Planning IV: 
Resource & Schedule Estimating

Outline
- Review of PSP Levels
- Overview
- Resource planning
- Estimating development and task time
- Combining multiple estimates
- Multiple regression
- Schedule estimating
- Earned value tracking
- Estimating accuracy
- Homework #5
Review of PSP Levels (Humphrey, 1995, p. 11)

- PSP0
  - Current process
  - Time recording
  - Defect recording
  - Defect type standard

- PSP1
  - Size estimating
  - Test report

- PSP2
  - Code reviews
  - Design reviews

- PSP2.1
  - Design templates

- PSP3
  - Cyclic development

Baseline

Planning

Quality Mgt

Cyclic

Overview (cf. Humphrey, 1995, p. 145)

- This chapter covers:
  - How to make plans for small programs
  - How to combine these into larger consolidated plans

- Schedule planning includes:
  - Resource loading
  - Resource utilization
  - Earned value tracking
  - …
Review of the PSP Project Planning Framework
(cf. Humphrey, 1995, p. 146)

- Define Requirements
- Produce Conceptual Design
- Estimate Product Size
- Estimate Resources
- Produce Schedule
- Develop Product
- Analyze the Process
- Tracking Reports

NOTE: Real life is not as linear as this framework suggests.


- In the PSP, the resource is your time.
- Productivity
  - Hours required / unit of work
  - Each job has many unique conditions and factors which affect productivity
    - See "cement" example, p. 148.
  - Estimate productivity by calculating the average and range from prior jobs (homework assignments)
**Estimating Task Time**

*(cf. Humphrey, 1995, p. 145)*

- The SW development task is a special instance of general tasks for which time estimates must be made.
  - See Fig. 6.3, p. 156, and general task-estimation steps.
- For SW development we prefer to base our estimates on historical data.
- We have three types of historical data which may be used:
  - A: Estimated object LOC & total actual development hours
  - B: Actual object LOC & total actual development hours
  - C: Actual total new/changed LOC & total actual development hours

**Development Time Planning Process** *(Humphrey, 1995, p. 149)*

- Obtain historical data
- Are there sufficient data for a regression calculation?
- Calculate historical productivity in actual new & changed LOC per hour
- Estimating Choice A
- Are there sufficient estimated data for a regression calculation?
- Calculate the prediction interval
- Do the regression calculation on estimated object LOC and actual hours
- Calculate the time required
- Calculate the time estimate

**Walk through diagram and steps, p. 148-153.**
Development Time Planning
Example (Humphrey, 1995, p. 149)

- Walk through example on p. 153-155
- See how regression parameters are calculated and used.

Combining Multiple Estimates
(cf. Humphrey, 1995, p. 158-163)

- Assume 4 estimates: a, b, c, d.
- The estimated hours and standard deviations are:
  - $H_a$, $H_b$, $H_c$, $H_d$ and $\sigma_a$, $\sigma_b$, $\sigma_c$, $\sigma_d$
- When estimates are independent (e.g. come from separate databases) and unbiased (not all from same project, under same manager, etc.):
  - $H_t = \text{total hourly time} = \sum H_i$
  - $\sigma_t = \text{total standard deviation} = \sqrt{\sum \sigma_i^2}$
  - $H_{\text{upper}} = H_t + \sigma_t$
  - $H_{\text{lower}} = H_t - \sigma_t$
Combining Multiple Estimates Under Dependence  
(cf. Humphrey, 1995, p. 158-163)

- Must use more involved calculation for the prediction interval when estimates to be combined are not statistically independent
- Use formulas on p. 160-162

Multiple Regression  
(cf. Humphrey, 1995, p. 162-166)

- The problem:
  - We don’t have detailed enough data.
  - e.g. We have total hours, new LOC, reused LOC, & modified LOC, but not hours by each of these LOC categories.

- The solution:
  - Multiple regression estimates the relative contributions.

- Example regression equation:
  - \( \text{Hours}_t = \beta_0 + \beta_1 \text{New}_k + \beta_2 \text{Reuse}_k + \beta_3 \text{Modified}_k \)
Multiple Regression (cont.)
(cf. Humphrey, 1995, p. 162-168)

- Gauss’s method is used to solve the simultaneous equations (cf. p. 560-564 for an example).
- The resulting equation is:
  - \( \text{Hours} = 6.71 + 0.0784 \times 650 + 0.0150 \times 3000 + 0.2461 \times 155 \)
  - \( = 141 \)
  - \( \beta_0 = 6.71 \) hours overhead
  - \( \beta_1 = 0.0784 \) hrs to develop a new LOC (12.76 LOC / hr)
  - \( \beta_2 = 0.0150 \) hrs to reuse a LOC (66.48 LOC / hr)
  - \( \beta_3 = 0.2461 \) hrs to modify a LOC (4.06 LOC / hr)
- The prediction interval calculation and formulas are shown on p. 166-168.
- Caution: Use regression with care. Don’t apply formula outside database limits.

Schedule Estimating: Overview
(cf. Humphrey, 1995, p. 168-170)

- Even with good estimates, if you make incorrect assumptions about daily / weekly available time, schedules can be seriously in error.
- Only time available for direct work can be used to set a schedule.
- Many other activities demand your time: vacation, sick, mail, committees, etc.
- Over time you should gather data on how you use your time, only then can you make good schedules.
  - Planning using this “unplanned time cushion” gives you some “slack” and room for adjustment for “crunch” times in your schedule.
- Typically only 50-75% of time can be spent on direct work.
Schedule Estimating: The PSP
Schedule Planning Procedure
(cf. Humphrey, 1995, p. 170-180)

- The procedure is documented by:
  - Fig 6.4: PSP Schedule Planning Diagram
  - Table 6.11 & 12: Schedule Planning Template & Example
  - Table 6.13 & 14: Task Planning Template & Example

- NOTE:
  - This is presented in a very TOP-DOWN approach, as opposed to a BOTTOM-UP approach which is commonly used in activity-based planning (cf. MGT 882).

- Look at and talk about Fig. 6.4, p. 171
- Walk through step-by-step sequence, & forms
- Discuss relationship of this method to project networks, activity-based planning, etc.
  - Show equivalent network for Humphrey’s task plan
  - Demonstrate project management software.

Earned Value: Definition

- “Earned value (EV) is a way to evaluate project progress. It establishes a relative value for every task and credits that value when [the task is complete].”

- EV allows progress to be tracked on different types of activities, and even when planned sequencing is changed, or tasks are added or deleted.

- EV = Percent based on proportion of total project.
Earned Value (cont.)

- EV is credited only when a task is completed.
  - No partial credit is given.
  - If tasks are large enough that intermediate tracking is desired, break them down and assign EV's to all sub-tasks.
- Question: What are some examples of small and large ISD/SE tasks?
- Set checkpoints based on total project size.
  - Over 2-3 weeks, 10 checks is too much
  - Humphrey:
    - > 1 per week, < 1 per day
    - 2-4 per week

EV Tracking Example
(cf. Humphrey, 1995, p. 182-195)

- Walk through:
  - Tables 6.15 & 16 - Task & Schedule Plans
  - Tables 6.17 & 18 - Actual
  - Table 6.19 - Adjusted schedule
    (additional task added to original schedule)
- Finished on time even with all the changes.
EV Conclusions

- Get management help for problems and alert them to changes.

EV & motivation
- It is hard to maintain motivation when working on activities which have no EV.
- Therefore, promptly put new activities into your plan, and
- Promptly drop activities.
- Remember, you are in charge, and the plan is there to help you.

Estimating Accuracy
(cf. Humphrey, 1995, p. 196-204)

- Estimation is difficult.
- Over- and under-estimation should balance out.
- Error% = 100 * (Act - Est) / Est
- Note student and class results in Fig's 6.6-13 on p. 197-201.
  - Over- and under-estimation
  - Improvement for some
  - Bad estimate after good ones.
  - ...
- DON'T OVERCOMPENSATE
- Learning time depends on each person
Estimating Accuracy (cont.)

- Small estimates
  - Small tasks have lots of variation.
  - To improve estimation, try to understand as many causes as possible.
  - Do this with consistent planning, using historical data, and planning in detail.

- Composite estimates
  - Composites are more reliable
  - Estimates are difficult when using evolving process data

- Overcompensation
  - Don’t estimate to “average” - you’ll always be off
  - Don’t adjust your intuition
  - Get feedback from colleagues

- Reasonableness
  - Is the estimate reasonable?
  - Strange β weights can be caused by:
    - Closely-clustered historical data
    - Estimating above and below the historical data range
    - Including outliers
Homework #5

- See “Homework Assignments” list and textbook instructions.