CS 350: Introduction to Software Engineering

Slide Set 4
Estimating with Probe II
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Lecture Topics

- The prediction interval
- Organizing proxy data
- Estimating with limited data
- Estimating accuracy
- Estimating considerations

The Prediction Interval

- The prediction interval provides a likely range around the estimate.
  - A 70% prediction interval gives the range within which the actual size will likely fall 70% of the time.
  - The prediction interval is not a forecast, only an expectation.
  - It applies only if the estimate behaves like the historical data.
  - It is calculated from the same data used to calculate the regression parameters.

The Range Calculation

- The range defines the likely error around the projection within which the actual value is likely to fall.
- Widely scattered data will have a wider range than closely bunched data.

$$\text{Range} = t(p,n)\sigma\sqrt{1+\frac{1}{n}+\frac{(x_k - x_{avg})^2}{\sum_{i=1}^{n}(x_i - x_{avg})^2}}$$

- The variables are
  - n - number of data points
  - σ - the standard deviation around the regression line
  - t(p, df) – the t distribution value for probability p (70%) and df (n-2) (degrees of freedom)
  - x – the data: k – the estimate, i – a data point, and avg – average of the data

The Standard Deviation Calculation

- The standard deviation measures the variability of the data around the regression line
  - the closer the actual values are to the estimates (the regression line) the lower the variance
- Widely scattered data will have a higher standard deviation than closely bunched data.

$$\text{Variance} = \sigma^2 = \frac{1}{n-2}\sum_{i=1}^{n}(y_i - \beta_0 - \beta_1 x_i)^2$$

- The standard deviation σ is the square root of the variance.

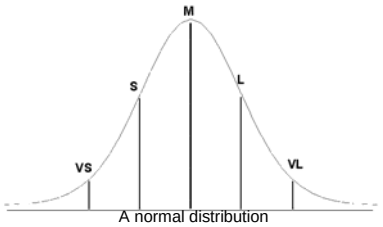
Calculate the Prediction Interval

- Calculate the prediction range for size and time for the example in lecture 3 (slides 42 and 43).
- Calculate the upper (UPI) and lower (LPI) prediction intervals for size.
  - UPI = P + Range = 538 + 235 = 773 LOC
  - LPI = P - Range (or 0) = 538 - 235 = 303 LOC
- Calculate the UPI and LPI prediction intervals for time.
  - UPI = Time + Range = 1186 +431 = 1617 min.
  - LPI = Time - Range (or 0) = 1186 - 431 = 755 min.

Intuitive Size Ranges -1

- In judging size, our intuition is generally based on a normal distribution.
- That is, we think of something as of average size if most such items are about that same size.
- We consider something to be very large if it is larger than almost all items in its category.
- When items are distributed this way, it is called a normal distribution.
- With normally distributed data, the ranges should remain reasonably stable with the addition of new data points.

Intuitive Size Ranges -2



A normal distribution

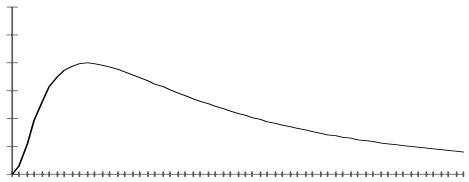
Intuitive Size Ranges -3

- With a large volume of data, you could calculate the mean and standard deviation of that data.
- For the size ranges
  - Medium would be the mean value.
  - Large would be mean plus one standard deviation.
  - Small would be mean minus one standard deviation.
  - Very large would be mean plus two standard deviations.
  - Very small would be mean minus two standard deviations.
- This method would provide suitably intuitive size ranges if the data were normally distributed.

The Distribution of Program Size Data

- Program size data are not normally distributed.
  - many small values
  - a few large values
  - no negative values
- With size data, the mean minus one or two standard deviations often gives negative size values.
- The common strategy for dealing with such distributions is to treat it as a log-normal distribution.

A Log-Normal Distribution



The Log-Normal Distribution

- To normalize size data, do the following:

1. Take the natural logarithm of the data.
2. Determine the mean and standard deviation of the log data.
3. Calculate the average, large, very large, small, and very small values for the log data.
4. Take the inverse log of the ranges to obtain the range size values.
5. This procedure will generally produce useful size ranges.

Organizing Proxy Data -4

- A mathematically precise way to determine the proxy size ranges is described in the text (pages 78-79).
- This simple way to determine these size ranges will work when you have lots of data. Otherwise, it can cause underestimates.
- Comparative estimating ranges

	VS	S	M	L	VL
Normal	-1.67	7.68	17.04	26.39	35.75
Log-Normal	5.55	9.19	15.22	25.21	41.75

Estimating with Limited Data -1

- Even after using PSP for many projects, you will have to make estimates with limited data when you
  - work in a new environment
  - use new tools or languages
  - change your process
  - do unfamiliar tasks
- Since estimates made with data are more accurate than guesses, use data whenever you can.
- Use the data carefully since improper use can lead to serious errors.

Estimating with Limited Data -2

- Depending on the quality of your data, select one of the four PROBE estimating methods.

Method	
A	regression with estimated proxy size
B	regression with plan added and modified size
C	the averaging method
D	engineering judgment

- To use regression method A or B, you need
  - a reasonable amount of historical data
  - data that correlate
  - reasonable β_0 and β_1 parameter values

Method A (Regression): Estimated Proxy Size

- Method A uses the relationship between estimated proxy size (E) and actual
  - added and modified size (LOC)
  - development time
- The criteria for using this method are
  - three or more data points that correlate ($R^2 > 0.5$)
  - reasonable regression parameters (table 6.6 on pg. 96)
  - completion of at least three exercises with PSP1 or higher

Method B (Regression): Plan Added and Modified Size

- Method B uses the relationship between plan added and modified size and
  - actual added and modified size
  - actual development time
- The criteria for using this method are
  - three or more data points that correlate ($R^2 > 0.5$)
  - reasonable regression parameters (table 6.6 on pg. 96)
  - completion of at least three exercises with PSP0.1 or higher

Method C: Averaging

- Method C uses a ratio to adjust size or time based on historical averages.
- The averaging method is easy to use and requires only one data point.
- Averages assume that there is no fixed overhead.
- The averaging method is described in the PROBE script in table 6.6 on page 96.

Method D: Engineering Judgment

- Use method D when you don't have historical data. Use judgment to
  - project the added and modified size from estimated part size
  - estimate development time
- Use method D when you cannot use methods A, B, or C.

Estimating Accuracy

- Planning is a skill that must be developed.
  - The PSP helps to build planning skills.
  - Even simple plans are subject to error.
    - unforeseen events
    - unexpected complications
    - better design ideas
    - just plain mistakes
- The best strategy is to plan in detail.
  - Identify the recognized tasks.
  - Make estimates based on similar experiences.
  - Make judgments on the rest.

Combining Estimates

- To combine multiple estimates made by a single developer
  - add the estimates for the separate parts
  - make one linear regression calculation
  - calculate one set of prediction intervals
- Multiple developers can combine independently-made estimates by
  - making separate linear regression projections
  - adding the projected sizes and times
  - adding the squares of the individual ranges and taking the square root to get the prediction interval

Estimating Error: Example

- When estimating in parts, the total error will be less than the sum of the part errors.
  - Errors tend to balance out.
  - This assumes no common bias.
- For a 1000-hour job with estimating accuracy of ± 50%, the estimate range is from 500 to 1500 hours.
- If the estimate is independently made in 25 parts, each with 50% error, the
  - total would be 1000 hours, as before
  - estimate range would be from 900 to 1100 hours

Combining Individual Errors

- To combine independently-made estimates
  - Add the estimated values.
  - Combine the variances (squares) of the errors.
- With 25 estimates for a 1000-hour job
  - Each estimate averages 40 hours.
  - The standard deviation is 50%, or 20 hours.
  - The variance for each estimate is 400 hours.
  - The variances add up to 10,000 hours.
  - The combined standard deviation is the square root of the sum of the variances, or 100 hours.
  - The estimate range is 900 to 1100 hours.

Class Exercise -1

- Start with three estimates.
  - A = 45 hours, + or - 10
  - B = 18 hours, + or - 5
  - C = 85 hours, + or - 25
- What is the combined estimate?

Class Exercise -2

- Start with three estimates.
  - A = 45 hours, + or - 10
  - B = 18 hours, + or - 5
  - C = 85 hours, + or - 25
- What is the combined estimate?
  - total = 45 + 18 + 85 = 148 hours
- What is the combined estimate range?

Class Exercise -3

- Start with three estimates.
  - A = 45 hours, + or - 10
  - B = 18 hours, + or - 5
  - C = 85 hours, + or - 25
- What is the combined estimate?
  - total = 45 + 18 + 85 = 148 hours
- What is the combined estimate range?
  - variance = 100 + 25 + 625 = 750
  - range = square root of variance = 27.4 hours
- What is the combined UPI and LPI?

Class Exercise -4

- Start with three estimates.
  - A = 45 hours, + or - 10
  - B = 18 hours, + or - 5
  - C = 85 hours, + or - 25
- What is the combined estimate?
  - total = 45 + 18 + 85 = 148 hours
- What is the combined estimate range?
  - variance = 100 + 25 + 625 = 750
  - range = square root of variance = 27.4 hours
- What is the combined UPI and LPI?
  - UPI = 148 + 27.4 = 175.4 hours
  - LPI = 148 – 27.4 = 120.6 hours

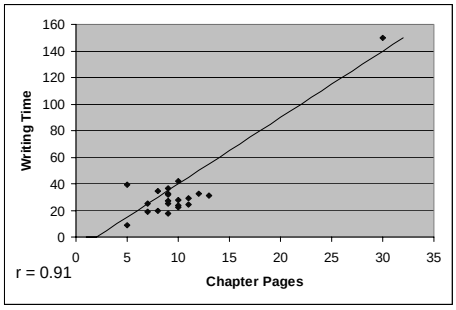
Using Multiple Proxies

- With size/hour data for several proxies
  - estimate each as before
  - combine the total estimates and prediction intervals as just described
- Use multiple regression if
  - there is a correlation between development time and each proxy
  - the proxies do not have separate size/hour data
- Multiple regression is not covered here but is a widely used technique.

Estimating Considerations

- While the PROBE method can provide accurate estimates, improper use of data can lead to serious errors.
- One extreme point can give a high correlation even when the remaining data are poorly correlated.
- Similarly, extreme points can lead to erroneous β_0 and β_1 values, even with a high correlation.

Correlation with an Extreme Point



Conclusions on Misleading Data

- With only one point moved to an extreme value, the correlation for the same data increased from 0.26 to 0.91.
- Similarly, the β_0 and β_1 values changed from
  - 18.23 to -17,76 for β_0
  - 1.02 to 5.08 for β_1
- With an average productivity of 3.02 and 3.31 hours per page, both of these β_1 values are misleading.
- With one extreme point, you probably should not use regression.

Messages to Remember

- The PROBE method provides a structured way to make size and development time estimates.
  - It uses your personal development data.
  - It provides a statistically sound range within which actual program size and development time are likely to fall.
- With a statistically sound estimating method like PROBE, you can calculate the likely estimating error.

Lecture Topics

- Using personal data
- Making task plans
- Making schedules
- Tracking project status
- Earned value
- Estimating job completion
- Project reporting

Using Data in Planning

- When planning development work, we must
  - make task plans
  - make project schedules
  - measure job status against the plan
  - report job status to management
- We must also manage the project
  - manage to the schedule
  - manage plan changes
  - manage project risks
  - manage product quality
- This lecture covers the topics of planning and schedule management.

Using Personal Data -1

- Precise and detailed data can help you to manage your personal and team work.
- Managers and customers care about
  - when you will finish the job
  - what the work will cost
  - the quality of the finished products
- With PSP data, you will know where you stand and can provide regular updates to your managers and customers.

Using Personal Data -2

- When all team members use PSP data to plan, manage, and track their personal work, the team can precisely report job status.
  - This will provide management with the information that they need.
  - It will also reassure the customers.
- Most importantly, using data will
  - convince management that you can manage your own work
  - allow management to continue supporting self-directed teamwork

Making Task Plans -1

- For both individual and team plans, the first steps are to
  - understand the job's goals and objectives
  - establish a strategy for doing the work
  - define the processes to use
- Then, you can
  - estimate the size of the job
  - define the tasks to be done
  - estimate the effort for each task
  - establish the task order
  - produce the schedule

Making Task Plans -2

- With PSP, you
  - were given the goals, strategy, and process
  - used the task order defined by the process
  - used PSP data to estimate the work
  - followed the process to do the job
- On a team project, the team must
  - agree on team goals
  - establish a strategy for the work
  - define the process to use
  - make a team plan
- These team building steps will be described later.

Making Task Plans -3

- After the team has made the overall plan, the next step is to break it into individual tasks.
- These tasks are assigned to the various team members to plan and to implement.
- When you are assigned team tasks, you use the PSP to
  - estimate and plan each task
  - follow your personal process to do the work
  - measure, track, and manage each step of the job
- The PSP works for individuals, whether they work alone or on team projects.

Scheduling

- Once you have determined the task order and task time, you can make the project schedule.
- This involves both project and period planning.
- The project plan consists of the tasks, task times, and task order.
- Period planning involves spreading the project tasks over a calendar period.

The Importance of Period Plans

- Developers focus on project plans, but live in a periodic world.
  - Projects have committed dates.
  - Businesses collect revenue, declare dividends, and pay salaries.
  - We all pay monthly bills and collect periodic paychecks.
  - We also take time off for weekends and scheduled vacations.
- The relationship between project plans and period plans is the source of most project problems.
- That is why it is important to use sound methods when making the project schedule.

Schedule Estimating

- To make a schedule, you need three things.
  - the estimated direct project hours for each task
  - a calendar of available direct hours
  - the order in which the tasks will be done
- Then, you need to
  - estimate the hours needed for each task
  - spread these task hours over the calendar of available hours

Available Direct Hours

- Staffing schedule
  - New projects are not instantly staffed.
  - You need a committed staffing plan.
- Produce a calendar spread of available hours.
  - At 52 weeks per year and 40 hours per week, 1 year = 2080 hours.
  - With 3 weeks of vacation and 10 holidays, 1 year =1880 hours (90%).
  - With 10% for meetings and 15% for mail and interrupts, 1 year ≈ 1000 to 1400 hours (50 to 65%).
  - Additional time is usually spent on project activities that are not related to the direct tasks.

Task Order

- The task order is driven by the development strategy.
  - You need a conceptual approach.
  - Each task needs completion criteria.
  - You must consider task interdependencies.
  - Also consider cost and cycle-time priorities.
- Determine the planned task order.
  - The initial task order provides a basis for planning.
  - The task order will change with new knowledge.

Produce the Schedule

- Estimate the hours that each task will take.
  - What portion of total hours have such tasks taken historically?
  - Will anything unusual affect this project?
  - To ensure that tasks are not omitted, consider the tasks for the entire project.
- Spread the task hours over the calendar.
  - Identify key project checkpoints.
  - Use a standard format.

Announcement!

- No recitations tomorrow, Feb. 24!
- However, there's a recitation assignment
- Task:
  - Be ready to demo two debuggers!
    - Set break point, examine vars, single step code, etc.
    - You will be required to show you know how to use the debuggers.
  - A worksheet will be available tomorrow with explicit requirements & what code you need to use
    - Essentially, repeat what happened in recitation only this time, you operate the debuggers.

The Task Planning Template

- The PSP task planning template is shown in table 7.2 (page 118).
- To fill out this template
  - list the tasks in expected completion order
  - enter the estimated hours for each task
  - add the hours in the cumulative hours column
- At this point, start to prepare the schedule planning template.

Schedule Planning Template

- The PSP schedule template is shown in table 7.1 (page 116).
- To start filling out this template
  - list the calendar dates in the left-hand column
  - use days or weeks, depending on project scale
    - for days, list every date
    - for weeks, use a standard day (for example, Monday)
  - list the planned direct project hours available each week
  - add the hours in the cumulative hours column
- Complete the task and schedule templates concurrently.

Completing the Plan

- For each task
  - look on the task template for the cumulative hours needed to complete that task
  - on the schedule template, find the week during which those hours are first exceeded
  - on the task template, enter that week's date in the *Date* column for that task
- You now have the task schedule.

Schedule Planning Example -1

On the **task planning** template, enter the estimated hours per task.

Task	Hours	Cum. Hrs.
A	2	2
B	5	7
C	4	11
D	7	18
E	3	21
F	5	26
G	6	32
H	3	35
I	2	37

Schedule Planning Example -2

On the schedule planning template, enter the direct hours available per day or week.

Day	Hours	Cum. Hrs.
1	3	3
2	5	8
3	5	13
4	5	18
5	4	22
6	6	28
7	5	33
8	5	38

Schedule Planning Example -3

On the task schedule, enter the day (or week) during which the cumulative hours for each task is reached.

Task	Hours	Cum. Hrs.	Day
A	2	2	1
B	5	7	2
C	4	11	3
D	7	18	4
E	3	21	5
F	5	26	6
G	6	32	7
H	3	35	8
I	2	37	8

Project Tracking -1

- Project tracking would be simple if
  - we always completed tasks in the planned order
  - no tasks were added or deleted
- This never happens.
  - Requirements always change.
  - Tasks get cancelled or deferred.
  - Some tasks are dropped and others are added.
  - Estimating errors are common.

Project Tracking -2

- To track project status in a dynamic environment, you need a way to assign a value that measures the contribution of each task towards the whole project.
- Then you can
  - add up the value of the completed tasks
  - compare this value to the value of the total job
  - calculate the percentage of job completion
- The PSP does this with a method called *earned value* (EV).

Earned Value

- Earned value (EV)
  - establishes a value for each task
  - permits progress tracking against the plan
  - facilitates tracking, even with changes to the plan
- Earned value principles
  - Earned value provides a common value for each task.
  - This value is the percentage of the total project hours that this task is planned to take.
  - The planned value is credited, no matter how long it actually took to do the task.
  - No value is given for partially-completed tasks.
  - Major plan changes require new plans.

Establish the Planned Value

- On the task template
  - add the number of project hours
  - calculate the percentage of the total hours for each task
  - enter this percentage as the planned value (PV) for that task
  - calculate the cumulative PV for each task
- On the schedule template, enter the cumulative planned value for the tasks to be completed each day or week.

Earned Value Example -1

Produce the PV, or the planned percentage of the total job that each task represents.

Task	Hours	Cu. Hrs.	Day	PV	Cum. PV
A	2	2	1	5.4	5.4
B	5	7	2	13.5	18.9
C	4	11	3	10.8	29.7
D	7	18	4	18.9	48.6
E	3	21	5	8.1	56.7
F	5	26	6	13.5	70.2
G	6	32	7	16.3	86.5
H	3	35	8	8.1	94.6
I	2	37	8	5.4	100.0

Earned Value Example -2

Enter the cumulative planned value for each day (or week).

Day	Hours	Cum. Hrs.	Cum. PV
1	3	3	5.4
2	5	8	18.9
3	5	13	29.7
4	5	18	48.6
5	4	22	56.7
6	6	28	70.2
7	5	33	86.5
8	5	38	100.0

Tracking the Plan

- As each task is completed, it earns the planned value.
  - Enter the earned value (EV) for that task.
  - Enter the date on which the task was completed.
  - Add the EV-to-date in the "Cumulative EV" column.
- In the schedule template, enter the cumulative EV for each day or week as it is completed.
- Track earned value versus planned value by day or week.

Tracking the Plan Example -1

During the project, enter on the **task planning** template the day each task is completed.

Task	Hours	Cum. Hrs.	Day	PV	Cum. PV	Done
A	2	2	1	5.4	5.4	1
B	5	7	2	13.5	18.9	2
C	4	11	3	10.8	29.7	4
D	7	18	4	18.9	48.6	5
E	3	21	5	8.1	56.7	
F	5	26	6	13.5	70.2	
G	6	32	7	16.3	86.5	
H	3	35	8	8.1	94.6	
I	2	37	8	5.4	100.0	

Tracking the Plan Example -2

On the **schedule template**, enter the earned value (EV) for each day.

Day	Hours	Cum. Hrs.	Cum. PV	EV
1	3	3	5.4	5.4
2	5	8	18.9	18.9
3	5	13	29.7	18.9
4	5	18	48.6	29.7
5	4	22	56.7	48.6
6	6	28	70.2	
7	5	33	86.5	
8	5	38	100.0	

Estimating Job Completion

- Assume that the project will continue to earn EV at the same rate as in the past.
- Extrapolate the time to project completion by extending the EV line until it reaches 100%.
- This is the likely project completion date, unless
  - the rate of progress changes
  - work for the remaining tasks deviates from the original plan

Estimating Completion Example -1

What is the actual EV per day?

Day	Hours	Cum. Hrs.	Cum. PV	EV	Proj. EV
1	3	3	5.4	5.4	5.4
2	5	8	18.9	18.9	18.9
3	5	13	29.7	18.9	18.9
4	5	18	48.6	29.7	29.7
5	4	22	56.7	48.6	48.6
6	6	28	70.2		
7	5	33	86.5		
8	5	38	100.0		
9					
10					
11					
12					
13					

When should you expect to finish?

Estimating Completion Example -2

Using the actual EV earned per day (9.72), enter the projected EV by day to project completion.

Day	Hours	Cum. Hrs.	Cum. PV	EV	Proj. EV
1	3	3	5.4	5.4	5.4
2	5	8	18.9	18.9	18.9
3	5	13	29.7	18.9	18.9
4	5	18	48.6	29.7	29.7
5	4	22	56.7	48.6	48.6
6	6	28	70.2		58.3
7	5	33	86.5		68.0
8	5	38	100.0		77.8
9					87.5
10					97.2
11					100.0

Plan Changes -1

- To track job progress, you must follow the plan.
- Since plans always change, you must regularly update the plan so that it represents what you currently plan to do.
- Of course, you must always keep copies of the original plans.
- Unless the plan differs significantly from the way that you now plan to work, merely add any new tasks and delete the cancelled ones.

Plan Changes -2

- Adding tasks reduces the earned value of all of the planned and completed work.
- Similarly, deleting tasks increases the earned values of the planned and completed tasks remaining in the plan.
- Most TSP support tools will make these EV and PV adjustments for you.
- For major plan changes, you must make a new plan.

Project Reporting

- When all team members consistently record their data, TSP teams will know precisely where they stand.
- They can track, manage, and report on their work.
- The following charts show how you can use these data to run a project.
- You can use these exact same methods to manage your personal work.

Example TSP Weekly Data - 1

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- When all team members consistently record their data, TSP teams can precisely track and manage their work.
  - They know the planned and actual data for each week and for the project to date.
  - They can precisely measure job status and estimate how long it will take to finish the work.

Question 1

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- Is this team ahead of or behind schedule, and by how much?

Answer to Question 1

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- Is this team ahead of or behind schedule, and by how much?
- The team has earned only 22.3 EV against a plan of 28.2 EV, so they are 26.5% behind.
- At the current rate, it will take 1.85 weeks to reach the planned 28.2 EV, so they are 1.85 weeks behind schedule.

Question 2

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- Why is the team behind schedule?

Answer to Question 2

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- Why is the team behind schedule?
- Although the team is working more than its planned weekly hours, the work is taking 23% longer than planned.

Question 3

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- At this rate, can the team members finish on the original plan of 17 weeks? If not, how late will they be?

Answer to Question 3

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- At this rate, can the team members finish on the original plan of 17 weeks? If not, how late will they be?
- The team has earned EV at 22.3/7 = 3.186 EV/week.
- At this rate, it will take (100-22.3)/3.186 = 24.2 more weeks to finish. This is 14.2 weeks behind the 17-week plan.

Question 4

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- Can this five-person team meet the original schedule? If not, what help would they need from management to do so?

Answer to Question 4

Week 7 Weekly Data	Plan	Actual	Plan/ Actual
Schedule hours for this week	121.0	126.7	0.95
Schedule hours this cycle to date	467.0	493.4	0.95
Earned value for this week	7.6	6.4	1.19
Earned value this cycle to date	28.2	22.3	1.26
To-date hours for tasks completed	354.3	458.0	0.77
To-date average hours per week			

- Can this five-person team meet the original schedule? If not, what help would they need from management to do so?
- To meet the schedule, they need to do 77.7 EV of work in 10 weeks, or 7.77 EV a week.
- To increase their latest rate of 6.4 EV a week by 20%, they must work 20% more hours, or add a team member.

Example Conclusions

- This team did increase their task hours somewhat and they also spent less time than planned in test.
- They also reprioritized the work and slightly reduced the total workload.
- They actually finished on the exact day originally planned.
- With the PSP, you will precisely know job status and will have the data to manage your own work.
- With this knowledge, you will usually meet your commitments.

Messages to Remember

- With the PSP, you can accurately plan and track your own work.
- With earned value, you can precisely judge job status and estimate the likely project completion date.
- This information will permit you to make accurate and timely management reports.
- When your reports indicate potential problems, you should report recommended remedial actions.
- On a self-directed team, you must tell management what you are doing to solve your own problems.