Scaling Up the Personal Software Process

Outline

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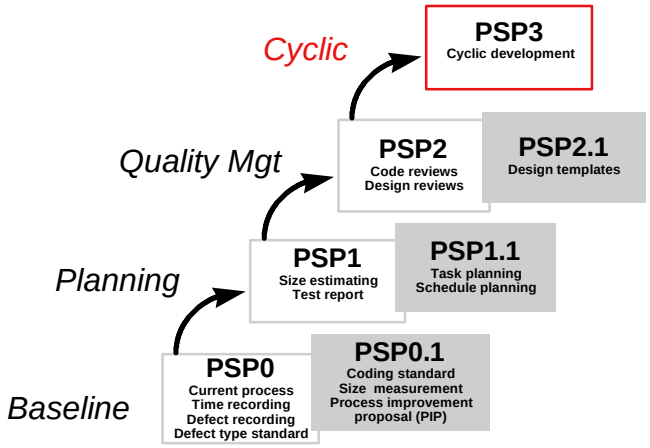
Review of PSP Levels *(Humphrey, 1995, p. 11)*



Overview *(cf. Humphrey, 1995, p. 353-354)*

- *The size of a similar software product increases an order of magnitude every 5-10 years.*
- *Ex: HP Laserjet software*
  - *LJ - 25,000 LOC*
  - *LJ-II - 200,000 LOC*
  - *LJ-III - 1,000,000 LOC*
- *Therefore, your software development process needs to be able to scale up over time.*
- *In this section we discuss problems, principles, and strategies associated with developing large-scale systems. The PSP3 is one example of how to do this.*

Abstractions *(cf. Humphrey, 1995, p. 354-356)*

- *Physical scientists use abstractions and laws to help abstract away the confusing details.*
- *Computer scientists cannot abstract away details, because the system will most likely become unusable.*
- *However, we are free to build and use whatever abstractions we wish. We just need to make these abstractions consistent and complete.*
- *Our work is intellectual, and has three components:*
  - *Memory: People can usually only remember 7 +- 2 "chunks", but patterns can enhance the amount of detail we can keep track of.*
  - *Skills: As we gain skills and experience, the number of "patterns" with which we are familiar grows, and thus so does our development ability.*
  - *Methods: By breaking down large processes for large projects into smaller sub-processes we can manage large development efforts.*

Stages of Product Size

(cf. Humphrey, 1995, p. 356-361)

Stage	· Description
0	· Very small program elements. · Written by programmers alone.
1	· Small programs or modules. · Designed, implemented, tested by programmers alone.
2	· Larger programs or components. · Typically developed by teams who develop & integrate multiple Stage-1 modules into larger Stage-2 components.
3	· Very large projects. · Involve multiple teams controlled & directed by a central project management.
4	· Massive multisystems. · Involve many autonomous or loosely federated projects.

•Within each range a given process is likely applicable to many projects.
•When you cross a scaleability boundary you will need new process features.
•Your boundaries are dependent on and change with your skills and abilities,
•thus your boundaries change over time.

Stage-0: Simple Routines

- *Smallest building blocks:*
  - *loops, if-then-else, …*
- *Experienced programmers do not design these constructs - that would be like designing how to add a string of numbers…*

Stage-1: The Program or Module

- *10's - several 100's LOC*
- *Design in your head, type in, compile.*
- *Beginning programming classes:*
  - *300 LOC*
  - *written from scratch*
  - *in a "dead" language*
  - *"clear" boxes*
- *Properties:*
  - *Not scaleable - can't continue to use intuitive methods to build large programs*
  - *By using purely intuitive methods, programmers don't develop scaleable methods.*
  - *Programmers may attempt to use these (familiar) methods on large-scale systems, unsuccessfully.*
- *Moving from 1->2*
  - *Interact with other developers and get ideas from them for the new and unfamiliar things with which you must now deal. cf. Fig 11.1, p. 358*

Stage-2: The Component

- *Entire programs are abstractions.*
- *Visualize interconnecting Stage-1 modules.*
- *Processes beyond their capacity at Stage-2 have two symptoms:*
  - *Inadequate design*
  - *Overlooked detail*
- *Problems:*
  - *Many details*
  - *Assumption of correctly working interacting modules*
- *Here you need good quality control and disciplined practices, and must work effectively in teams.*
- *Moving 2->3*
  - *Must master larger-sized programs*
  - *Must have and follow system standards, especially for early defect prevention & removal.*
  - *Must practice defensive programming and design for testability.*
  - *Team relationships must become more formalized, and must be supported by formal team processes.*

Stage-3: The System

- *Work with large multi-component systems.*
- *Understand the external interfaces of these components, but not their inner workings.*
- *Problems:*
  - *Hiding functional complexity from users (so they are not overwhelmed with the multitude of capabilities).*
  - *Maintaining component quality: integration is difficult if not impossible with low quality components.*
- *Your PSP could totally change, or become totally focused on a small part of the overall process.*
- *Moving 3->4*
  - *Reduce centralized control, because:*
  - *No one could possibly track all the activities.*
  - *No one could understand all the components.*
  - *Too many communication paths would be necessary.*
  - *Data to central control would be late & incomplete, and would thus lead to poor decision-making.*
  - *Centralized control de-motivates the people at the bottom, who need to take effective action on their own.*

Stage-4: The Multisystem

- *While system-wide standards, communication methods, and processes are required to manage multi-systems, the subsystems are developed under quite independent teams, with independent requirements.*
- *Requires:*
  - *Extraordinary quality.*
  - *Security, access authorization, audit trails…*
  - *Know and follow system standards precisely.*
  - *Thus developers must be highly disciplined.*

Developing Large-Scale Programs *(cf. Humphrey, 1995, p. 361-364)*

- *Approaches to developing large-scale systems:*
  - *Use your or someone else's prior process*
    - *You have built a similar product*
  - *Start & explore - Boehm's spiral model*
    - *You know how to start but not how to complete it*
  - *Prototype / throw away*
    - *You don't even know how to start*
    - *It is unlikely you'll build a system understanding by following an iterative incremental process*
- *Large-scale development is disintegration (design) and reintegration (integration) - your process must support this.*
- *Large systems evolve by enhancement and accretion of smaller systems*
  - *interfaces adapt between the smaller systems*
  - *there must be structured methods for understanding and controlling changes, and for capturing and disseminating knowledge*

Scaleable Systems *(cf. Humphrey, 1995, p. 363)*

- *A SW system is scaleable if:*
  - *it can be disintegrated into smaller components*
  - *the smaller components can be developed*
  - *the system can be reintegrated (without modifying the components during integration)*
  - *it has an essence - conceptual integrity*

A Potential Problem with Abstractions *(cf. Humphrey, 1995, p. 364-365)*

- *Just breaking down a system into fewer smaller pieces does not automatically solve the scaleability problem*
  - *Ex: 1,000,000 LOC*
    - *500 5LOC parts created*
    - *200,000 unfamiliar parts still must be dealt with*
- *In order to have useful scaleability, the system must be subdivided, but the parts must at the same capture significant system functionality*

The Development Strategy

(cf. Humphrey, 1995, p. 365-368)

- *A good development strategy:*
  - *Naturally matches the system's structure*
  - *Exposes key risks as early as possible*
- *There are many strategies, none of which are the single best strategy - each has advantages and disadvantages.*
- *You must choose a strategy that best fits your project.*
- *Several strategies:*
  - *Progressive ("pipeline")*
    - *System processes information in a sequential manner*
  - *Functional Enhancement*
    - *Kernel + enhancements, see working system earliest*
  - *Fast-Path Enhancement*
    - *Demonstrate key timing/system problems as early as possible*
  - *Dummy*
    - *Top-down, layered, good for kernel of enhancement approaches*

PSP3 *(cf. Humphrey, 1995, p. 368-371)*

- *Principal role*
  - *an example of a foundation process for large-scale SW development*
- *Therefore it must handle increased complexity and be able to relate to team processes*
- *cf. Fig 11.3, p. 369, for overview*

The Overall PSP3 Approach

- *Plan conceptual design, estimate size, plan development work*
- *High level design subdivides work*
  - *These will define activities for subsequent cycles*
  - *100-300 LOC (new & changed) per cycle*
- *For each cycle*
  - *establish spec's for current cycle*
  - *follow regular development process for the current sub-system*
  - *be especially attentive to quality (thorough reviews, defect prevention, removal) since subsequent cycles will use this code*
- *Develop tests and perform reviews*
  - *test development may find as many defects as testing does*
  - *revise tests / reviews based on information from the other*
- *Reassess & recycle*
  - *Determine your status and reevaluate your plan*
  - *Check data against plan / schedule and update if necessary*

Homework #7 *(cf. Humphrey, 1995, p. 353-354)*

- *Assignment 10A*
  - *Three-variable multiple regression*
  - *cf. p. 760-764, Assignment Kit #11, & PSP 3*