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)

<table>
<thead>
<tr>
<th>PSP0</th>
<th>Current process</th>
<th>Time recording</th>
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<tbody>
<tr>
<td>PSP1</td>
<td>Task planning</td>
<td>Size measurement</td>
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<tr>
<td>PSP2</td>
<td>Design templates</td>
<td>Size estimating</td>
</tr>
<tr>
<td>PSP3</td>
<td>Cyclic development</td>
<td>Cyclic</td>
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</tbody>
</table>

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
- ...


<table>
<thead>
<tr>
<th>Customer Need</th>
<th>Define Requirements</th>
<th>Produce Conceptual Product</th>
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<tbody>
<tr>
<td></td>
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<td>Estimate Resources</td>
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<td>Develop Product</td>
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<td>Analyze the Process</td>
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<td>Tracking Reports</td>
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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
Calculate the hours required
Calculate the shortest and longest likely times
Are there sufficient estimate data for a regression calculation?
Do the regression calculation on actual object LOC and actual hours
Calculate the time required
Calculate the prediction interval
Do the regression calculation on estimated object LOC and actual hours
Calculate the time required
Calculate the prediction intervals

Combining Multiple Estimates
Assume 4 estimates: a, b, c, d.
The estimated hours and standard deviations are:
- \( H_a, H_b, H_c, H_d \) and \( s_a, s_b, s_c, s_d \)
- When estimates are independent (e.g. come from separate databases) and unbiased (not all from same project, under same manager, etc.):
  - \( H_t = \sum H_i \)
  - \( s_t = \sqrt{\sum s_i^2} \)
  - \( H_{upper} = H_t + s_t \)
  - \( H_{lower} = H_t - s_t \)

Combining Multiple Estimates Under Dependence
(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
(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:
- \( \text{Hours}_t = \beta_0 + \beta_1 \text{New}_t + \beta_2 \text{Reuse}_t + \beta_3 \text{Modified}_t \)
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:
  \[
  \begin{align*}
  \text{Hours} &= 6.71 + 0.0784 \times 650 + 0.0150 \times 3000 + 0.2461 \times 155 \\
  &= 141
  \\
  b_0 &= 6.71 \text{ hours overhead} \\
  b_1 &= 0.0784 \text{ hrs to develop a LOC (12.76 LOC/hr)} \\
  b_2 &= 0.0150 \text{ hrs to reuse a LOC (66.48 LOC/hr)} \\
  b_3 &= 0.2461 \text{ hrs to modify a LOC (4.06 LOC/hr)}
  \\
  \end{align*}
  \]
- 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

Estimating Accuracy (cont.)

- 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 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.