conditions. Compare this information with the performance measurement baseline to identify variances at completion important to company management and any applicable customer reporting requirements including statements of funding requirements.

Revisions and Data Maintenance.

- 28. Incorporate authorized changes in a timely manner, recording the effects of such changes in budgets and schedules. In the directed effort prior to negotiation of a change, base such revisions on the amount estimated and budgeted to the program organizations.

29. Reconcile current budgets to prior budgets in terms of changes to the authorized work and internal replanning in the detail needed by management for effective control.
30. Control retroactive changes to records pertaining to work performed that would change previously reported amounts for actual costs, earned value, or budgets. Adjustments should be made only for correction of errors, routine accounting adjustments, effects of customer or management directed changes, or to improve the baseline integrity and accuracy of performance measurement data.
31. Prevent revisions to the program budget except for authorized changes.
32. Document changes to the performance measurement baseline.