Disciplined Software Engineering
Lecture #5

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Lecture #5 Overview - Resource and Schedule Planning

Resource and schedule planning overview

The planning process

Resource estimating

Schedule estimating

Earned value tracking

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Why Resource and Schedule Plans Are Needed

Provides a business basis for doing the work

- **establishes the price**
- **sets the schedule**
- **permits agreement on the work**

Establishes a management framework

- **defines commitments**
- **helps groups coordinate their work**
- **allows status tracking**

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Estimating Accuracy

Planning is a skill that must be developed
- the PSP helps to build planning skill
- even simple plans are subject to error
  - unforeseen events
  - unexpected complications
  - just plain mistakes

The best strategy is to plan in detail
- identify the recognized tasks
- estimate based on similar experience
- make judgments on the rest

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An Estimating Error Example

When estimating in parts, the total error is less than the sum of the part errors

- errors tend to balance
- this assumes no common bias

For a 1000 hour job

- with estimating accuracy of + or - 50%
- the estimate range is from 500 to 1500 hours

In 25 parts, each with 50% error

- the total would be 1000 hours as before
- the estimate range is from 900 to 1100 hours

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Combining Individual Errors

In combining individual estimates

- combine the estimated values
- add the estimate variances

With 25 estimates

- each estimate averages 40 hours
- the standard deviation is 50% or 20 hours
- the variance for each is 400
- the variances thus total 10,000
- the combined standard deviation is the square root of the variance, or 100
- the estimate range is thus 900 to 1100 hours

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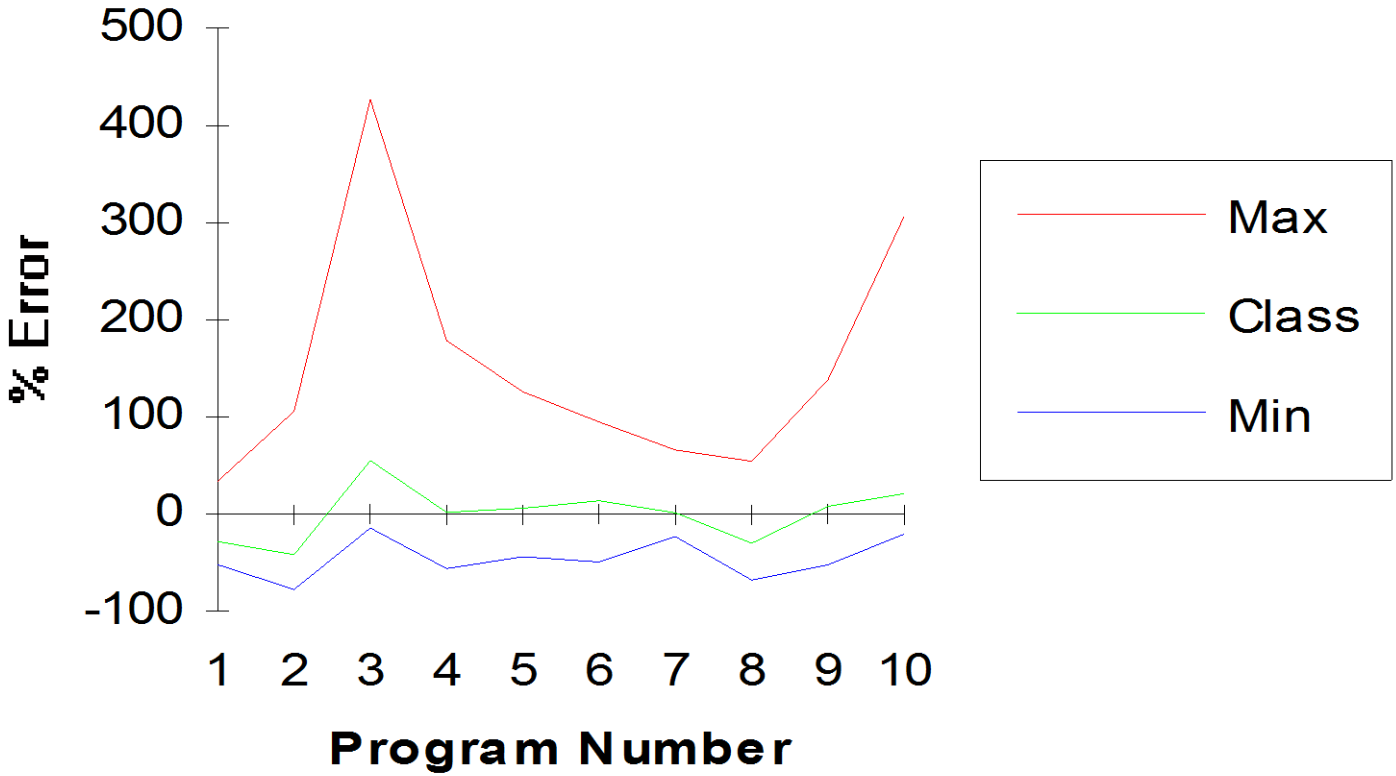
Size Planning Errors - 12 Students



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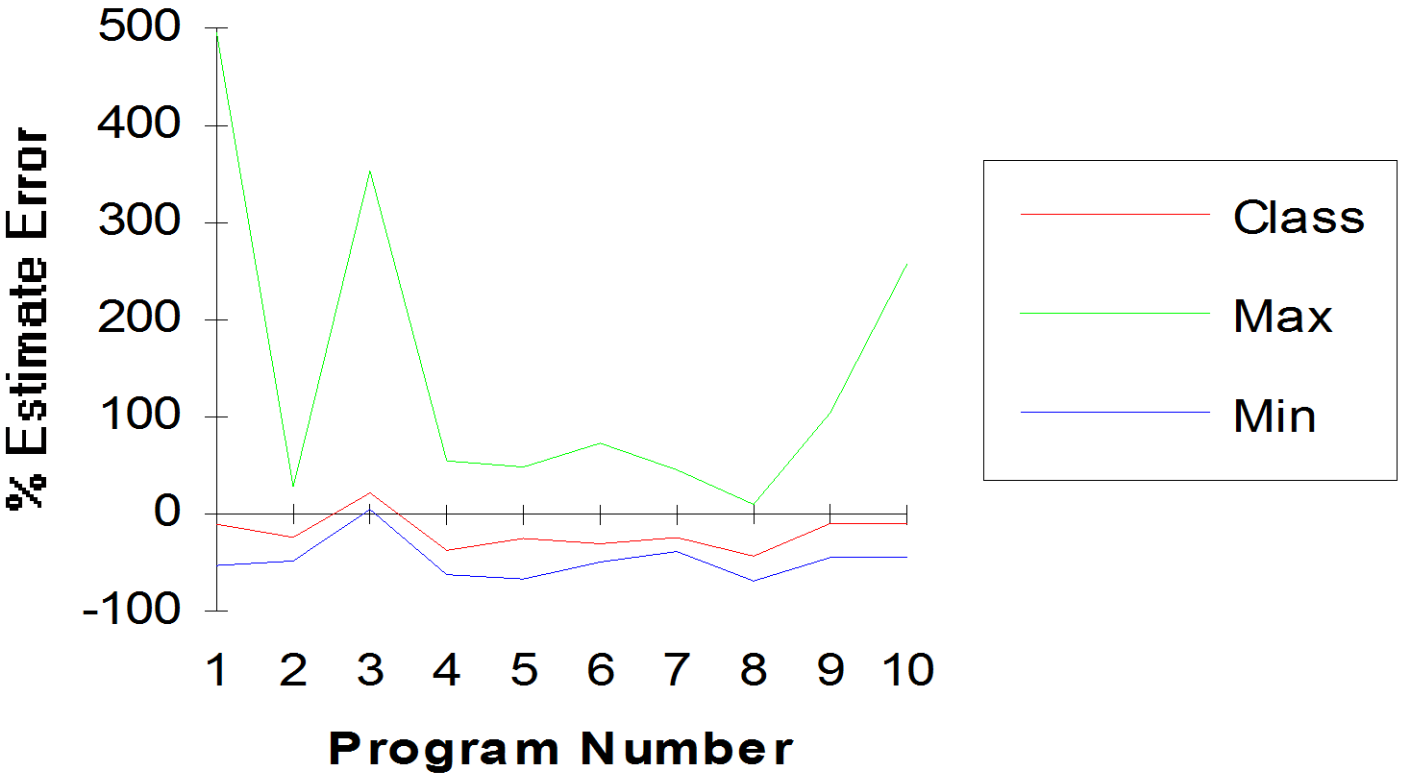
Time Estimating Accuracy - 12 Students



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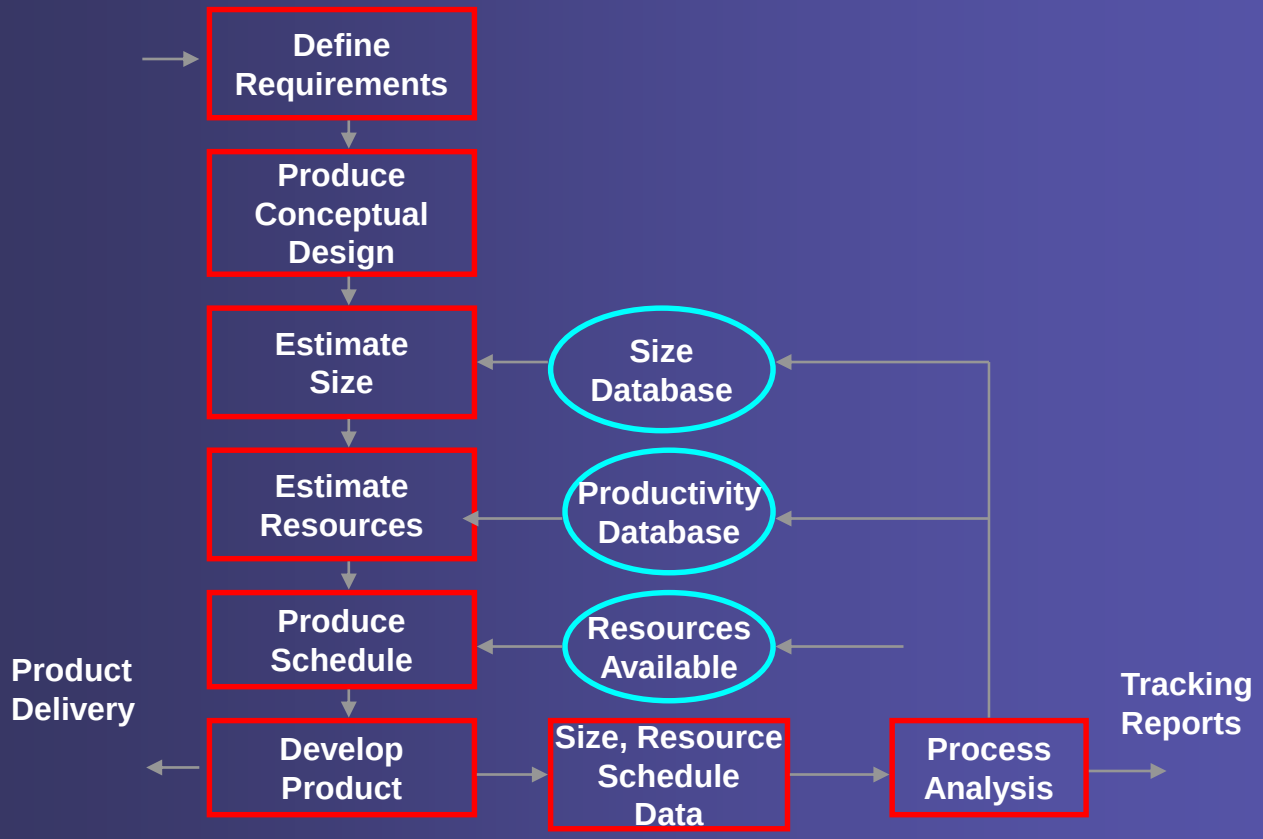
The Planning Process



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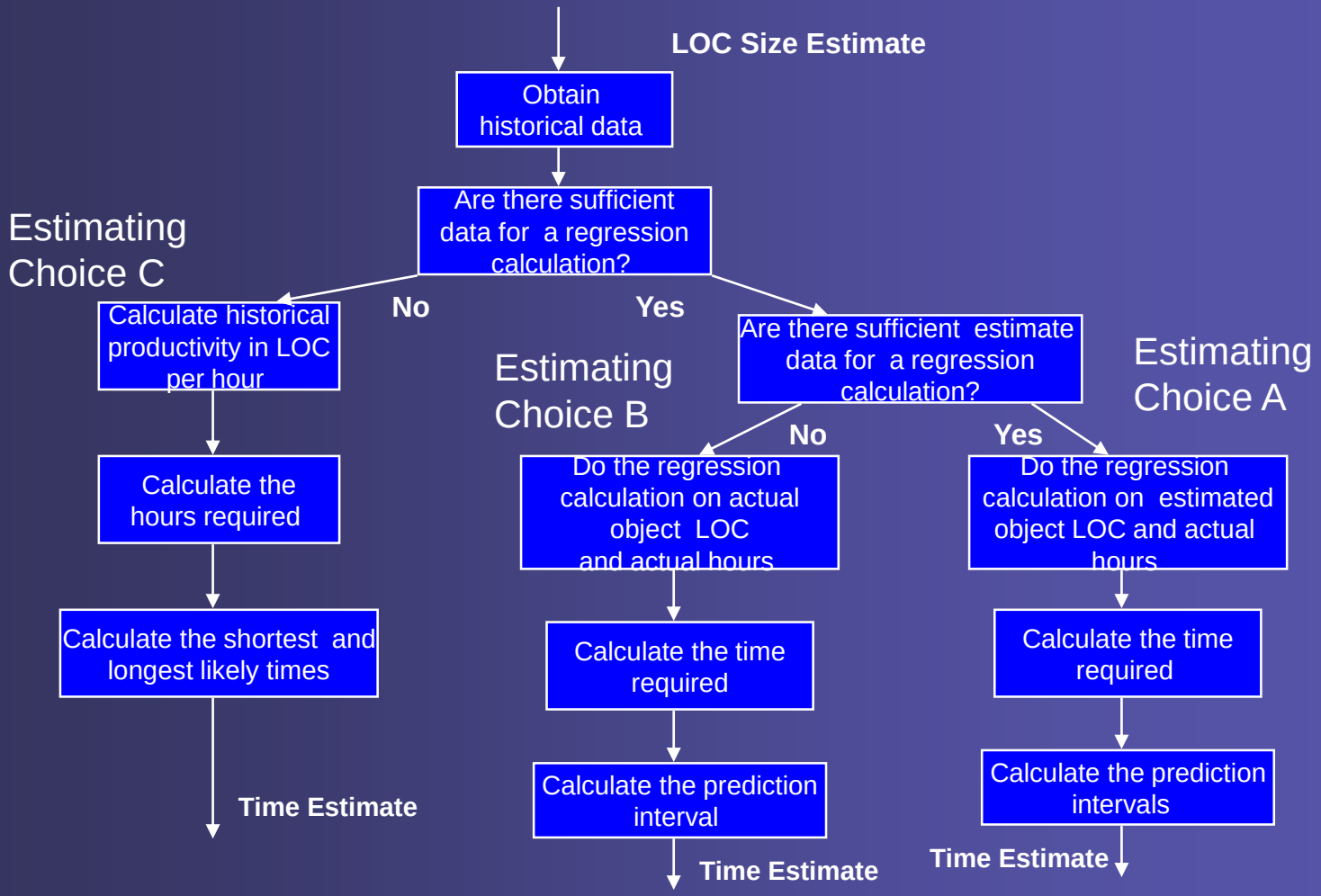
Planning Development Time



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The Resource Planning Process

Start with a size estimate

Identify available data

Use regression when you have 3+ sets of data that correlate.

Use data for estimated LOC to actual hours where available.

Calculate the prediction interval.

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Regression in Resource Planning

The regression method for resource planning is identical to that used for size estimating.

If multiple estimates are combined from the same data

- **combine the parts, i.e, if 3 LOC estimates were made, combine their object LOC as input to one resource estimate**
- **do the same for the prediction interval**

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Example of Combining Resources

Start with 3 estimates

- **A - 45 hours + or - 10**
- **B - 18 hours + or - 5**
- **C - 85 hours + or - 25**

The combined estimate is

- **total = 45 + 18 + 85 = 148 hours**
- **variance = 100 + 25 + 625 = 750**
- **range = square root of variance = 27.4 hours**
- **estimate is from 121 to 175 hours**

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Using Multiple Proxies

If you have 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 covered later

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Resource Estimate Summary

To make a resource estimate

- start with a size estimate
- use the PROBE method
- use your historical size and hours data
- use regression if you have sufficient data

Calculate the prediction intervals

- use the same method as with size estimates
- use the size and hour data

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Schedule Estimating

To make a schedule you need three things

- the estimated direct project hours
- a calendar of available direct hours
- the order in which the tasks will be done

You then need to

- estimate the hours needed for each task
- spread these hours over the calendar of available hours

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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 a year and 40 hour weeks - one year = 2080 hours**
- **with 3 weeks vacation and 10 holidays, one year = 1880 hours (90%)**
- **with 10% for meetings, 5% for mail, ... one year = 1000 to 1400 hours (50 to 65%)**

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The Task Order

The task order must be driven by the development strategy

- **you need a conceptual approach**
- **each task needs completion criteria**
- **must consider task interdependencies**
- **also consider cost and cycle time priorities**

Determine planned task order

- **task order will change with new knowledge**
- **the initial task order provides a basis for planning**

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Produce the Schedule

Estimate the hours for each task

- what portion of total hours have such tasks historically taken?
- will anything unusual affect this project?
- to ensure tasks are not omitted, spread the task time for the entire project

Spread the task hours over the calendar

- identify key project checkpoints
- use a standard format

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Task Planning Template

The PSP task planning template is in Table C47 (page 693)

To start filling out this template

- list the tasks in their expected order of completion
- enter the hours each task is expected to take
- add the hours in the cumulative hours column

At this point, start to prepare the schedule planning template

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Schedule Planning Template

The PSP schedule template is in Table C49 (page 695)

To start filling out this template

- list the calendar dates in the left column
- use days or weeks, depending on project scale
  - for days, list every date
  - for weeks, use a standard day, say Monday
- list the planned direct project hours to be available that week
- add the hours in the cumulative hours column
- complete the task and schedule templates together

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Completing the Plan

For each task

- find the cumulative hours to complete that task on the task template
- find the week on the schedule template when those hours have first been exceeded
- enter the week's date in the Date column for that task on the task template

You now have the task schedule

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Schedule Planning Example - 1

Using form C47, start with an estimate of the hours per task

Task	Hours	Cum. Hrs
1	2	2
2	5	7
3	4	11
4	7	18
5	3	21
6	5	26
7	6	32
8	3	35
9	2	37

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Schedule Planning Example - 2

Using form C49, estimate the direct hours available per day

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

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Schedule Planning Example - 3

Enter the task schedule: the day on which the cumulative hours for each task are reached

Task	Hours	Cum. Hrs	Day
1	2	2	1
2	5	7	2
3	4	11	3
4	7	18	4
5	3	21	5
6	5	26	6
7	6	32	7
8	3	35	8
9	2	37	8

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Earned Value

The purpose of earned value is to

- establish a value for each task
- permit progress tracking against the plan
- facilitate tracking even with plan changes

The principles behind earned value are

- it provides a common value for each task
- this value is the percent of total project hours this task is planned to take
- no value is given for partial task completion
- major plan changes require new plans

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Establish the Planned Value

On the task template

- total the project hours
- calculate the % each task is of the total hours
- enter this % 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 week

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Schedule Planning Example - 4

Next, produce the planned value (PV), or the % of the total job that each task represents

Task	Hours	Cum. Hrs	Day	PV	Cum. PV
1	2	2	1	5.4	5.4
2	5	7	2	13.5	18.9
3	4	11	3	10.8	29.7
4	7	18	4	18.9	48.6
5	3	21	5	8.1	56.7
6	5	26	6	13.5	70.2
7	6	32	7	16.3	86.5
8	3	35	8	8.1	94.6
9	2	37	8	5.4	100.0

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Schedule Planning Example - 5

Next, enter the cumulative planned value for each day

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

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Tracking the Plan

As each task is completed, it earns the planned value

- enter this earned value (EV) for that task
- enter the date of task completion
- add the EV to date in the cumulative EV column

In the schedule template, enter the cumulative EV for each week as it is completed

Track earned value versus planned value by week

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Projecting Project Completion

Assume that the project will continue to earn value at the rate it has in the past.

Extrapolate to project completion by linearly extending the EV line until it reaches 100%.

This is the likely project completion date unless

- **the rate of progress can be accelerated**
- **the work for the remaining tasks can be reduced below the original plan**

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Schedule Planning Example - 6

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

Task Done	Hours	Cum. Hrs	Day	PV	Cum. PV	
• 1	2	2	1	5.4	5.4	1
• 2	5	7	2	13.5	18.9	2
• 3	4	11	3	10.8	29.7	4
• 4	7	18	4	18.9	48.6	5
• 5	3	21	5	8.1	56.7	
• 6	5	26	6	13.5	70.2	
• 7	6	32	7	16.3	86.5	
• 8	3	35	8	8.1	94.6	
• 9	2	37	8	5.4	100.0	

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Schedule Planning Example - 7

Also, enter on the schedule template the earned value 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	

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Schedule Planning Example - 8

Using the actual EV earned per day of 9.72, enter the 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

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Changing the Plan - 1

For small plan changes, the earned value amounts can be adjusted as follows

- **assume the change is a task addition**
- **estimate the hours for the new task**
- **determine the new task PV%**
- **add this amount to the project total**
- **proportionally reduce the value of every task by the ratio 100/(100 + new task PV)**

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Changing the Plan - 2

The plan is still tracked against the original planned value schedule.

By adding a task, the value of all the completed and planned tasks is reduced.

When tasks are deleted, the value of all the completed and planned tasks is increased.

For major plan changes, you must produce a new plan.

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Plan Change Example - 1

To add a task, proportionately reduce the other task PVs so they total 100

Task	Hours	Cum. Hrs	PV	Cum. PV	Adj. EV	Cum. EV
1	2	2	5.4	5.4	4.8	4.8
2	5	7	13.5	18.9	11.9	16.7
3	4	11	10.8	29.7	9.5	26.2
4	7	18	18.9	48.6	16.7	42.9
5	3	21	8.1	56.7	7.1	50.0
6	5	26	13.5	70.2	11.9	61.9
7	6	32	16.3	86.5	14.3	76.2
8	3	35	8.1	94.6	7.1	83.3
9	2	37	5.4	100.0	4.8	88.1
10	5	42	13.5	113.5	11.9	100.0

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Plan Change Example - 2

Enter the adjusted EV for each completed task but track to the original EV plan

Day	Hours	Cum. Hrs	Cum. PV	EV	Adj. EV
1	3	3	5.4	5.4	4.8
2	5	8	18.9	18.9	16.7
3	5	13	29.7	18.9	16.7
4	5	18	48.6	29.7	26.2
5	4	22	56.7	48.6	42.8
6	6	28	70.2		
7	5	33	86.5		
8	5	38	100.0		

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PSP1.1 Additions

The PSP is augmented to include

- resource estimating: already covered
- schedule estimating: already covered
- a new project plan summary

The project plan summary adds

- the cost performance index
- reuse data

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The Cost Performance Index

The cost performance index (CPI) is

- a measure of the degree to which projects are completed within planned cost
- an index of around 1.0 is most desirable
- an index of less than 1.0 indicates that projects are costing more than planned
- an index of more than 1.0 indicates that projects are costing less than planned
- if the index is much more than 1.0, it indicates overly conservative planning

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Reuse

The reuse measures are % reused and % new reused

A high value of % reused is desirable

- resources are concentrated on developing new products
- resources are not spent on redeveloping existing products.

A high value of % new reused indicates that a high percentage of the new and changed LOC are planned for future reuse.

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Assignment #5

Read Chapter 6

Using PSP1.1, write program 5A to do a numerical integration, using Simpson's rule.

Use program 5A to calculate the values of the normal distribution integral for three values: from minus infinity to 2.5, to 0.2, and to -1.1.

Follow the program, assignment, and process specifications in Appendices C and D.

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Numerical Integration - 1

In principle, numerical integration treats a function as composed of multiple rectangular areas.

It then adds these areas to produce the integral value.

The trick is to sum these areas so as to minimize the error.

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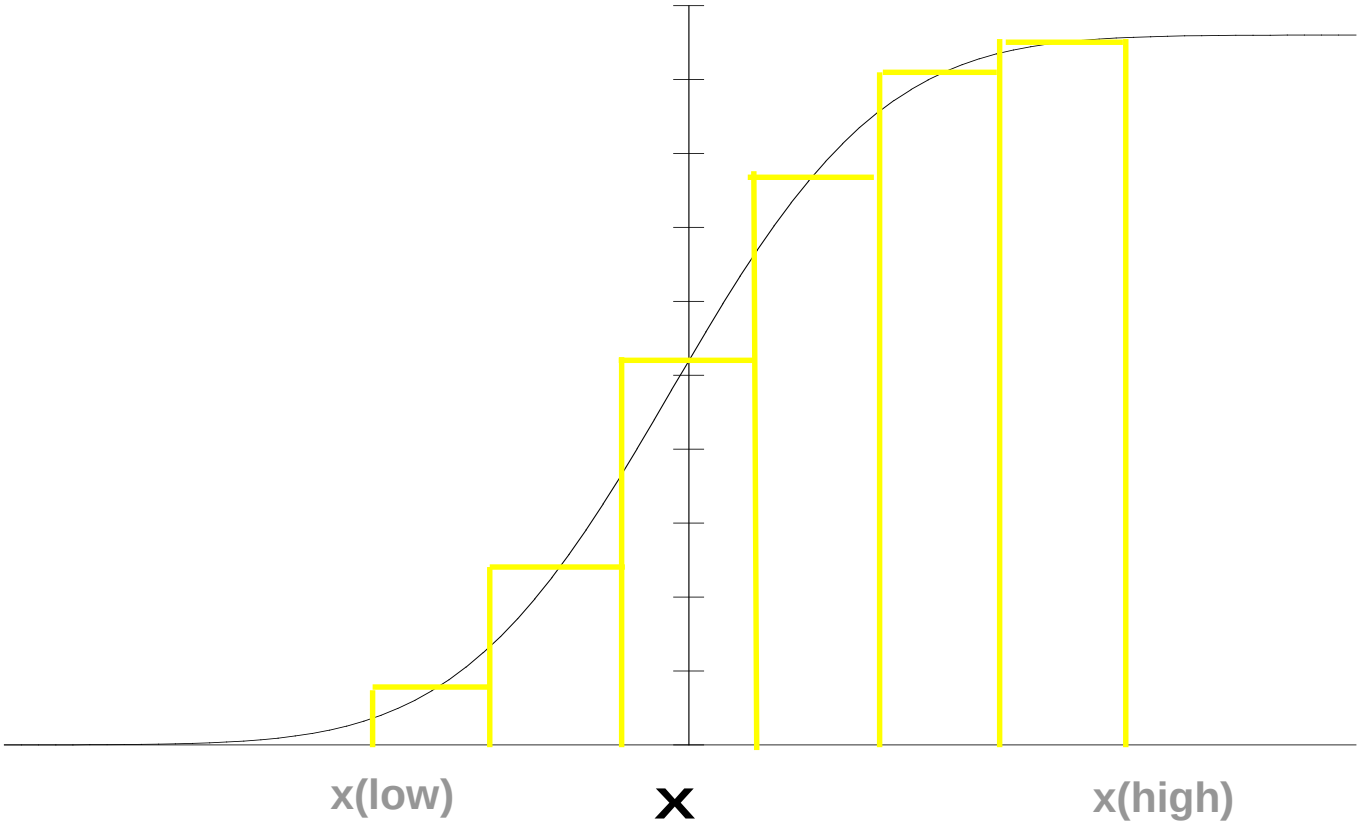
Integrating a Function



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Numerical Integration - 2

The formula for calculating the integral is

$$\int_{x_{low}}^{x_{high}} F(u)du = \frac{W}{3}\left[F(x_{low}) + 4F(x_{low}+W) + 2F(x_{low}+2W) + 4F(x_{low}+3W) \ldots 2F(x_{high}-2W) + 4F(x_{high}-W) + F(x_{high})\right]$$

Here

- **W is the width of the rectangular cells**
- **F is the value of the function for each x value**

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Numerical Integration - 3

To determine the integration limits

- most statistical functions are integrated from minus infinity to some value
- statistical distributions have a total area of 1.0 when integrated from minus to plus infinity

With symmetric functions (the normal and t distributions) the procedure is

- for positive values of x, integrate from 0 to x and add 0.5 to get the answer
- for negative values of x, integrate from 0 to the absolute value of x and subtract from 0.5 to get the answer

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Messages to Remember from Lecture 5 - 1

1 - You can use the PROBE method to estimate

development hours.

2 - This also gives you the likely hourly range

within which the project will be completed.

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Messages to Remember from Lecture 5 - 2

3 - With an accurate estimate you can make an

accurate schedule.

4 - The earned value method helps you to track

progress and project job completion.

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