Personal Software Process™
for Engineers: Part I

Introduction to the PSP™
Defect Removal
Estimation of Project Size
Microsoft Project Design

READING FOR THIS LECTURE
Modern Structured Analysis by Edward Yourdon

PSP Principles
As computing professionals you should know your own performance.
You should measure, track, and analyse your work.
You should learn from your performance variations.
You should incorporate these lessons in your personal practices.
You should be able to predict your performance in future for your planning and self-management.

What is a PSP?
A PSP is a personal process for developing software. However principles apply to projects.
• defined steps
• forms
• standards
A PSP is a measurement and analysis framework to help you characterize and estimate your process.
It is also a defined procedure to help you to improve your performance.

The CMMI and the PSP
The CMMI was developed by the SEI with the help of leading software groups.
The SW-CMM characterizes the most effective large-scale software practices.
The SW-CMM has been integrated into the larger CMMI model.
The PSP
• applies the SW-CMM
• is for individual work

• Originally COMP3710 was PSP
• The process can be applied to all levels of organisation
The Capability Maturity Model for Software (SW-CMM®) is a model for judging the maturity of the software processes of an organization and for identifying the key practices that are required to increase the maturity of these processes.

The Software CMM has become a de facto standard for assessing and improving software processes. Through the SW-CMM, the SEI and community have put in place an effective means for modeling, defining, and measuring the maturity of the processes used by software professionals.

Ref: http://www.sei.cmu.edu/cmm/cmm.html

The PSP Main Benefits

- Higher quality - PSP enables engineers to remove more defects early, at the source. On average, engineers inject 58% fewer defects after PSP training than before. PSP and TSP technology can also enable organizations to establish numerical quality requirements (or measures) for software-intensive products (e.g., defect density limits, percent defect free by phase, and component quality profiles).
- Improved Planning - PSP provides measures from which to develop resource planning. Cost and schedule problems often begin when engineers make commitments based on inaccurate size and resource estimates. PSP methods provide more accurate size and resource estimates using statistical techniques and historical data. Engineers’ schedule estimating errors before PSP training averaged 39.4%, and after training they averaged 10.4% ahead of schedule.

Defect Detection

- Recognize defects
- Prevent defects
**PSP Defect Removal - Ch8**

Humphrey

- Code Reviews.
  - Review before compile
  - Set up review measures, such as efficiency and detection rates
  - Review against a standard - either CMMI or specific requirements.
  - Separate Design and Code reviews
    - Reduce review material
    - Remove design defects and simplify
  - Use checklists

**PSP Defect Removal - 2**

- Design Reviews.
  - Develop your design with a review in mind. You should explain all terms used
  - The designs you develop must have a clear purpose and function
  - Have a design review process
  - Review in stages
    - Complete: all elements present
    - Verify structure and flow
  - Check logical constructs
  - Verify design against client requirements and Quality Assurance documents.
  - Develop Quality Plan for review

**Planning**

- Make plans based on estimates
- Measure progress to develop better plans

**PSP helps you plan. Why make Plans?**

- To make commitments you can meet
- To provide a basis for agreeing to take on a job
- To guide your work
- To help track your progress
- To complete project on time and on budget

**The Project Planning Framework**

**Popular Estimating Approaches**

In order to estimate the size of a project, you must develop a suitable measure. The measure must correlate with effort or it cannot be used for effort estimation.

In Software Projects there are five main methods of estimating project size.

- Fuzzy logic
- Function points
- Standard components
- Delphi
- PROBE

From these estimates you can calculate project effort in hours or days.
Fuzzy Logic Size Estimating - 1

Gather size data on previously developed programs
Subdivide these data into size categories and subcategories

<table>
<thead>
<tr>
<th>Subrange</th>
<th>Very Small</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>Very Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Range</td>
<td>1,148</td>
<td>1,514</td>
<td>2,000</td>
<td>2,630</td>
<td>3,467</td>
</tr>
<tr>
<td>Very Small</td>
<td>4,570</td>
<td>6,025</td>
<td>8,000</td>
<td>10,471</td>
<td>13,804</td>
</tr>
<tr>
<td>Small</td>
<td>18,197</td>
<td>23,988</td>
<td>32,000</td>
<td>41,687</td>
<td>54,954</td>
</tr>
<tr>
<td>Medium</td>
<td>72,444</td>
<td>95,499</td>
<td>128,000</td>
<td>165,958</td>
<td>218,776</td>
</tr>
<tr>
<td>Large</td>
<td>288,403</td>
<td>380,189</td>
<td>512,000</td>
<td>660,693</td>
<td>870,964</td>
</tr>
</tbody>
</table>

Fuzzy Logic Size Estimating - 2

When estimating a new program, compare the planned program with prior programs and select the most appropriate size category.

For a Medium-Small, estimated LOC = 23988

Fuzzy Logic Advantages

Fuzzy logic estimating
* Is based on relevant historical data
* Is easy to use
* Requires no special tools or training
* Provides reasonably good estimates where new work is like prior experience

Fuzzy Logic Disadvantages

The disadvantages of fuzzy logic are
* It requires a lot of data
* The estimators must be familiar with the historically developed programs
* It only provides a crude sizing
* It is not useful for new program types
* It is not useful for programs much larger or smaller than the historical data

Function Point Estimating - 1

A function point is a unit
* Based on application functions (inputs, outputs, data files, inquiries, interface files)
* This has been refined to input data, entity types and output data in the Mark II formulation.
* Scaled or weighted by simple, average, complex

For job complexity such as data communication, transaction rate etc., some companies use Adjusted Function Point estimates, adjusting a further +/- 35%. However this has been found to increase the error in the calculations.

Function Point Estimating - 2

Procedure
* Determine numbers of each function type in the application.
* Judge the scale and complexity of each function.
* Calculate function point total.
* Use historical data on development rate per function point to make the estimate of delivery rate
* Multiply function points times estimated delivery rate to get the estimate of work effort.
Function Point Advantages

The advantages of function points are the following:
- They are usable in the earliest requirements phases.
- They are independent of programming language, product design, or development style.
- There exists a large body of historical data.
- It is a well-documented method.
- There is an active users’ group.
  See http://www.asma.org.au/

Function Point Disadvantages

The disadvantages of function points are the following:
- You cannot directly count an existing product’s function point content.
- Without historical data, it is difficult to improve estimating skill.
- Function points do not reflect language, design, or style differences.
- Function points are designed for estimating commercial data processing applications.

Standard Component Sizing - 1

Establish the principal product size levels.
- Components, modules, screens, etc.
- Determine typical sizes of each level.

For a new product
- Determine the component level at which estimation is practical.
- Estimate how many of those components will likely be in the product.
- Determine the maximum and minimum numbers possible.

Standard Component Sizing - 2

Calculate the size as the
+ number of components of each type times typical sizes of each type
+ total to give size

Calculate for the maximum, minimum, and likely numbers of components.

Calculate size as
+ (maximum+4*likely+minimum)/6

Standard Component Sizing - Advantages and Disadvantages

Advantages
- Based on relevant historical data
- Easy to use
- Requires no special tools or training
- Provides a rough estimate range

Disadvantages
- Must use large components early in a project
- Limited data on large components

Delphi Size Estimating

Uses several estimators
- Each makes an independent estimate.
- Each submits estimate to a coordinator.

Coordinator
- Calculates average estimate
- Enters on form: average, other estimates (anonymous), and previous estimate

Experts meet
- Discuss tasks they defined
- Privately re-estimate

When re-estimates stabilize
- Average is the estimate
- Range is range of original estimates
Delphi Size Estimating - Advantages and Disadvantages

Advantages
* can produce very accurate results
* utilizes organization’s skills
* can work for any sized product

Disadvantages
* relies on a few experts
* is time consuming
* is subject to common biases

PROBE - Size Estimating by Proxies

The basic issue
* Good size measures are detailed.
* Early estimators rarely can think in detail.

Alternatives
* Wait to estimate until you have the detail.
* Make your best guess.
* Identify a suitable proxy.

Size Estimating Proxies - 2

A good proxy should correlate closely to development costs.
A good proxy would be easy to visualize early in development.
It should also be a physical entity that can be counted.

Example Proxies

Function points
Objects
Product elements
* components
* screens, reports, scripts, files
* book chapters

Function Points as Proxies - 1

Data show that function point counts correlate well with development time.
Function points can be visualized early in development.
To use function points properly, trained estimators are required.

Function Points as Proxies - 2

Function points cannot directly be counted.
Conversion factors are available for counting LOC and calculating function points from the LOC value.
The function point users group (IFPUG) is refining the function point method.
Standard Components as Proxies

Component count correlation with development depends on the components.

A lot of development data is required.

Component counts are hard to visualize early in development.

Components are machine countable.

Objects as Proxies -1

Correlation with development hours

- Numbers of objects correlate reasonably well.
- Object LOC correlate very closely.
- Object LOC can be estimated using the standard component estimating method.
- Then calculate LOC estimate from historical relationship between object LOC and program LOC.

Objects as Proxies -2

When objects are selected as application entities, they can be visualized early in development.

Functions and procedures can often be estimated in the same way.

Objects, functions, procedures, and their LOC can be automatically counted.

Estimation and Assessment of Effort

The Measurement Process

Analysis of Full Data Set (17 Completed Projects)
**Function based measures & Components of System Size**

**The PSP Proxy Based Method**

PSP uses PROBE method with objects as proxies. The process used is:
- Set up standard code counting method
- Divide project into modules or objects
- Estimate the size of each object by its type using historical data.
- Then use
  - Estimated object LOC and actual development time
  - Calculate correlation \( r \) between data. Need \( r^2 > 0.5 \)
  - Do a regression calculation Est Obj LOC to Development Hours
  - Calculate prediction interval considering size estimation error and productivity variations.

**Terminology**

- You need to apply these not calculate them
- Understand what they are for

**Object LOC Correlation With Development Hours**

**What is…. Appendix A Humphrey**

- **Correlation of Data**
  - You can measure the lines of codes and the time it takes to write them.
  - If you could estimate the lines of code, can you calculate an estimated time from that data?
  - Is LOC and time correlated?
  - Graph LOC and time and put a line of best fit between the points
  - The correlation is a measure of how close the numbers pair up, and is related to the sung of the squares minus the square of the sums.

- **Regression Coefficient.** This straight line has an equation
  \[ y = \beta_0 + \beta_1 x \]
  \( \beta_0, \beta_1 \) are the regression coefficients

- **Prediction Interval** is a measure of the likely error of your estimate deviating from the line by one variance in a percentage of cases.

**Estimation as GQM**

- What are your goals
- What questions does this raise
- What do you measure to get this
What are your Goals, Questions, Measures.

- You want to reduce your defects in design
- Is the Quality Assurance of design met
- QA must be measurable
- You want to develop a design review process
- What are the Requirements of a design
- Requirements must be measurable
- You want to improve your estimates of your
time to design a system
- Make some estimates eg time/product or
time/Use Case(input) that you want to reach
  and see if you can reach them
- Measure your rate and compare to actuals

Using Function Point Estimation

- You will be using a simple Function Point estimation in Tutorial based on the Function points estimated from the E-R diagram (30 per entity).
- When you have completed your Concept Design as the end of this course, you can made a more accurate estimate of the Function Points of the system and update your estimates for the remainder of the Project (post Concept Design).
- Include this in Your Plan Review Report.

Tutorials

- What you are doing
- Why you are doing it

Project Management

- Project Deliverables
  - PP02 - establish a measured performance baseline.
  - PP02 - make changes to effort, resource, and duration or re-scheduling plans.
  - PSR - review your practice in change and yield management. Analyse your project management by measurements.
- What sort of measures are there for Project management?

Microsoft Project

- Attributes to learn in Tutorial Week 2
  - Load Template file
  - Estimate effort per phase then per task
  - Estimate scheduling such as tasks in parallel
  - Save Baseline of your MS Project
  - Enter Variations over the next week as versions to track changes
  - Enter Actual data of what time you spent on each task
  - Produce Status Reports each week

Design Process - See Humphrey Ch 10

- Design is learning
- Requirements Uncertainty
- Conceptual Design
- Design Quality must be maintained at all levels
  - Completeness
  - Accurate
  - Precise
Design Process -2

- Design templates
  - Notation compatible with implementation
  - Design should include:
    - Internal dynamic representation, eg DFD
    - Internal static such as Data Table
    - External static eg Interface or inheritance
    - External dynamic such as Reports and Forms
  - or call return behaviour of methods
- Design strategy
  - Start with a critical module and design and implement related elements from that level up or
  - Top down design that starts with top level objects that use lower level abstractions that must be specified then designed.

Design Process -Tutorial - See Yourdon

- Requirements
  - Client’s List
  - E-R diagrams
  - Use Cases 1&2
- Design strategy
  - Top down DFD to level 1 from E-R
  - Expand Data Dictionary to include DFD processes and flows
  - Expand DFD to level 2&3 for Use Cases
  - Design Data Table for DFD
  - Design Interface for Use Cases
  - Verify against Client’s List

Design Project Deliverables

PSR03 - to include Quality Assurance Plan
PPM - Planning Module DFD, Data Table and Interface
PTM - Tracking Module DFD, Data Table and Interface
PDC01 - Design Change on a given design

Pair Work Guidelines - see paper on web

- Use ‘we’ when you discuss the project
- Share work as the driver and observer - switch on 10 mins or task completion
- Stay focused on the task - respect your team mate
- Do not be negative, give it a go
- Detect defects as you go - observer
- Do not fight over design - debate differences
- Share the work space and the contributions
- Review any individual work between tutorials
- Have regular planned breaks - time them

Quality Assurance

- This is set by SIP
- You have to satisfy it in your designs
- You have to plan how you will check you are satisfying it
QA for Project

Metrics for sub characteristics will be given

Your role is to evaluate the metrics of your particular design

The metrics may apply to only one part of the design or all of your design

* Eg Suitability is a functionality sub-metric that applies to the completeness of your design products as a how.