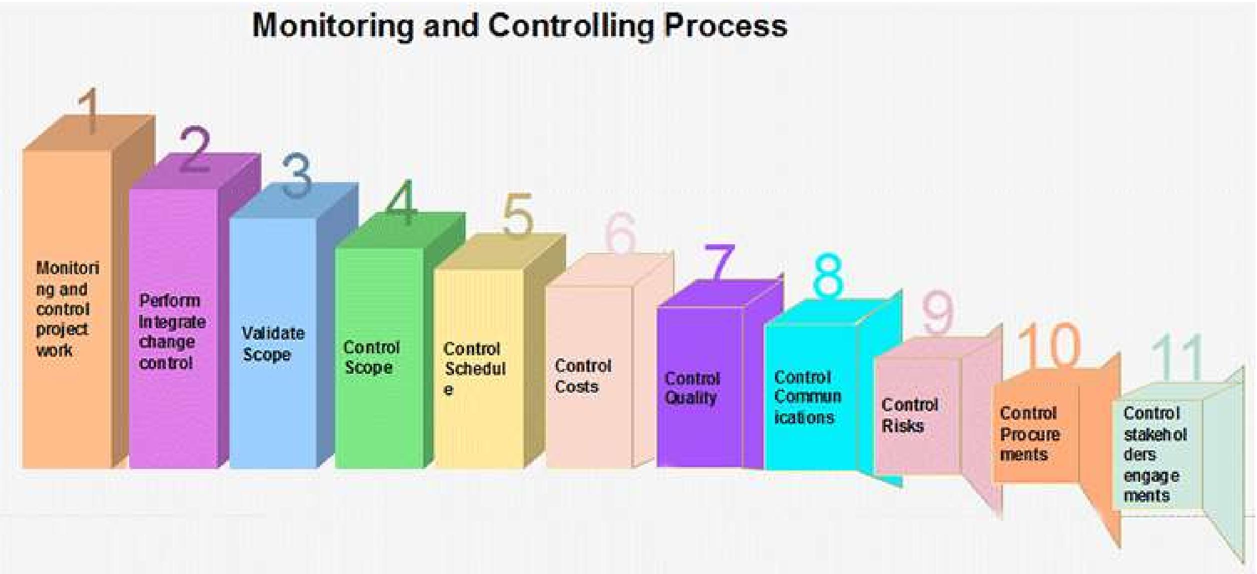
Monitoring the Control

Introduction:

Monitoring and Controlling are processes needed to track, review, and regulate the progress and performance of the project. It also identifies any areas where changes to the project management method are required and initiates the required changes.

The Monitoring & Controlling process group includes eleven processes, which are:



1. **Monitor and control project work:** The generic step under which all other monitoring and controlling activities fall under.
2. **Perform integrated change control:** The functions involved in making changes to the project plan. When changes to the schedule, cost, or any other area of the project management plan are necessary, the program is changed and re-approved by the project sponsor.
3. **Validate scope:** The activities involved with gaining approval of the project's deliverables.
4. **Control scope:** Ensuring that the scope of the project does not change and that unauthorized activities are not performed as part of the plan (scope creep).
5. **Control schedule:** The functions involved with ensuring the project work is performed according to the schedule, and that project deadlines are met.
6. **Control costs:** The tasks involved with ensuring the project costs stay within the approved budget.

7. **Control quality:** Ensuring that the quality of the project?s deliverables is to the standard defined in the project management plan.
8. **Control communications:** Providing for the communication needs of each project stakeholder.
9. **Control Risks:** Safeguarding the project from unexpected events that negatively impact the project's budget, schedule, stakeholder needs, or any other project success criteria.
10. **Control procurements:** Ensuring the project's subcontractors and vendors meet the project goals.
11. **Control stakeholder engagement:** The tasks involved with ensuring that all of the project's stakeholders are left satisfied with the project work.

Creating the Framework:

Exercising control over a project and ensuring that targets are met is a matter of regular monitoring, finding out what is happening, and comparing it with current targets. If there is a mismatch between the planned outcomes and the actual ones then either replanning is needed to bring the project back on target or the target will have to be revised. Figure 9.1 illustrates a model of the project control cycle and shows how, once the initial project plan has been published, project control is a continual process of monitoring progress against that plan and, where necessary, revising the plan to take account of deviations. It also illustrates the important steps that must be taken after completion of the project so that the experienced gained in any one project can feed into the planning stages of future projects, thus allowing us to learn from past mistakes. See Chapter 11 for a In practice we are normally concerned with departures from the plan in four discussion of software dimensions - delays in meeting target dates, shortfalls in quality, inadequate quality. functionality, and costs going over target. In this chapter we are mainly concerned with the first and last of these.

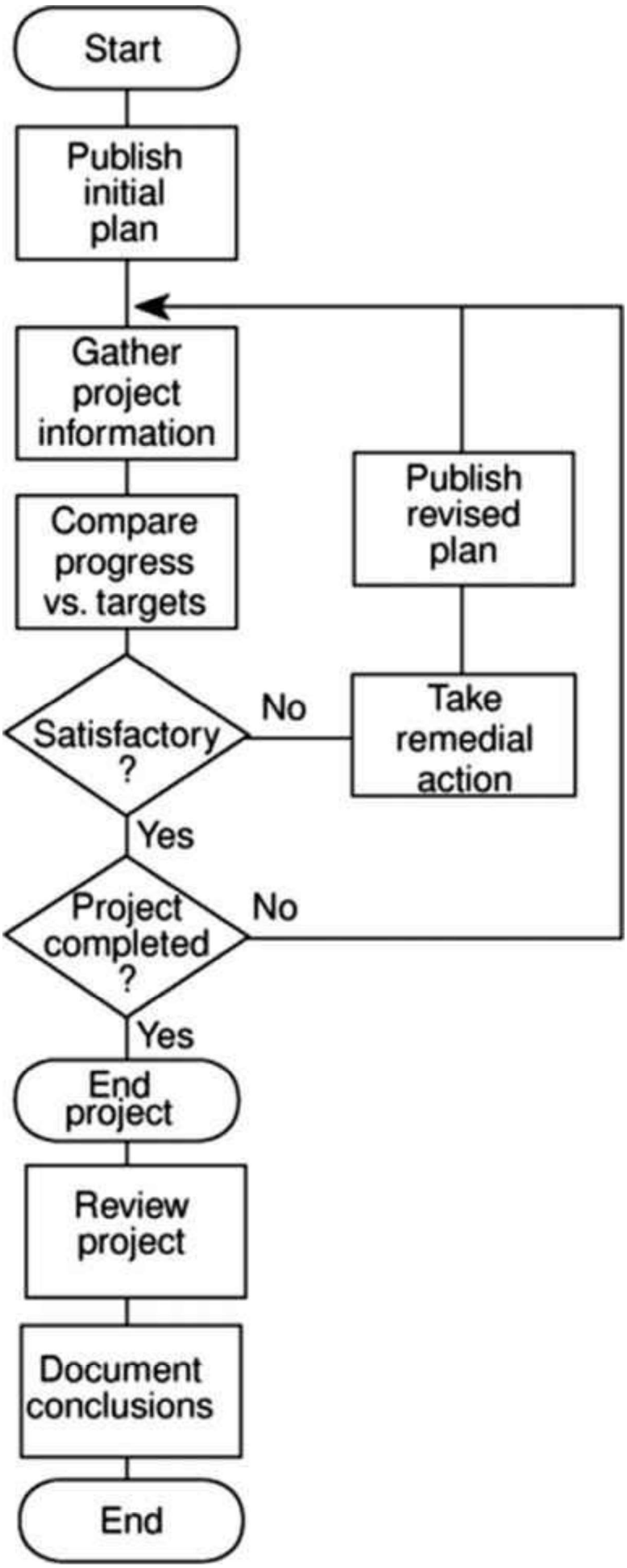

Start
Publish initial plan
Gather project information
Publish revised plan
Compare progress vs. targets
Satisfactory ?
No
Take remedial action
Yes
Project completed ?
No
Yes
End project
Review project
Document conclusions
End

Figure 9.1 The project control cycle.

Responsibility

The overall responsibility for ensuring satisfactory progress on a project is often the role of the project steering committee or Project Board. Day-to-day responsibility will rest with the project manager and, in all but the smallest of projects, aspects of this can be delegated to team leaders.

Figure 9.2 illustrates the typical reporting structure found with medium and The concept of a reporting large projects. With small projects (employing around half a dozen or fewer staff) hierarchy was introduced individual team members usually report directly to the project manager, but in in Chapter 1. most cases team leaders will collate reports on their section's progress and forward summaries to the project manager. These, in turn, will be incorporated into project-level reports for the steering committee and, via them or directly, progress reports for the client.

Team leader

Steering committee-A

Client

Project manager A

Team leader

Team leader

Team leader t t t

Analysis/design Programming Quality control section section section

User documentation section

In a PRINCE 2 environment, there is a Project Assurance function reporting to the Project Board and independent of the Project Manager.

Figure 9.2 Project reporting structures.

Reporting may be oral or written, formal or informal, or regular or ad hoc and some examples of each type are given in Table 9.1. While any effective team leader or project manager will be in touch with team members and available to discuss problems, any such informal reporting of project progress must be complemented by formal reporting procedures - and it is those we are concerned with in this chapter.

Assessing progress

Progress assessment will normally be made on the basis of information collected and collated at regular intervals or when specific events occur. Wherever possible, this information will be objective and tangible - whether or not a particular report has been delivered, for example. However, such end-of-activity deliverables might

Table 9.1 Categories of reporting Report type	Examples	Comment
Oral formal	weekly or monthly	while reports may be oral formal written
regular	progress meetings	minutes should be kept
Oral formal	end-of-stage review	while largely oral, likely to receive and
ad hoc	meetings	generate written reports
Written formal	job sheets, progress	normally weekly using forms
regular	reports	
Written formal	exception reports,	
ad hoc	change reports	
Oral informal	canteen discussion,	often provides early warning; must be
ad hoc	social interaction	backed up by formal reporting

The PRINCE 2 standard described in Appendix A has its own terminology.

Short, Monday morning team progress meetings are a common way of motivating staff to meet short term targets.

not occur sufficiently frequently throughout the life of the project. Here progress assessment will have to rely on the judgement of the team members who are carrying out the project activities.

Setting checkpoints

It is essential to set a series of checkpoints in the initial activity plan. Checkpoints may be:

• regular (monthly, for example);

• tied to specific events such as the production of a report or other deliverable. Taking snap-shots

The frequency with which the a manager needs to receive information about progress will depend upon the size and degree of risk of the project or that part of the project under their control. Team leaders, for example, need to assess progress daily (particularly when employing inexperienced staff) whereas project managers may find weekly or monthly reporting appropriate. In general, the higher the level, the less frequent and less detailed the reporting needs to be.

There are, however, strong arguments in favour of formal weekly collection of information from staff carrying out activities. Collecting data at the end of each week ensures that information is provided while memories are still relatively fresh and provides a mechanism for individuals to review and reflect upon their progress during the past few days.

Major, or project-level, progress reviews will generally take place at particular points during the life of a project - commonly known as review points or control points. PRINCE 2, for example, designates a series of checkpoints where the status of work in a project or for a team is reviewed. At the end of each project Stage, PRINCE 2 provides for an End Stage Assessment where an assessment of the project and consideration of its future are undertaken.

Collecting the Data:

As a rule, managers will try to break down long activities into more controllable tasks of one or two weeks duration. However, it will still be necessary to gather information about partially completed activities and, in particular, forecasts of how much work is left to be completed. It can be difficult to make such forecasts accurately.

A software developer working on Amanda's project has written the first 250 lines Exercise 9.1 of a Cobol program that is estimated to require 500 lines of code. Explain why it would be unreasonable to assume that the programming task is 50% complete. How might you make a reasonable estimate of how near completion it might be?

Where there is a series of products, partial completion of activities is easier to estimate. Counting the number of record specifications or screen layouts produced, for example, can provide a reasonable measure of progress.

In some cases, intermediate products can be used as in-activity milestones. The first successful compilation of a Cobol program, for example, might be considered a milestone even though it is not the final product of the activity code and test.

Partial completion reporting

Many organizations use standard accounting systems with weekly time sheets to charge staff time to individual jobs. The staff time booked to a project indicates the work carried out and the charges to the project. It does not, however, tell the project manager what has been produced or whether tasks are on schedule.

It is therefore common to adapt or enhance existing accounting data collection systems to meet the needs of project control. Weekly time sheets, for example, are frequently adapted by breaking jobs down to activity level and requiring information about work done in addition to time spent. Figure 9.3 shows a typical example of such a report form, in this case requesting information about likely slippage of completion dates as well as estimates of completeness.

Asking for estimated completion times can be criticized on the grounds that frequent invitations to reconsider completion dates deflects attention away from the importance of the originally scheduled targets and can generate an ethos that it is acceptable for completion dates to slip.

Weekly timesheets are a valuable source of information about resources used.

They are often used to provide information about what has been achieved. However, requesting partial completion estimates where they cannot be obtained from objective measures encourages the 99% complete syndrome -tasks are reported as on time until 99% complete, and then stay at 99% complete until finished.

Time Sheet

Rechargeable hours

Project	Activity code	Description	Hours this week	Complete	Scheduled completion	Estimated completion
ra	A243	Code mod A3	12	30	24/4/99	24/4/99
P34	0771	Pocument take-on	20	90	1/4/99	29/3/99
Total recharged hours			32			

Non-rechargeable hours

Code	Description	Hours	Comment & authorization
z99	day in lieu	s	Authorized by RfS
Total non-rechargeable hours		2	

Figure 9.3 A weekly time sheet and progress review form.

There are a number of variations on the traffic-light technique. The version described here is in use in IBM and is described in Down, Coleman and Absolon, Risk Management for Software Projects, McGraw-Hill, 1994.

Risk reporting

One popular way of overcoming the objections to partial completion reporting is to avoid asking for estimated completion dates, but to ask instead for the team members' estimates of the likelihood of meeting the planned target date.

One way of doing this is the traffic-light method. This consists of the following steps:

• identify the key (first level) elements for assessment in a piece of work;

• break these key elements into constituent elements (second level);

• assess each of the second level elements on the scale green for 'on target', amber for 'not on target but recoverable', and red for 'not on target and recoverable only with difficulty';

• review all the second level assessments to arrive at first level assessments;

• review first and second level assessments to produce an overall assessment.

For example, Amanda decides to use a version of the traffic-light method for reviewing activities on the IOE project. She breaks each activity into a number of component parts (deciding, in this case, that a further breakdown is unnecessary) and gets the team members to complete a return at the end of each week. Figure 9.4 illustrates Justin's completed assessment at the end of week 16.

Activity Assessment Sheet Staff JU8lin								
Ref: loE/P/l 3 Activity		/: Code & test module C						
Week number	13	14	15	16	17	18		
Activity Summary	*	A	A	R				
Component							Comments	
Screen handling procedures	t	A	A	&				
File update procedures		&	R	A				
Housekeeping procedures	»	&	&	A				
Compilation		&	&	R				
Test data runs	c-	*	&	A				
Program documentation	&	&	A	R				

Note that this form refers only to uncompleted activities. Justin would still need to report activity completions and the time spent on activities.

Figure 9.4 A traffic-light assessment of IoE/P/13.

Traffic-light assessment highlights only risk of non-achievement; it is not an attempt to estimate work done or to quantify expected delays.

Following completion of assessment forms for all activities, the project manager uses these as a basis for evaluating the overall status of the project. Any critical activity classified as amber or red will require further consideration and often leads to a revision of the project schedule. Non-critical activities are likely to be considered as a problem if they are classified as red, especially if all their float is likely to be consumed.

Visualizing Progress:

Having collected data about project progress, a manager needs some way of presenting that data to greatest effect. In this section, we look at some methods of presenting a picture of the project and its future. Some of these methods (such as Gantt charts) provide a static picture, a single snap-shot, whereas others (such as time-line charts) try to show how the project has progressed and changed through time.

The Gantt chart

One of the simplest and oldest techniques for tracking project progress is the Gantt chart. This is essentially an activity bar chart indicating scheduled activity dates

Henry Gantt (1861-1919) was an industrial engineer interested in the efficient organization of work.

and durations frequently augmented with activity floats. Reported progress is recorded on the chart (normally by shading activity bars) and a 'today cursor' provides an immediate visual indication of which activities are ahead or behind schedule. Figure 9.5 shows part of Amanda's Gantt chart as at the end of Tuesday of week 17. Code & test module D has been completed ahead of schedule and code & test module A appears also to be ahead of schedule. The coding and testing of the other two modules are behind schedule.

Gavin

Code & test module A

Purdy

Code & test module B

Justin_

Code & test module C

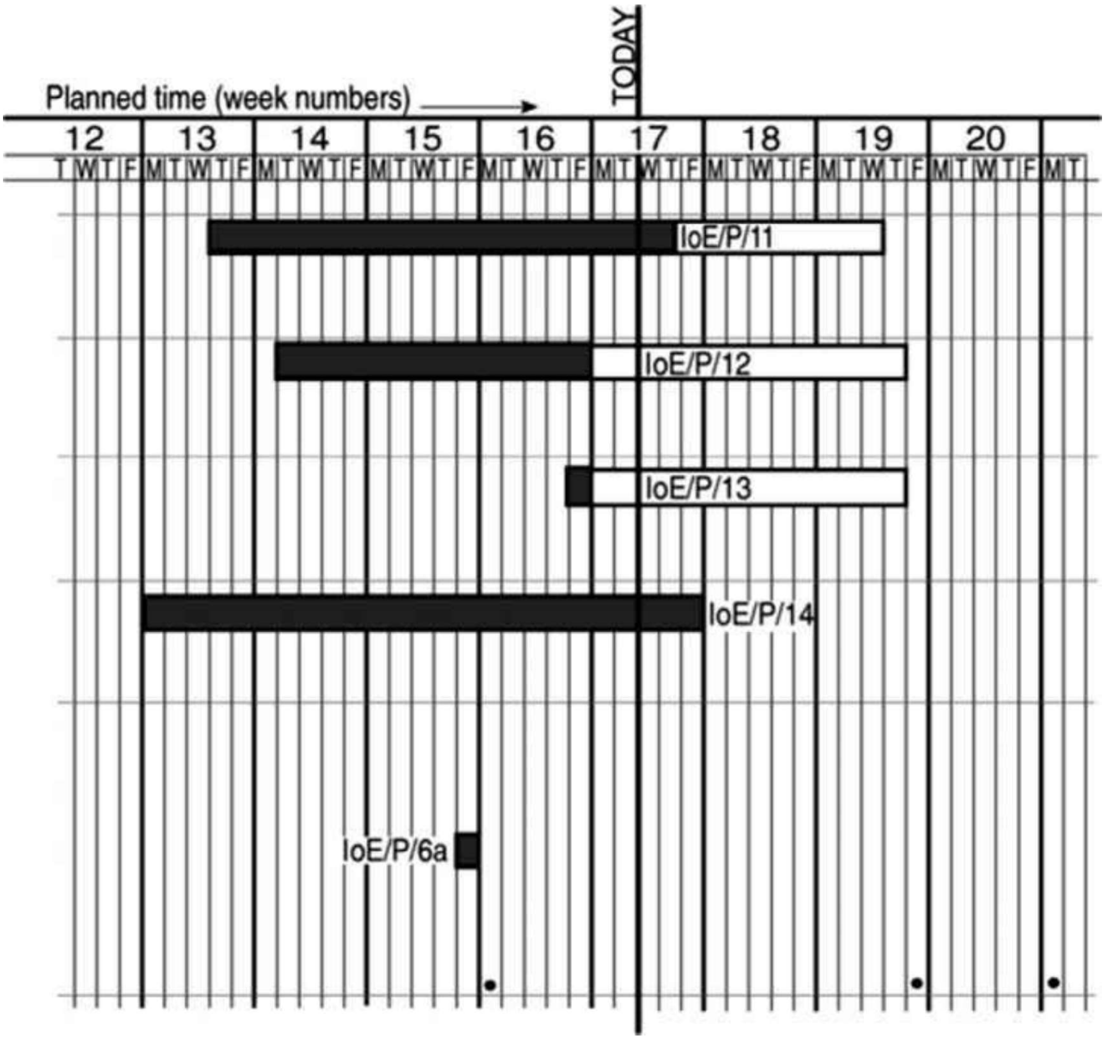


Figure 9.5 Part of Amanda's Gantt chart with the 'today cursor' in week 17. The slip chart

Spencer

Code & test module D

Amanda

Specify overall system Check specifications Check module C spec

Review meetings

Figure 9.5 Part of Amanda's Gantt chart with the 'today cursor' in week 17. The slip chart

A slip chart (Figure 9.6) is a very similar alternative favoured by some project managers who believe it provides a more striking visual indication of those activities that are not progressing to schedule - the more the slip line bends, the greater the variation from the plan. Additional slip lines are added at intervals and, as they build up, the project manager will gain an idea as to whether the project is improving (subsequent slip lines bend less) or not. A very jagged slip line indicates a need for rescheduling.

Ball charts

A somewhat more striking way of showing whether or not targets have been met is to use a ball chart as in Figure 9.7. In this version of the ball chart, the circles indicate start and completion points for activities. The circles initially contain the original scheduled dates. Whenever revisions are produced these are added as second dates in the appropriate circle until an activity is actually started or

Planned time (week numbers) » 12 I 13 I 14 I 15 I 16 I

IJMVMd l.'MVildld l.'MVMId JlifYIHU L'.IH Mrild I.'MVjHU l,'M7/Mld l.'MVjfclti

Planned time (week numbers) » 12 I 13 I 14 I 15 I 16 I

IJMVMd l.'MVildld l.'MVMId JlifYIHU L'.IH Mrild I.'MVjHU l,'M7/Mld l.'MVjfclti

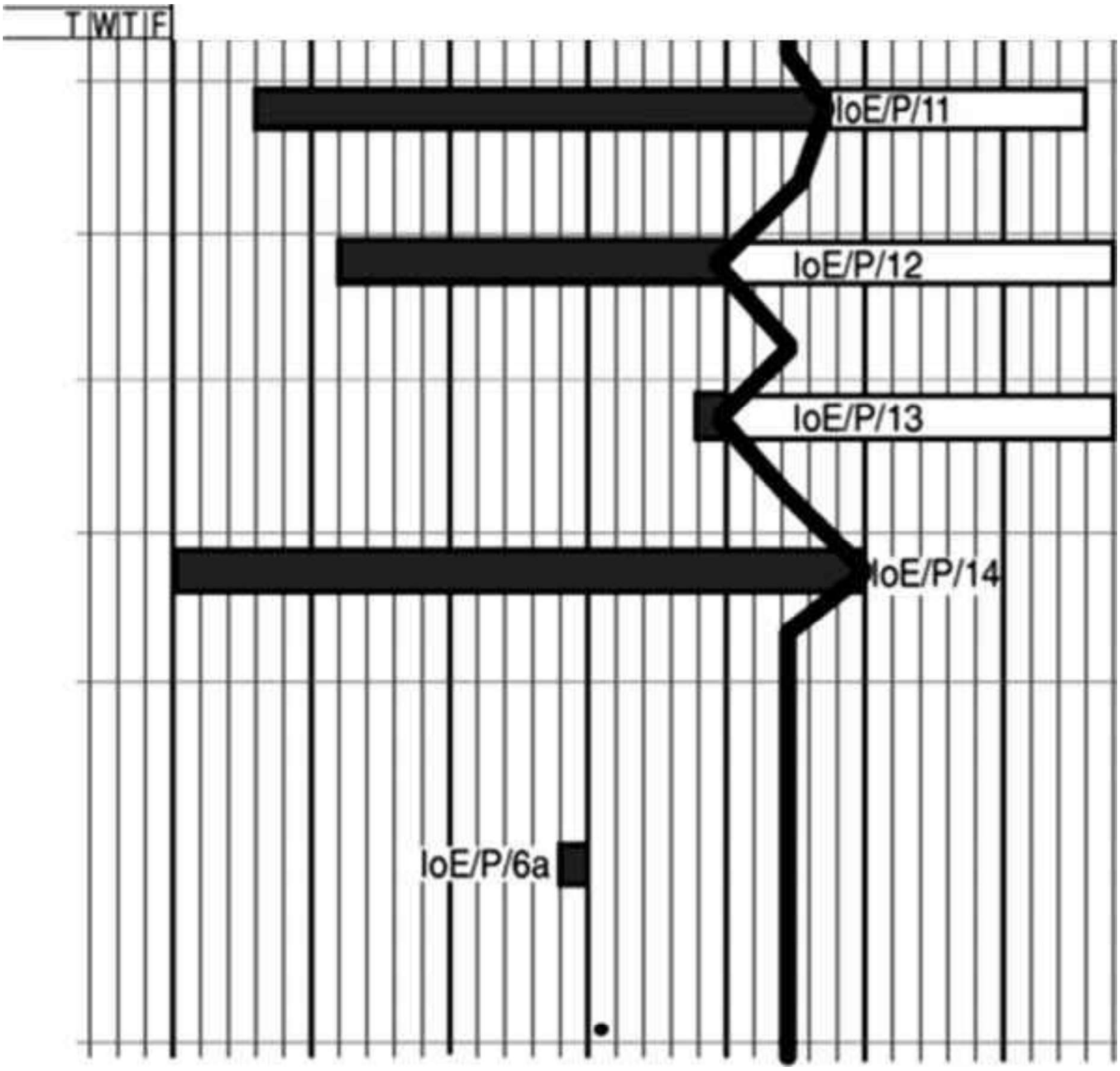


Figure 9.6 The slip chart emphasizes the relative position of each activity.

Gavin

Code & test module A

Purdy

Code & test module B

Justin

Code & test module C

Spencer_

Code & test module D

Amanda

Specify overall system Check specifications Check module C spec

Review meetings

Figure 9.6 The slip chart emphasizes the relative position of each activity.

completed when the relevant date replaces the revised estimate (in bold italic in Figure 9.7). Circles will therefore contain only two dates, the original and most recent target dates, or the original and actual dates.

Where the actual start or finish date for an activity is later than the target date, the circle is coloured red (dark grey in Figure 9.7) - where an actual date is on time or earlier than the target then the circle is coloured green (light grey in Figure 9.7).

Such charts are frequently placed in a prominent position and the colour coded balls provide a constant reminder to the project team. Where more than one team is working in close proximity, such a highly visible record of achievement can encourage competitiveness between teams.

Another advantage of ball charts over Gantt and slip charts is that they are relatively easy to keep up to date - only the dates and possibly colours need to be changed, whereas the others need to be redrawn each time target dates are revised.

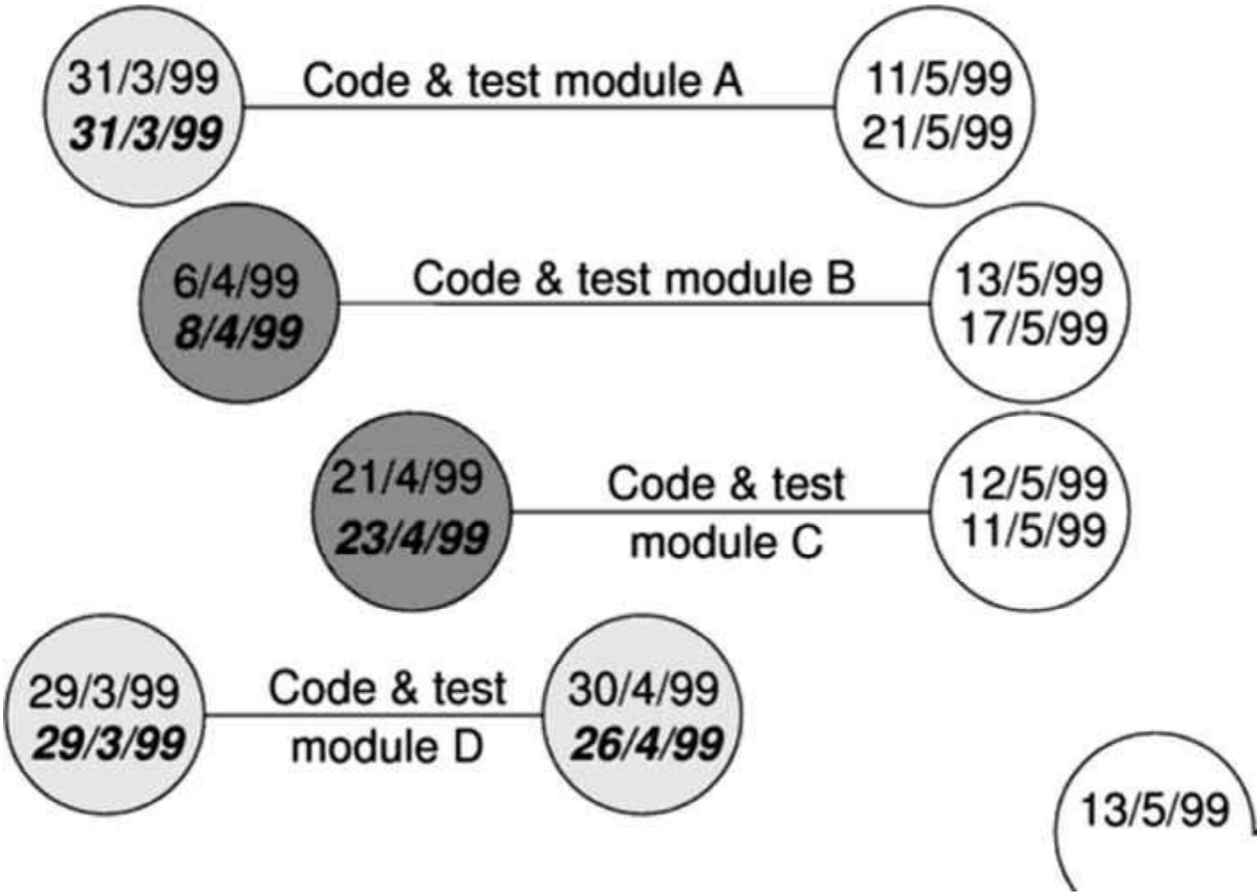
The timeline

One disadvantage of the charts described so far is that they do not show clearly the slippage of the project completion date through the life of the project. Knowing the current state of a project helps in revising plans to bring it back on target, but analysing and understanding trends helps to avoid slippage in future projects.

The timeline chart is a method of recording and displaying the way in which targets have changed throughout the duration of the project.

Figure 9.8 shows a timeline chart for Brigette's project at the end of the sixth week. Planned time is plotted along the horizontal axis and elapsed time down the vertical axis. The lines meandering down the chart represent scheduled activity

David Youll in Making Software Development Visible, John Wiley & Sons, 1990, describes a version of the ball chart using three sets of dates and part-coloured balls.



System (20/5/99

21/5/99/ Integration V 28/5/99 Figure 9.7 The hall wall chart provides an incentive for meeting targets.

completion dates - at the start of the project analyse existing system is scheduled to be completed by the Tuesday of week 3, obtain user requirements by Thursday of week 5, issue tender, the final activity, by Tuesday of week 9, and so on.

At the end of the first week Brigette reviews these target dates and leaves them as they are - lines are therefore drawn vertically downwards from the target dates to the end of week one on the actual time axis.

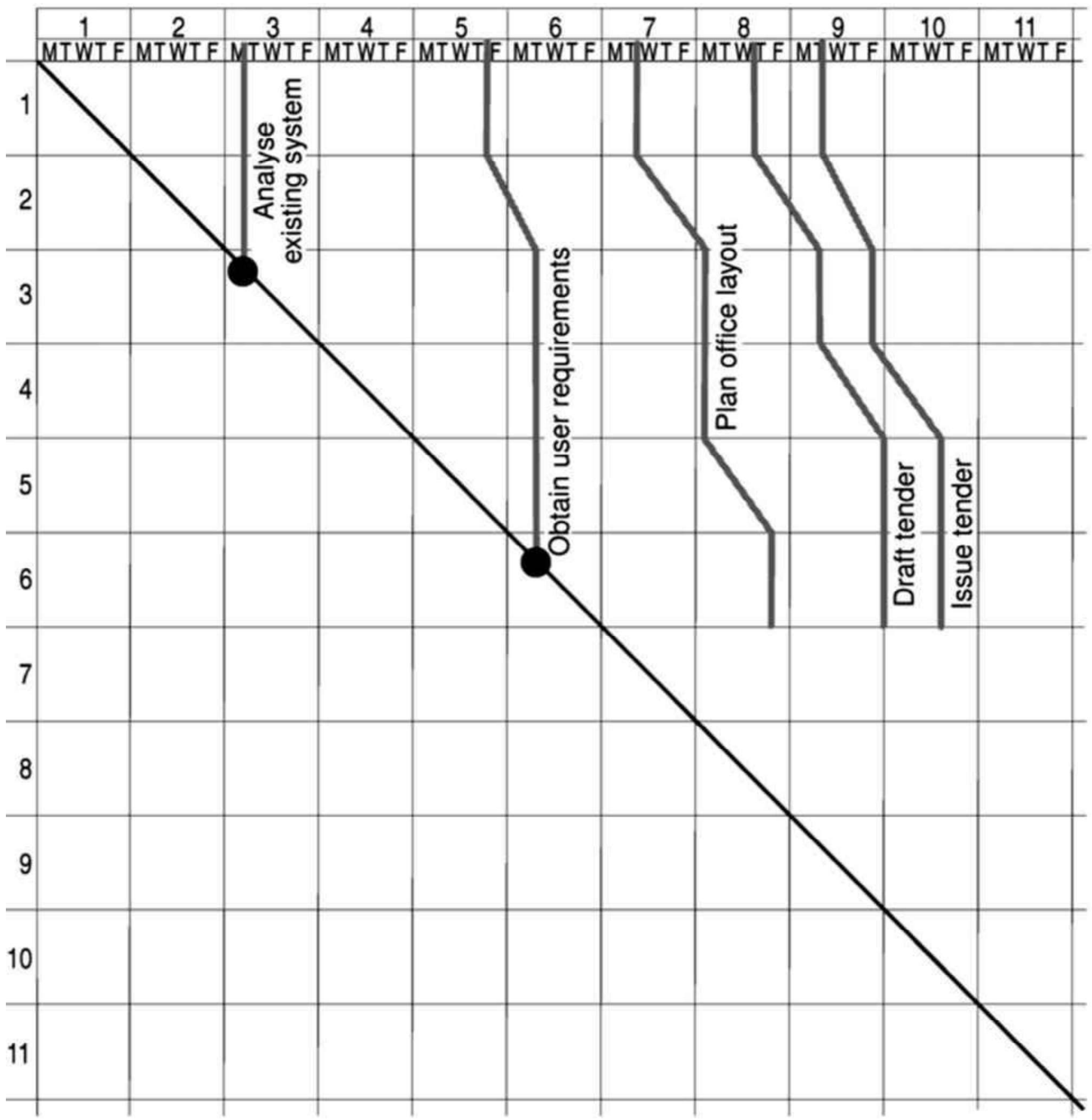
At the end of week two, Brigette decides that obtain user requirements will not be completed until Tuesday of week six - she therefore extends that activity line diagonally to reflect this. The other activity completion targets are also delayed correspondingly.

By the Tuesday of week three, analyse existing system is completed and Brigette puts a blob on the diagonal timeline to indicate that this has happened. At the end of week three she decides to keep to the existing targets.

At the end of week four she adds another three days to draft tender and issue tender.

Note that, by the end of week six, two activities have been completed and three are still unfinished. Up to this point she has revised target dates on three occasions and the project as a whole is running seven days late.

Exercise 9.2 By the end of week 8 Brigette has completed planning the office layout but finds that drafting the tender is going to take one week longer that originally anticipated. What will Brigette's timeline chart look like at the end of week 8? If the rest of the project goes according to plan, what will Brigette's timeline chart look like when the project is completed?



MliWTF

MTWTF

MTWTF

MTWTE.

Planned Time Week number

Brigette's timeline chart contains only the critical activities for her project; • indicates actual completion of an activity.

For the sake of clarity, the number of activities on a timeline chart must be limited. Using colour helps to distinguish activities, particularly where lines cross.

Figure 9.8 Brigette 's timeline chart at the end of week six.

The timeline chart is useful both during the execution of a project and as part of the post-implementation review. Analysis of the timeline chart, and the reasons for the changes, can indicate failures in the estimation process or other errors that might, with that knowledge, be avoided in future.

Cost Monitoring:

Hxpenditure monitoring is an important component of project control. Not only in itself, but also because it provides an indication of the effort that has gone into (or at least been charged to) a project. A project might be on time but only because more money has been spent on activities than originally budgeted. A cumulative expenditure chart such as that shown in Figure 9.9 provides a simple method of comparing actual and planned expenditure. By itself it is not particularly meaningful - Figure 9.9 could, for example, illustrate a project that is running late or one that is on time hut has shown substantial costs savings! We need to take account of the current status of the project activities before attempting to interpret the meaning of recorded expenditure.

Project costs may be monitored by a company's accounting system. By themselves, they provide little information about project status.

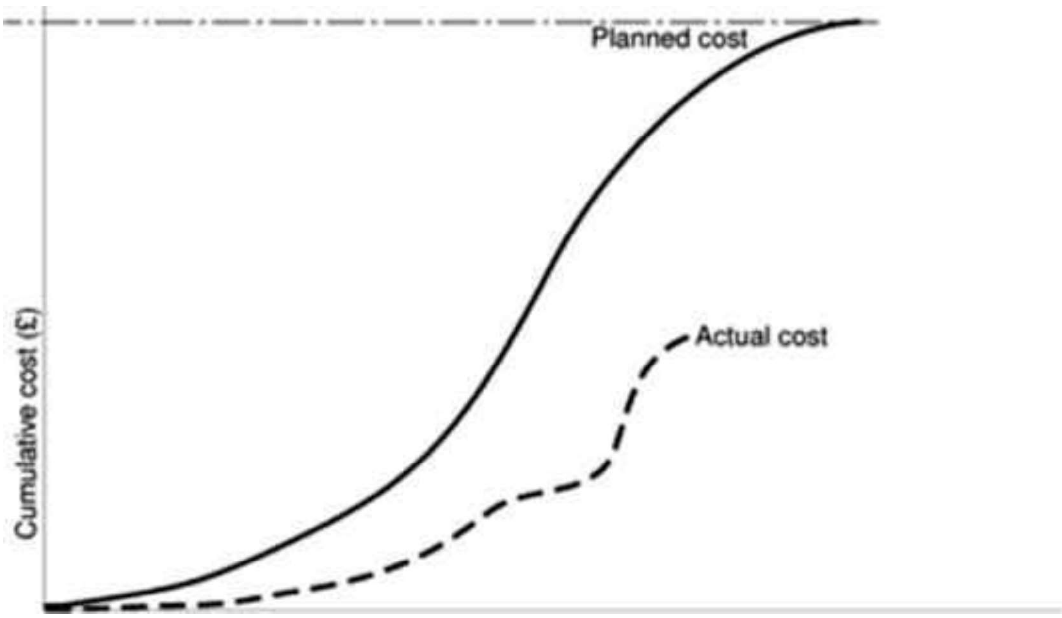


Figure 9.9 Tracking cumulative expenditure.

Time (weeks)

Figure 9.9 Tracking cumulative expenditure.

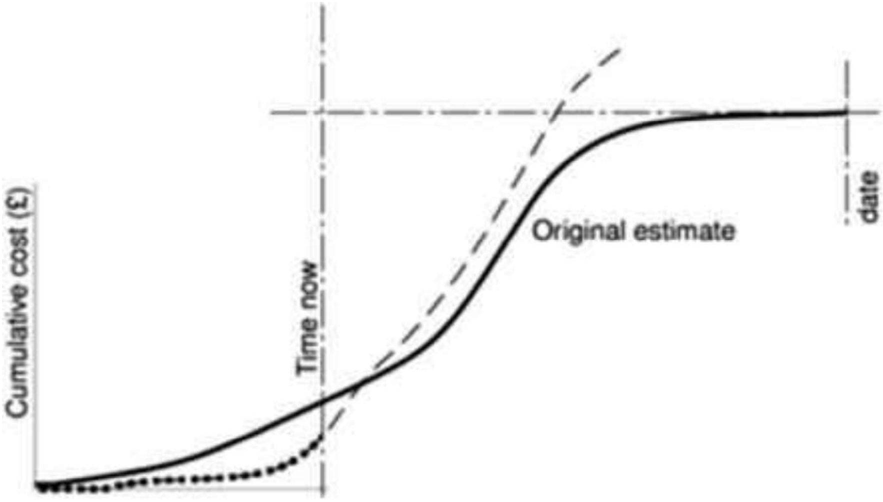
Cost charts become much more useful if we add projected future costs calculated by adding the estimated costs of uncompleted work to the costs already incurred. Where a computer-based planning tool is used, revision of cost schedules is generally provided automatically once actual expenditure has been recorded. Figure 9.10 illustrates the additional information available once the revised cost schedule is included - in this case it is apparent that the project is behind schedule and over budget.

9.6 Earned Value

Earned Value Analysis, also known as Budgeted Cost of Work Performed, is recommended by a number of agencies including the US and Australian departments of defence. It is also recommended in BS 6079.

Earned Value Analysis has gained in popularity in recent years and may be seen as a refinement of the cost monitoring discussed in the previous section. Earned Value Analysis is based on assigning a 'value' to each task or work package (as identified in the WBS) based on the original expenditure forecasts. The assigned value is the original budgeted cost for the item and is known as the baseline budget or budgeted cost of work scheduled (RC WS). A task that has not started is assigned the value zero and when it has been completed, it. and hence the project, is credited with the value of the task. The total value credited to a project at any point is known as the earned value or budgeted cost of work performed (BCWP) and this can be represented as a value or as a percentage of the BCWS.

Original total cost



Time (weeks)

Revised total cost

Revised estimate ^

Original total cost

Project costs augmented by project monitoring can be used to generate forecasts of future costs.

Figure 9.10 The cumulative expenditure chart can also show revised estimâtes of cost and completion date.

Where tasks have been started but are not yet complete, some consistent method of assigning an earned value must be applied. Common methods in software projects are:

• the 0/100 technique Where a task is assigned a value of zero until such time that it is completed w hen it is given a value of I00*£ of the budgeted value;

• the 50/50 technique Where a task is assigned a value of 50% of its value as soon as it is started and then given a value of I00# once it is complete;

• the milestone technique Where a task is given a value based on the achievement of milestones that have been assigned values as part of the original budget plan.

Of these, we prefer the 0/100 technique. The 50/50 technique can give a false sense of security by over-valuing the reporting of activity starts. The milestone technique might be appropriate for activities w ith a long duration estimate but. in such cases, it is better to break that activity into a number of smaller ones.

The baseline budget

The first stage in setting up an earned value analysis is to create the baseline budget. The baseline budget is based on the project plan and shows the forecast grow th in earned value through time. Earned value may be measured in monetary values but, in the case of staff-intensive projects such as software development, it is common to measure earned value in person-hours or workdays. Amanda's baseline budget, based on the schedule shown in Figure 8.7, is shown in Table 9.2 and diagrammatically in Figure9.11. Notice that she has based her baseline budget on workdays and is using the 0/100 technique for crediting earned value to the project.

Table 9.2 Amanda's bast-line budget calculation

Task	Budgeted workdays	Scheduled completion	Cumulative workdays	cumulative earned value
Specify overall system	34	34	34	14.35
Specify module B	15	49 i	\ 64	27.00
Specify module D	15	49 J		
Specify module A	20	54	84	35.44
Check specifications	2	56	86	36.28
Design module D	4	60	90	37.97
Design module A	7	63	97	40.93
Design module B	6	66	103	43.46
Check module C spec	1	70	104	43.88
Specify module C	25	74	129	54.43
Design module C	4	79	133	56.12
Code & test module D	25	85	158	66.67
Code & test module A	30	93	188	79.32
Code & lest module B	28	94 i	| 231	97.47
Code & test module C	15	94 J		
System integration	6	100	237	100.00

Amanda's project is not expected to be credited with any earned value until day 34, when the activity specify overall system is to be completed. This activity was forecast to consume 34 person-days and it will therefore be credited with 34 person-days earned value when it has been completed. The other steps in the baseline budget chart coincide with the scheduled completion dates of other activities.

Earned Value:

Earned value refers to a value assigned to work, which can be stated in hours and/or dollars (or your local currency). Earned value management (EVM), on the other hand, is a tool used to measure and predict project performance by comparing planned versus actual earned value. Because EVM can track costs and schedules, it is quite useful for forecasting future projects. Earned value management provides stakeholders with additional insight into a project's status, as it compares actual time and money spent versus the planned hours and budget. Earned value and EVM were first developed and used in the 1960s by the US Department of Defense to track its various programs including NASA.

Calculated Earned Value:

Earned value (EV) is a way to measure and monitor the level of work completed on a project against the plan. Simply put, it’s a quick way to tell if you’re behind schedule or over budget on your project. You can calculate the EV of a project by multiplying the percentage complete by the total project budget. For example, let’s say you’re 60% done, and your project budget is $100,000 — your earned value is then $60,000. However, to properly use earned value, a few additional calculations must be considered. The largest benefits of earned value result from completing both cost and schedule variance analyses.

Earned value calculations in project management

1. **Schedule Variance (SV):** Schedule variance is the difference between your planned progress and your actual progress to date. The SV calculation is EV (earned value) - PV (planned value). Let’s assume you have a four-month-long project, and you’re two months in, but the project is only 25% complete. In this case, your EV = 1 months (25% of four months), and your PV = 2 months. Therefore your SV is 1 - 2 = -1. Since the number is negative, it indicates you’re behind schedule.

2. **Cost Variance (CV):** Similar to SV, cost variance is the difference between how much you planned on spending thus far and your actual costs to date. The CV calculation is: CV = EV - AC (actual cost). Let’s use the earlier example. Your

project budget is $100,000 and you're 60% done, which means your EV is $60,000. If you've spent $70,000 so far to get to this point in the project, your CV is -$10,000. You can tell you're over budget because the number is negative, which may indicate a problem with the project or that the project could go over budget or run out of money.

3. **Schedule Performance Index (SPI):** This measure is similar to SV but is often preferred as it translates the numbers into a value that is easily compared across tasks or projects. The SPI calculation is: SPI = EV/PV. When SPI is above 1.00, you're ahead of schedule. If it's below 1.00, you're behind. To take the example from above, SPI would be 1/2 = 0.5. Using SPI is different than simply comparing your progress against your baseline. Comparing your actual schedule against your plan may indicate you're behind on two tasks. So, you know where your immediate problem is, but not necessarily how it impacts the overall project or your expected completion date. Using earned value, you can calculate your SPI both by task and for the project as a whole. When you take the SPI for each task and look at the bigger picture, you can see that your project is ahead of schedule, even with two late tasks. This helps you better understand the overall impact of the late tasks on the project.

4. **Cost Performance Index (CPI):** As with SPI, CPI allows you to simplify the answer for better analysis. The CPI calculation is: CPI = EV/AC. When CPI is over 1.00, you're under budget, and when it's under 1.00, you're overspending. In the scenario above, CPI = 60,000/ 70,000 = 0.86, indicating an overspend. CPI can be used to forecast your project's completion. For example, you can divide your total project budget by your current CPI to get the expected total cost at completion. The formula is Estimate at Completion (EAC) = Budget/ CPI. In the above example, this would be $100,000/ 0.86 = $116,279.07. Meaning, that at this point in the project, based on current trends, you will likely end up overspending your budget by $16,279.07. Knowing this early allows you the time to either find ways to cut costs or secure more funding.