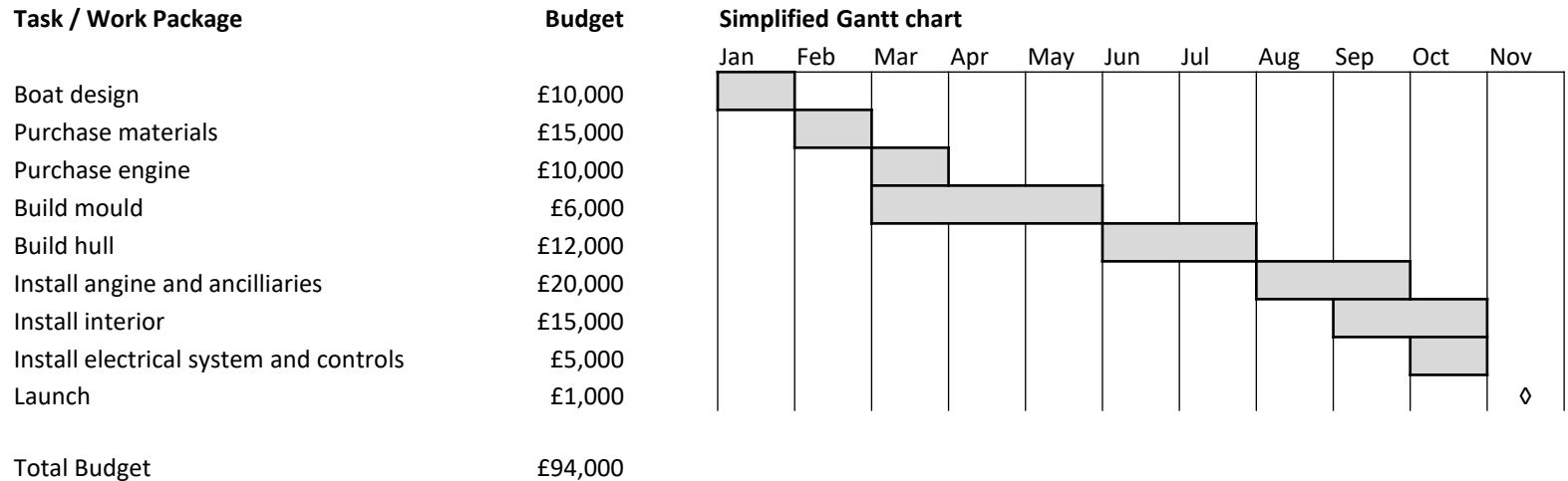**Department of Mechanical, Materials and Manufacturing Engineering**

Project Monitoring - Part 2

- *Explaining EVA using a worked example*

- *Defining BCWS, BCWP and ACWP*

The technique of Earned Value Analysis is presented using the example of a project building a power boat

Task / Work Package | **Budget** | **Simplified Gantt chart**

| Task / Work Package	Budget	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Boat design	£10,000	▣										
Purchase materials	£15,000		▣									
Purchase engine	£10,000			▣								
Build mould	£6,000			▣	▣	▣						
Build hull	£12,000						▣	▣				
Install angine and ancilliaries	£20,000								▣	▣		
Install interior	£15,000									▣	▣	
Install electrical system and controls	£5,000										▣	
Launch	£1,000											◊
Total Budget	£94,000											

- To the right of this are the task names

- The column to the right shows the budgeted (or predicted) cost of each task

- On the right hand side is a simplified Gantt chart indicating the expected progress of the project.
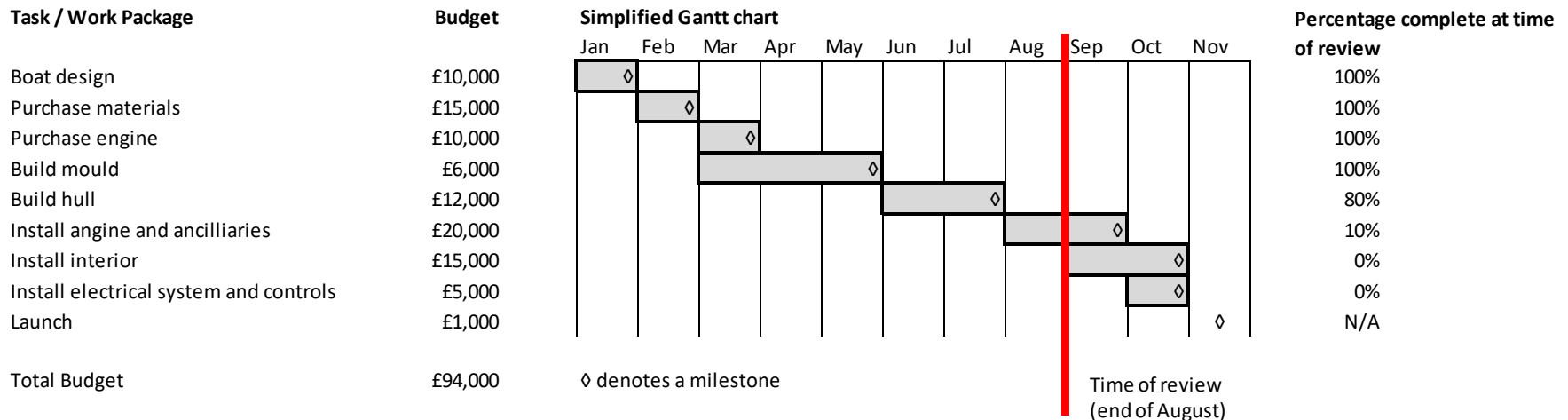
→ *It is usual to assume that all spend increases linearly within a task unless extraordinary (e.g. lumpy) costs are expected*.

- From this data we can plot the budgeted cost at convenient points

- In his case we plot on a monthly basis

- We will always use time, but it is equally possible to plot on the basis of milestones

Cumulative predicted monthly spend
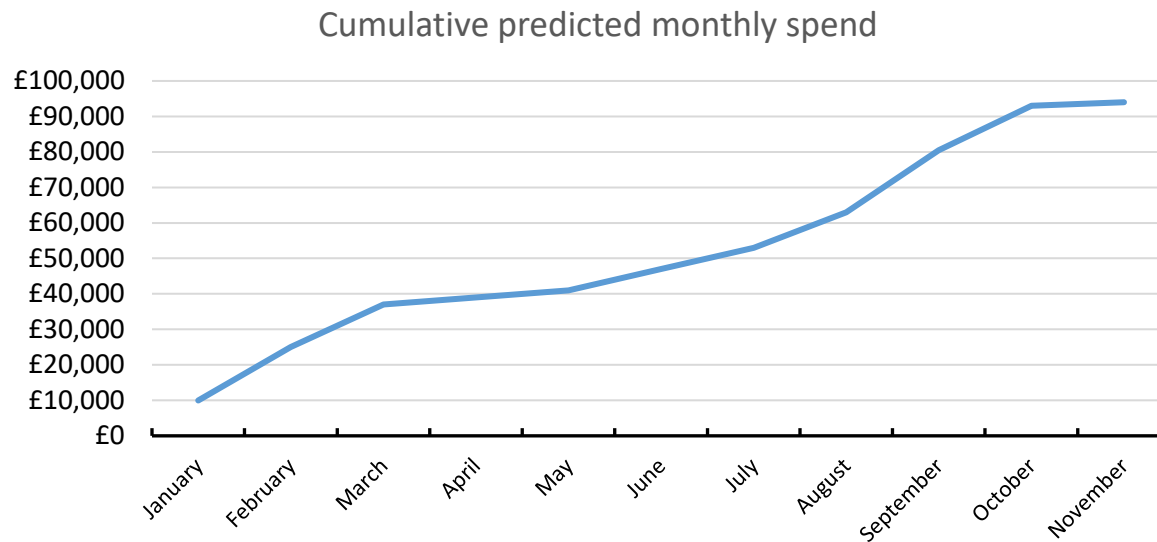
Now we can construct our programme showing the expected costs

- Sometimes it is convenient to show milestones as well

- This shows milestones at the end of tasks (not always the case)

- It is usual to try to keep time between milestones reasonably short
    - Longer tasks may be sub-divided to achieve this

- We are carrying out a review at the end of August, so the state of the programme at that stage is indicated.

Task / Work Package	Budget	Simplified Gantt chart	Percentage complete at time of review
Boat design	£10,000	Jan ◊	100%
Purchase materials	£15,000	Feb ◊	100%
Purchase engine	£10,000	Mar ◊	100%
Build mould	£6,000	Mar–May ◊	100%
Build hull	£12,000	Jun–Jul ◊	80%
Install angine and ancilliaries	£20,000	Aug–Sep ◊	10%
Install interior	£15,000	Sep–Oct ◊	0%
Install electrical system and controls	£5,000	Oct ◊	0%
Launch	£1,000	Nov ◊	N/A
Total Budget	£94,000	◊ denotes a milestone	Time of review (end of August)

- Note that at this point, only 80% of "Build hull" is complete and only 10% of "Install engine and ancillaries" is complete.

The Budgeted Cost of Work Scheduled (BCWS)

- Now we introduce the first of the parameters, or Key Performance Indicators (KPIs), that we require to carry out the **Earned Value Analysis** (EVA)

- The first step is to plot out the estimated cumulative spend at each stage.
    - In this case at the end of each month.

- This is called the "**Budgeted Cost of Work Scheduled**" **(BCWS)**

Month	BCWS	Cumulative BCWS
January	£10,000	£10,000
February	£15,000	£25,000
March	£12,000	£37,000
April	£2,000	£39,000
May	£2,000	£41,000
June	£6,000	£47,000
July	£6,000	£53,000
August	£10,000	£63,000

This shows the data that have been drawn from the previous chart

- Note that the numbers reflect *where we expect to be*

- **NOT** where we are

- NOTE that we will plot the *cumulative* budget

CUMULATIVE BCWS - BY MONTH
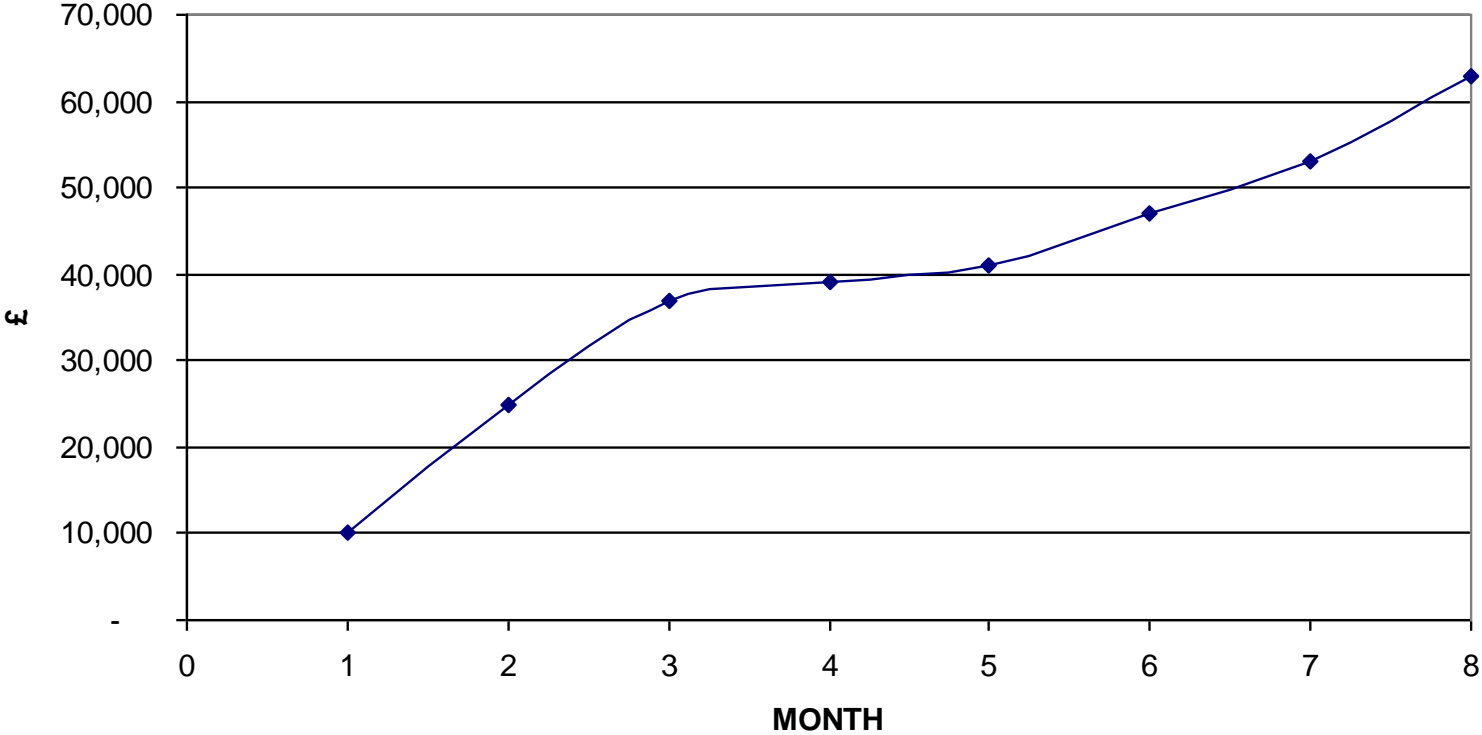
THE PROJECT AT THE TIME OF THE REVIEW

At the review it is probable that:

- The costs are not to plan
- The programme is not to schedule

At the August review, the Programme Manager finds that the programme is as shown below.

→ Note that costs are presented as **budgeted costs against the plan, whereas progress is the actual progress**

Task / Work Package	Budget	Simplified Gantt chart	Percentage complete at time of review
Boat design	£10,000		100%
Purchase materials	£15,000		100%
Purchase engine	£10,000		100%
Build mould	£6,000		100%
Build hull	£12,000		80%
Install angine and ancilliaries	£20,000		10%
Install interior	£15,000		0%
Install electrical system and controls	£5,000		0%
Launch	£1,000		N/A
Total Budget	£94,000	◊ denotes a milestone	Time of review (end of August)

Gantt chart months: Jan Feb Mar Apr May Jun Jul Aug

Compare this to the planned programme:

- Actual schedule:
    - Build mould takes 4 months rather than the planned 3
    - Build hull starts one month late
    - The build hull task is 80% complete
    - The install engine task is only 10% complete

- Actual costs:
    - Build mould costs £12,000 rather than £6,000
    - Build hull is £8,000 (at 80% complete) rather than £12,000
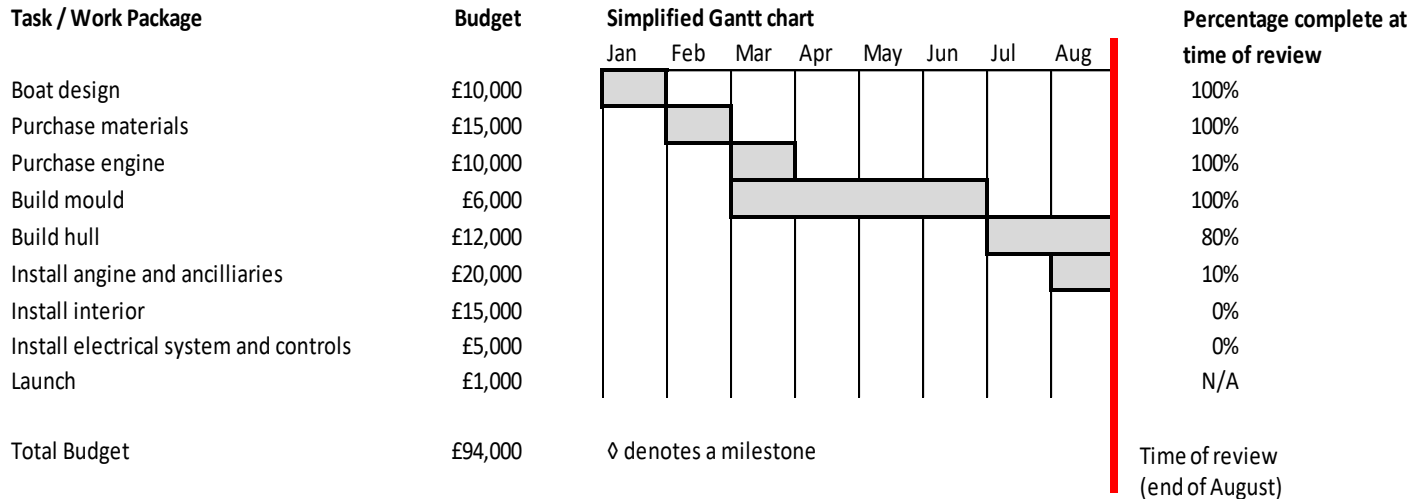   - Install engine is £500 (at 10% complete) rather than the £5,000 expected at the end of August

The Budgeted Cost of Work Performed (BCWP)

- The BCWP is a measure of how much work has actually been completed, also known as **"Earned Value"**

- If we monitor the work on he basis of the budgeted (expected) costs, then an under-spend indicates that less work than expected has been completed

Example:

- At the review BCWS = £100,000 and the BCWP = £80,000

- This indicates that only 80% or the planned work has been done.

- At the completion of the project the BCWP can not be greater than the BCWS → **as this refers to budgeted cost, it can not reflect over-spend**

- In mid programme, BCWP > BCWS indicates that the work is *ahead* of schedule.

The next step: calculate the BCWP for the revised programme from the original BCWS

Task / Work Package	Budget	Simplified Gantt chart	Percentage complete at time of review
		Jan Feb Mar Apr May Jun Jul Aug	
Boat design	£10,000		100%
Purchase materials	£15,000		100%
Purchase engine	£10,000		100%
Build mould	£6,000		100%
Build hull	£12,000		80%
Install angine and ancilliaries	£20,000		10%
Install interior	£15,000		0%
Install electrical system and controls	£5,000		0%
Launch	£1,000		N/A
Total Budget	£94,000	◊ denotes a milestone	

Time of review (end of August)

Using budgeted cost, but actual schedule!

- First three tasks don't change

- Build mould task is still £6,000 but spread over 4 rather than 3 months.

- Build hull is 80% of £12,000 = £9,600.

- Install engine = 10% of £10,000 = £1,000

Now we extend the table to include BCWP:

Month	BCWS	Cumulative BCWS	BCWP	Cumulative BCWP
January	£10,000	£10,000	£10,000	£10,000
February	£15,000	£25,000	£15,000	£25,000
March	£12,000	£37,000	£11,500	£36,500
April	£2,000	£39,000	£1,500	£38,000
May	£2,000	£41,000	£1,500	£39,500
June	£6,000	£47,000	£1,500	£41,000
July	£6,000	£53,000	£4,800	£45,800
August	£10,000	£63,000	£6,800	£52,600

….. and plot cumulative BCWP with BCWS
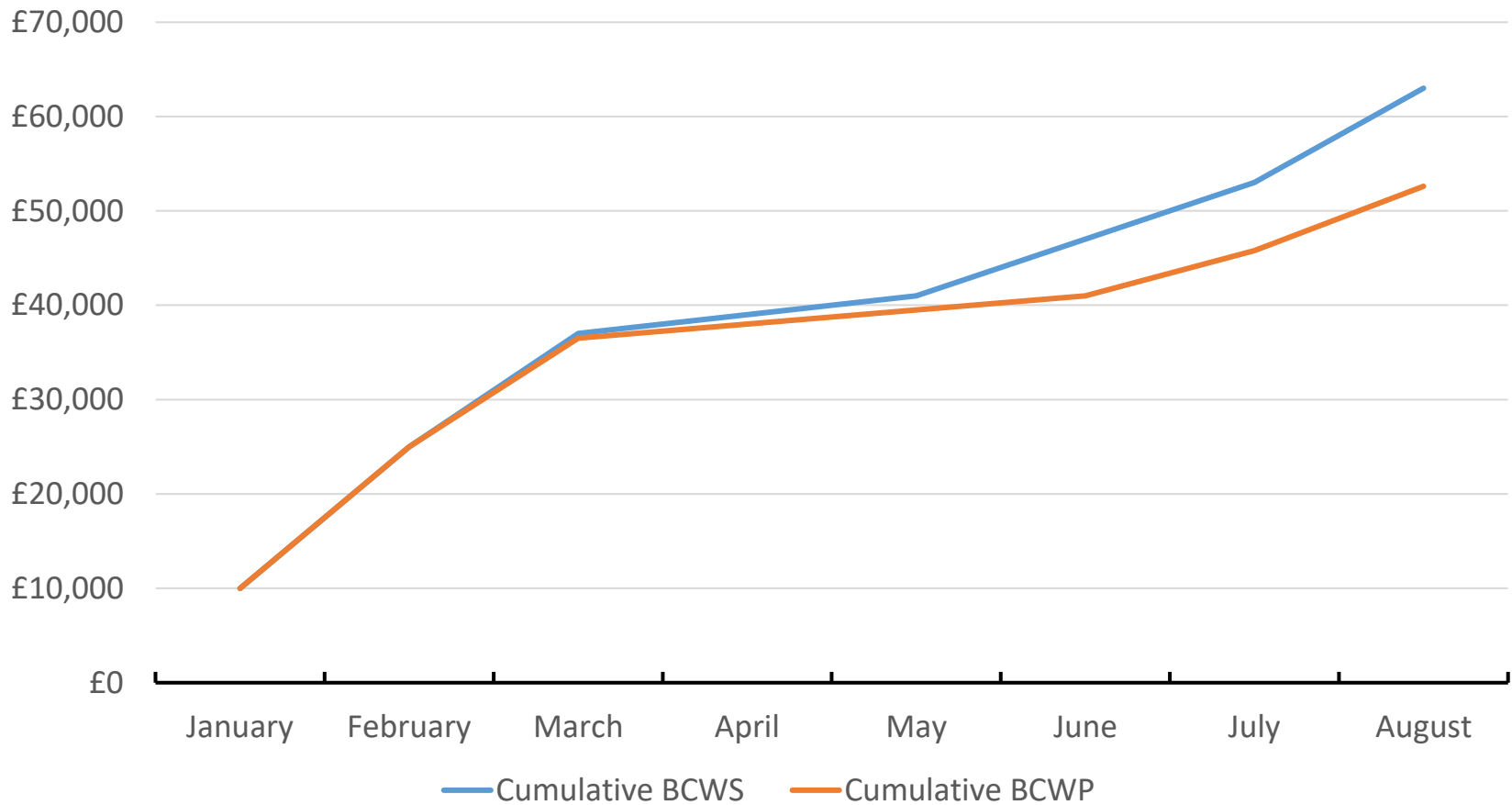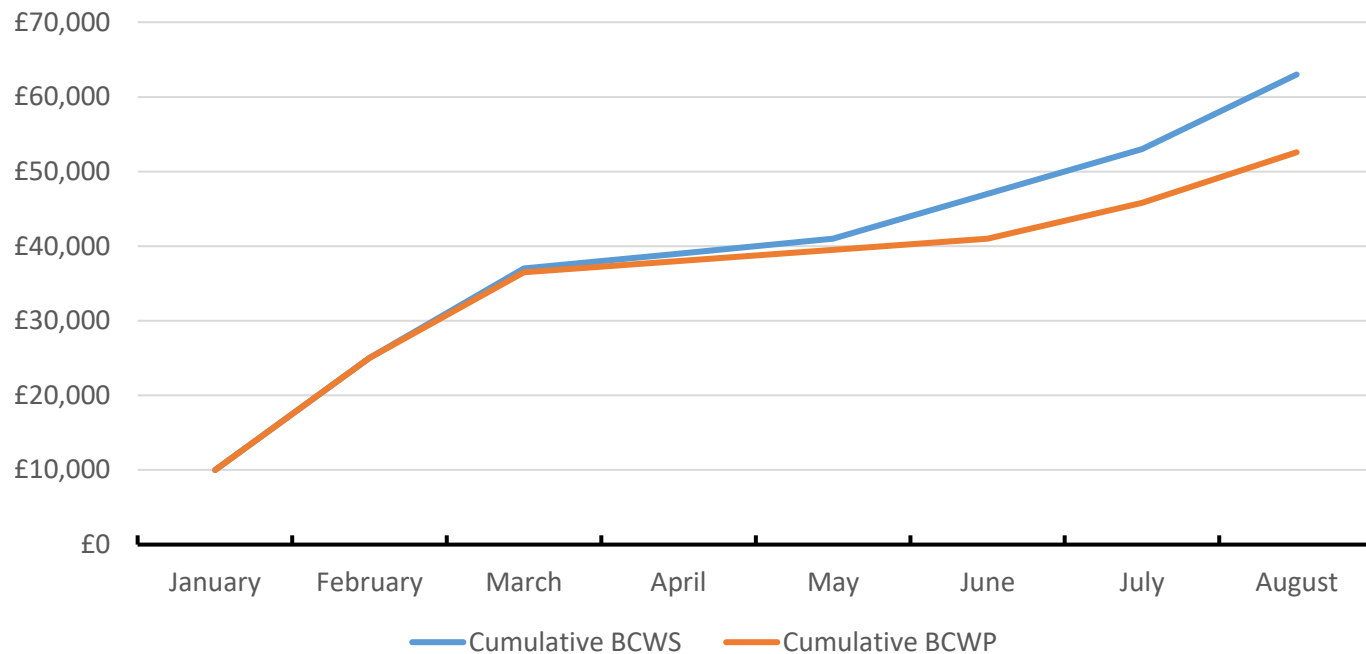
In this case BCWP runs below BCWS

- The programme is running behind schedule (about a month in August)

- At this point, the programme is under-delivering

The Actual Cost of Worked Performed (ACWP)

- The **ACWP** represents the true (incurred) cost of the programme

- When compared with the **BCWP** it shows the cost compared with the budget.

    - If **ACWP < BCWP** then the cost is less than planned

    - If **ACWP > BCWP** the cost is more than planned

- Unlike **BCWP**, the **ACWP** can be more than **BCWS** at the end of the project – it simply represents an over-spend

- The data is drawn from the data presented at the review

Task / Work Package	Spend	Simplified Gantt chart	Percentage complete at time of review
		Jan Feb Mar Apr May Jun Jul Aug	
Boat design	£12,000		100%
Purchase materials	£15,000		100%
Purchase engine	£10,000		100%
Build mould	£12,000		100%
Build hull	£8,000		80%
Install angine and ancilliaries	£500		10%
Install interior	£0		0%
Install electrical system and controls	£0		0%
Launch	£0		N/A
Total Spend	£57,500	◊ denotes a milestone	Time of review (end of August)

Using actual cost & actual schedule

- From this given data, we add the ACWP to the table

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Month	BCWS	Cumulative BCWS	BCWP	Cumulative BCWP	ACWP	Cumulative ACWP
January	£10,000	£10,000	£10,000	£10,000	£12,000	£12,000
February	£15,000	£25,000	£15,000	£25,000	£15,000	£27,000
March	£12,000	£37,000	£11,500	£36,500	£13,000	£40,000
April	£2,000	£39,000	£1,500	£38,000	£3,000	£43,000
May	£2,000	£41,000	£1,500	£39,500	£3,000	£46,000
June	£6,000	£47,000	£1,500	£41,000	£3,000	£49,000
July	£6,000	£53,000	£4,800	£45,800	£4,000	£53,000
August	£10,000	£63,000	£6,800	£52,600	£4,500	£57,500

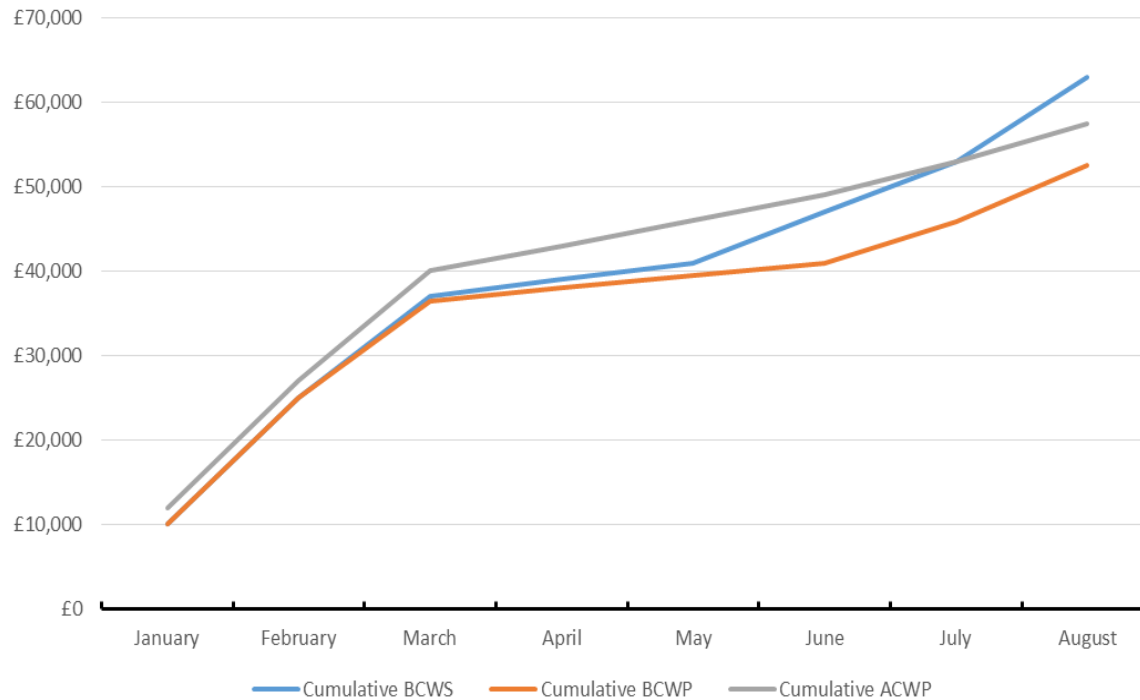….. And, as usual, show this graphically by plotting.
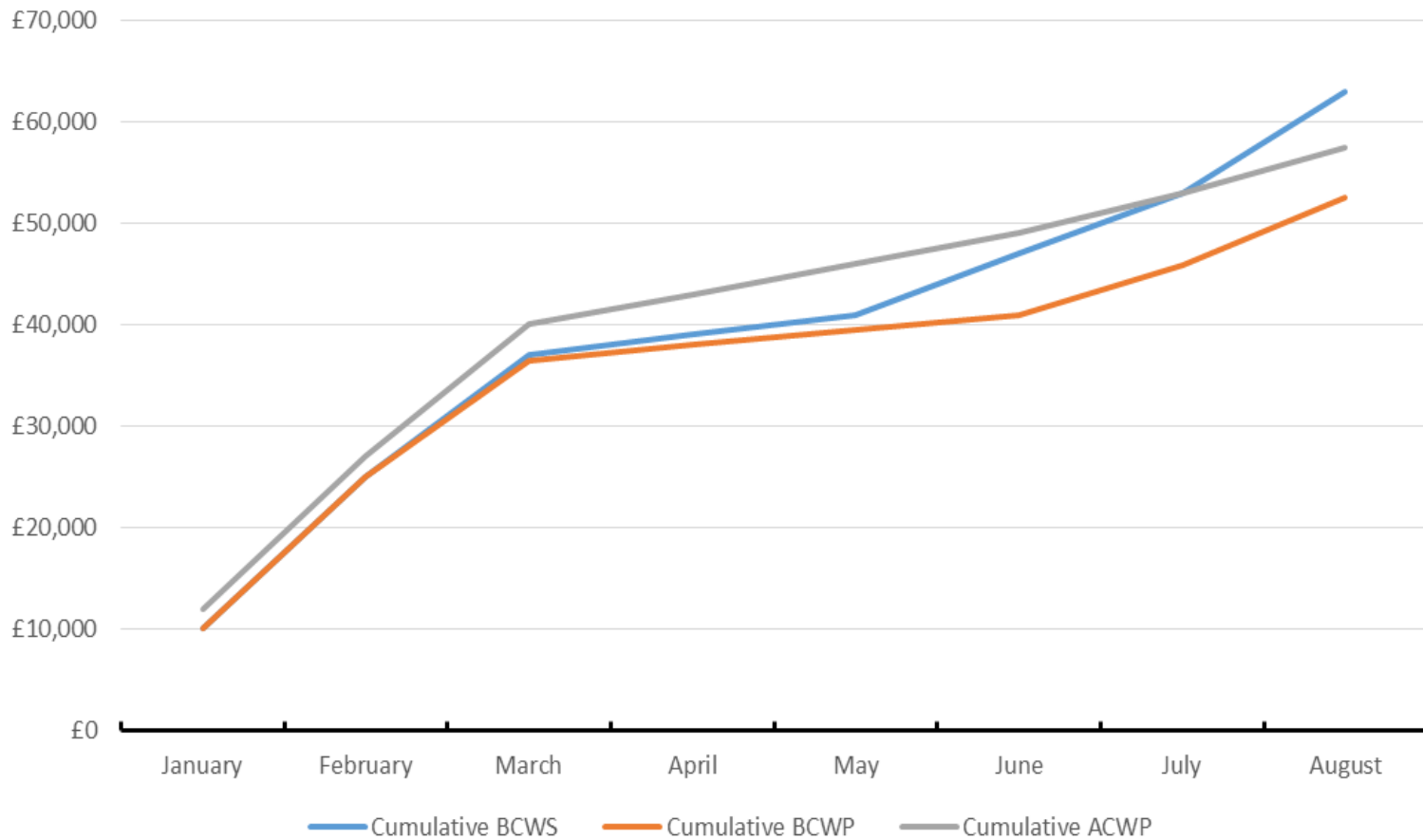
- Note that we compare ACWP with BCWP (not BCWS)

- ACWP represents the true cost of the work that we have done, NOT that we planned
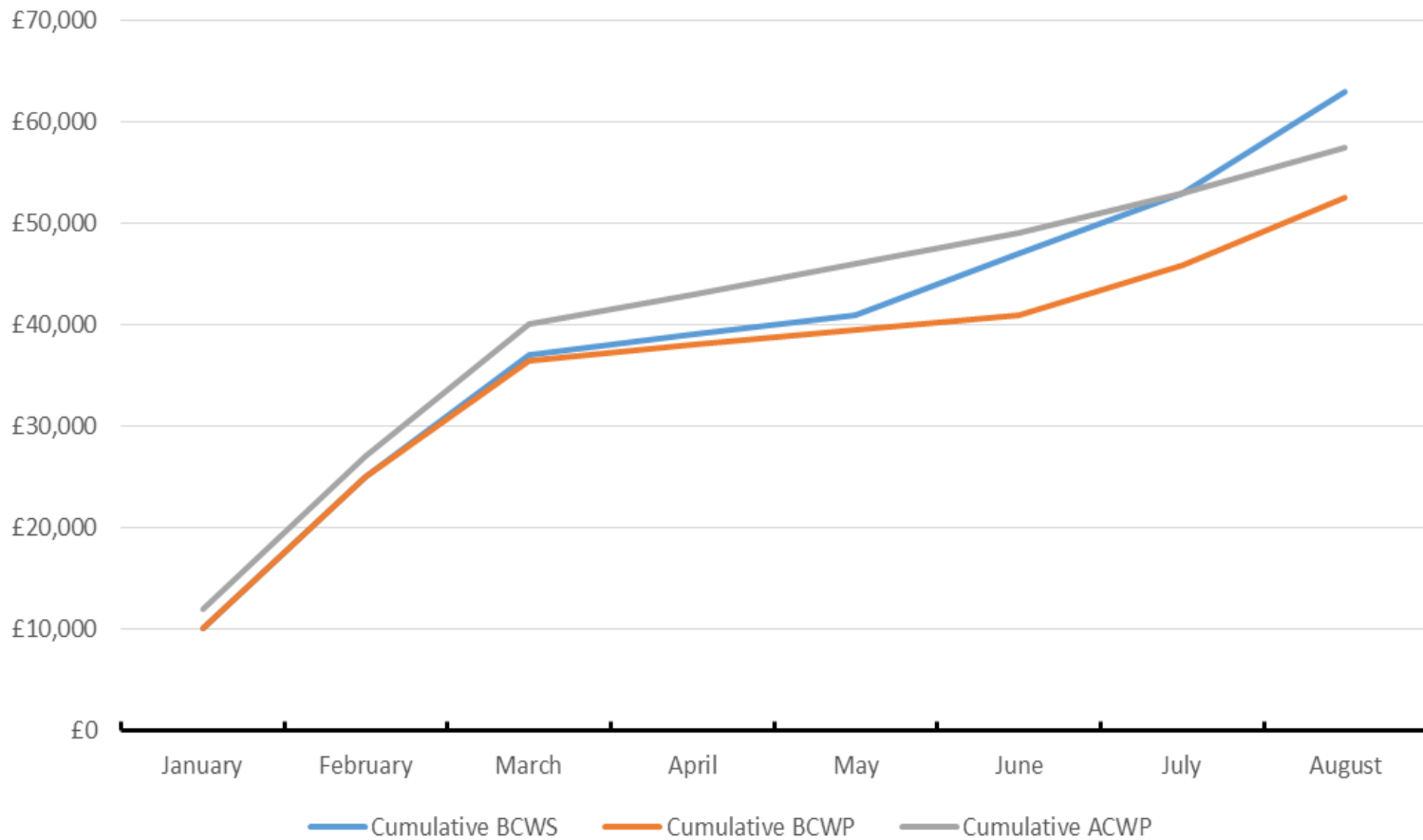
project is costing *more* than planned (about £6,000 in August)

→ We are overspending!

- **These three lines (BCWS, BCWP and ACWP) form the basis of EVA**

- From these we can see how the project is performing in terms of
  - Schedule
  - Cost