Implementing an Effective Use of the Integrated Program Management Tools

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Integrated Program Management is not just managing the Technical aspects for the program and looking to achieve the program goals. It involves teamwork and accountability. Besides the technical piece, there is an entire team effort, which includes Cost Estimates and Analysis, Scheduling, and Earned Value Management, which work together to present a total picture of the program. In the past there has been a tendency to "silo" these disciplines and not identify or use the them in an integrated way. The purpose of this paper is to illustrate how the use of Integrated Program Management Principles and Best Practices will enhance the program.

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Executive Overview

What many do not realize is that there is a common thread between Technical Requirements, Cost, Schedule, and EVM, it is the WBS. Each discipline is linked to each other for purposes of managing the program. Without Technical Requirements and a Statement of Work determining Cost or Schedule would be impossible. The same is true for EVM, without Cost and Schedule to establish a baseline, tracking progress and having the ability to estimate what the program costs will be, would also be impossible. A well-constructed WBS can make the difference between a well-executed program and one that sends the Portfolio and Program Manager running for the hills.

The purpose of the WBS is to provide a technical "road map" of the entire program, through completion. Each technical leg of the WBS relates to a deliverable piece of the program. No matter which leg of the WBS you pick there are costs, time (schedule), and performance (EVM) associated with that element. One of the keys to creating well planned out WBS, is to break down the tasks, below Level 3, into manageable units.

The purpose of IPM is to utilize all the tools (Cost, Schedule, and EVM) to provide a sound well founded Cost Baseline, an associated Time Baseline, and a methodology for measuring progress. One tool that will lead to successful Integrated Program Management, is communication. Without communication up and down the Organizational and WBS chain, the program will be fraught with misinterpretations and will be subjected to overruns and delays that need to be explained. The relationship between the Stakeholder Program Office and the Contractor Program Office need to have a relationship of transparency and communication, while at the same time keeping final decision making and funding with the Stakeholder.

Implementing Earned Value Management (EVM) is often maligned as being too cumbersome by program managers and technical staff. But, taking a closer look, EVM follows the key principles of Integrated Program Management (IPM) in tracking the progress of a program in terms of cost and schedule. Program Managers and technical staff tend to look upon EVM as a process that gets in their way of managing the program, in fact EVM is a tool that can add a crucial level of insight to running the program.

This paper outlines this an approach and illustrates how key components and best practices for planning, scheduling, and monitoring can lead to the effective implementation of Integrated Program Management. This paper will also provide practical guidelines on how to implement an integrated approach utilizing the IPM Tools across programs and organizations.

The Basics of Integrated Program Management

Integrated Program Management (IPM) is can be illustrated as a chair with the legs, Organization, Cost, Schedule, and Performance Measurement (EVM), all of these principles need to be working in concert to hold up the chair, without one of the legs the program becomes difficult to manage As you picture the chair, think of the technical requirements of the program as the seat, which must bear the weight of the program and provides strength through decisions made with the four principles of IPM, finally the back of the chair, which will hold up the program as it bends between cost, schedule, and technical influences can be an illustration of risk management. Each of the elements of IPM will be discussed further in the paper. Integrated Program Management is very much like a chair, with supporting seat, legs and a back to shore up the program and anticipate potential problems.

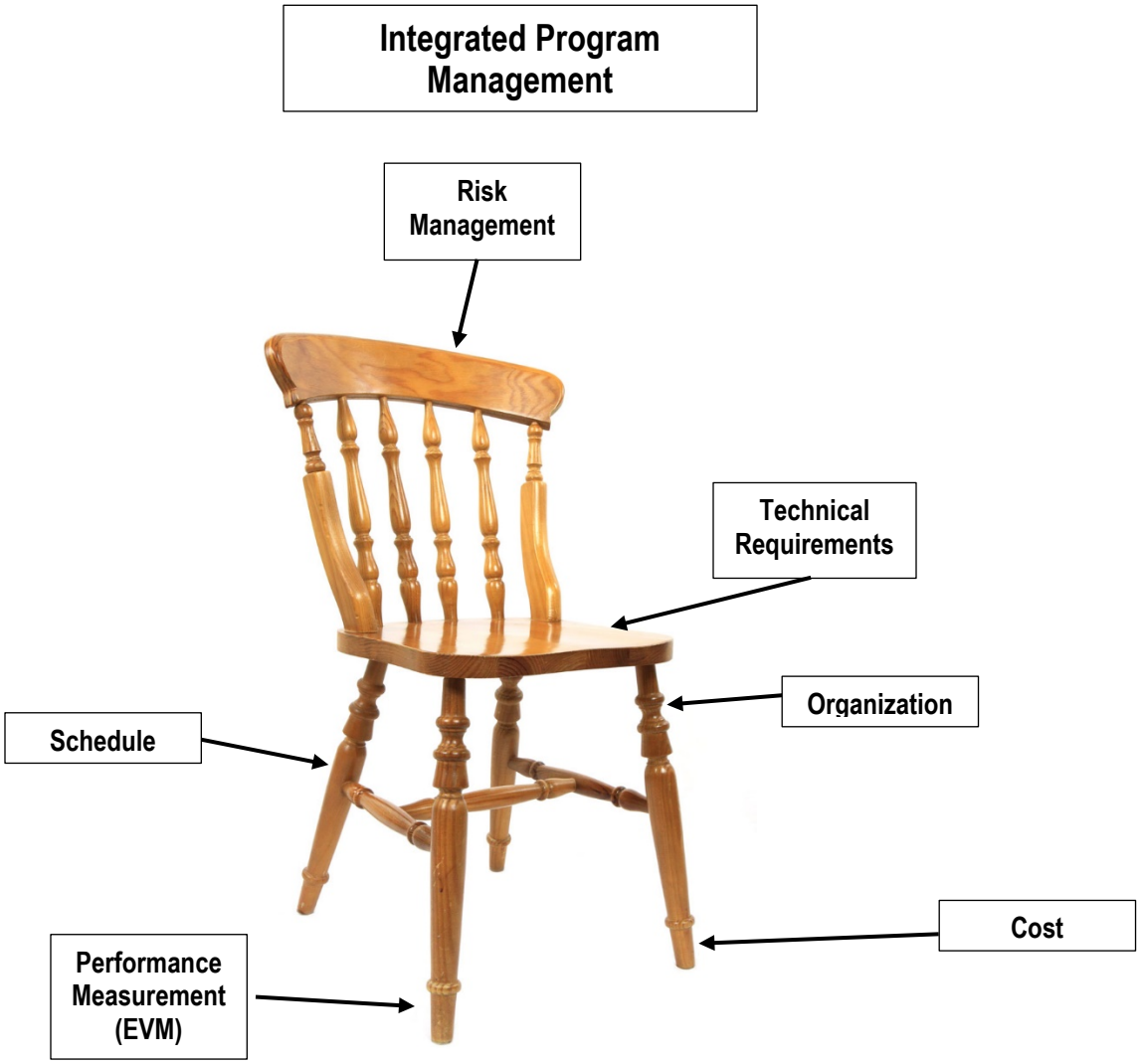


Figure 1 Integrated Program Management

Organization

Organization can be broken down with 7 elements: 1) Scope or Requirements, 2) Program Work Statement (PWS), 3) Work Breakdown Structure (WBS), 4) Responsibility Assignment Matrix (RAM), 5) Organization Breakdown Structure (OBS), 6) An initial Cost Estimate (Government Cost Position) and 7) Direction. These elements establish what needs to be done, tasks associated with the scope of work, a product-oriented road map, and who is responsible for Scope Tasks as they fall under the WBS.

During the organization phase is where the program manager/office gets their "ducks in a row," with the assistance of the Engineering team, Scheduling team, and Cost and EVM team.

Work Breakdown Structure (WBS)

"A Work Breakdown Structure (WBS) provides a consistent and visible framework for defense materiel items and contracts within a program." With uniformity of definition and a consistent approach used for development of a WBS, the result is improved communication in the acquisition process and direction to industry in extending contract work breakdown structures. To ensure all DoD WBS were using a common structure MIL-STD -881 was developed, the latest update to the MIL-STD is, MIL-STD-881D - dated April 9, 2018.

MIL-STD-881, latest revision D, is the "Department of Defense Standard Practice" for the development of "Work Breakdown Structures for Defense Materiel Items". This Standard is to be used by all Department of Defense (DoD) Departments and Agencies and should be included as a contract requirement; it is mandatory for all programs subject to DoD Instruction 5000.02, for use in MIL STD EVMS.

"The MIL-STD-881D establishes summary Work Breakdown Structures for aircraft systems, ship systems, space systems, surface vehicle systems, etc. All these summary Work Breakdown Structures depict the first three levels of the WBS that are common to most generic systems.

The MIL-STD breaks down 11 types of systems to provide guidance for the use of each of the appendices specifying at least three or four WBS levels. Some appendices specify five levels, with Level 1 being the entire system or program.

Below is an example of a WBS Dictionary:

WBS Level	WBS Code	WBS Name	WBS Description	PWS/SOW Mapping
1	1	Aircraft System	X Series Aircraft System to fly to the moon	
2	1.1	Air Vehicle	X Series Air Vehicle to fly to the moon	
3	1.1.1	Air Frame	X seriese air frame	
3	1.1.2	Avionics	Brains behind the air frame	
4	1.1.2.1	Comms	Communications	
5	1.1.2.1.1	Antenna	Thinging to pick up signals	1.1, 1.2, 1.3.1, 1.13.1
5	1.1.2.1.2	Receiver	Box to interpert signals picked up by Antenna	1.1, 1.2, 1.13.2
5	1.1.2.1.3	Transmitter	Box to send out signals when we talk	1.1, 1.2, 1.3.1, 1.13.3
4	1.1.2.2	Navigation	Back seat driver	
4	1.1.2.3	Fire Control	Off/Def weapons in case we run into aliens	
3	1.1.3	Propulsion	Engine to propel x series air frame	
2	1.2	Training	Training for operation and maintenance of X Series Air Vehicle	

Table 1 WBS Dictinary

Scope, Requirements, Program Work Statement (PWS), and Statement of Work

The first and most important is to develop a comprehensive **Scope Document**. This document becomes the "What" in "what are we making here." In this document will reside the basis for the program, design, build, testing, quality, and manpower anticipated to be used. A project scope document is a critical piece of project paperwork that gets teams and stakeholders aligned on the boundaries of a project before it even begins. A well-crafted scope document can save you from major headaches by defining the

following project elements:

- **Justification:** A brief statement regarding the business need your project addresses. (A more detailed discussion of the justification for the project appears in the project charter.)
- **Product scope description:** The characteristics of the products, services, and/or results your project will produce.
- **Acceptance criteria:** The conditions that must be met before project deliverables are accepted.
- **Deliverables:** The products, services, and/or results your project will produce.

The **Requirements Document** serves as a document that delineates what the project is expected to do. The requirements are concerned with the systems prime mission and what secondary missions will be accomplished when the program is completed. The down side of developing vague requirements is that the scope document will also be vague, and both the requirements and scope will be open to interruption, most time with disastrous results. Short cuts in planning often require re-planning or worse.

Program Work Statement (PWS) or Statement of Work (SOW) is a formal document that defines the entire scope of the work involved for a vendor and clarifies deliverables, costs, and timeline. It is needed in situations where a project involves vendors and external contributors in addition to the internal project team of the PWS, which does not delineate the scope of the government technical staff.

Below is an example of a WBS from MIL-STD 881:

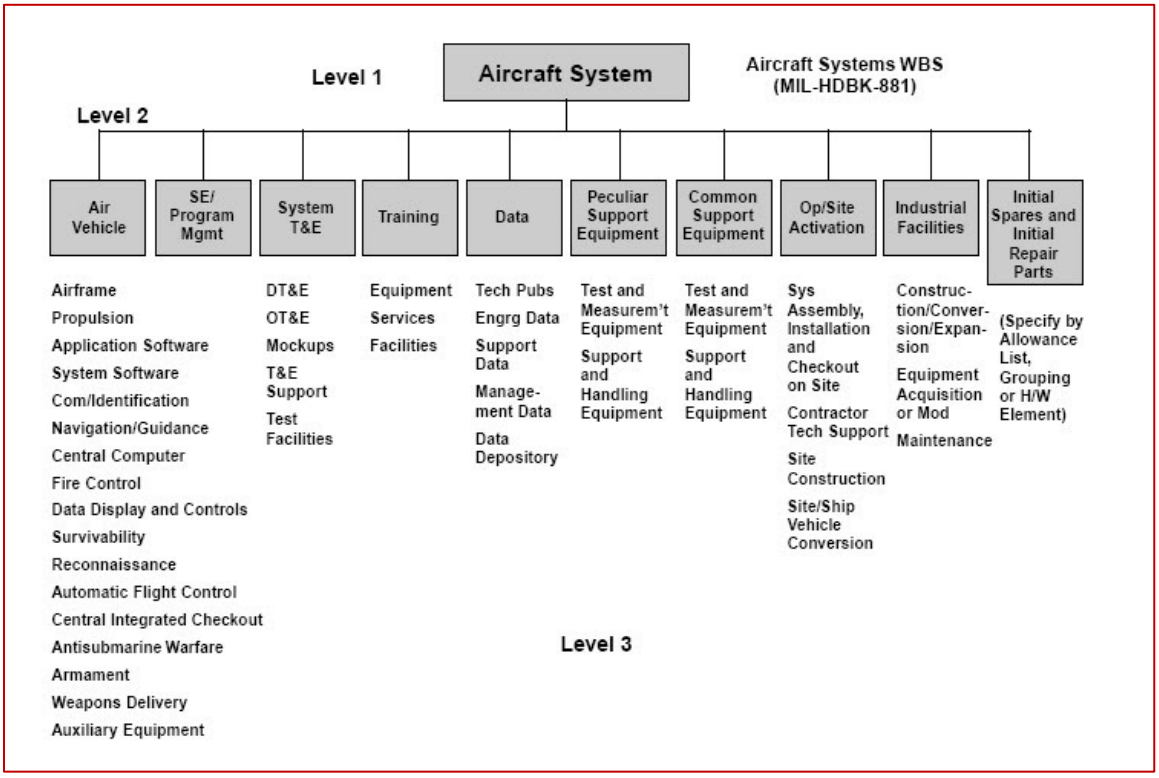


Figure 2 WBS Example

Organizational Breakdown Structure

An Organizational Breakdown Structure is an intermediate level of a different chart that many of you are already familiar with: The Work Breakdown Structure. The OBS displays organizational relationships and then uses them for assigning work to resources in a project.

Below is an example of an Organizational Breakdown Structure:

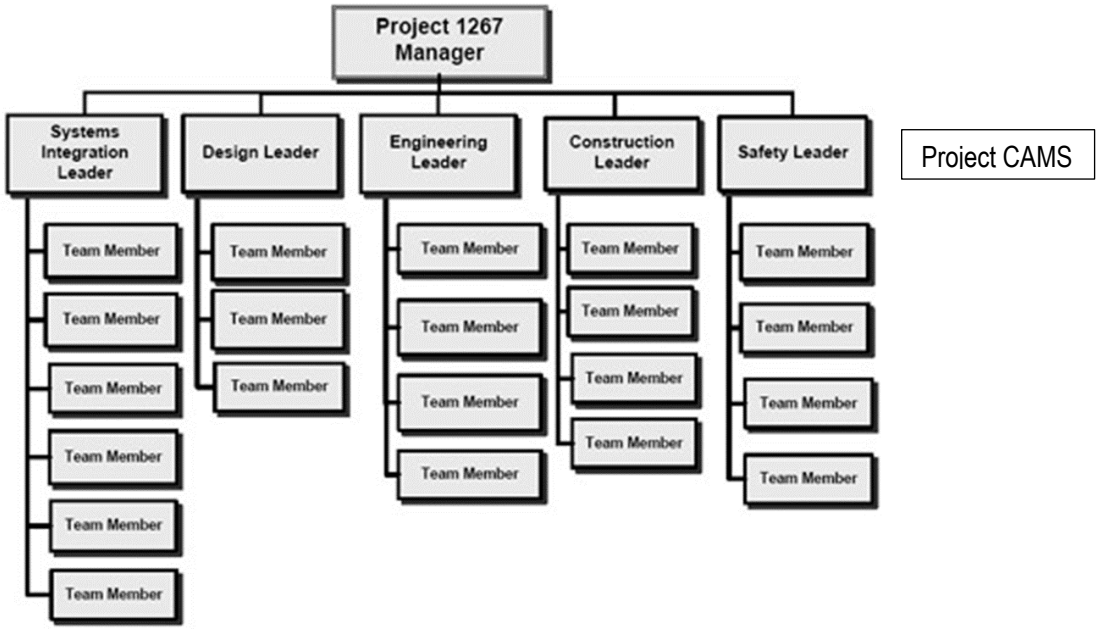


Figure 3 OBS Example

As you can see at Level 3 there are still many details that can be added to the WBS, for a complex program. A good "rule of thumb" when setting up a WBS, is not to make it too complex that you get lost trying to manage it. Remember this structure needs to have the versatility to accept changes in the future, as technology improves.

Responsibility Assignment Matrix (RAM)

A Responsibility Assignment Matrix (RAM) is the result of combining the WBS and OBS to create work assignments by organization and WBS, at the intersection of the Control Account and second or third tier of the OBS is where the Control Account Manager (CAM) appears.

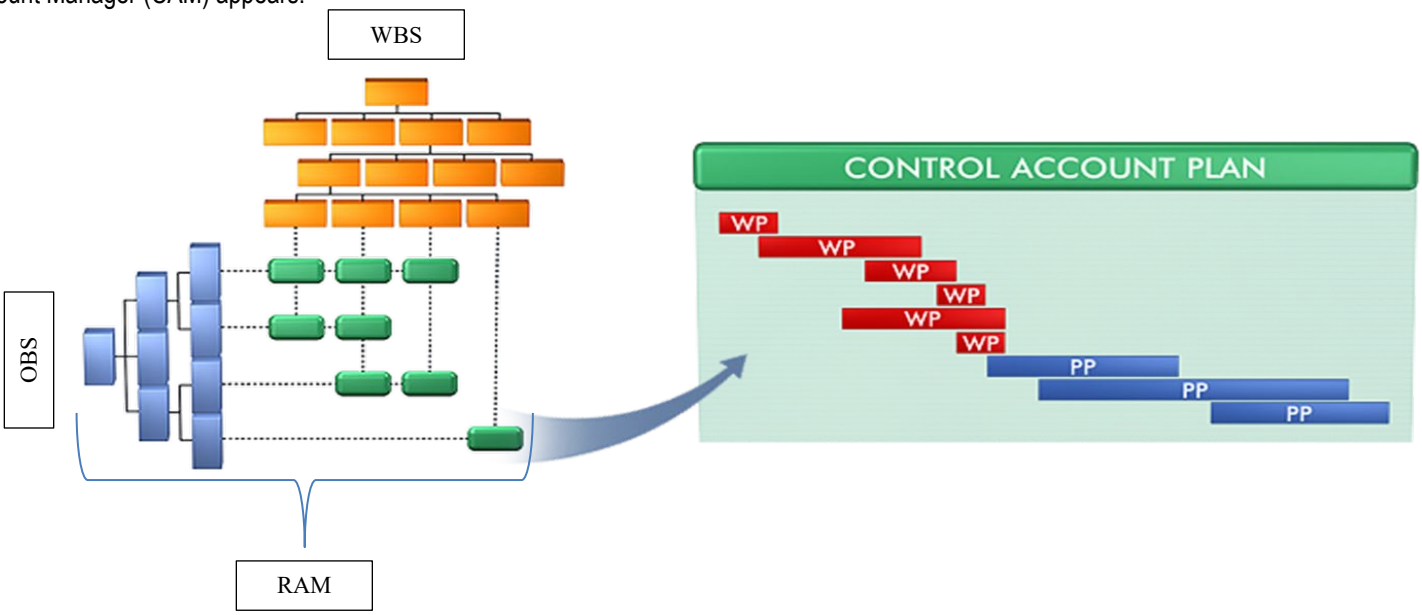
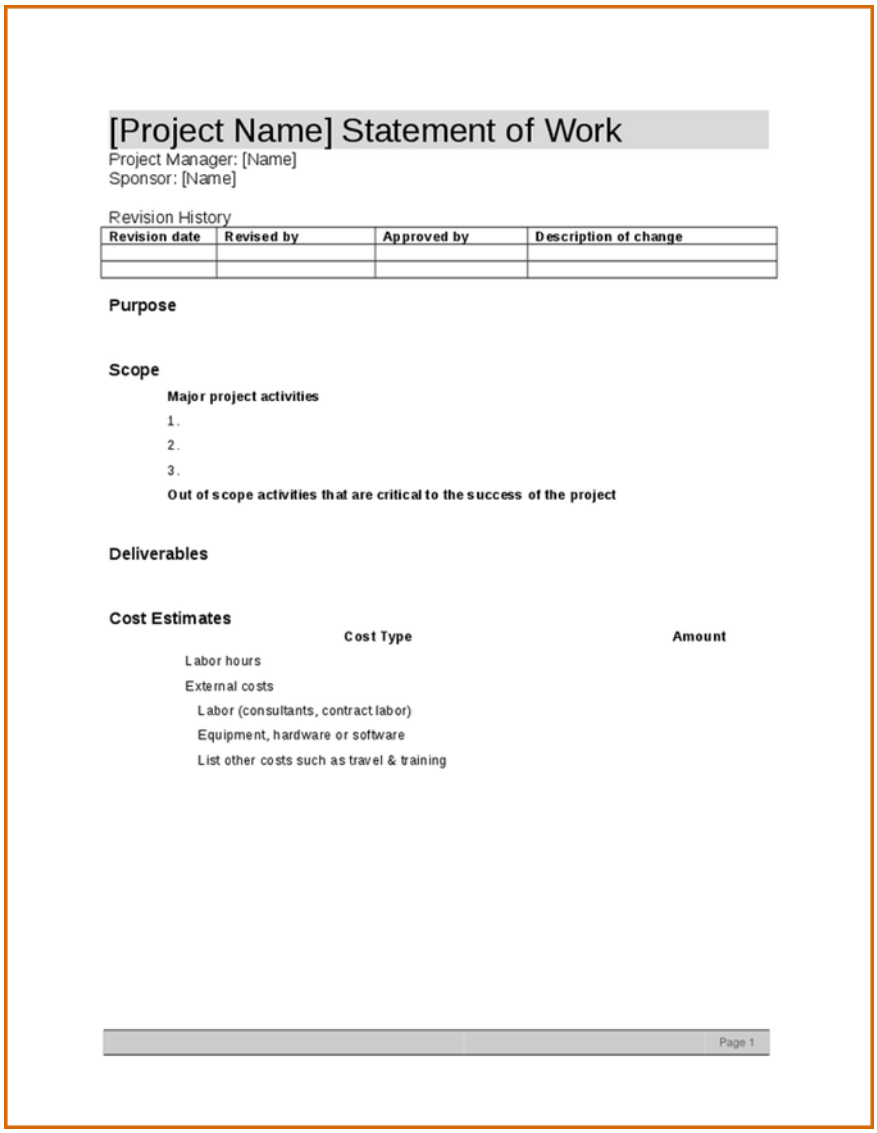


Figure 4 RAM and Control Account Examples

Authorization

Prior to beginning any Planning, the work must be authorized, the flow for this would include authorization from the government to the contractor and from the contractor's program office to the responsible Control Account Managers (CAMs). Without authorization work may not be started.

Below is an example of a Work Authorization Document (WAD):



[Project Name] Statement of Work

Project Manager: [Name]
Sponsor: [Name]

Revision History

Revision date	Revised by	Approved by	Description of change

Purpose

Scope

Major project activities

1.
2.
3.

Out of scope activities that are critical to the success of the project

Deliverables

Cost Estimates

Cost Type	Amount
Labor hours	
External costs	
Labor (consultants, contract labor)	
Equipment, hardware or software	
List other costs such as travel & training	

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Figure 5 WAD Example

Direction involves the Program Office (PMO) leading the effort to Authorize, Assign, and Direct the Project Work, after the PMO has directed the project work to begin there will be similar output from the contractor's PMO organization. The following artifacts may be (but not limited to) the output of this phase:

- Work Authorization
- Budget and Change Logs
- RAM
- High Level Schedule
- Kicking off the Planning Process

Planning

Planning needs to work hand in hand with the other disciplines, but initially is used to develop an estimated cost and schedule, based on the scope of the work and sorted by the PWS and WBS to determine what each element of the program will cost, this will be used to establish the Baseline Cost. Risk may also be calculated to determine the likelihood of completing the program within the allocated budget.

The Cost, Schedule, and EVM teams assess the Cost Estimate and create a "Time Phased" spread of how the budget should be spread. Unless these are maintenance, management, or monitoring tasks. The Time Phased Budget will have peaks and valleys depending on the ebb and flow of the work, in each of the Control Accounts. The Control Account Manager is responsible for approving how the manpower and costs are spread and will be held accountable.

Within the Time Phased Budget and Schedule there will be **Summary Planning Packages and Planning Packages**, generally these are broadly defined tasks that do not have a clear-cut plan forward. Traditionally the period of when these tasks must be planned within 6 months in advance of the work beginning, creating a **Rolling Wave** of planning, as the program progresses. In some cases, such as software development, the System Integrator will shorten the frequency to 3-month planning events, this practice shouldn't happen, if the Software Development piece of the WBS and the Schedule are in sync to accommodate Agile Planning.

Agile Planning

Much of Agile Planning relies on the WBS, rather than the schedule or the reporting structure. Many programs get lost in the minutia of wanting to know how Sprints are doing and reporting them in the EVMS. Because of the Agile nature of Sprints, being Time Boxed, they need to be planned at a very low level and should <u>not</u> be Baselined, the result will be the need to write more Baseline Change Requests (BCRs) than you ever thought possible. So how should you plan the Agile Software Development piece of the program? In the example, below, The Epic should be aligned with the Control Account, as a group of Functional Features. The Feature has a specific function, within the program and should be planned with Costs and Resources, as you would plan a Work Package, features that are undefined can be represented as Planning Packages, until they have more definition. This is often driven by backlog and future definitization.

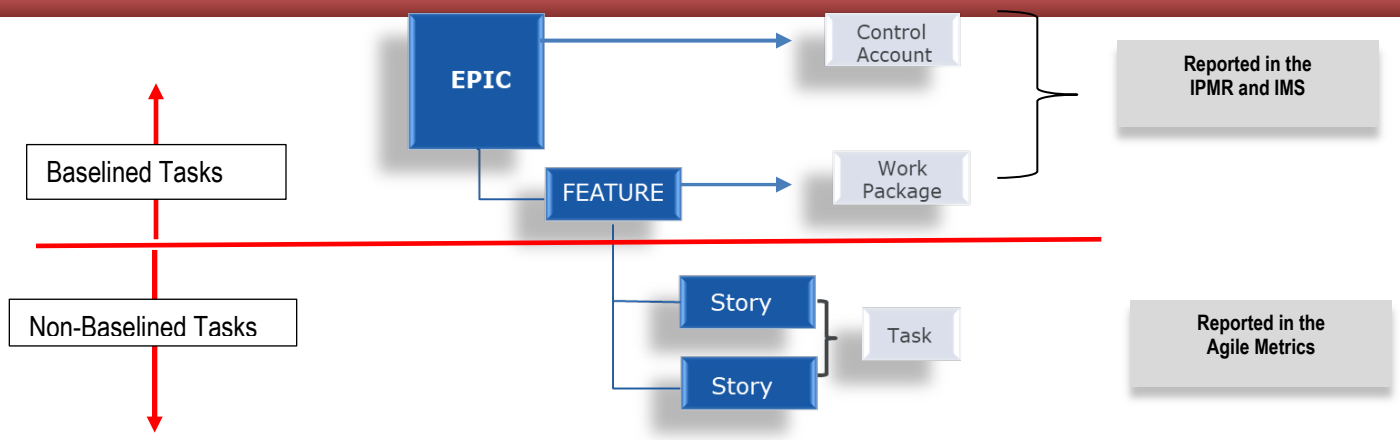


Figure 6 Agile Example

Baseline Changes will happen, they happen to most programs, but they should be limited to as few as possible**. An Agile program is different, in that there is constant movement, with changes in Stories, changes to backlog, and at times changes in technical requirements. However *not all changes affect the Baseline*. Particularly in an Agile environment all changes need to be tracked, so how do your account for those changes? Below are some questions that you'll need to ask, before you call it a Baseline Change:**

- Will the change impact the Baseline? **Look at the tasks in the Schedule and Time Phased Budget and determine if Baseline is affected.**
- Can the change take place within the existing timeframe of the Feature? **Generally, in an Agile program most changes take place within the Time Box of the Feature, which the Stories/Sprints are supporting. If this is the case, there is no need to submit a BCR, because the change occurs with the Baseline of the Feature.**

- If**, after long and thoughtful examination** the change impacts the Baseline, a BCR needs to be submitted**.** It all goes back to careful and thoughtful PLANNING and development of the program WBS.

Schedule

Schedule, many times the length of the schedule is determined by when the product is needed and when the budget will be allocated to begin the program. There is a temptation to "pile" all the levels into one Master Schedule because MS Project has filters, a cautionary note is that this limits the number of schedulers that can work on the schedule at one time, rather than having a scheduler responsible for Levels 1 and 2, and others working on Levels 3 & 4 schedules, based on technical organization. Linking all levels of the schedule (Levels 1 – 4) also has some caveats, although this makes statusing the schedule much easier, if Level of Effort (LOE) tasks are linked to discrete tasks you will get a false percent complete at the higher levels.

It is best to avoid using LOE, as an Earned Value Type, unless the task is truly a task that supports the program and requires no deliverables. A much better, and more accurate way to represent traditional LOE tasks, is to plan them as Apportioned Effort. With Apportioned Effort you are planning a percentage labor from the traditional discrete activities. Using Apportioned Effort means that when the discrete earns value or progress the apportioned efforts tasks also earn progress.

Just as the Cost Baseline is made of the cost of the various elements in the WBS, so are the schedules. Ideally there are 4 levels of schedules used in managing a program:

- **Milestone Schedule (Level 1)**: Represents the program's major components. Major components are displayed as a bar chart with key program milestones.
- **Summary Schedule (Level 2)**: Each major component is further subdivided. In most cases Level 2 schedules can only be shown as a bar chart although key constraints and Milestones are also included and are most often used to brief at a high level.
- **Intermediate Schedule (Level 3)**: This is the first level where a meaningful critical path is obtained, and the schedule can be used to monitor and control the project. This level recommended for the IMS, it takes the summary levels from each of the Program's Detailed schedule with status.
- **Detailed Schedule (Level 4)**: The Detailed Schedule is primarily used by the CAM for detailed planning. A portion of the lower level (say Level-3) schedule is broken down into greater detail to the maximum/desired extent possible. Generally used for short term planning to effectively work towards the larger overall goal. It is at this level where Planning Packages reside. Summary Planning Packages may be shown in the Intermediate schedule.

Schedules can go to lower levels, however generally past Level 3, they are not published outside of those working with the Control Account Managers (CAMs).

In several cases we have seen the scheduler explain to the Program Manager that if you have a single schedule which can be filtered to show Detailed, Intermediate, Summary, and Milestone, life for the scheduler will become

much easier. This approach is exactly the opposite. A far more practical way to status the IMS is to have the Control Account summaries, from the Detailed Schedules (Level 4) linked to the Control Accounts in the Intermediate Schedule (Level 3) or IMS. In this way updating a few links in the Level 3 schedule is all that needs to happen, unless there are complicated re-planning efforts happening each month, which shouldn't be the case.

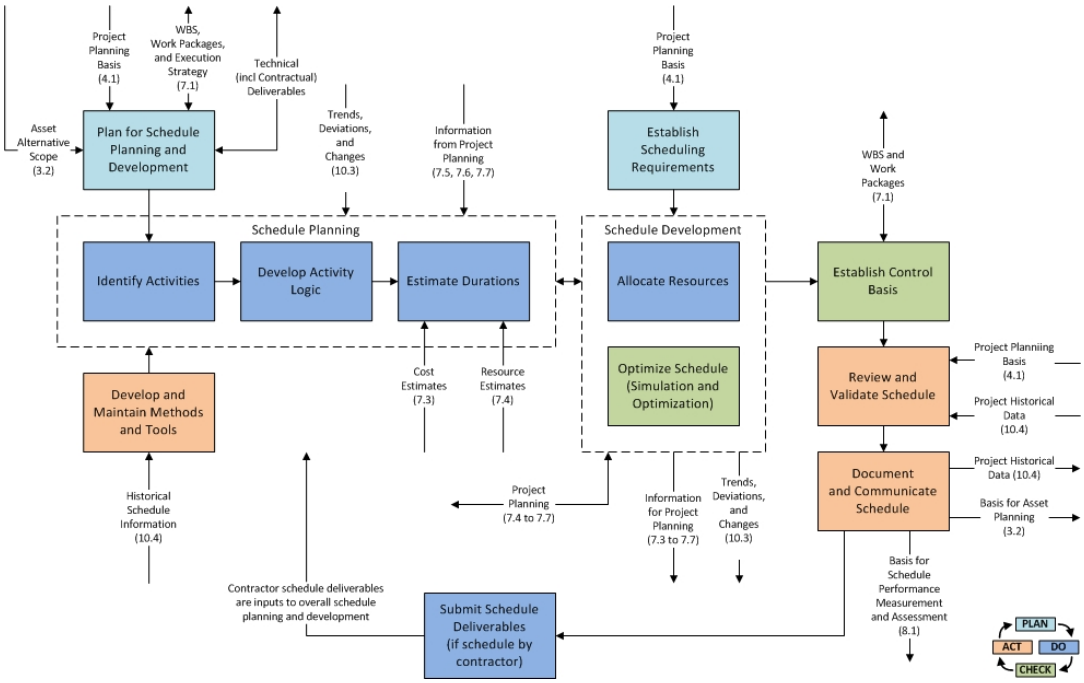


Figure 7 Scheduling Flow Diagram

Schedule Traceability The scheduling system provides traceability between the various levels of the IMS, as well as traceability among WPs and PPs. This requires the application of two processes, referred to as "vertical" and "horizontal" traceability. Traceability is maintained between the baseline, actual, and forecast dates in the IMS.

Vertical traceability is demonstrated by the consistency of data between the various levels of schedules and the consistency of data between various WBS elements and/or IMP/IMS elements (if applicable) within the schedules. Since upper-tiered schedules set the parameters for lower level schedules, it is imperative that lower-level schedules are traceable to, and logically support, upper-tiered milestones to ensure program schedule integrity.

Horizontal traceability is demonstrated through work that is planned in a logical sequence, considering the interdependencies among tasks/activities, ensuring that the overall schedule is rational and provides a methodology for evaluating the impact of current schedule status on subsequent tasks/activities and milestones. Horizontal integration depicts schedule dependencies and constraints, focusing on relationships within the same scheduling level, including between different program elements such as “hand-offs” of products.

Control

Control is the process of measuring the value of the work accomplished (to date) on the program and determining whether the program will complete on budget and on schedule. If performance measurement was as easy as all of that, everyone would be doing it. The type of measurement that is used on a program is determined by several factors, among which are total cost, total
time required. Control, or Program Control is where the activities take place that are most often associated with EVM.

Measuring Progress, using EVM guidelines, schedules, or completed milestones

- **Analyzing the Progress vs. Plan and Actual,** utilizing performance reporting or schedules
- **Development of Estimates to Complete (EAC),** based on the actual work completed and how long it will take to complete all the work
- **Development of Risk Analysis,** utilizing burn rates, the percentage complete, and time remaining, what are the chances the project will complete on time
- the time required to complete task within the WBS. Once the time and costs for the program are aligned, the Schedule Baseline is established.

	IPM Responsibility Matrix				
	Cost	EVM	Schedule	Technical Lead	Program Manager
Measuring Progress	I	R	R	A	I
Analyzing Progress	I	R	R	I	I
Developing Estimates at Complete	R	R	S	A	I
Development of Risk Analysis	R	R	S	S	I
Development of Burn Rate Analysis	R	R	I	I	I
R = Responsible	A = Assist	S = Secondary	I = Inform		

Table 2 IPM Responsibility Matrix

Cost Estimating and Analysis

Once the Budget has been approved, based on the Government Cost Position, the Cost Estimating and Analysis is still going strong, however it becomes a cooperative effort between the Cost, EVM, and Schedule groups.

Cost and EVM work together to develop EAC, Risk Analysis, and Burn Rate Analysis. The EVM group using formulas developed based on Schedule, Progress, and Actuals to Date and the Cost group utilizing Actuals to-date, Time Remaining, and data from the initial Cost Estimate.

Earned Value Management (EVM)

The purpose of EVM is to ensure sound planning and resourcing of all tasks required for contract performance. It promotes an environment where contract execution data is shared between project personnel and government oversight staff and in which emerging problems are identified, pinpointed, and acted upon as early as possible. EVM provides a disciplined, structured, objective, and quantitative method to integrate technical work scope, cost, and schedule objectives into a single cohesive contract baseline plan called a Performance Measurement Baseline (PMB) for tracking contract performance.

The rigor of the EVM efforts are dictated by: Contract type (FFP, FPIF, CPIF), Type of System, Budget, Duration, and Acquisition Path. These dictate the frequency and detail of reports and metrics on the program. For purposes of keeping abreast of the progress of the program informal metrics can be put in place to add to the comfort level of the program office.

Much of the "hassle" of using EVM is setting up the EVM Infrastructure, the Authorization, the WBS, and the Planning. The reason that the Control portion gets much of the blame, is that reporting is regarded as the messenger and it is very hard to argue with results

EVM is on the surface a daunting means of measuring performance of a project, but when you take away the mystery of the rules and formulas, it becomes something that most everyone does on a regular basis. The first thing that causes confusion in the world of Earned Value are the Acronyms. There are two sides of the EVM community, the Department of Defense side and the PMI side.

Function	DoD	Definition	PMI	Definition
Budget	BCWS	Budgeted Cost of Work Scheduled	PV	Planned Value
Progress	BCWP	Budgeted Cost of Work Performed	EV	Earned Value
Actuals	ACWP	Actual Cost of Work Performed	AV	Actual Value
Cost Variance	CV	Cost Variance	CV	Cost Variance
Schedule Variance	SV	Schedule Variance	SV	Schedule Variance
Earned Schedule	ES	Earned Schedule	ES	Earned Schedule

Table 3 EVM Terms and Definitions (DoD/PMI)

Scaled Performance Analysis (SPA)

EVMS, has become a 4-letter word to many organizations often pointing out that the problem is not that EVM is difficult, but that they would like to use a scaled approach to keeping track of the project's performance.

A **Scaled Performance Analysis (SPA),** sometimes referred to as EVM Lite, recognizes that budgets versus actual costs are not meaningful enough for assessing true project technical/schedule/cost status. The SPA approach should be used for programs/projects less than $50.0M (>$50.0M). The process is to plan the work, with a WBS, unlike Full EVM the WBS for SPA consists of 3 – 4 levels, with the Control Accounts at Level 3.

Planning/Implementation/Reporting can be developed using an Excel Workbook either a template or a more organic approach based on the organizational needs.
Time-Phased Planning and statusing can be accomplished within the Program/Project Excel Workbook

Selecting a **Performance Measurement Type** limits the Earned Value Type of planned work to **Milestone, Weighted Milestones, % complete,** and limited **Overhead (only for Management Tasks).**

With the **Implementation** is conducted at a higher level (WBS Level 3 – 4) the **Reporting** requirements become less stringent than the traditional EVM formats. The reporting formats can be adapted to reflect what is meaningful to the project team. A Scaled Performance Analysis approach is useful for Program/Project Managers to take what is meaningful from EVM and use it to manage their program.

Level	WBS	Definition	EVM Definition
1	1.1	System Level	Total Program
2	1.1.1	Activity Level	Summary Activity
3	1.1.1.1	Task Level	Control Account
4	1.1.1.1.1	Sub-Task Level	Work Package

Table 4 SPA WBS Levels

The above is an example of a basic 4 level WBS, which can be used for a basic project, as projects become more complex more levels are often used to be able to account for the complexity of the project. One of the frequent downfalls in Organizing and

Planning is to make the WBS too complex, due to the desire for reporting and the lower levels. MIL STD 881 defines the WBS Levels up to Level 3 for most programs, below you will see an example of an Aircraft System WBS, to Level 3, provided by the MIL STD.

EVM *for Agile*

Where does EVM fit into Agile development?
Traditional EVM measures Work Pkgs, Planning Pkgs, ACWP, BCWP, BCWS, CPI, SPI, EAC, etc.
EVM for Agile Development

- EVM for Agile still uses work packages and planning packages for determining workloads and schedules.
- EVM data collection changes to sprints, Features, and Epics.

Below the EPIC is the Feature at the Work Package (WP) level, which breaks the EPIC into functional packages. Features are decomposed into Stories and Story points, Sprints are statused by, in this case, Stories and Story Points, which are maintained in an Agile Program Management Tool. As Sprints are completed they are statused as weighted milestones and rolled up to the Feature Level Status of Features is rolled up to the EPIC level or Control Account

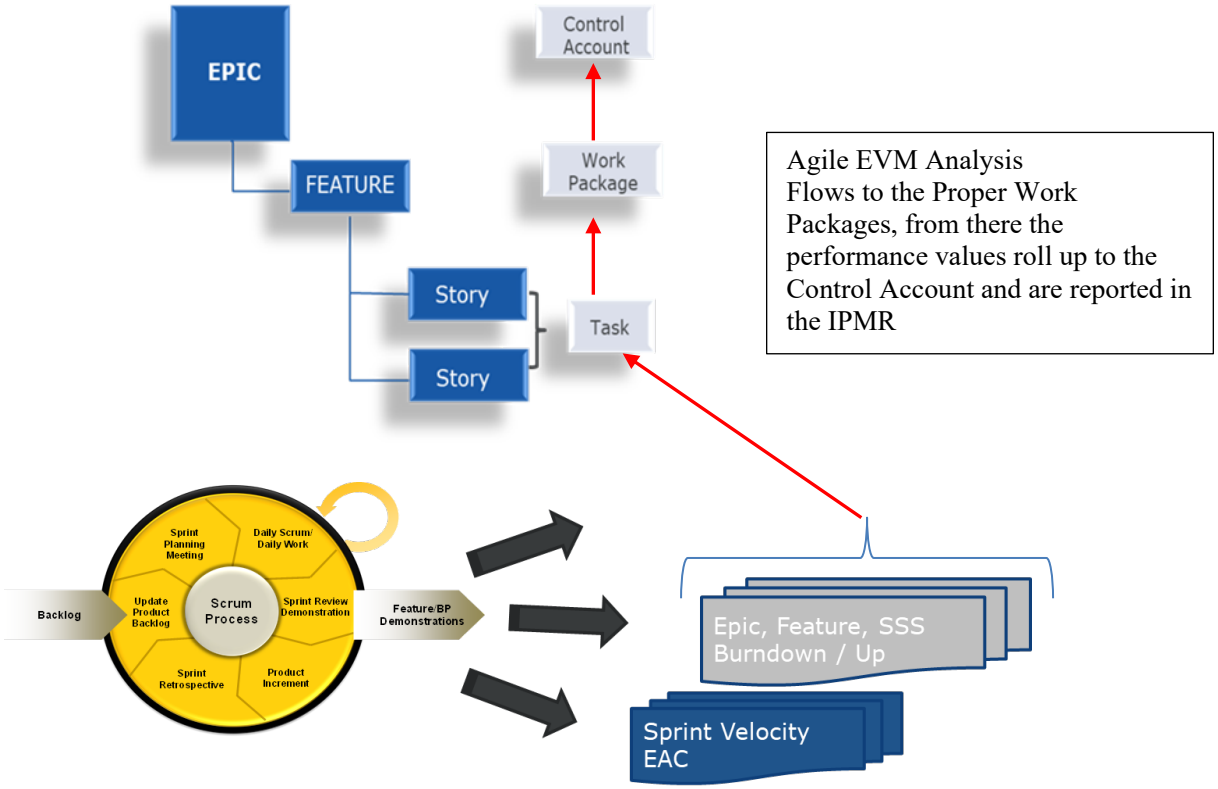


Figure 8 Agile EVM Process

Estimates at Completion

Program Managers, Technical Managers, Cost and EVM Analysts have been trying to get a handle on Estimates at Completion (EAC) and Estimates to Complete (ETC) for decades. At the end of the day the formula breaks down to "What have you spent" and "How much more do you think you will spend." Developing an accurate ETC or EAC, can be a challenge, due to the many expectations and approaches.

Managing Expectations

Program Managers generally want to have a single number estimate, or one by Level 2 WBS. In EVM literature there are at least 5 accepted Independent Estimate at Completion formulas, ranging from simple to complex, depending on at what stage of the program you are estimating the completion, however, the program managers will want to review the details with their technical managers, generally at Level 3 and 4 of the WBS. Technical Managers want to see the details generally at WBS Levels 3 and 4, when the technical managers review the EAC with their Control Account Managers (CAMs). To review the details of how the EAC was calculated.

How the ETC/EAC comes together

There are several approaches to developing an accurate ETC/EAC and generally there are at least a couple of paths going on the achieve the final product.

The approach to developing the ETC/EAC is dependent upon at what point the program is, in its life. The **Top-down approach** is practical for the initial stage of strategic decision-making and in situations where the information required to develop accurate duration and costs estimates is not available in the initial phase of the project. Hence, top-down estimates are used initially until the tasks in WBS are defined clearly, which enable the development of well-defined schedules and budget.

The **Bottom-up approach** is typically more reliable and preferred for estimating because it assesses each work package from the bottom, working up to a deliverable and phase. It is practical to use when project schedules and budget from previous similar projects are available for reference. Estimating duration and costs for each work package facilitates the development of schedules and a time-phased budget, which are required to monitor and control the project as it progresses.

Top Down and Bottom up EACs should be limited to either Bi-annually or annually. For a much quicker assessment it is advised to use an EVM EAC formula.

EVM EAC Formulas

Basic ETC/EAC formulas are (Note: All formulas are using Cumulative Values):

$$ETC = BAC - BCWP$$
$$EAC = CUM\ ACWP + ETC$$

EAC formulas are generally selected by the program office, depending on which one they have the most confidence and divided into categories of: Best Case, Worst Case, and Most Likely. Below are typical formulas that predict the outcomes.

Best Case: $$ACWP + \frac{(BAC - BCWP)}{1}$$

This is the most optimistic equation used for determining EAC

Most Likely: $$ACWP + \frac{(BAC - BCWP)}{(0.5*SPI) + (0.5*CPI)}$$

Note that in this equation 0.5 represents the percentage of time completed on the program, if the program is 25% complete the denominator would be (0.25*SPI) + (.025*CPI). Being able to take into consideration the progress of the program as well as performance indices, makes this equation is most times accurate in determining the EAC.

Worst Case: $$ACWP + \frac{(BAC - BCWP)}{(SPI) * CPI)}$$

This equation takes the indices into account by falls short in accounting for the program progress, thus making the outcome the highest possible value for EAC.

An equation that I've found to deliver an answer that is in between the Worst Case and the Most Likely is the following:

Independent EAC (IEAC): $ACWP + \frac{(BAC - BCWP)}{(BCWP/ACWP)}$

Because BCWP is divided by the actual cost (ACWP) we are using the CPI and assuming that the cost performance will not change through the remainder of the program. This equation can be simplified to ACWP + Budgeted Cost of Work Remaining divided by CPI.

$$ACWP + \frac{BCWR}{CPI}$$

On a quarterly basis it is a good idea to take the Bottoms Up Estimate at Completion and compare it with a Range Estimate derived from the equations for Best Case, Worst Case, and Most Likely, to see how it compares.

Risk Analysis

There are three types of Risk that are dealt with during the Life Cycle of a program:

- Technical Risk
  - Schedule Risk
  - Cost Risk

Technical Performance Risk is defined "the possibility of a system issue that prevents it from working as intended," often resulting in deviation in technical performance which results in completing the program on and on budget. Both the Technical Risks and their mitigation can have an impact both Cost and Schedule, depending on the degree of change that is required to complete the affected tasks.

Schedule Risk is often found on the schedule's Critical Path (just a reminder, a critical activity may or may not be on the critical path) or the "Highest Risk Path" on a Critical Path Methodology (CPM) schedule. Uncertainty is established by evaluating all the scheduled activities, looking at the original duration and the remaining duration to determine whether the activities can be accomplished in the time remaining. Schedule Risk is measured in Time.

Cost Risk is measured in dollars (on multi-year programs either "then year dollars" or "current year dollars" are used. Cost Risk looks at the tasks in the program and based on performance determines whether they can finish on target.

In the analysis of Risk EVM, Cost, and Schedule all play a part, since there is a performance factor, actual time or dollars expended (burn rate), and estimate at completion, which can be reported in either hours or dollars.

Risks are reported on a 5x5 matrix with the horizontal axis showing Consequences and the vertical axis showing Likelihood, assigning a number 1 – 5 as to what the likelihood and consequences are, giving the risk a value. These risks are shown for the

Program and Level 3 WBS elements. Below is a chart, from previous Galorath Briefings, that shows the steps in analyzing Programatic risks.

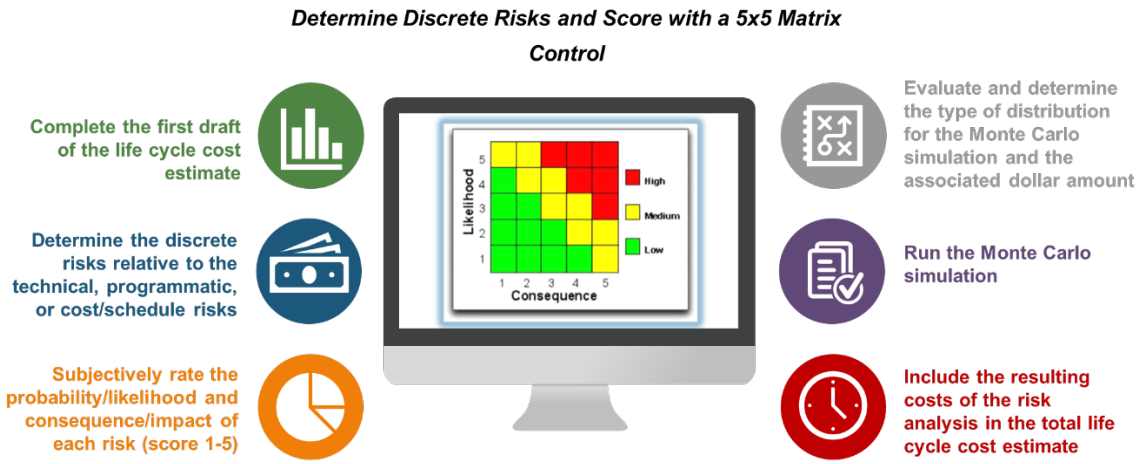


Figure 9 Risk Determination

Reporting and Metrics

The primary reporting tool is the IPMR, this is also a primary point of contention, during the contract negotiating process. Below is a table from the OSD AAP EVMIG, showing the EVM reporting requirements.

Contract Value	Applicability	Notes	Source
< $20M	Not required	IPMR should be used if cost and/or schedule reporting is requested by the PMO	IPMR DID DI-MGMT81861A
≥ $20M & < 50M	Required monthly when EVM requirement is on contract	Formats 2, 3, and 4 may be excluded from the Contract Data Requirements List (CDRL) at Program Manager discretion based on risk	IPMR DID DI-MGMT81861A
≥ $50M	Required monthly when EVM requirement is on contract	All Formats must be included in the CDRL	IPMR DID DI-MGMT81861A

Table 5 AAP EVM Reporting Requirements

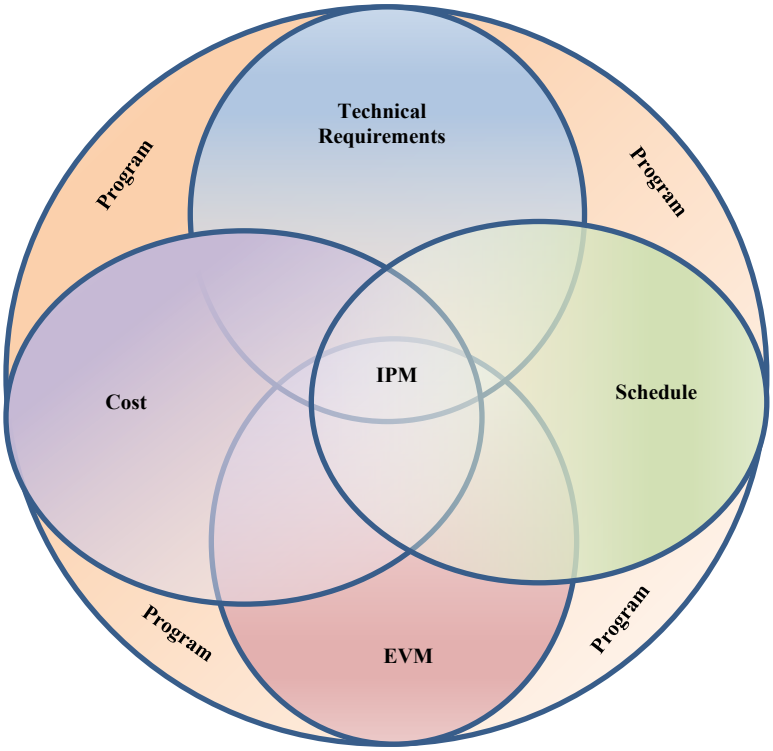
Each program can define additional reporting and metrics to keep the entire program office informed (this is Integrated Program Management). These can include traditional EVM Reports and Metrics, Agile Reports and Metrics, Schedule Reports and Metrics, or Risk Reports and Metrics that can enhance the flow of information within the program office. However, reports and metrics need to be defined at the onset of the program. The frequency of reporting also needs to be set early in the life of the program. Otherwise if new reports, meetings, and metrics come up on an ad hoc basis, causing confusion, as to the status of the program and what sorts of information and actions are required.

Summary

This paper has outlined the disciplines and tools involved in integrating the program management process. Without integrating Technical, Cost, Schedule, and EVM together with a defined process of Organization, Authorization, Planning, Control, and Reporting and Metrics an organized approach to program management.

In all the parts of Integrated Program Management, from the above details, Technical, Cost, Schedule, and EVM play major collaborative roles, that need to contribute and communicate. But these contributions cannot be performed in a vacuum, communication, cooperation, and transparency need to become a way of life, for the program. As you can see below each of the disciplines are connect to the management of the program, without their integration, chaos will run rampant.

Just as in running an organization, communication and transparency need to take place, if one area is unaware of what is going on with the others, the chance of duplicated work is high and has a high likelihood of causing an increase in both time and effort.



Integrated Program Management Relationships

Figure 10 Integrated Program Management

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ABOUT THE AUTHOR

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Mr. Thompson has over 30 years of experience working in Program Management, Cost Estimating, Risk Analysis, and Earned Value Management. He has developed cost, schedule, and EVM models and provided technical support to program management, assisting in problem definition, solution, and requirements development/definition through analysis, planned and executed several IBRs. He has lead program controls groups in support of both Government and contractor programs. For the past two years Mr. Thompson has been a guest lecturer twice at the United States Naval Academy, Economics for Engineers class.

Experienced with cost estimating, cost modeling, program management, and performance management programs as well as DFARS and DoDi 5000.2. His program experience includes B-1B, B-2, V-22, UH-1, F-35, F-18, E-2 C/D, C-130, J-UCAS, N-UCAS, IPPS-A, and classified satellite programs. Mr. Thompson has also provided Earned Value and Agile support to AAP assisting with the authoring and editing of their Agile Guides and Agile EVM Toolkit, and assisted DCMA with an audit at a contractor.

Mr. Thompson is a Certified Earned Value Professional (EVP #720). Experienced with mentoring programs, instruction, and establishing training programs.

Mr. Thompson is a long-time member of ICEAA, previously on the Board of Directors as Executive Vice-President and Treasurer, also serving the board in roles of Workshop Chairman (2010, 2012, 2015, 2016, and 2018) and various Workshop related Lead roles, Membership and Chaptering Chair, Chapter President and Chapter Vice-President of the Southern Maryland Chapter. Mr. Thompson is also a member of CPM, NDIA, and AACE.