Scaling Up the Personal Software Process

Outline

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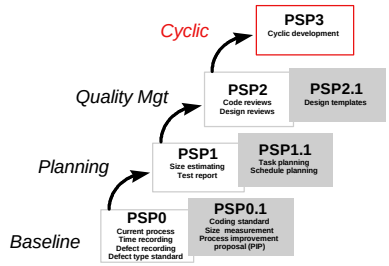
Review of PSP Levels *(Humphrey, 1995, p. 11)*



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