Electronics and
Computer Science

University of Southampton

Monitoring and Controlling Projects

COMP6204: Software Project Management and Secure Development

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Overview

- Objectives
- Introduction, Monitoring and Control
- Schedule and Cost Tracking
- Earned Value Technique
- Gathering Work Performance Info
- Determining Schedule & Cost Status and Variances
- Schedule & Cost Performance indices (SPI)
- Earned Value Forecasting

Objectives

- The key learning objectives of this chapter are
  - Know how schedule and cost tracking is done on a project
  - Understand how variances are calculated and managed
  - Learn the Earned Value Technique in project tracking
  - Understand how project reporting to stakeholders is done
  - Learn the various quality control measures taken and the various quality management tools used for this purpose

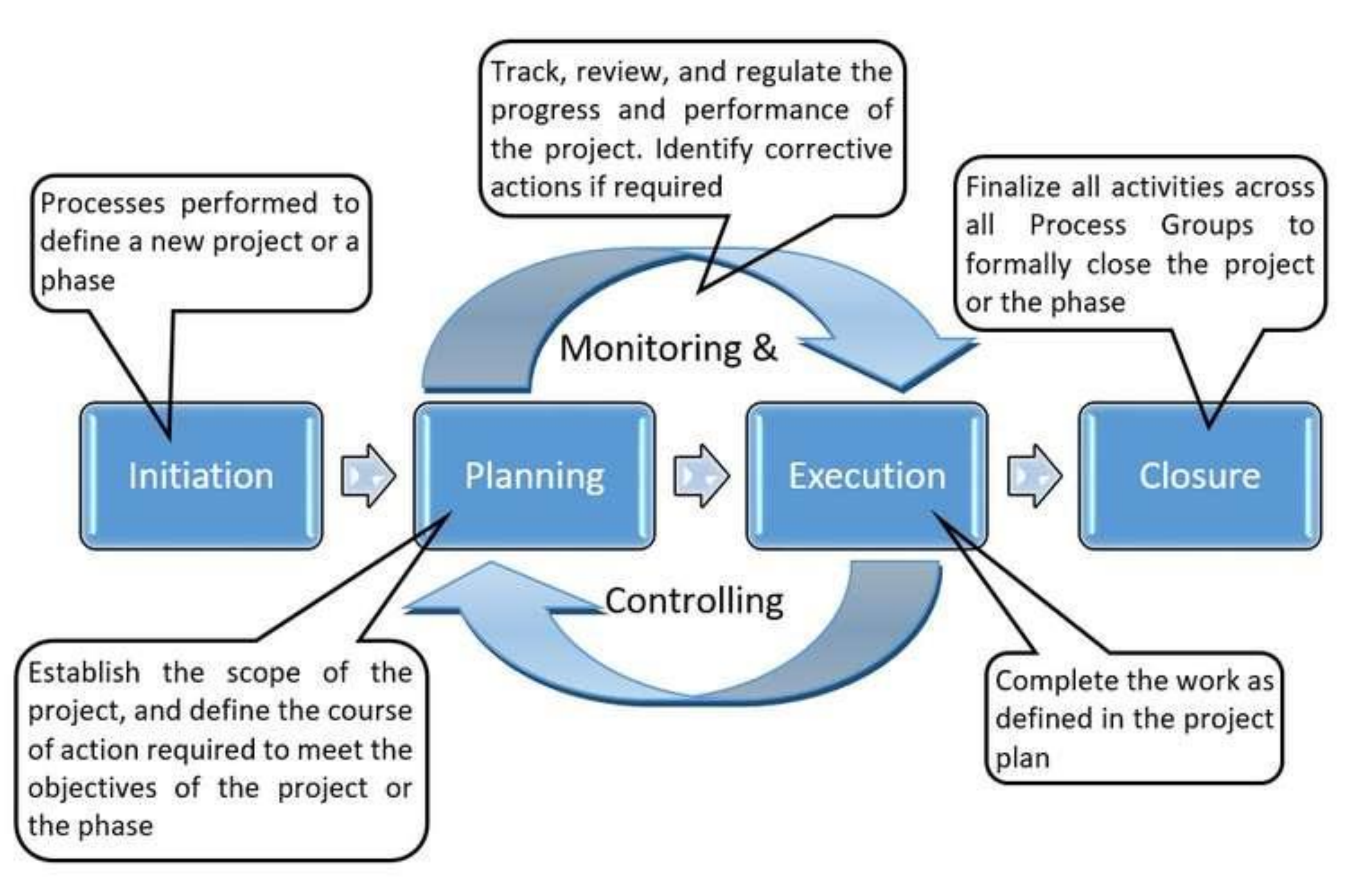
Introduction

- While the project is being executed, it also needs to be checked whether the execution is happening as per the plan.
- A project manager spends most of his time in execution, monitoring and controlling a project.
- Having a good, workable plan is one thing and being able to execute it is another.
- If the execution does not happen as per the plan, and this leads to issues later on.
  - This is a monitoring and controlling failure on the project.

Project Management Process Groups (Reminder)

- A *process* is a series of actions directed toward a particular result
  - Project management can be viewed as a number of related processes
- Project management process groups
  - Initiating processes
  - Planning processes
  - Executing processes
  - Monitoring and controlling processes
  - Closing processes

Project Management Process Groups (Reminder)



Monitoring

- *Monitoring* involves regularly measuring progress to control that the project is meeting its objectives.
- As the project is being executed, data is collected on the actual parameters of the project
  - Actual scope delivered, actual start and end dates, actual costs incurred, actual quality measurements.
- All these actual parameters are then compared with the ones mentioned in the plan
  - If there is a variance, then we need to do further analysis to see if the variance is a favourable one or an unfavourable one.

Control

- When we determine that a particular variance is unfavourable then we may need to take an action to bring the project back on track.
  - This action is called corrective action and is a part of the Control function.
  - Sometimes unfavourable variance may not warrant a response at all.
  - There are also cases when the variance is within limits and, hence, does not warrant a response but we decide to take a preventive action to avoid issues in future.
- The two types of actions – corrective and preventive actions, are often referred to as CAPA (corrective and preventive actions).

Schedule and Cost Tracking

- The two most important areas to track on a project are schedule and cost.
  - During planning the project schedule is baselined and so is the cost.
- While executing, the actual values are collected and compared against the baseline and a variance is computed.
- The most important variances computed are:
  - Schedule Variance (SV): This is the difference between the baseline finish date and the actual finish date of an activity or the entire project.
  - Cost Variance (CV): This is the difference between the baseline cost and the actual cost of an activity or the entire project.
  - Effort Variance (EV) / Work Variance: This is the difference between the baseline effort and actual effort spent on an activity or the entire project.

Variance– An Example

Parameter	Activity-1	Activity-2	Activity-3
Baseline Finish Date Cost Effort	 1st August 2012 £20,500 10 Man Days	 15th August 2012 £10,250 3 Man Days	 5th Sept 2012 £60.025 25 Man Days
Actual Finish Date Cost Effort	 1st August 2012 £20,500 10 Man Days	 17th August 2012 £9,000 3.25 Man Days	 4th Sept 2012 £62.025 23 Man Days
Variances SV CV EV	 _ _ _	 2 days late -£1,250 0.25 Man Days	 -1 day £2.000 -2 Man Days

Earned Value Technique

- Earned Value (EV) is a technique used to track a project's progress based on cost parameters.
- It helps calculate both schedule and cost variances but gives all values in terms of costs.
- Given a *baseline*, using the EV technique project managers and their teams can determine how well the project is meeting scope, time, and cost.
- It used actual values and comparing them with the *baseline.*
- The baseline information includes:
  - Scope data (WBS tasks) – Time data (start and finish estimates for each task)
  - Cost data (cost estimates for each task)

Earned Value Management – Cont.

- Earned value provides information which enables effective decision making by knowing:
  - What has been achieved of the plan;
  - What it has cost to achieve the planned work;
  - If the work achieved is costing more or less than was planned;
  - If the project is ahead of or behind the planned schedule.

Gathering Work Performance Info

- Earned Value Technique requires the compilation of several pieces of information from the project.
  - EVM can be *intimidating* to some project managers, due to the *many terminologies* associated with it, but none of these are difficult.
- Some of these terms are:
  - Budget at Completion (BAC)
    - It represents the original project budget. It is determined during project planning and readily available.

Planned Value (PV)

- Planned Value is the budgeted cost for work scheduled (BCWS).
- PV varies based on the scope of work in consideration and the point where you're at in the overall schedule.
  - PV = Total project cost × Percentage of planned work
  - For example, let's say, the PV for your 5-month project is £25,000:
  - PV for the complete project = £25,000 = BAC
  - PV at 2 months = £25,000 × 40% = £10,000
- You can also calculate PV for a time period, say, month 2 to month 4 = £25,000 × 60% = £15,000.

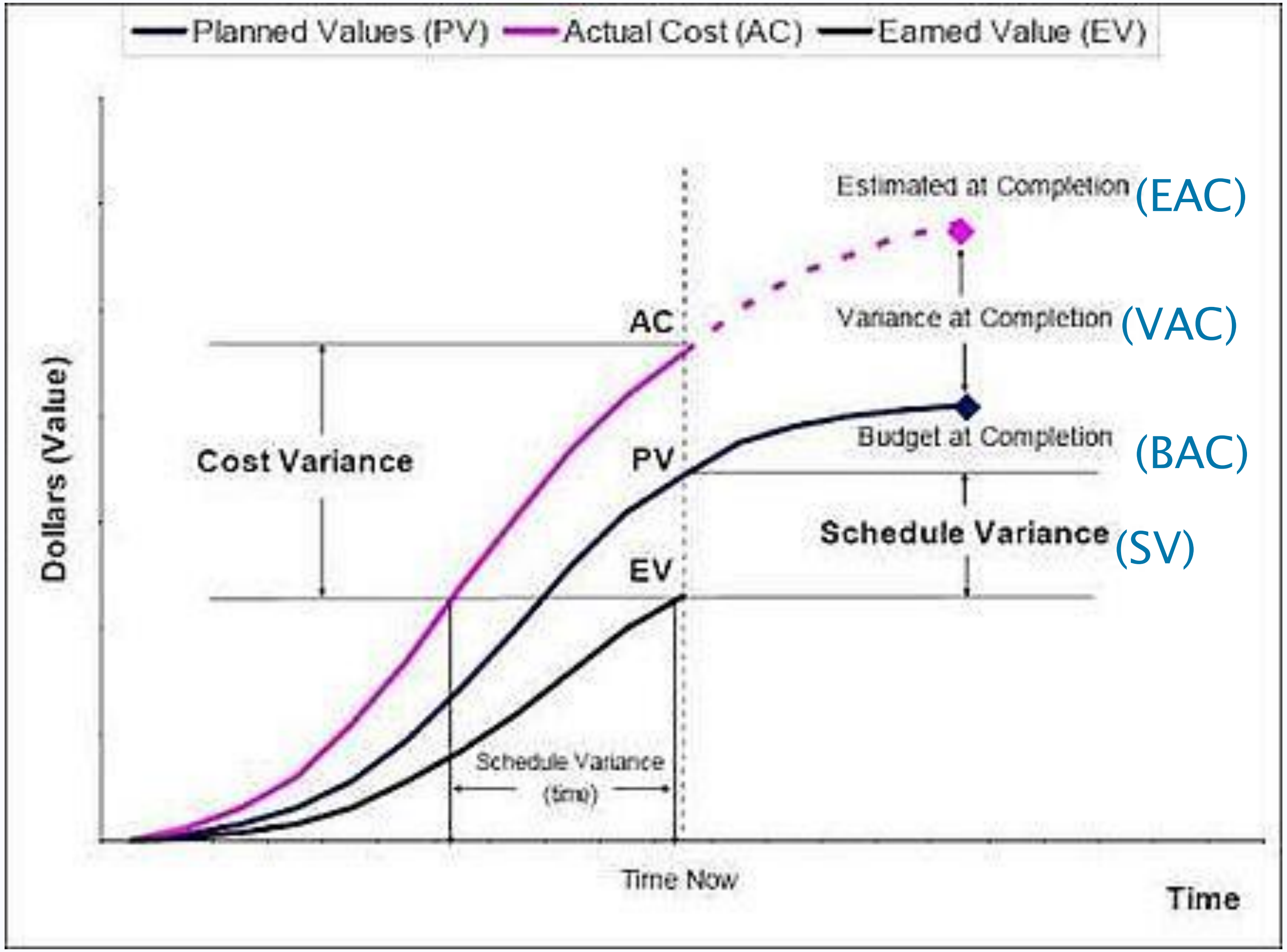
Actual Costs (AC)

- Actual costs, also referred to as actual cost of work performed (ACWP), is relatively straightforward.
  - If you are using a robust project cost management software, tracking actual costs should not be a challenge.
  - However, it's important to remember to include several hidden costs—material, resource, hardware, software licenses, overheads, etc.
- You can look at AC cumulatively, accounting for all the activities done from the beginning of the project to date or over a specific time period.
  - ***In our example, let's assume, AC at the end of 2 months = £15,000***

Earned Value (EV)

- Now, this is where EV gets interesting.
- You have made a plan to finish some amount of work and budgeted accordingly.
- But, from experience, you know that there is bound to be some discrepancy from your estimate.
  - At the end of 2 months, you may have planned to complete 40% of your work, but let’s say you managed to just finish 30%.
- The question, then, is, what is the budgeted cost for this work? EV, also called as budgeted cost for work performed (BCWP), gives you the answer.
- In our example:
  EV = Total project cost × percentage of actual work = £25,000 × 30% = £7,500

Earned Value Management System (EVMS)



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Determining Schedule Status

- Using the calculation so far, we have determined whether we are
    1. *ahead* or *behind* our *schedule*
    2. *under* or *above* the *estimated cost*.
- It's time to determine *how far ahead* or *behind* schedule
- Or how much *under* or *above* the *estimated cost*.
- To do this, we will calculate another *four values* from the initial four we *gathered* from the project *data*.

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Variance Analysis

- At this point, the project manager wants to know how far off we are from the project baseline.
- This can be determined through
  - Schedule Status
    - Schedule Variance (SV)
    - Schedule Performance Index (SPI)
  - Cost Status
    - Cost Variance (CV)
    - Cost Performance Index (CPI)

Schedule Variance (SV)

- *Schedule variance* is a *quantitative indicator* of your *divergence* from the *initial planned schedule*.
- A *negative* SV indicates that we are *behind* schedule,
- A *positive* SV indicates that we are *ahead of schedule* and *zero* means that we are *exactly on schedule*.

$$SV = EV - PV$$

- In our example, *SV at 2 months* = £7,500 – £10,000 = -£2,500

  SV% = (SV/PV) *100 = (-£2,500/£10,000) *100 = -25%

  – This implies that we are *25% behind* schedule.

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Schedule Variance (SV) – Con.

- It's interesting to note that we aim to understand schedule, a time component, from the perspective of costs.
- To arrive at these costs though, we needed to know the scope of work planned and completed.
- This is how the three pillars—*scope*, *time* and *cost* come together in Earned Value Management (*EVM)*.

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Cost Variance (CV)

- *Cost variance* is a quantitative indicator of your divergence from the initial planned budget.
- A negative CV indicates that we are over budget, a positive CV indicates that we are under budget and zero means that we are exactly on budget.

  CV = EV – AC

  – In our example, CV at 2 months = £7,500 – £15,000 = -£7500

  CV% = (CV/EV) *100 = (-£7,500/£7,500) *100 = -100%

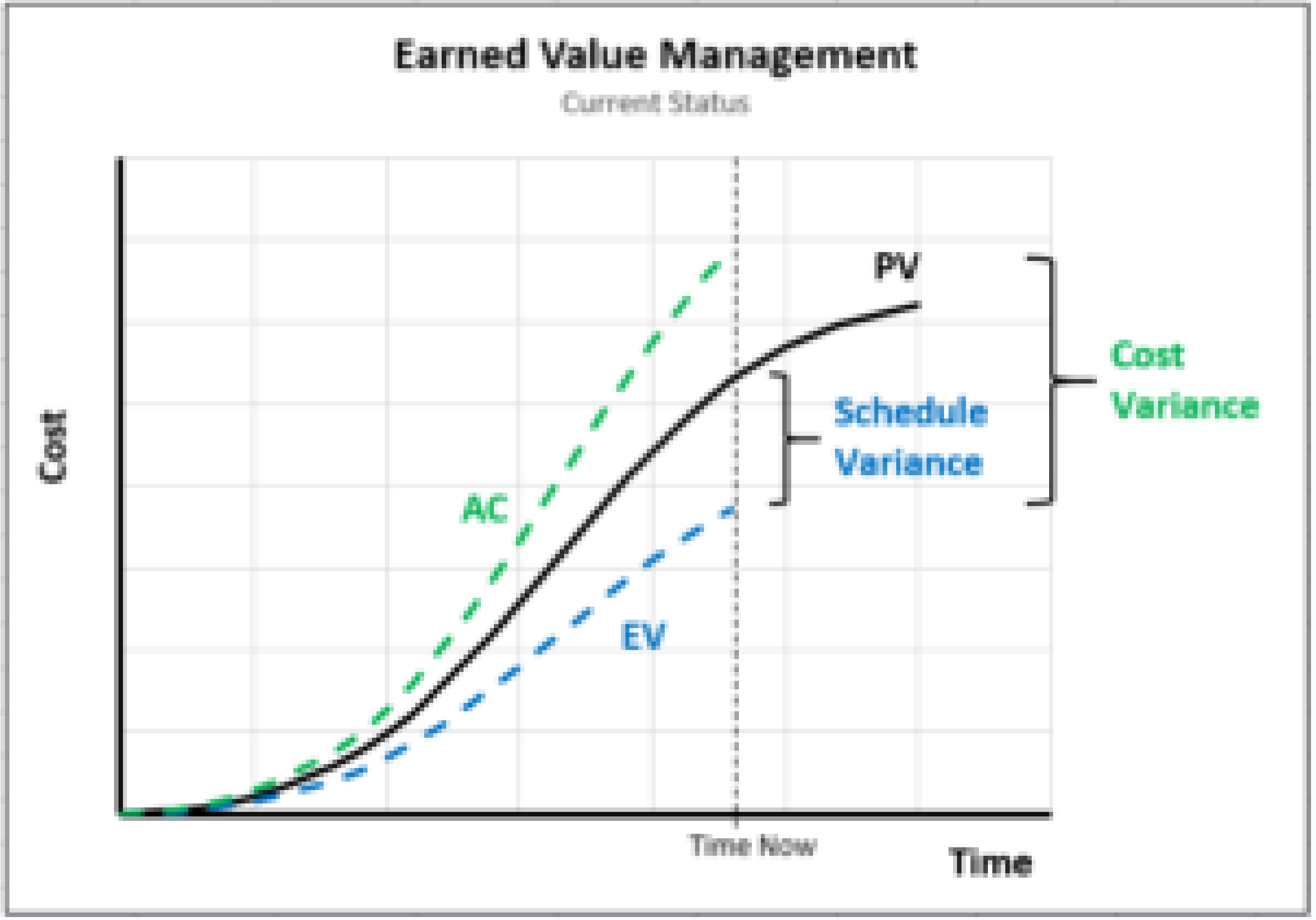
- This implies that we are 100% over budget.
- Again, this is an instance of how scope, time and cost come together to give you a clear picture of where you stand at the moment in your project.

Calculating Variances

- We can summarise all calculations as below:

Parameter	Formula	Calculation	Value
Schedule Variance (SV)	EV - PV	£7500 - £10,000	-£2500
SV%	(SV/PV) *100	(-£2,500/£10,000) *100	-25%
Cost Variance (CV)	EV - AC	£7500 - £15,000	-£7500
CV%	(CV/EV) *100	(-£7,500/£7,500) *100	-100%

Schedule Variance (SV)/Cost Variance (CV)



Schedule Performance Index (SPI)

- Another way of looking at project performance, apart from variance, is through *indexes*.
- *Schedule Performance Index (SPI)* gives a sense of project performance from a schedule perspective.

  $$SPI = EV/PV$$

  – SPI > 1 indicates the project is ahead of schedule and SPI < 1 indicates the project is behind schedule. The SPI, greater than 1.0 is good.
- In our example, SPI = £7,500/£10,000 = 0.75, indicating the project is only going 75% as per the original plan or it’s 25% behind schedule.

Cost Performance Index (CPI)

- *Cost Performance Index (CPI)* gives a sense of project performance from a cost perspective.

  CPI = EV/AC

  – CPI > 1 indicates the project is under budget and CPI < 1 indicates the project is over budget.

- In our example, CPI = £7,500/£15,000 = 0.5

  – CPI = 0.5 means the project has spent *twice* amount that it should have at this point.

  – CPI = 1.0 means the project is on target budget.

  – CPI = 2.0 means the project has spent half the amount that it should have at this point.

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Calculations So Far

- We can summarise all calculations as below:

Parameter	Formula	Calculation	Value
Schedule Variance (SV)	EV - PV	£7500 - £10,000	-£2500
SV%	(SV/PV) *100	(-£2,500/£10,000) *100	-25%
Schedule Performance Index (SPI)	*EV/PV*	£7,500/£10,000	0.75
Cost Variance (CV)	EV - AC	£7500 - £15,000	-£7500
CV%	(CV/EV) *100	(-£7,500/£7,500) *100	-100%
Cost Performance Index (CPI)	CPI = EV/AC	£7,500/£15,000	0.5

Interpreting Earned Value Numbers

- In general, *negative numbers for cost and schedule variance indicate problems in those areas*
- Negative numbers mean the project is *costing more* than *planned* or *taking longer* than planned
- Likewise, *CPI* and *SPI less than one or less than 100 percent* indicate *problems*

Earned Value Forecasting

- Earned Value Management contains four calculations which give the project manager a *forecast* into future performance of the project:
    1. Estimate to Complete (ETC)
    2. Estimate at Completion (EAC)
    3. Variance at Completion (VAC)
    4. To Complete Performance Index (TCPI)
- Each of these are, in essence, an extrapolation from the previous calculation which was used to determine the status of the project right now.

Estimate to Complete (ETC)

- Estimate to Complete (ETC) represents the expected cost required to complete the project.
- It measures only the *future* budget needed to complete the project, not the *entire* budget (that's the EAC, next).
- It allows the project manager to compare the funding needs to finish the project with funding available.
- The ETC can be calculated either for each task or for the whole project.

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Estimate to Complete (ETC) – Calculations

- There are two ways to calculate ETC:

1. Based on past project performance

   $ETC = (BAC - EV) / CPI$ CPI: Cost Performance Index

- Since each of the input variables (right side of the equation) has been determined prior to this step, the ETC can be calculated either for each task or directly for the whole project.

2. Based on a new estimate

   – This is called a *Management ETC*. This means that a new estimate of the remaining tasks in the project is performed.

ETC Calculations – Cont.

- In our example task we will calculate the ETC based on the past performance of the project – approach No 1 in previous slide:
  - *ETC = (BAC – EV) / CPI*
  - *ETC = (£25000 - £7500)/0.5 = £35000*
- This project is worth £25,000 and has already spent £15000. Don't worry, be happy, right? Wrong.
- Based on its past performance we will need another £35000 to complete it.

BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC	EAC	VAC	TCPI
25000	10000	7500	15000	-2500	0.75	-7500	0.5	35000			

Estimate at Completion (EAC)

- The EAC is the full project cost expected at completion (the new project budget).
- It can be calculated on a task-by-task basis or once for the entire project.
- There are multiple ways to calculate it based on how you expect the future of the performance of the project to be.

EAC Method 1– Future performance will be based on the budgeted cost

- If you think the existing variance was a unique event and the rest of the project should go according to plan, simply add the remaining project budget to the actual cost incurred to date (AC).
- This method does not assume the project finishes on budget.
- Rather it considers the one-time event and adjusts the whole project plan upward or downward to estimate the final result.

$$EAC = AC + (BAC - EV)$$

$$EAC = £15000 + (£25000 - £7500) = £32500$$

EAC Method 2 – Future cost performance will be based on past cost performance

- If you think the past performance is not unusual and the past performance is a good indicator of the future, you will use this formula.

  EAC = AC + [(BAC – EV) / CPI]

  EAC = 15000 + [(£25000-£7500) / 0.5] = £50000

- This is the *worst-case* scenario that you have used forecasting using the current trajectory.

EAC Method 3

- Future cost performance will be influenced by past schedule performance
- Since schedule and cost performance are usually related, there could be a reason to adjust the cost performance based on the schedule performance.
- For example, let’s say the CPI (cost efficiency) is very low but SPI (schedule efficiency) is high, you would be justified in thinking that the final cost performance won’t likely be as bad as the CPI would suggest.

EAC Method 3 – Cont.

- Future cost performance will be influenced by past schedule performance
- In the following formula an average of the CPI and SPI are used to extrapolate the final project cost.

$$EAC = AC + [(BAC - EV) / (CPI \times SPI)]$$

- You could also use a combination of the SPI and CPI instead of a straight average. In the formula below, 20% of the SPI and 80% of the CPI has been used to determine the final project cost.

$$EAC = AC + [(BAC - EV) / (0.8 \cdot CPI \times 0.2 \cdot SPI)]$$

EAC Method 4

- A new estimate is produced
  - In this case a Management ETC can be added to the to-date cost (AC) to determine the final EAC.

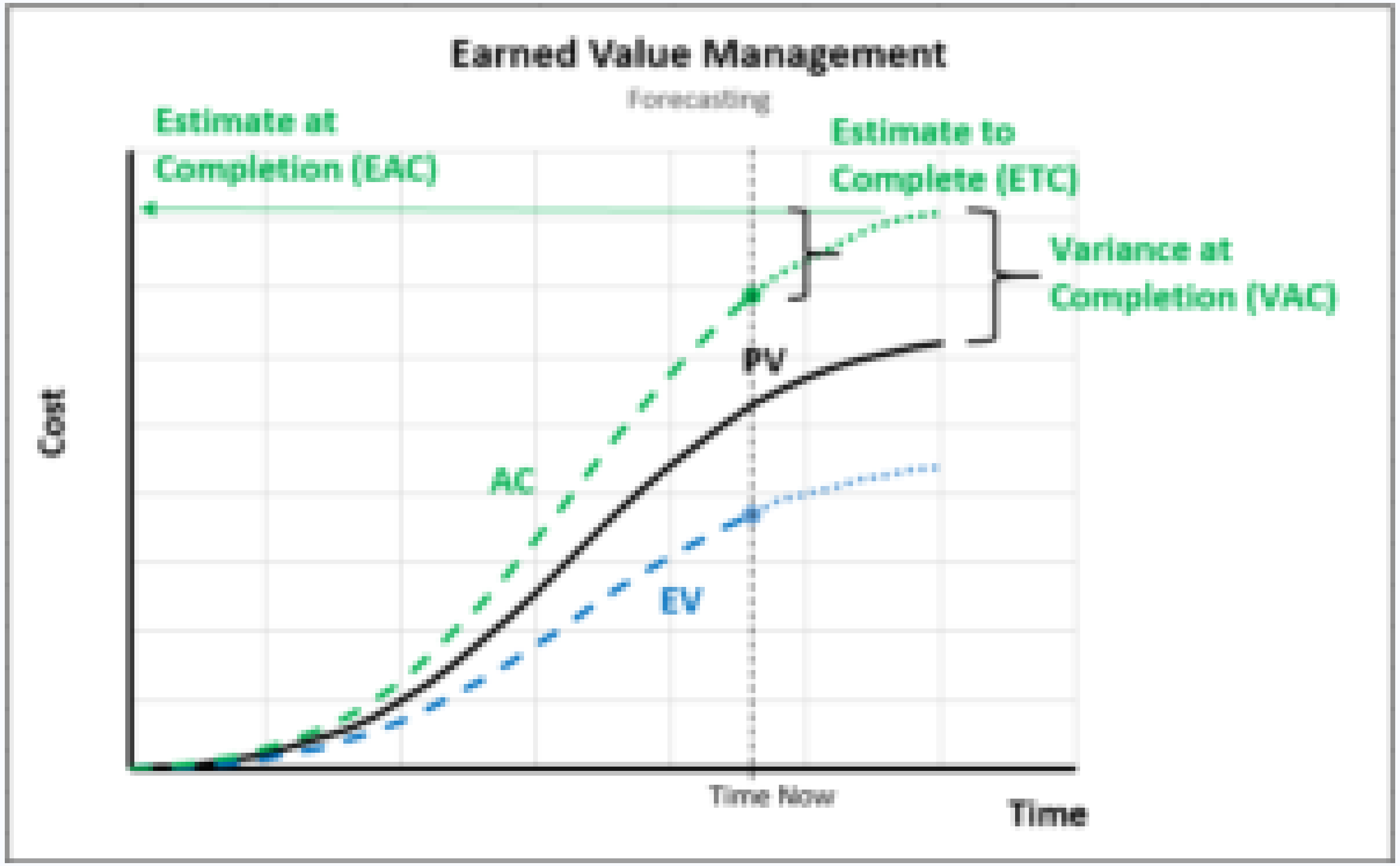
$$EAC = AC + ETC$$

Estimate at Completion (EAC) – Conclusion

- The first two forecasting methods represent the *low* and *high* extremes.
- The third represents an attempt to forecast *somewhere in between* those extremes.
- Finally, the fourth method represents a new estimate, a brand-new value taken from other sources if none of the other methods are able to produce the desired result.

BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC	EAC	VAC	TCPI
25000	10000	7500	15000	-2500	0.75	-7500	0.5	35000	50000		

Estimate at Completion (EAC)



Variance at Completion (VAC)

- The VAC is a forecast of what the variance, specifically the Cost Variance (CV), will be upon the completion of the project.
- It is the size of the expected cost overrun or underrun.
- In many situations the project manager must request additional funding as early as possible, or at least report the potential for an overrun.
- The VAC represents the size of this request. The formula is:
  - *VAC = BAC – EAC*
    = Old Budget – New Budget

BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC	EAC	VAC	TCPI
25000	10000	7500	15000	-2500	0.75	-7500	0.5	35000	50000	25000	

To Complete Performance Index (TCPI)

- The TCPI represents the *efficiency level*, specifically the TCPI, that will make the project finish on time.
- It can be a powerful indicator because it is generally easy to ascertain if your people will be as productive as the *indicator* tells you.
- This indicator tends to be a bigger red flag than other indicators.
- For example, if it says your people need to be *twice as efficient* as the schedule, it tends to make you take notice that action needs to be taken.

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To Complete Performance Index (TCPI) – Calculation

There are two ways to calculate the TCPI:

1. To achieve the original budget
   If the goal is to achieve the original project budget, that is, the overrun or underrun has not resulted in a change to the project schedule and/or budget, the following formula applies:

   $$TCPI = (BAC - EV) / (BAC - AC)$$

2. To achieve the EAC
   If the goal is to achieve the project's EAC, that is, a change has been made to the project and the EAC is the new project budget, use this formula. The EAC becomes the target of the project, and this scenario applies.

   $$TCPI = (BAC - EV) / (EAC - AC)$$

TCPI Calculation – An Example

- We will assume the project budget has not been revised (EAC is simply a projection) and the goal is still the original project budget (formula #1, above).

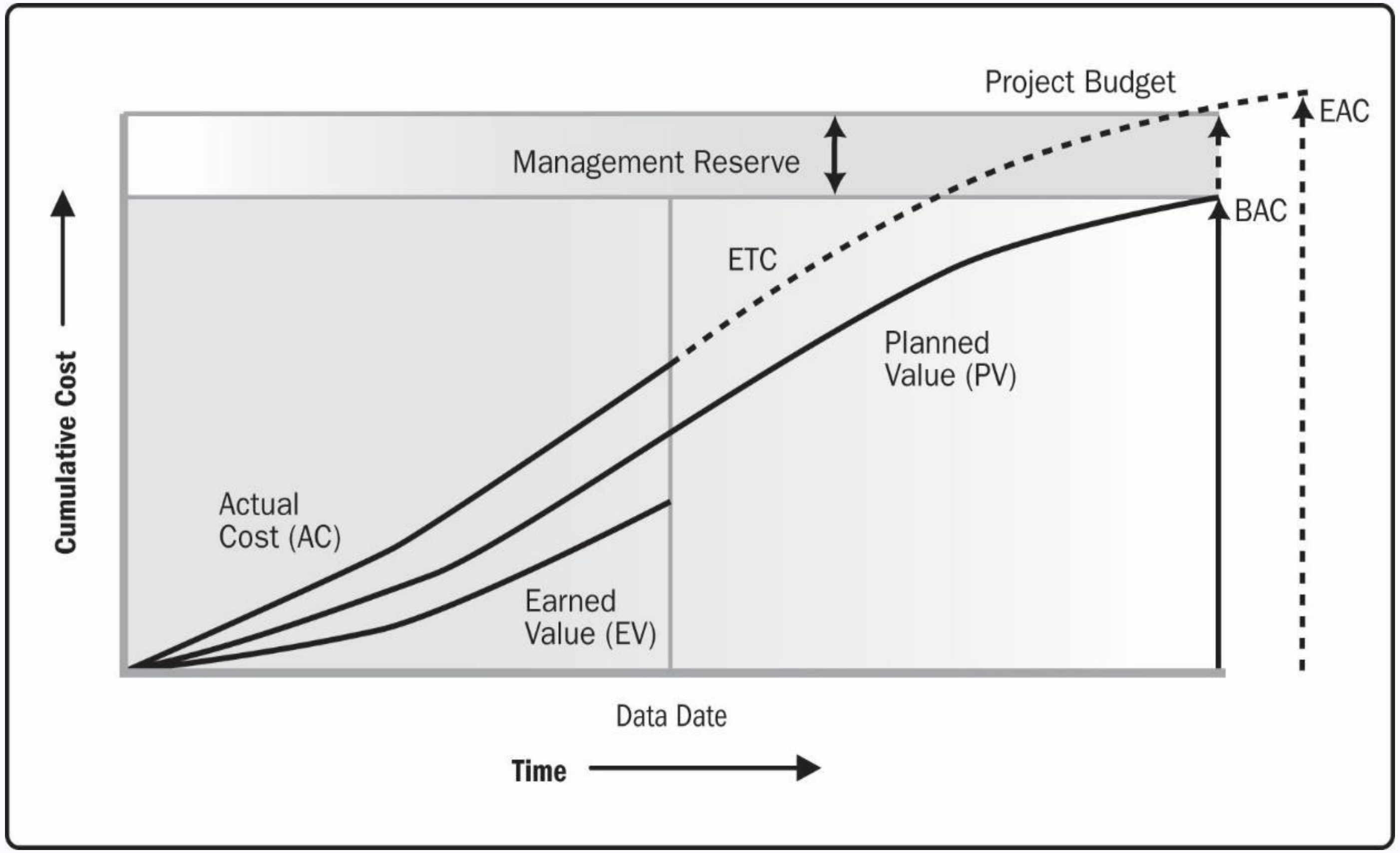
  TCPI = (BAC – EV) / (BAC – AC)

  TCPI = (£25000 -£7500)/ (£25000 - £15000) = 1.75

- This project team must be 75% more efficient than they have been to finish on budget. A seemingly difficult task.

BAC	PV	EV	AC	SV	SPI	CV	CPI	ETC	EAC	VAC	TCPI
25000	10000	7500	15000	-2500	0.75	-7500	0.5	35000	50000	25000	1.75

Earned Value, Planned Value, and Actual Cost



Source: Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Sixth Edition* (2017).

Performance Reports

- Status reports describe where the project stands at a specific point in time.
  - This is a cumulative report of all project activities from the beginning of the project until today. It is a long report and, hence, not sent very frequently.
- Progress reports describe what the project team has accomplished during a certain period.
  - This is a report of the progress of activities from the last time the report was sent. So, this report frequency is higher, and it is shorter that the previous report.
- Forecasts predict future project status and progress based on past information and trends

Controlling Scope

- You cannot control the scope of a project unless you have first clearly defined the scope and set a scope validation process in place
- You also need to develop a process for soliciting and monitoring changes to project scope.
- Stakeholders should be encouraged to suggest beneficial changes and discouraged from suggesting unnecessary changes

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Integrated Change Control

- Integrated change control involves *identifying*, *evaluating*, and *managing* changes throughout the project's life cycle
- Objectives are as follows:
  - Influence the factors that cause changes to ensure that changes are beneficial
  - Determine that a change has occurred
  - Manage actual changes as they occur
- The project team must focus on delivering the work as planned.
- ***However, if changes are necessary the initial plan should be revised.***

Handling Changes

- Changes are a reality in projects.
- These are asked by the stakeholders as they add more value to them.
- However, too many changes are not good as they lead to rework, frustration, and increased costs.
- Changes are also difficult to implement towards the later stages of the project.
  - For example, if the change requires the project's design to be modified then it would be too costly and difficult to implement such a change once the development is almost complete.
- It is best to anticipate changes and have a change control process in place to handle changes as and when they come.

Elements of Change Control Process

- A good change control process should have the following elements:
  1. Change Request Template: This is a standard form that needs to be filled in by the requester of the change.
  2. Change Request SPOC: This is a representative of the team who acts as a Single Point of Contact (SPOC) for changes requested to the project.
  3. Impact Analysis Team: This is a list of people who would be responsible to analyse all change requests and forward their analysis to the approving authority.
  4. Approving Authority: This is the name(s) of one or more stakeholders who would take a decision on whether the requested change should be included or not.

Change Control Process – Cont.

- The following process should be followed for all requested changes:
  1. Feasibility Study: Is it technically possible to implement the requested change?
  2. Impact Analysis: How does the change impact the project's schedule, cost, risk, resources and quality?
  3. Determining Options: What are the various in which this change can be implemented?
  4. Getting Approval: Presenting the analysis and recommendations to the approving authority of the project

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Project Quality Management

- Key outputs of *quality control* include:
  - quality-control measurements, verified deliverables, work performance information, change requests, project management plan updates, and project documents updates
- Outcomes are acceptance decisions, rework, and process adjustments
- What is quality?
  - Quality, simplistically, means that a product should meet its specification.

Challenges of Software Quality

- There is a tension between customer quality requirements (*efficiency*, *reliability*, etc.) and developer quality requirements (*maintainability*, *reusability*, etc.).
- Some quality requirements are *difficult* to specify in an *unambiguous* way.
- Software specifications are usually *incomplete* and often *inconsistent*.
- Therefore, with the previous definition:
  - "*Quality*, simplistically, means that a *product* should meet its *specification*."

We face a difficult dilemma

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Software Quality Programme

- For physical manufactured products like cars or televisions
  - Quality control is able to control the quality of the generated product by controlling the physical manufacturing process
  - such control can compensate for weaknesses in design and/or materials.
  - monitoring items produced, adjusting processes as necessary to achieve acceptable rates of failure (in testing or in use).

Software Quality Programme

- In software development there is no equivalent
  - as there is no opportunity for action at production time to compensate for analysis and design issues.
  - For example, there is no equivalent in software production of resolving a problem with a car component which fails too often in service by specifying a higher grade of steel during production.

The quality compromise

- We cannot wait for specifications to improve before paying attention to quality management.
- We must put quality management procedures into place to improve quality in spite of imperfect specification.

Quality-Control Tools

- Data gathering tools such as check sheets, statistical sampling, questionnaires, and surveys
- Data analysis: Performance reviews and root cause analysis
- Inspection/ Checklists
- Testing/product evaluations
- Data representation: cause-and-effect diagrams, control charts, histograms, and scatter diagrams

Seven Basic Tools of Quality (ASQ*)

1. Cause-and-effect diagrams: Help you find the root cause of quality problems
2. Check sheets: A Check Sheet is a tool to collect both qualitative and quantitative facts about quality problems.
   – When it is used to collect quantitative data, then known as tally sheet
3. Control charts: Illustrate the results of a process over time and show if a process is in control
4. Histograms: Show a bar graph of a distribution of variables

* *American Society for Quality (ASQ)*

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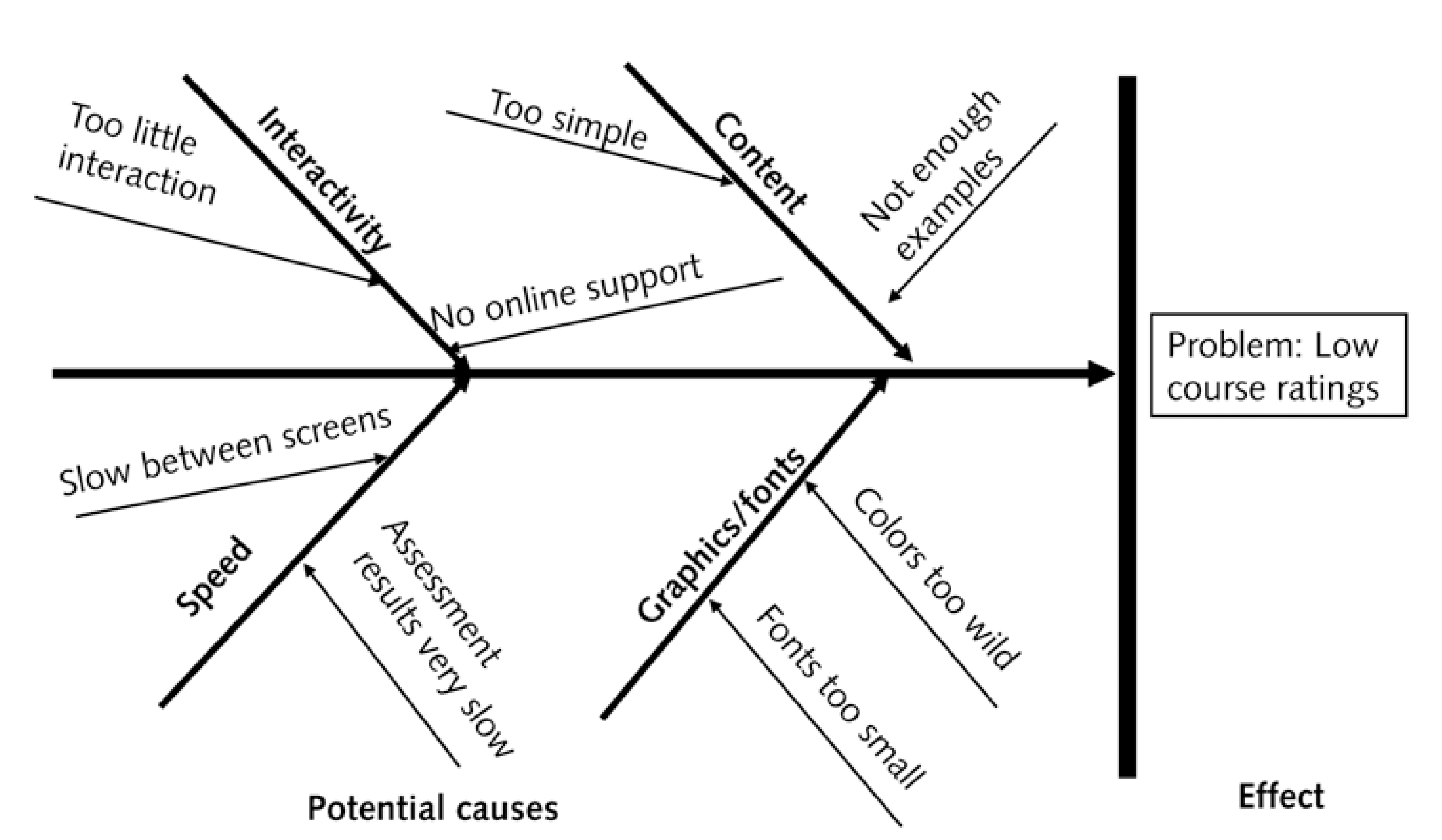
Seven Basic Tools of Quality (ASQ)

5. Pareto charts: Help you identify and prioritize problem areas
6. Scatter diagrams: Show if there is a relationship between two variables
7. Stratification: A technique used to separate data to see patterns in data.
   - A run chart displays the history and pattern of variation of a process over time.
   - A flow chart is a graphical display of the logic and flow of processes that help you analyze how problems occur and how processes can be improved

Sample Cause-and Effect Diagram

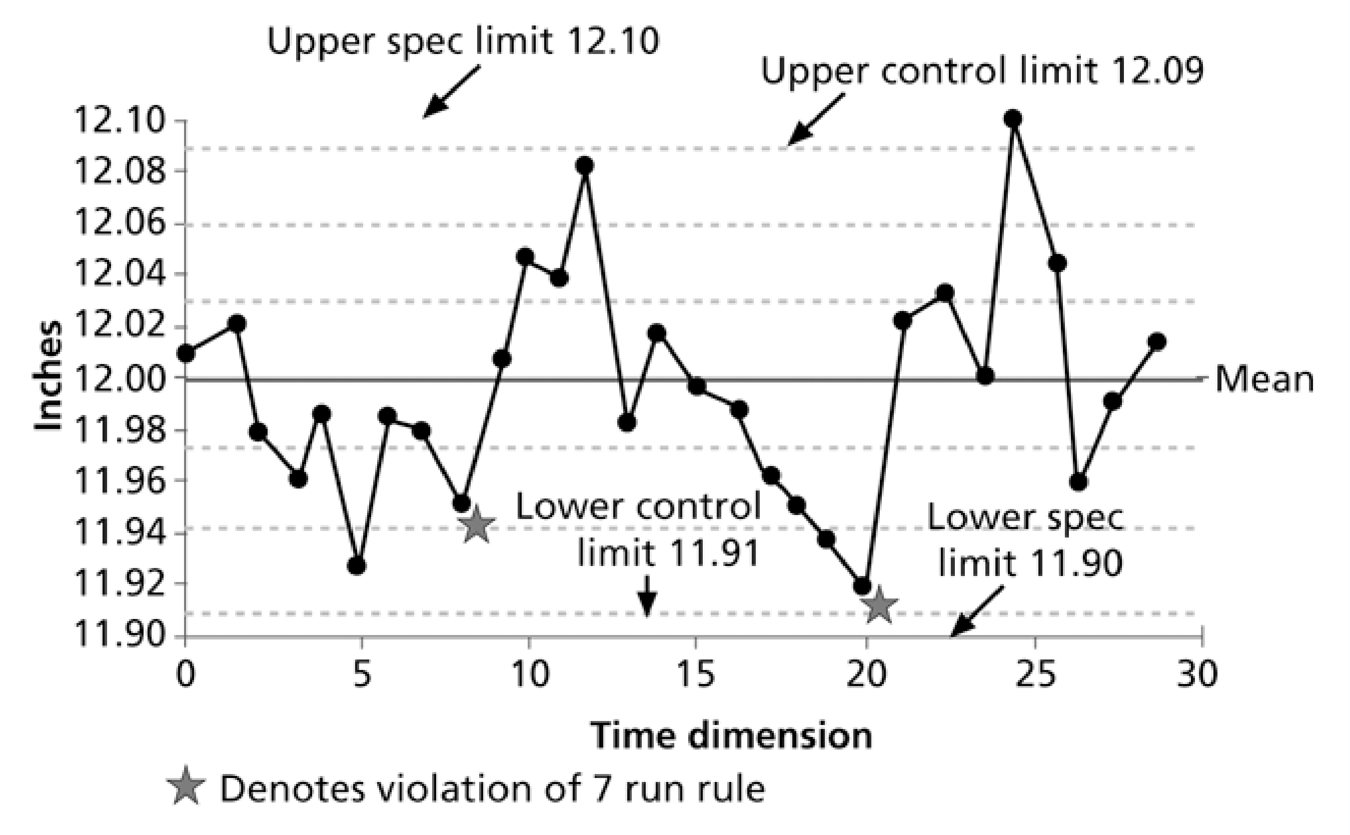


Sample check sheet

Defect	Day 1	Day 2	Day 3	Day 4	Total
Broken link	5	3	2	4	14
Spelling error	2	1	2	2	7
Wrong format	3	2	4	1	10

Sample Control Chart

A control chart is a graphical display of data that illustrates the results of a process over time.



Schwalbe, Information Technology Project Management, Sixth Edition, 2010

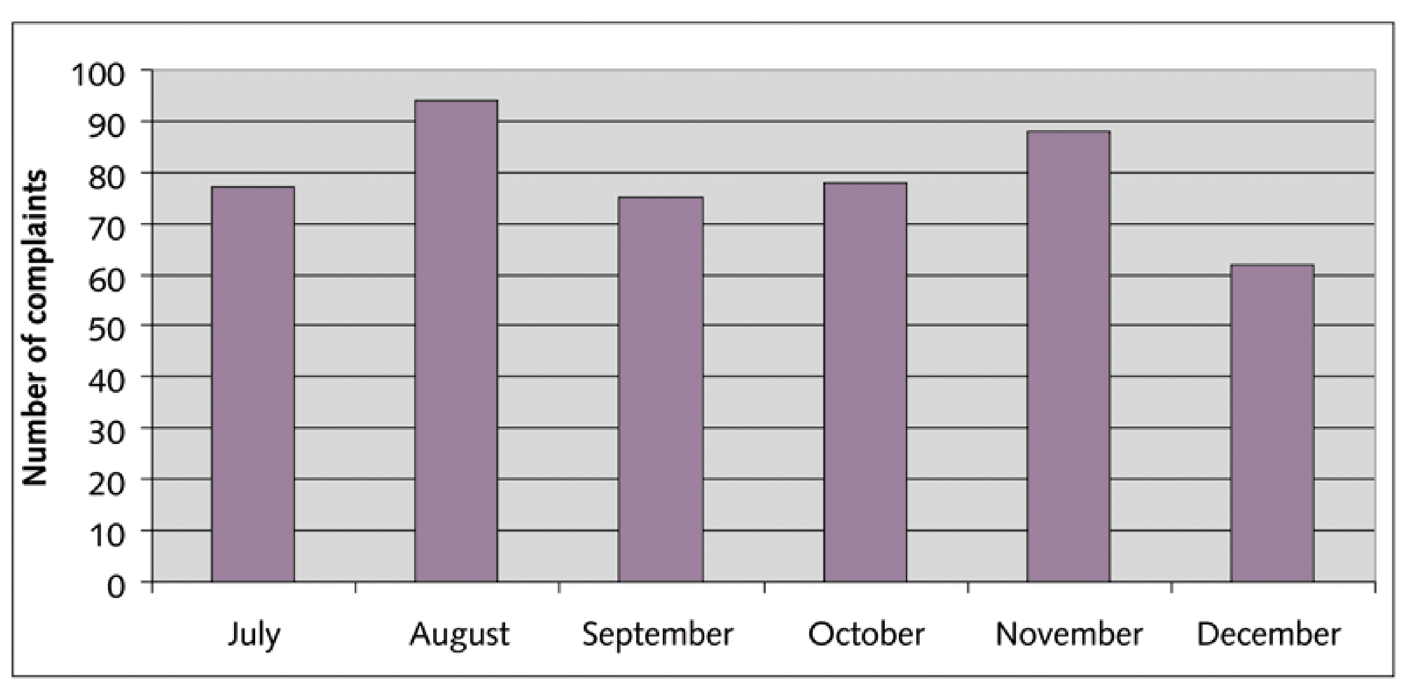
Control chart - Cont.

- Control charts allow you to determine whether a process is *in control* or *out of control*.
- When a process is *in control*, any variations in the results of the process are created by *random* events.
- Processes that are in control do not need to be *adjusted*.
- When a process is *out of control*, variations in the results of the process are caused by *non-random* events.
- When a process is out of control, you need to identify the causes of those non-random events and adjust the process to correct or eliminate them.

Control chart - The seven-run rule

- You can use control charts and the *seven-run rule* to look for patterns in data.
- The *seven-run rule* states that if seven data points in a row are all below the mean, above the mean, increasing, or decreasing, then the process needs to be examined for non-random problems.
- In the previous Figure data points that violate the seven-run rule are starred.
  - The first starred point has seven data points in a row that are all below the mean. The second one has seven data points in a row that are all decreasing.

Sample Histogram

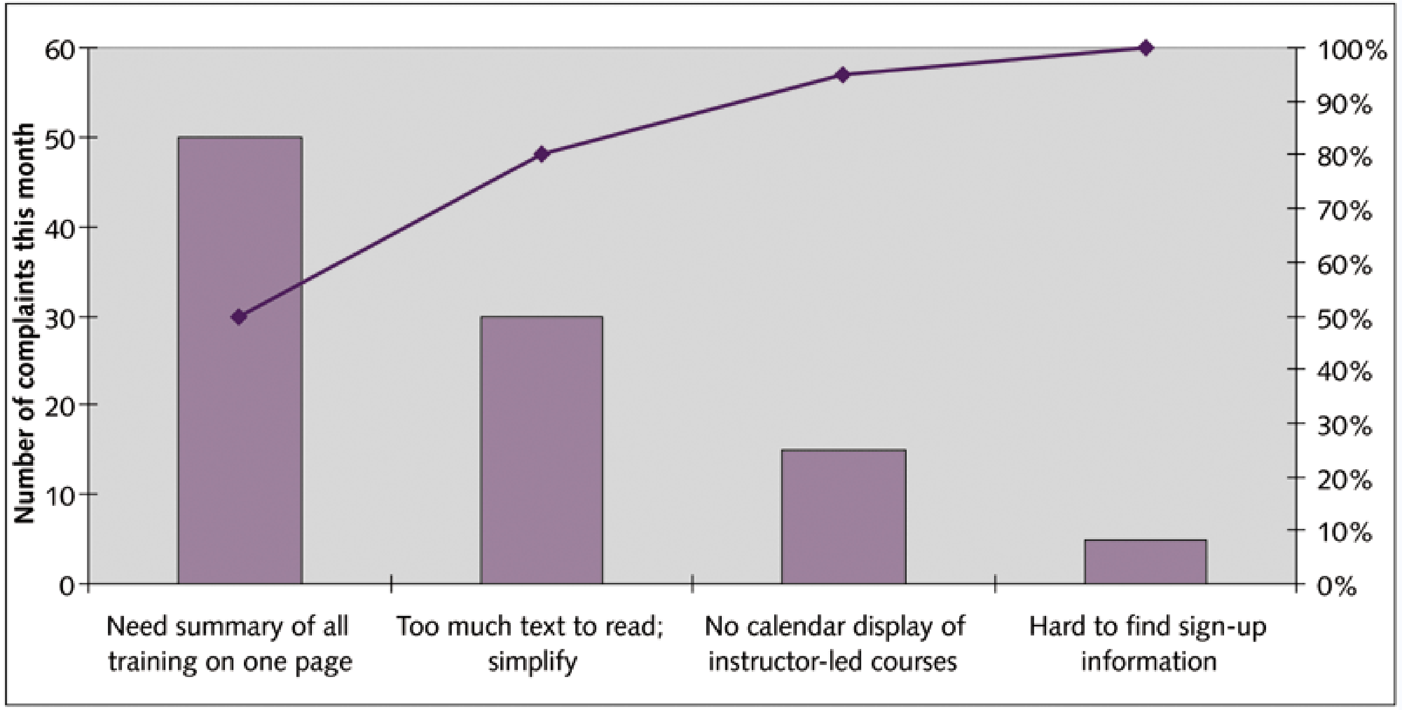


Each bar represents an attribute or a characteristic of a problem or a measurement point, and the height of the bar represents its frequency.

Pareto charts

- A Pareto chart is a histogram that can help you *identify* and *prioritize problem* areas.
- The variables described by the histogram are *ordered* by *frequency* of *occurrence* in a column chart, and a *line chart* is added to show *cumulative percentage* on the right of the chart.
- Pareto charts help you identify the *vital few contributors* that *account* for *most quality problems* in a system.
- Pareto analysis is sometimes referred to as the *80/20 rule*, meaning that 80% of problems are often due to 20% of the causes.

Sample Pareto Chart



- The solid line represents the cumulative amount of problems. Note that Pareto charts work best when the problem areas are of equal importance.

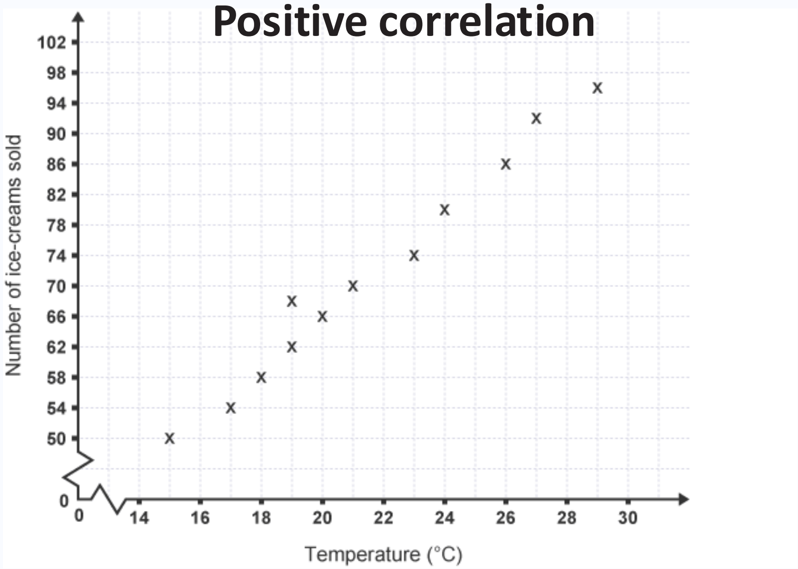
- For example, if a life-threatening problem was reported, it should be considered before less important problems.

Scatter diagram

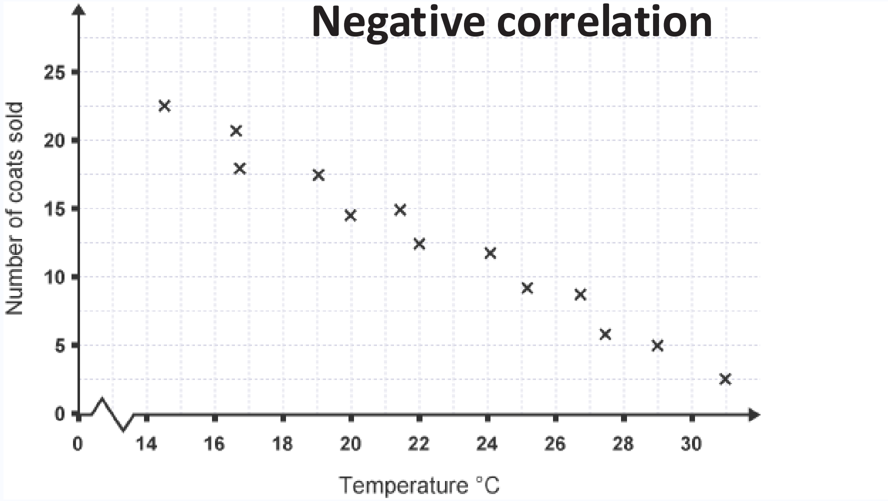
- A scatter diagram helps show if there is is a correlation, or connection between two sets of data.
- The closer data points are to a diagonal line, the more closely the two variables are related.
- Types of correlation : Graphs can either have *positive* correlation, *negative* correlation or *no correlation*.
- Note: it is important to remember that correlation does not imply causation. If data plotted on a scatter graph shows correlation, we cannot assume that the increase in one of the sets of data caused the increase or decrease in the other set of data – it might be coincidence or there may be some other cause that the two sets of data are related to.

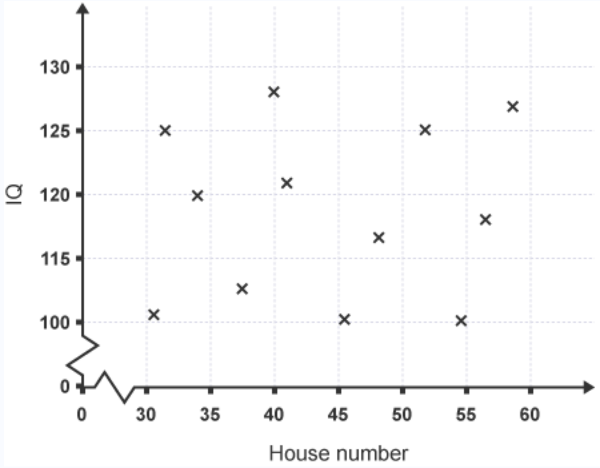
Types of correlation

Positive correlation



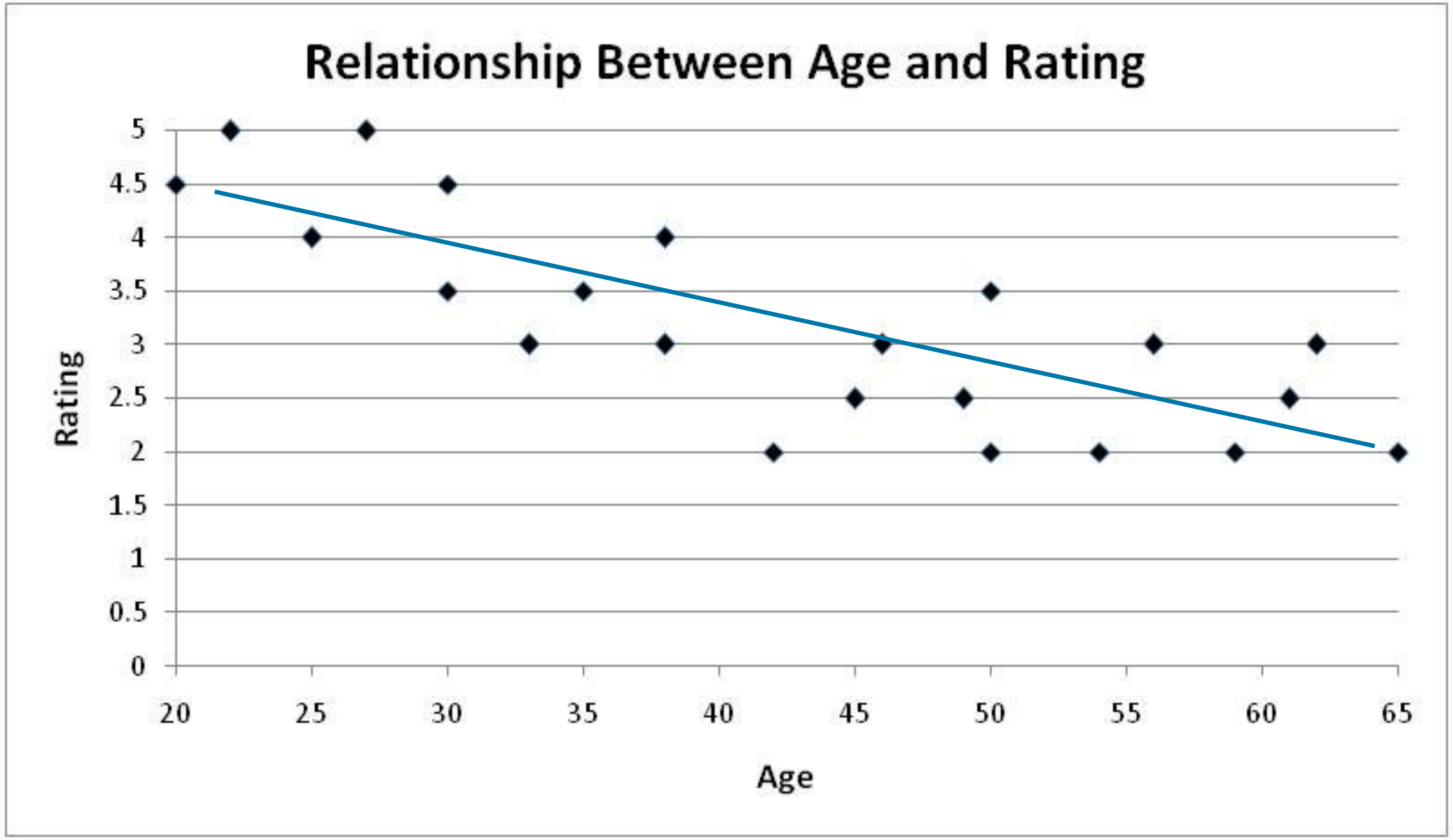
Negative correlation





No correlation

Sample Scatter Diagram



Stratification

- *Stratification* is a technique used to *separate* data to see patterns in data.
- Some sources use *run charts* or *flow charts* in place of stratification.
- A *run chart* displays the history and pattern of variation of a process over time. It is a line chart that shows data points plotted in the order in which they occur.
- You can use run charts to perform trend analysis to forecast future outcomes based on historical results.
- For example, trend analysis can help you analyse how many defects have been identified over time to determine if there are trends.

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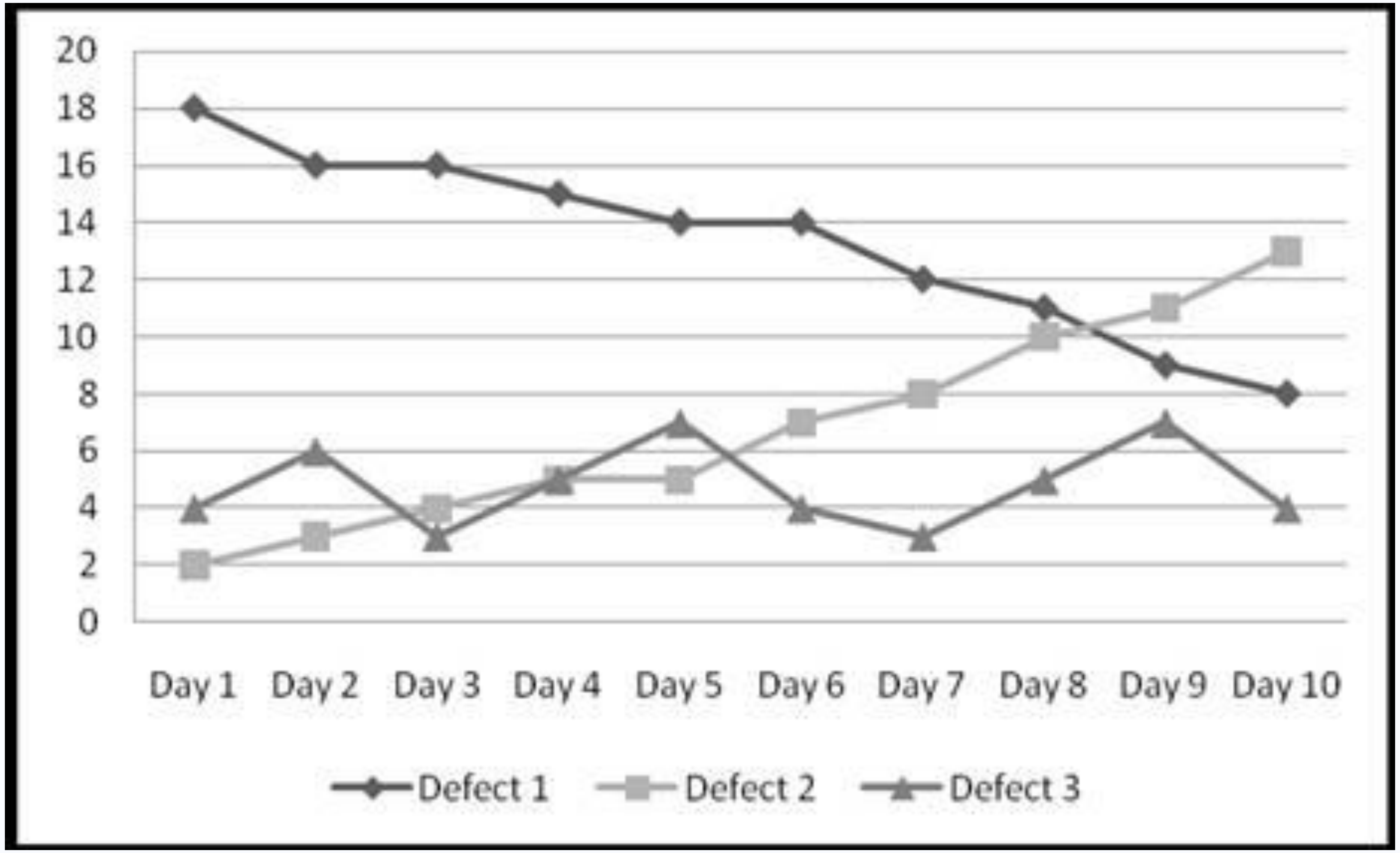
Sample Run Chart



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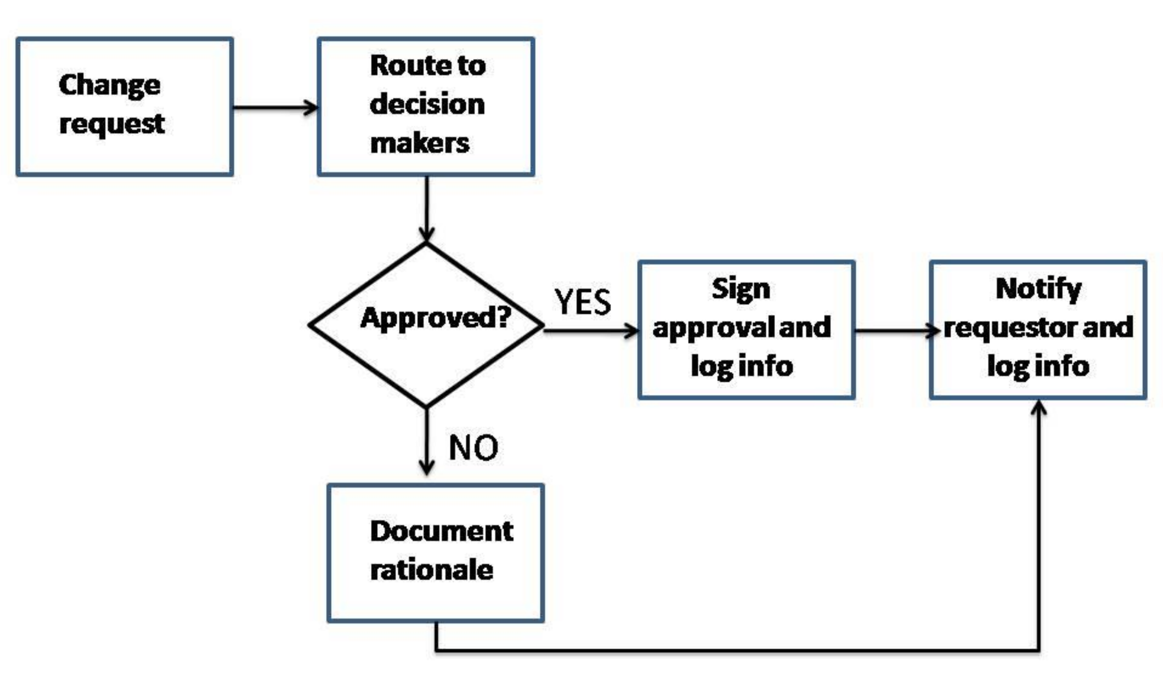
Sample Flowchart



A **flow chart** is a graphical display of the logic and flow of processes that help you analyse how problems occur and how processes can be improved. They show activities (using the square symbol), decision points (using the diamond symbol), and the order of how information is processed (using arrow symbols).

Monitoring And Controlling Agile/Hybrid Projects

- In agile, work progress and results are monitored in each Daily Scrum and in each Sprint Review.
- In case of deviations from the plan, one can quickly initiate actions , i.e. controls, such as rescheduling, possibly adapt the procedure and learn from it (inspect, adapt and learn).
- Burn charts show project team velocity.
- Velocity measures the productivity rate at which the deliverables are produced, validated, and accepted within a predefined interval.

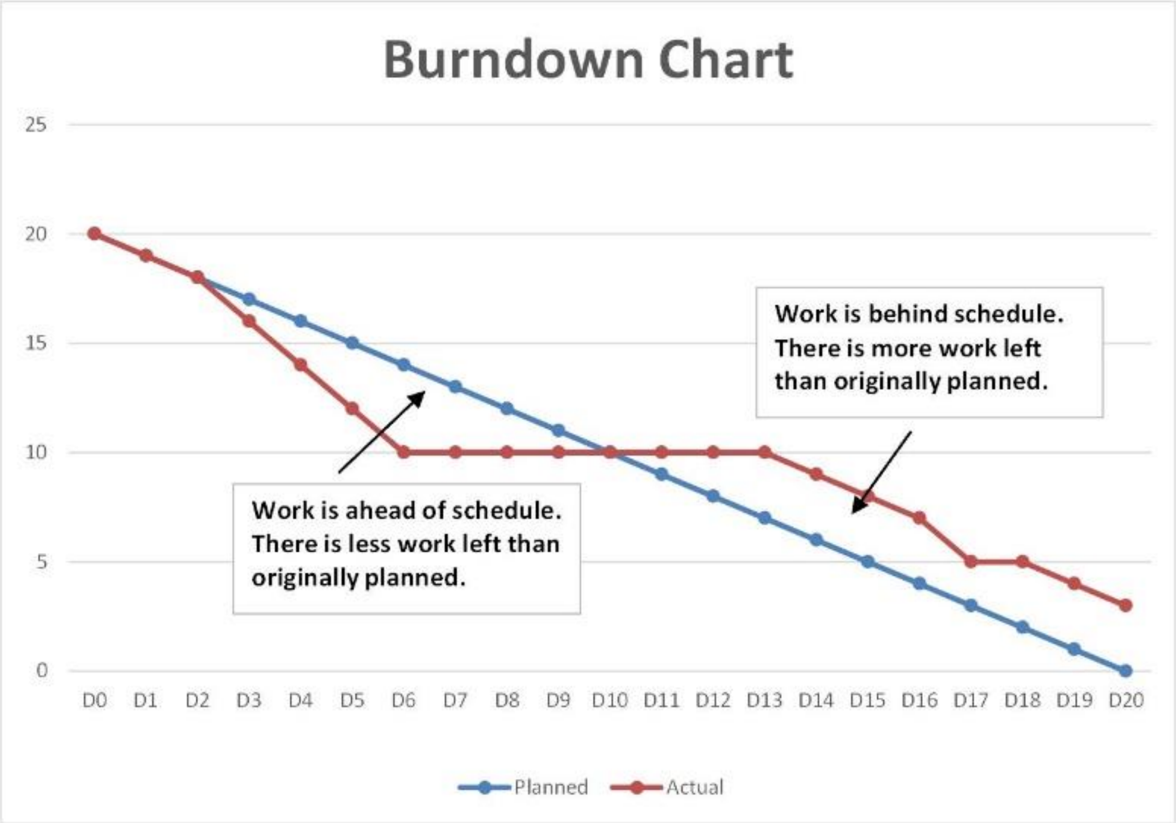
Monitoring And Controlling Agile/Hybrid Projects

- You can create the following types of burn charts:
  - Burndown charts show the amount of work (number of tasks) remaining compared to the plan. They are often used for each sprint and discussed during sprint retrospectives.
  - Burnup charts show the amount of work (tasks) completed compared to the plan. They can be used during each sprint, and they can also show progress for several sprints.
  - Combined burn charts show how much work has been completed and how much remains.

Sprint Burndown Chart

Number of Tasks

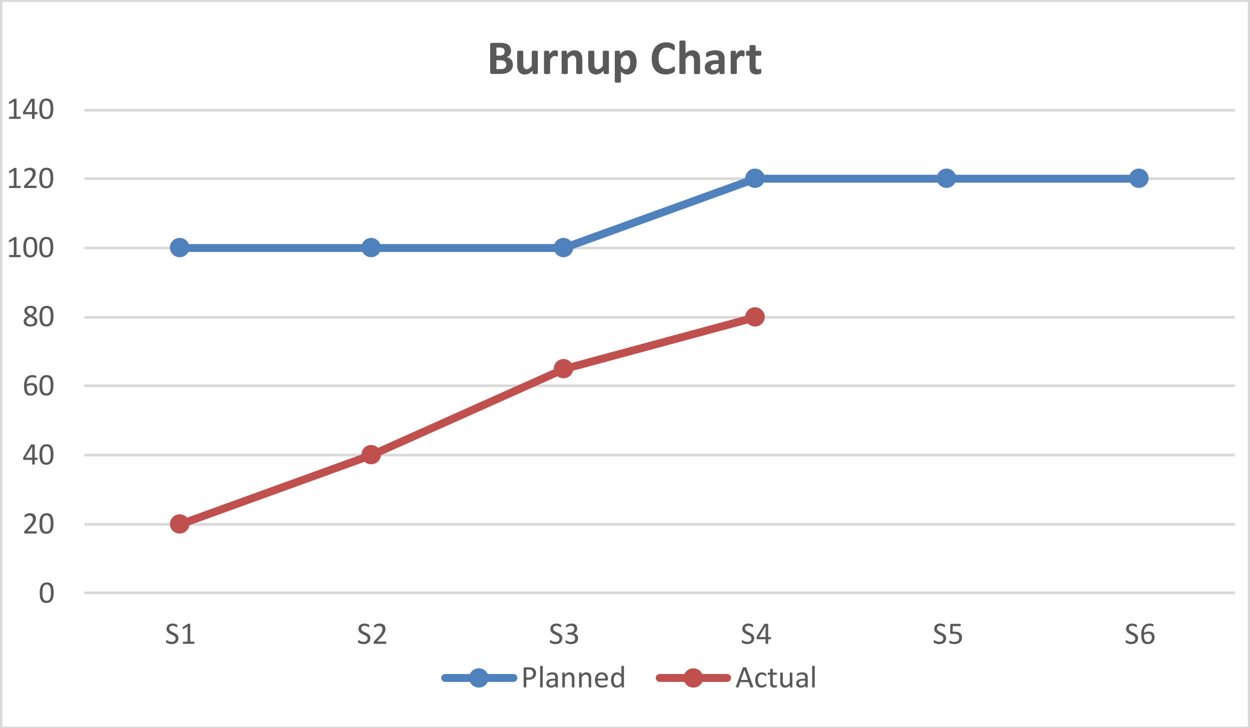
Days	Planned	Actual
D0	20	20
D1	19	19
D2	18	18
D3	17	16
D4	16	14
D5	15	12
D6	14	10
D7	13	10
D8	12	10
D9	11	10
D10	10	10
D11	9	10
D12	8	10
D13	7	10
D14	6	9
D15	5	8
D16	4	7
D17	3	5
D18	2	5
D19	1	4
D20	0	3



Sample Burnup Chart

Number of Tasks

Sprints	Planned	Actual
S1	100	20
S2	100	40
S3	100	65
S4	120	80
S5	120	
S6	120	



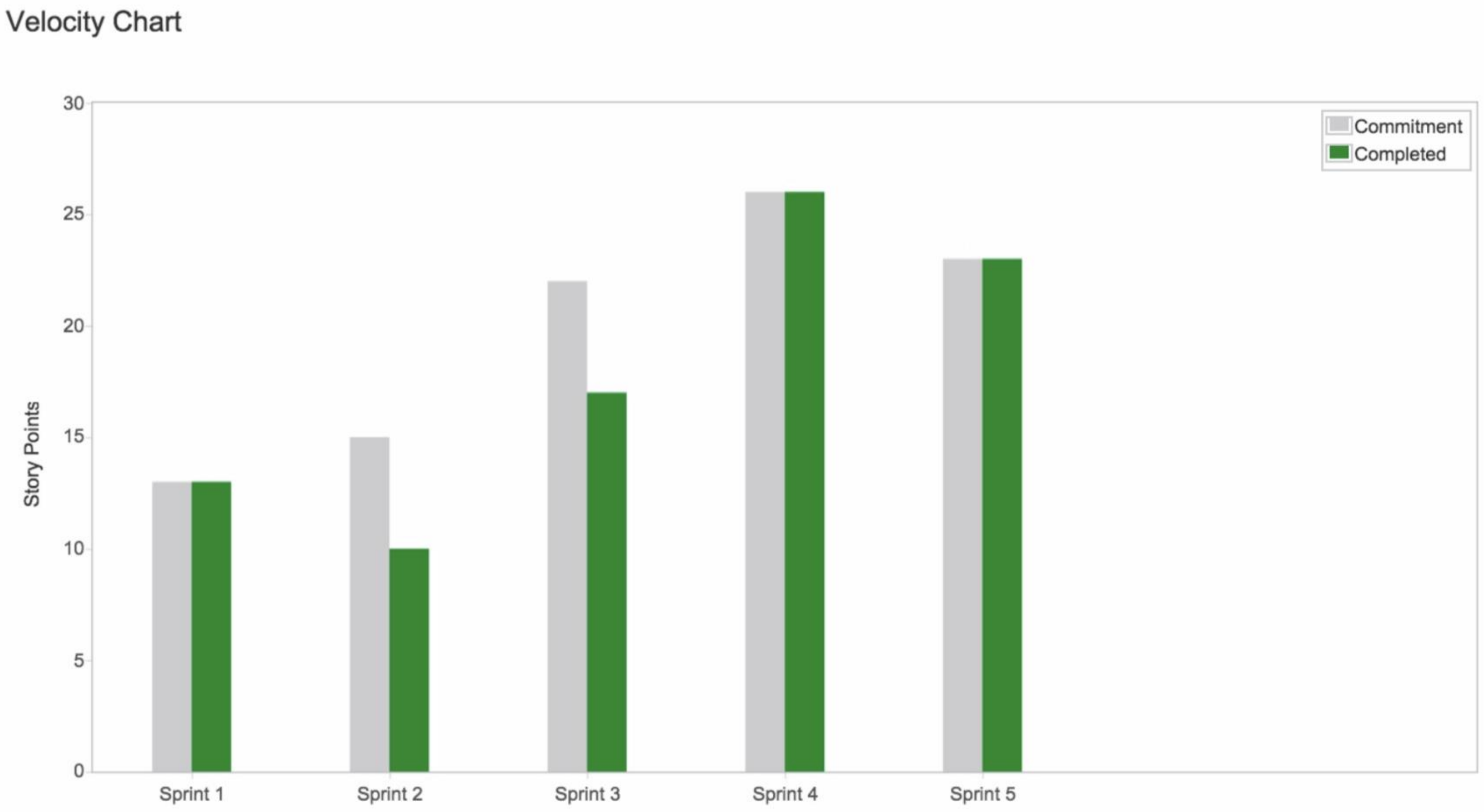
Velocity Charts

- Sprint teams use velocity to measure how much work they can complete in each iteration.
- It is widely used to help teams create accurate and efficient timelines.
- Sprint team velocity is not constant; rather, it varies.
  - Note that velocity charts are not intended to be a tool for monitoring the team.
  - They are most useful as a tool for release planning.
- The velocity chart is created after the first sprint and updated after each completed sprint.

Velocity Charts – Cont.

- The velocity of the sprints helps managers to calibrate the release plan.
- The Velocity Chart shows the amount of value delivered in each sprint, enabling you to predict the amount of work the team can get done in future sprints.
- It is useful during your sprint planning meetings, to help you decide how much work you can feasibly commit to.

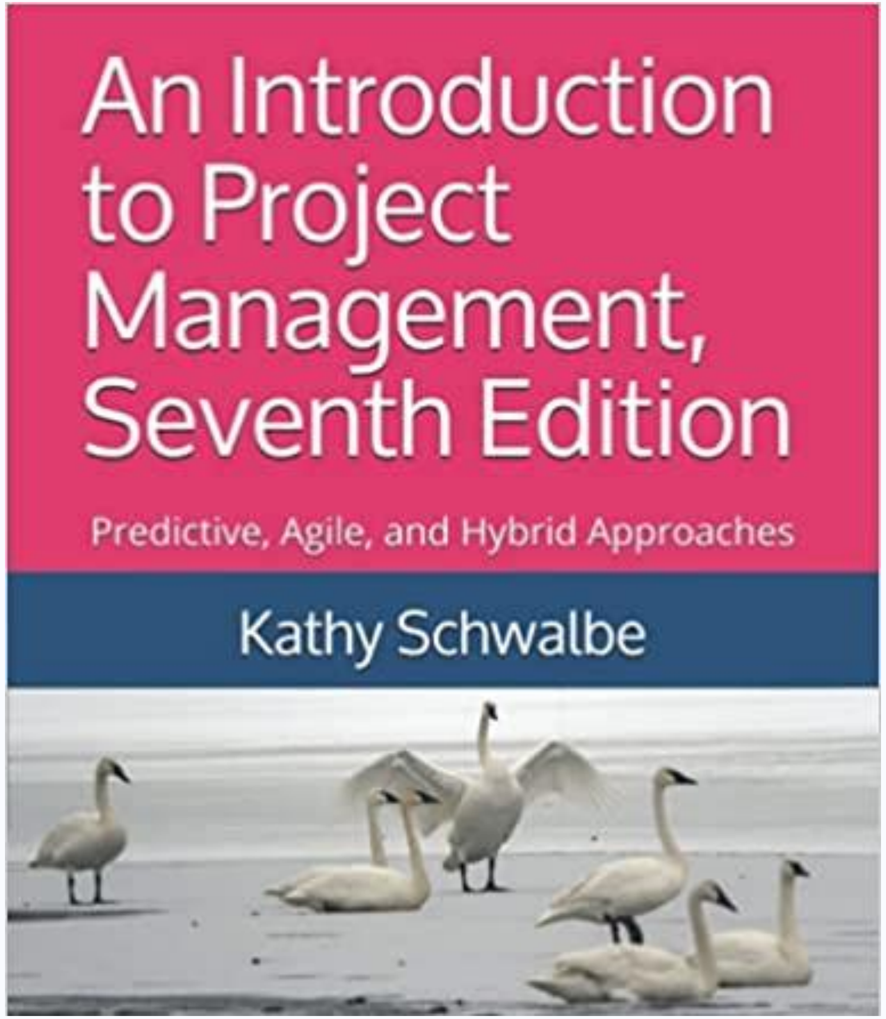
Sample Velocity Chart



Sprint	Commitment	Completed
Sprint 1	13	13
Sprint 2	15	10
Sprint 3	22	17
Sprint 4	26	26

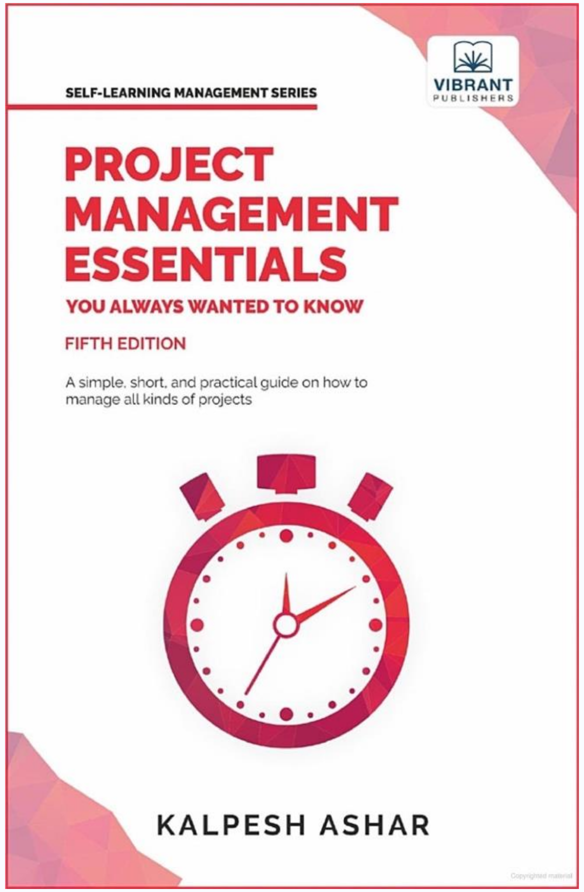
Reference

- Chapter 8: Monitoring and Controlling Projects



Reference

- Chapter 6 of:
  Project Management Essentials You Always Wanted To Know, 5ed



YOUR QUESTIONS