Software Engineering Institute | Carnegie Mellon

From Scientific Methods to High Maturity with PSP^sm/TSP^sm

High Maturity made easy!

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The Road to High Maturity: PSP/TSP

We all know the characteristics of a high maturity process.

We can get to high maturity through scientific measures that inform our decisions and our work as the work progresses.

Let's talk about high maturity and the barriers to getting there.

Quantitative Project Management: CMMI

SG1: The project is quantitatively managed using quality and process-performance objectives.

SP 1.4-1: Manage Project Performance
Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action as appropriate.

SG2: The performance of selected sub-processes within the project's defined process is statistically managed.

To implement, use Process Performance Baselines (PPB) and Process Performance Models (PPM).

Purpose of Organizational PPM and PPB

To engineer successfully:

1. Define aggressive but achievable objectives.
2. Develop a plan with sufficient detail that you can commit to the objectives.
3. Measure and control the process variations and the project progress.
4. Adjust the plan, as needed, to meet the objectives.

What Makes This Difficult?

You must have measures to estimate, evaluate, and control the quality and process performance of a project.

However, there are difficult challenges to measurement:

- **Sufficiency** of data at planning time
- **Definition** of data and sub-processes to monitor the performance variations
- **Accuracy** of the data used for analysis and control
- **Context** of the data must be understood
- **Size** of the data set may be insufficient for application of statistical methods

The TSP/PSP Approach

TSP and PSP fill the gap:

- Measurement and planning framework
- Estimation and planning for individuals and teams
- Evaluation of plan and performance
- Monitoring of quality

We can apply these to both individuals and projects.

PSP Principles

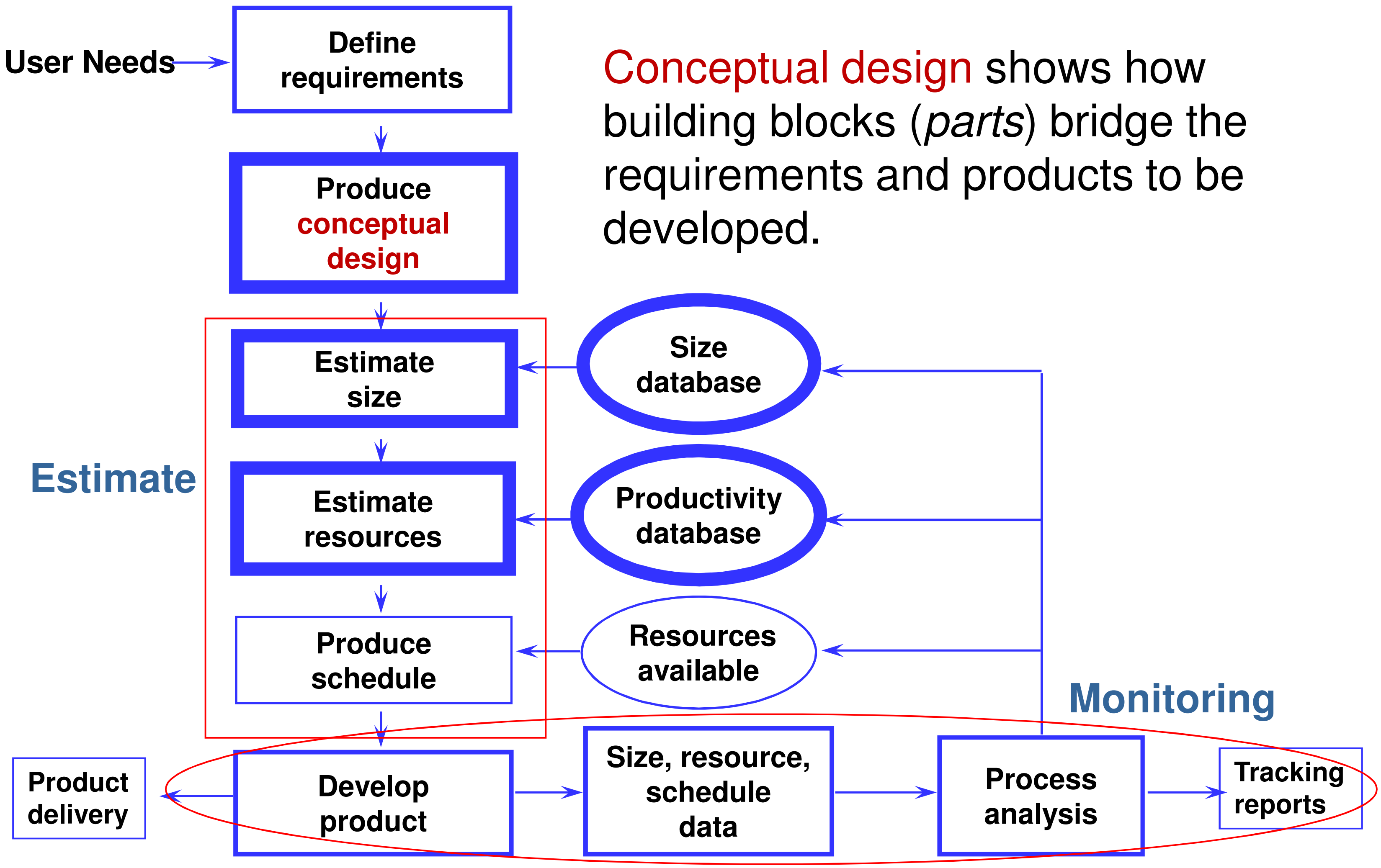
The quality of a software system is determined by its worst components.

A developer learns *s*kills for continual process improvement.

- Learn to estimate, measure, track, analyze, and make a detailed plan
- Habitually log data: time, defects, and size
- Understand current performance and performance variation
- Improve the process using the Process Improvement Proposal (PIP)
- Establish quality before testing

PSP – The Planning Framework

Conceptual design shows how building blocks (*parts*) bridge the requirements and products to be developed.



Size Estimation Dilemma in Project Planning

Early in a project, very little information is available for estimating.

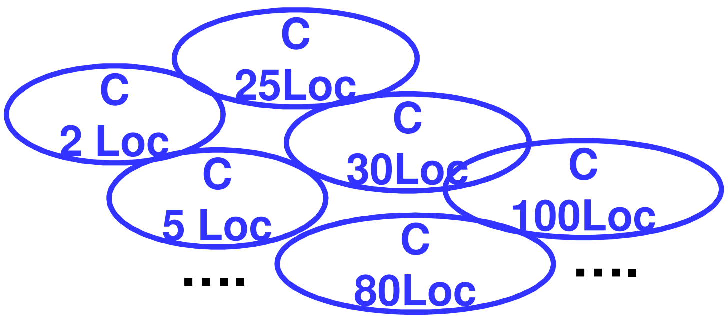
Accurate effort estimates are needed to make accurate plans and commitments.

The Proxy Based Estimating (PROBE) Method makes accurate, early estimation possible.

PSP PROBE Method: PROXY Size Metric

Early project challenge: no precise sizes identified for parts to be developed.

Fuzzy logic helps to specify the size for each type of object: **VS, S, M, L, VL.**



Relative Size Metric

C++ Object Size in LOC per Method					
Category	VS	S	M	L	VL
Calc	2.34	5.13	11.25	24.66	54.04
Data	2.6	4.79	8.84	16.31	30.09
I/O	9.01	12.06	16.15	21.62	28.93
Logic	7.55	10.98	15.98	23.25	33.83
Set-up	3.88	5.04	6.56	8.53	11.09
Text	3.75	8	17.07	36.41	77.66

Log Normal Distribution is assumed

Avg-2ρ, Avg- ρ, Avg, Avg+ρ, Avg+2ρ

Calc	2.34	5.13	11.25	24.66	54.04

Calculate part size

PSP PROBE Method: PROXY Size Estimate

NEW OBJECTS:	TYPE	METHODS	REL. SIZE	Estimated Size LOC *	Actual Size LOC *
Data_ReadIn	IO	1	L	21.6	26
Compute_rxy, b0, b1	C	1	L	24.7	24
Compute_Predict_ Int_(calc_yk)					
Significance test					
Compute_txy(calc_txy)	C	1	M	11.3	12
Compute_pxy	C	1	M	11.3	5
Compute_calc_tail	C	1	S	5.1	1
Compute_Σ	C	1	M	11.3	19
(NO) subtotal from page 2				0.0	0
TOTAL NEW OBJECTS (NO)				85.2	87

Variations at elementary level balance out at the total level

Planned (85.2) — **Actual** (87)

C++ Object Size in LOC per Method					
Category	VS	S	M	L	VL
Calc	2.34	5.13	11.25	24.66	54.04
Data	2.6	4.79	8.84	16.31	30.09
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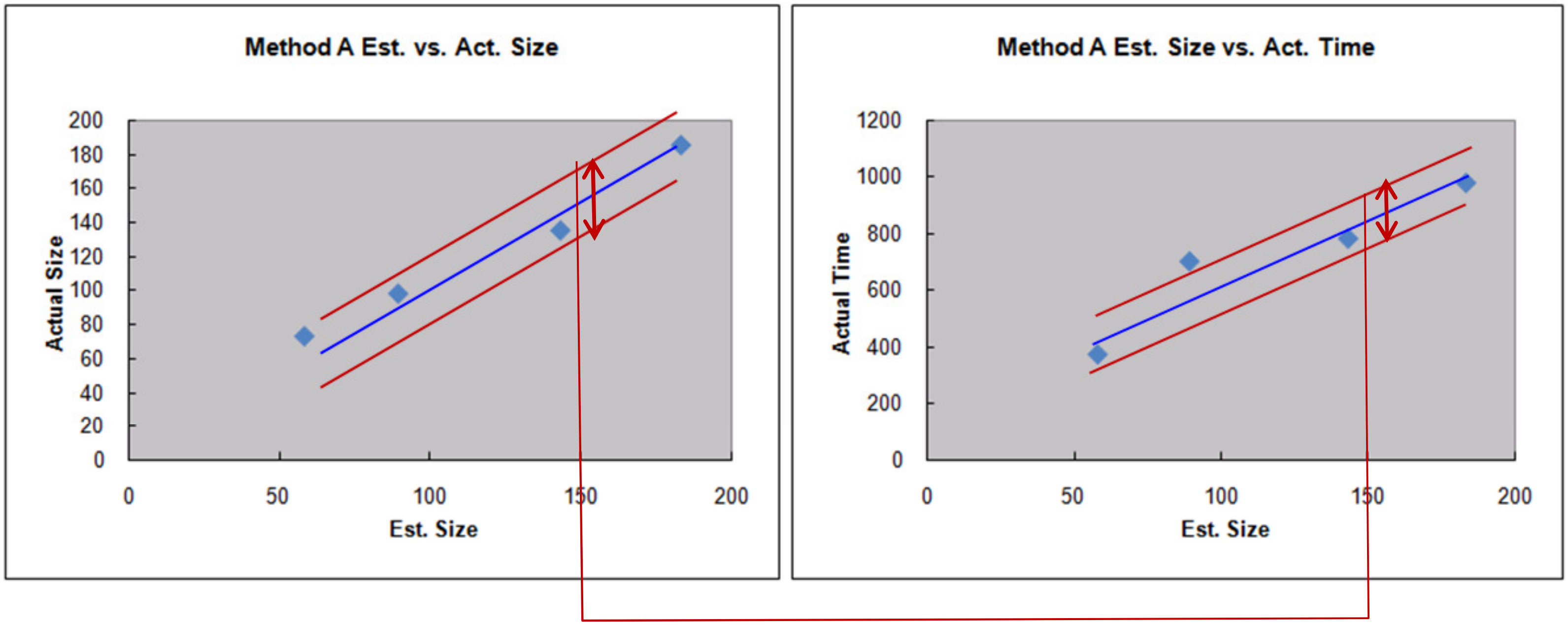
PROBE Method: PPMs on Size and Time



Using Correlation between "Estmate" and "Actual"

70% Prediction Interval

"Size range" **"Time range"**

PPB and PSP Prediction Interval

		Size	Time
Estimated Object LOC:	E = BA+NO+M	254.44	
Regression Parameter:	B_0	19.89	202.31
Regression Parameter:	B_1	0.87	4.28
Estimated N	$N = B_0 + B_1 * E$	240.3	
Estimated Total LOC:	T = N + B - D - M + R	621.3	
Estimated Total New Reuse (sum of * LOC):		121.66	
Estimated T	$Time = B_0 + B_1 * E$		1290.3
Prediction Range:	Range	19.9	254.6
Upper Prediction Interval:	UPI = N + Range	260.3	1544.9
Lower Prediction Interval:	LPI = N - Range	220.4	1035.6
Prediction Interval Percent		70%	70%
Method Selected		A	A
R^2		0.98	0.89

Size estimate

Regression on Size Data

Regression on Time Data

Objectives

Prediction Interval

Process Performance Range (Baselines) for this project

⇨ **PROBE Method helps agile planning with accuracy!**

TSP Principles

Use a self-directed team to manage knowledge work.

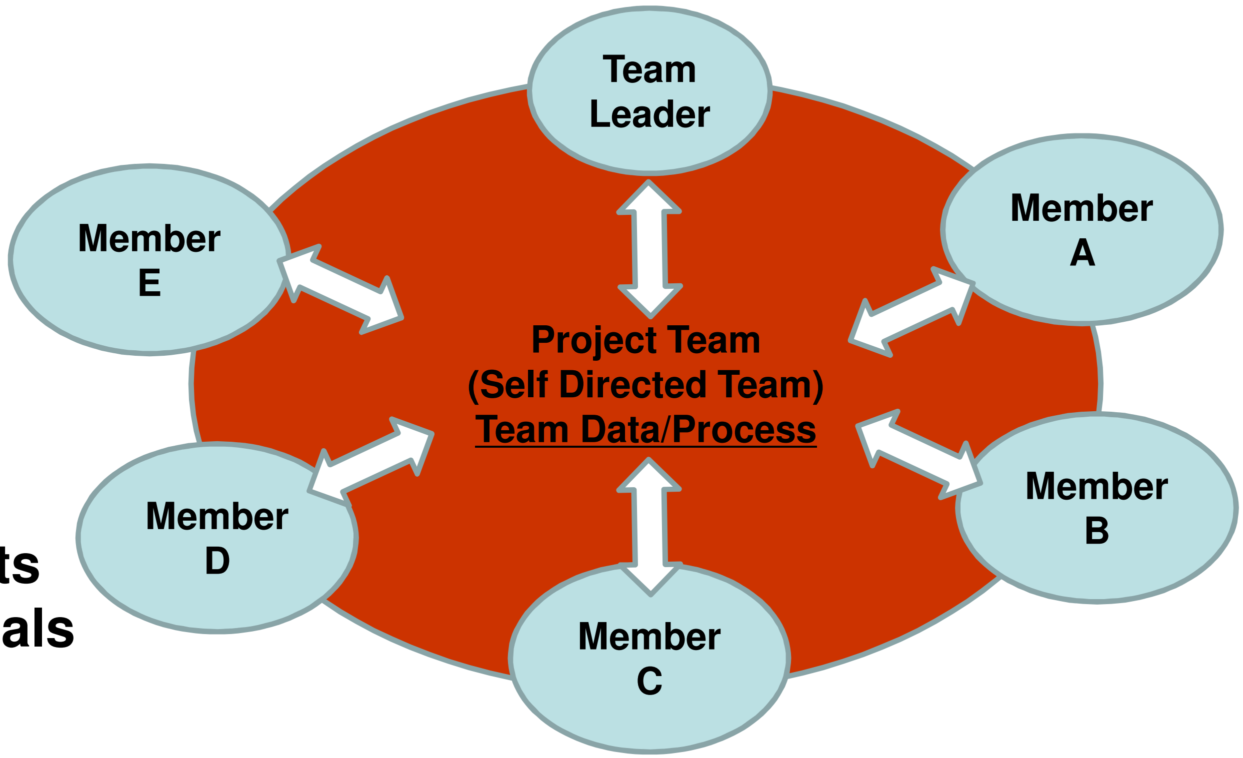
- Knowledge work must be managed by the team and individuals who actually do the work.
- The TSP launch process creates a self-directed team.
- A detailed plan is developed before committing objectives to management and the customer.
- Team management is accomplished through TSP weekly meetings and management reporting.

TSP Launch Process

A qualified coach guides the team through a defined process to develop its plan and to negotiate that plan with management.

Ref. SEI Course: "Leading a Development Team"

Project Level Data Decomposed to and Re-aggregated from Individual Data in TSP



Requirements
Business goals
Team goals

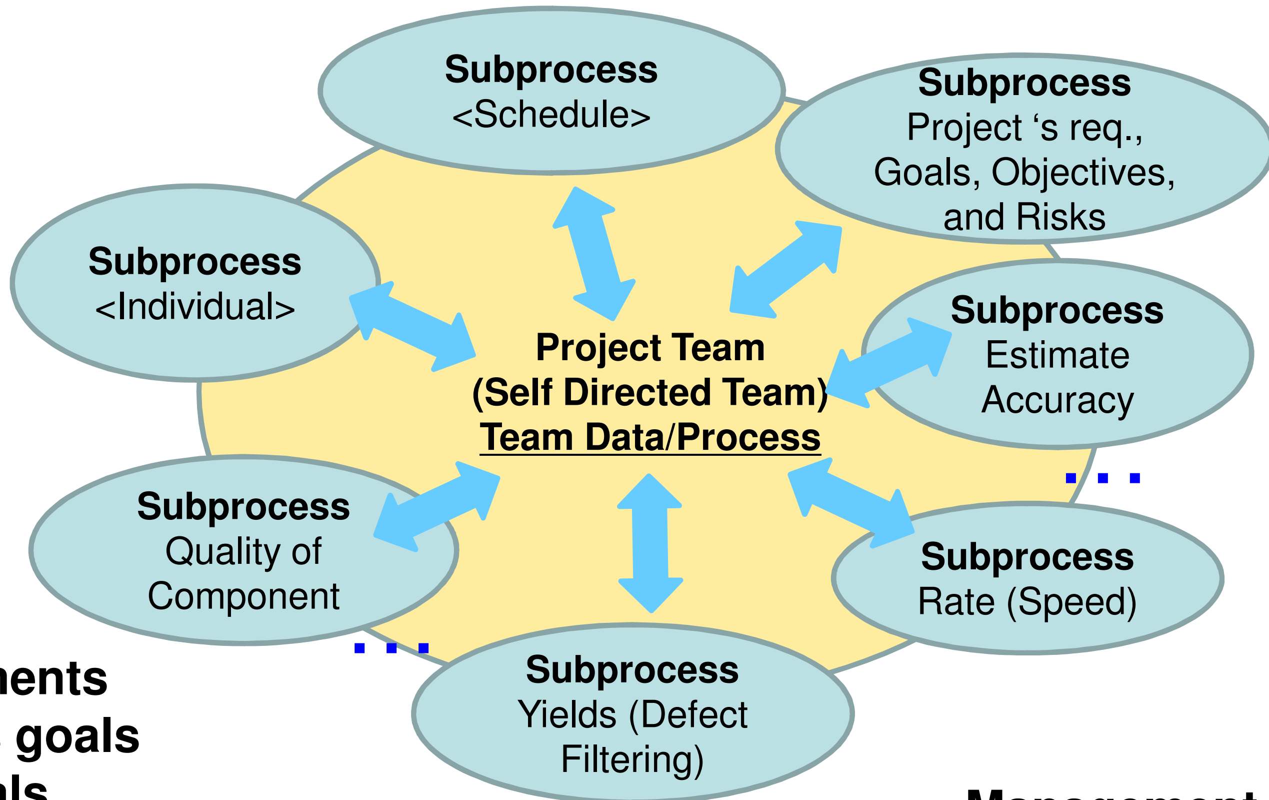
Launch/Relaunch

Team data/plan → Individual data/plan Status/updated

Launch/Relaunch

↔ Team data/status/plan’

TSP Derived Measures for Subprocesses Generated from the Team Data in Real Time



Requirements
Business goals
Team goals

Launch/Relaunch

Team data/plan

Launch/Relaunch

Individual data/plan
Status/updated
<on event>

Weekly

Team data/status/plan'

Weekly

Management Report

TSP WEEK – Weekly Progress Status:
Variance in Task Hour Goal and Project End Date

TSP Week Summary - Form WEEK

Name	Consolidated Near-Term Plan		Date	8/28/06
Team	The "A" Team			
Status for Week	7	Selected Assembly	Cycle	
Week Date	8/21/06	SYSTEM		

Task Hours %Change	
Baseline	1488.0
Current	1541.6
%Change	3.6%

Weekly Data	Plan	Actual	Plan / Actual	Plan - Actual
Schedule hours for this week	99.0	61.6	1.61	37.4
Schedule hours this cycle to date	441.8	318.7	1.39	123.1
Earned value for this week	6.1	4.5	1.36	1.6
Earned value this cycle to date	26.8	22.0	1.22	4.8
To-date hours for tasks completed	338.7	286.4	1.18	
To-date average hours per week	63.1	45.5	1.39	
EV per completed task hour to date	0.065	0.077		

Project End Dates	
Baseline	11/27/06
Plan	11/27/06
Predicted	7/23/07

Task Hours planned at start and current

Current week number

Project completion date
at start-baseline
at start-top down planning
at now projected

TSP WEEK – Weekly Progress Status:
Variance in Schedule Hours

Weekly Data	Plan	Actual	Plan / Actual
Schedule hours for this week	99.0	61.6	1.61
Schedule hours this cycle to date	441.8	318.7	1.39
Earned value for this week	6.1	4.5	1.36
Earned value this cycle to date	26.8	22.0	1.22
To-date hours for tasks completed	338.7	286.4	1.18
To-date average hours per week	63.1	45.5	1.39
EV per completed task hour to date	0.065	0.077	

Week

61.6 hours worked for this week, which is 61% less than the plan

Cycle

318.7 hours worked in total, which is 39% less than the plan

TSP WEEK – Weekly Progress Status:
Variance in Weekly Completed Tasks

Weekly Data	Plan	Actual	Plan / Actual
Schedule hours for this week	99.0	61.6	1.61
Schedule hours this cycle to date	441.8	318.7	1.39
Earned value for this week	6.1	4.5	1.36
Earned value this cycle to date	26.8	22.0	1.22
To-date hours for tasks completed	338.7	286.4	1.18
To-date average hours per week	63.1	45.5	1.39
EV per completed task hour to date	0.065	0.077	

Week

36% under to the plan for this week

Cycle

22% under to the plan for this cycle

TSP WEEK – Weekly Progress Status:
Variance in Accuracy of Estimate

Weekly Data	Plan	Actual	Plan / Actual
Schedule hours for this week	99.0	61.6	1.61
Schedule hours this cycle to date	441.8	318.7	1.39
Earned value for this week	6.1	4.5	1.36
Earned value this cycle to date	26.8	22.0	1.22
To-date hours for tasks completed	338.7	286.4	1.18
To-date average hours per week	63.1	45.5	1.39
EV per completed task hour to date	0.065	0.077	

Accuracy on Task Hours Estimate

18% under estimate of Task Hours

Accuracy on Schedule Hours Estimate

39% under estimate of Task Available Hours per Week

TSP WEEK – Weekly Progress Status:
Variance in Progress

Question: When will this project complete?

Weekly Data	Plan	Actual	Plan / Actual
Schedule hours for this week	99.0	61.6	1.61
Schedule hours this cycle to date	441.8	318.7	1.39
Earned value for this week	6.1	4.5	1.36
Earned value this cycle to date	26.8	22.0	1.22
To-date hours for tasks completed	338.7	286.4	1.18
To-date average hours per week	63.1	45.5	1.39
EV per completed task hour to date	0.065	0.077	

Schedule Growth = 1.39/1.18=1.17

Net 17% growth expected

Quantitative Management in TSP

TSP team strives to manage their planned schedule using the following:

- Workload growth rate
- %Task hours added to the baseline
- Review rate
- Defect injection and removal rate
- Process and phase yield, etc.

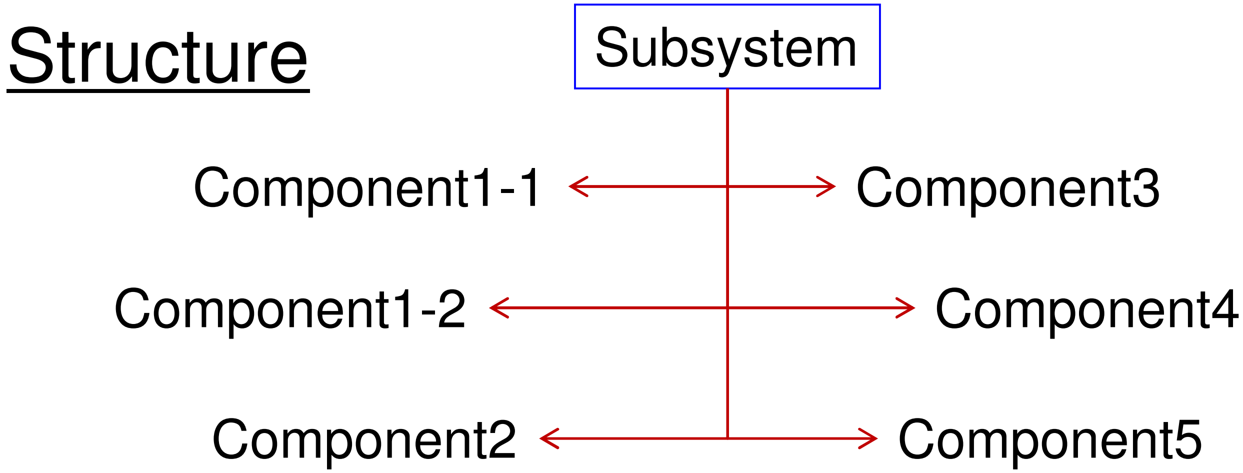
⇨ These may be used to generate PPM and PPB.

TSP Quality Profile

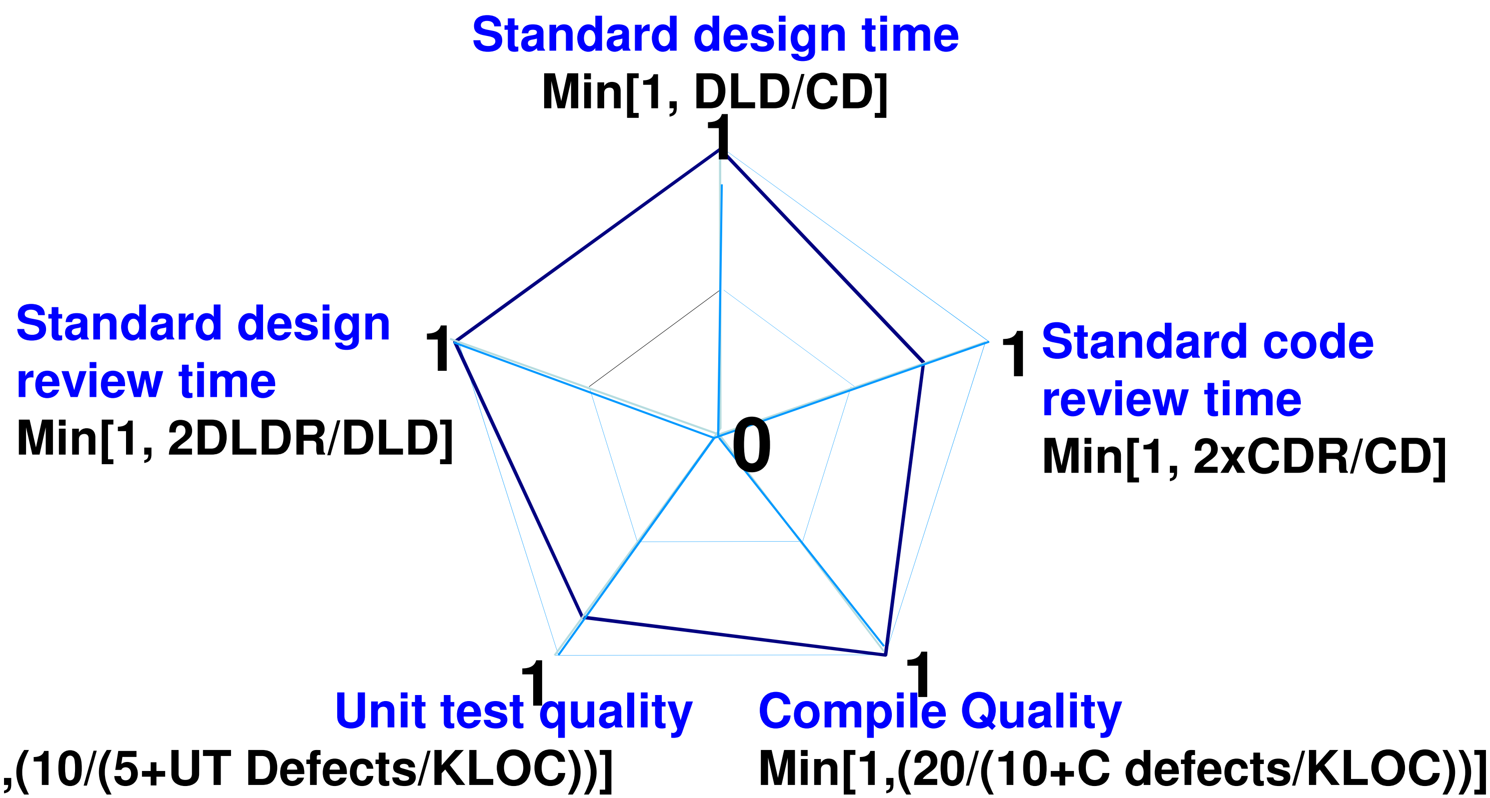
The Quality Profile and Process Quality Index (PQI) are useful tools for quantitative management, but they must be used carefully.

Example:

1. An excellent PSP engineer was assigned to develop the six components, in the example below.
2. Only one defect was reported in the IT phase.
3. Component1-1 and Component1-2 are closely related.
4. TSP planning and quality parameters were used for the first time.



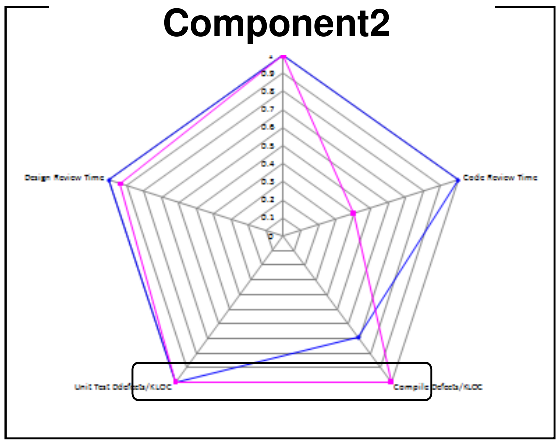
TSP Quality Profile for Component



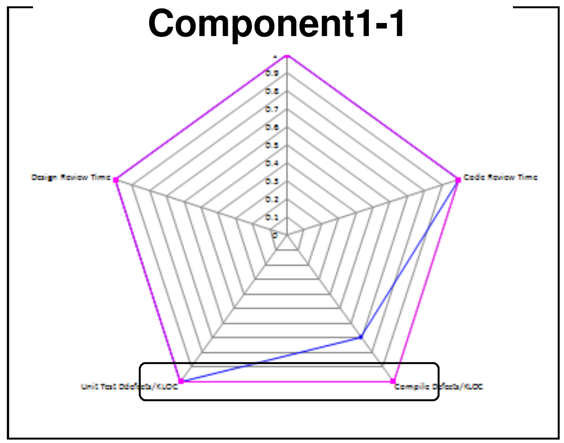
PQI is given by multiplication of the five indexes.

Ref. A Self-Improvement Process for Software Engineers, Addison Wesley 2006

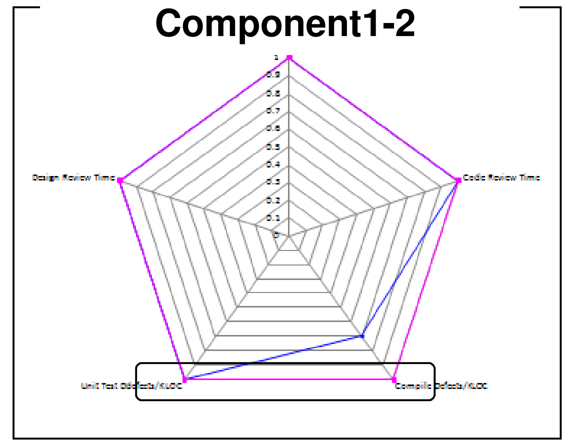
The Selected Six Components



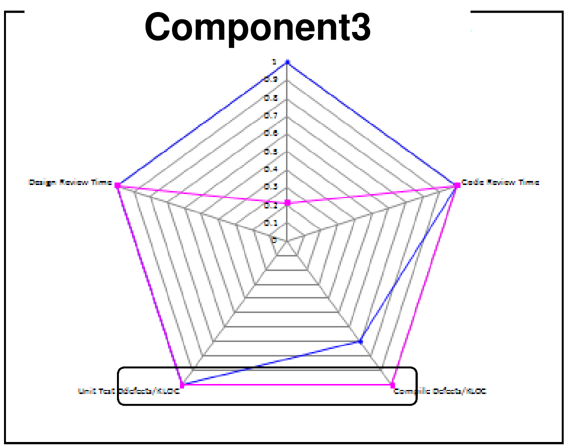
PQI = 0.38



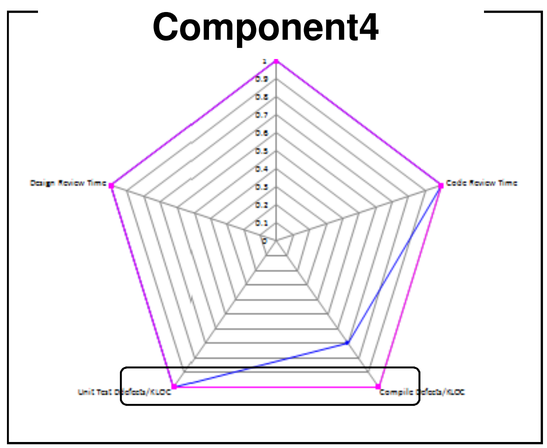
PQI = 1.00



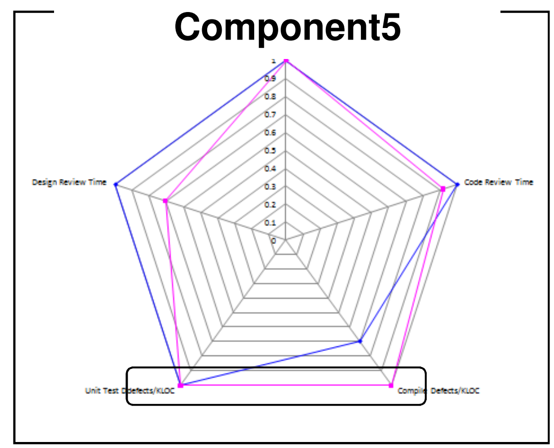
PQI = 1.00



PQI = 0.21

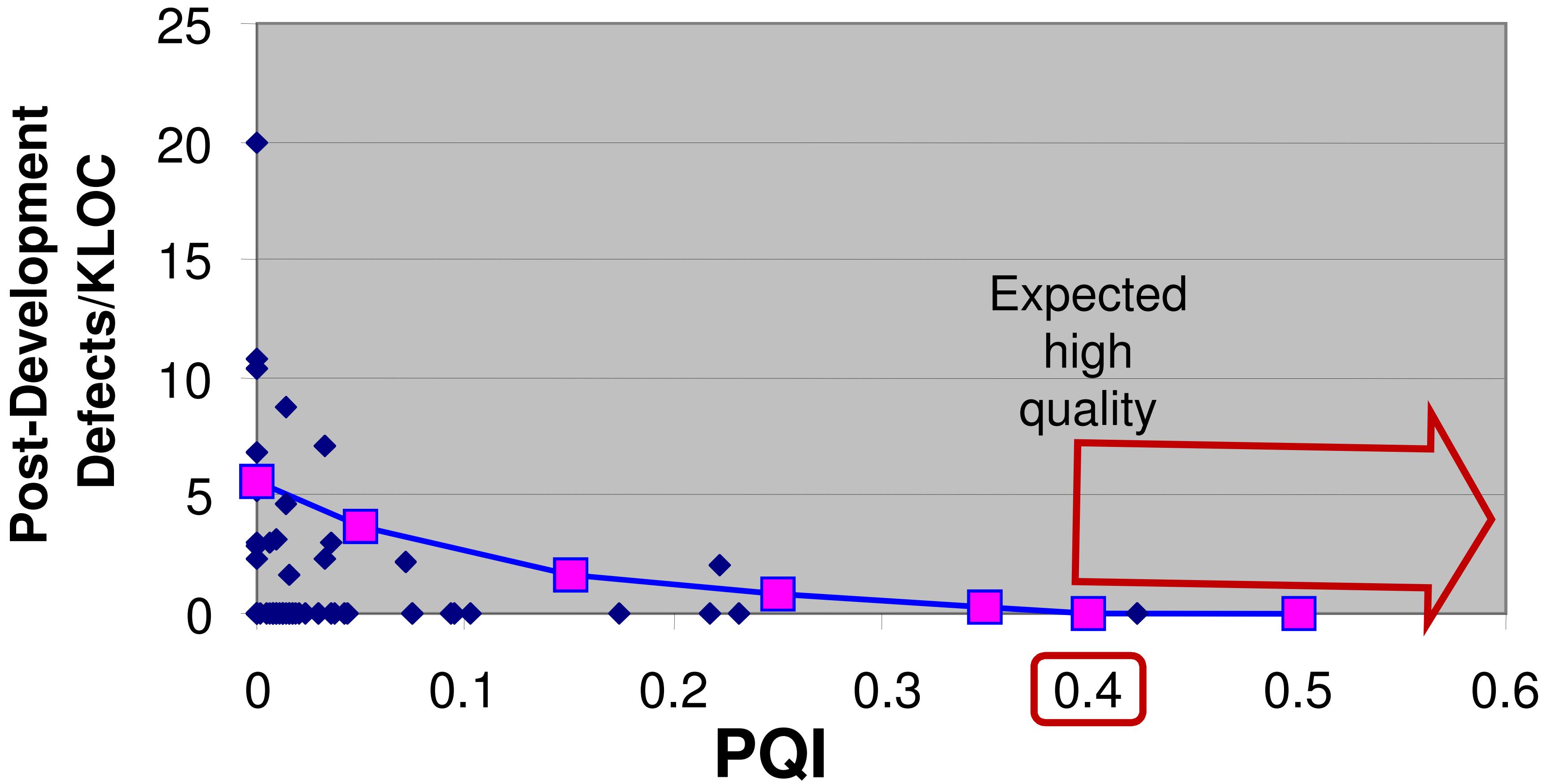


PQI = 1.00



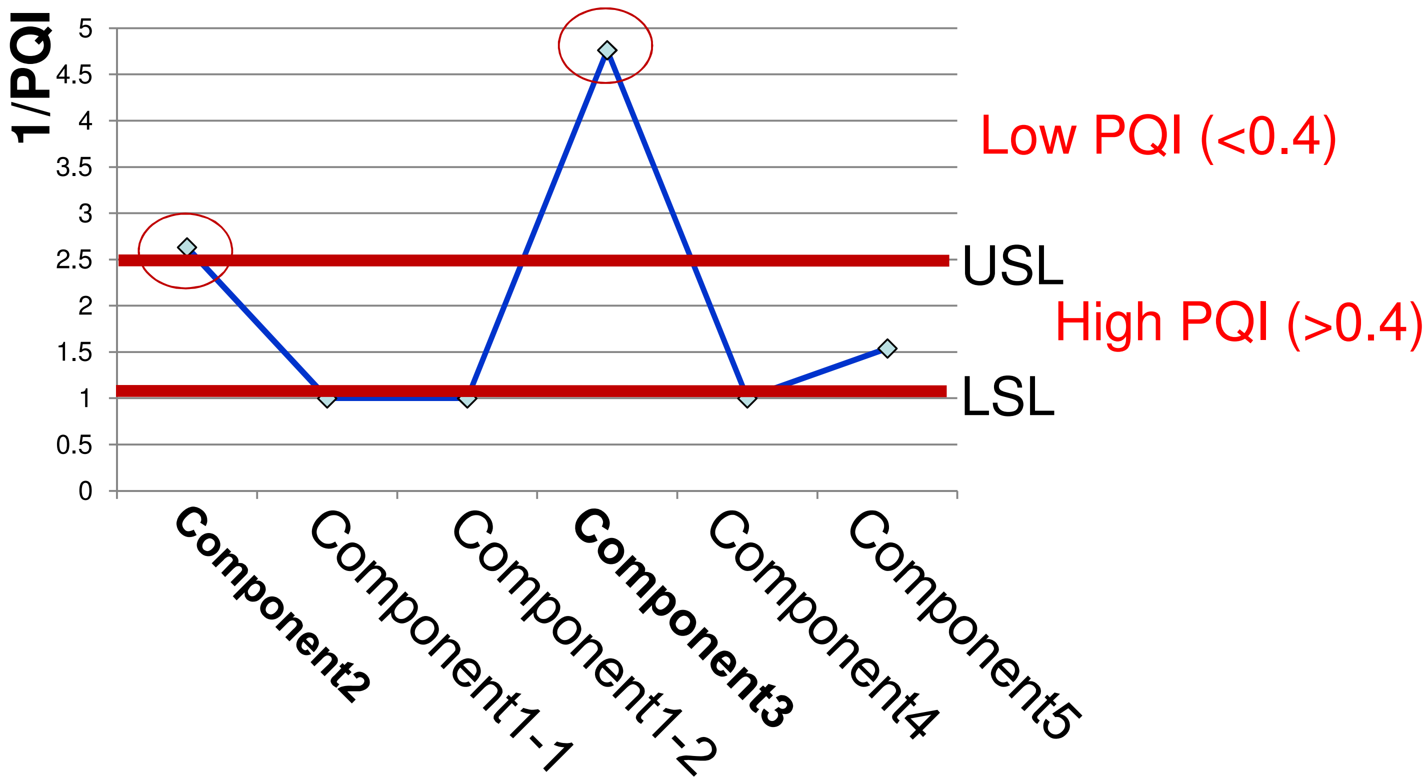
PQI = 0.65

PQI vs. Post-development Defects



Reference: Watts Humphrey, Winning with Software, Addison Wesley, 2001

c-Control Chart to Determine Defect-Risk Component



Does a High PQI Mean the Component Is Really Good?

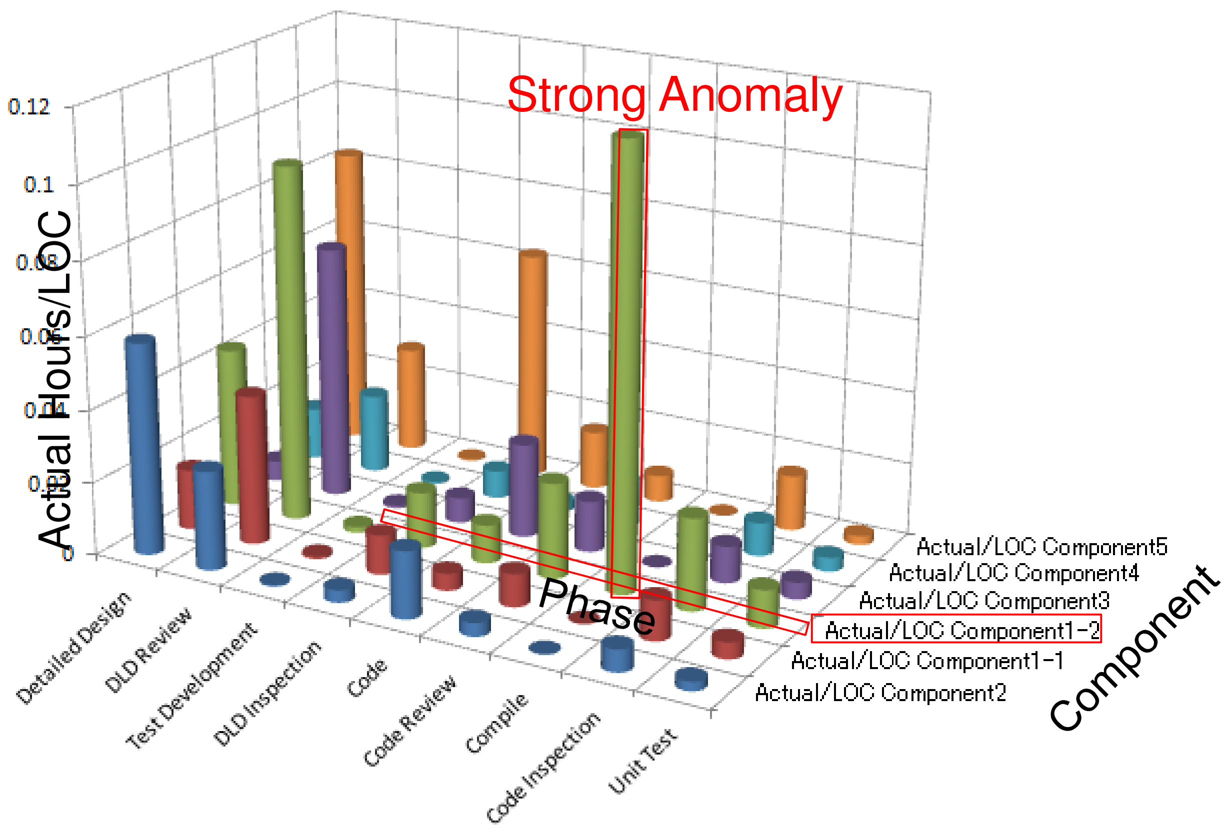
Reasons for a defective but high PQI component:

- Defects are present but not found during compile and unit test.
- Half of development work time is spent in ineffective review.
- Design and code progresses with missing components that are identified in later phases.
- Defect may not be recorded, etc.

Proposal: An Experience-based Rule to Identify a Defect-risk Component with a High PQI Value

1. Compare “time in phase, actual%” for similar components that have been worked by a PSP engineer.
2. Identify a component that shows a different pattern in “time in phase, actual %” distribution, especially for later phases. This may be considered a defect-risk component.
3. Group the components that are closely related to the defect-risk component. Each component in the group may be a defect-risk even if it has a high PQI value.

"Time in phase, actual%" Analysis of the Six Components



1. Component1-2 is a defect-risk component.
2. If Component1-1 and Component1-2 are *closely related*, the component1-1 may be defect-risk.

Summary

The CMMI high maturity practices, i.e., the PPM and PPB, are easily implemented in the PSP and TSP .

Project level PPM and PPBs are generated by aggregating individual-level data of time, defect, and size for estimating and quantitative management of a project.

Prediction interval, control chart, and significance are used to present variations in estimating, monitoring, and evaluating respectively and TSP data are used to derive these.

The sub-process must not only be within specification but should be stable. (A high PQI does not necessarily guarantee that the component is defect free.) The stability should be examined by the developers.

Questions?

Thank you for your attention.

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