Lessons Learned in Seamless Integration of CMMI, TSP, and PSP
Why All Three Are Needed

CMMI Technology Conference
November 14, 2007
ais
Advanced Information Services Inc.

Winner IEEE Software Process Achievement Award
http://www.sei.cmu.edu/managing/ieee-award/ieee.award.html
Topics

- Issues
  - Quality and Schedule
  - Rational Management and Commitment
  - Insanity and Malpractice

- Three Improvement Perspectives
  - Organization - CMM/CMMI
  - Individual - PSP
  - Team - TSP

- Lessons Learned
Quality Is More Important Than Schedule

In today’s software marketplace, the principal focus is on cost, schedule, and function; quality is lost in the noise. This is unfortunate since poor quality performance is the root cause of most software cost and schedule problems.

Watts Humphrey
Rational Management - Developers

- When pressed for early deliveries, the responsible team members say

  Ñí understand your requirements, I will do my utmost to meet it, but until I make a plan, I cannot responsibly commit to a date.
When pressed for early deliveries, the responsible managers say

I trust you to create an aggressive and realistic plan, I will review the plan, but I will not commit you to a date that you can not meet.
Rational Management - Principles

- Set challenging goals
- Get the facts
- Use facts and data
- Anticipate and address problems
Insanity or Malpractice?

Insanity
Doing the same thing over and over and expecting a different result

Malpractice
An organization which does not have a top-management-sponsored continuous improvement initiative in place
<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Key Process Areas (KPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Optimizing</td>
<td>Continuous process improvement, Defect prevention, Technology change management, Process change management</td>
</tr>
<tr>
<td>4</td>
<td>Managed</td>
<td>Product and process quality, Quantitative process management, Software quality management</td>
</tr>
<tr>
<td>3</td>
<td>Defined</td>
<td>Engineering process, Organization process focus, Organization process definition, Training program, Integrated software management, Software product engineering, Intergroup coordination, Peer reviews</td>
</tr>
<tr>
<td>2</td>
<td>Repeatable</td>
<td>Project management, Requirements management, Software project planning, Software project tracking, Software quality assurance, Software configuration management, Software subcontract management</td>
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</tbody>
</table>

**Capable Maturity Model**
Comparing SW-CMM to CMMI

<table>
<thead>
<tr>
<th>SW-CMM Key Process Areas</th>
<th>CMMI Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defect Prevention</td>
<td>Causal Analysis and Resolution</td>
</tr>
<tr>
<td>Technology Change Management</td>
<td>Organizational Innovation and Deployment</td>
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<tr>
<td>Process Change Management</td>
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<tr>
<td>Quantitative Process Management</td>
<td>Organizational Process Performance</td>
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<tr>
<td>Software Quality Management</td>
<td>Quantitative Project Management</td>
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<tr>
<td>Organization Process Focus</td>
<td>Organizational Process Focus</td>
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<td>Organization Process Definition</td>
<td>Organizational Process Definition</td>
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<td>Training Program</td>
<td>Organizational Training</td>
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<td>Integrated Software Management</td>
<td>Integrated Project Management</td>
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<td>Software Product Engineering</td>
<td>Risk Management</td>
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<td>Intergroup Coordination</td>
<td>Requirements Development</td>
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<tr>
<td>Peer Reviews</td>
<td>Technical Solution</td>
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<tr>
<td>Requirements Mgmt</td>
<td>Product Integration</td>
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<td>Software Project Planning</td>
<td>Verification</td>
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<tr>
<td>Software Project Tracking &amp; Oversight</td>
<td>Validation</td>
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<tr>
<td>Software Subcontractor Management</td>
<td>Decision Analysis and Resolution</td>
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<tr>
<td>Software Quality Assurance</td>
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<td>Software Configuration Management</td>
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Issues Addressed by CMM

- Getting management attention
- Maintaining long-term improvement focus
- Guiding the improvement work
GM Results ï Schedule

Ø Average number of days late in meeting milestones declined from over 50 days to fewer than 10 following organization focus on CMMI

General Motors Presentation, SEPG, Boston, MA, 2003
CMM Results vs Defects

The TSP in Practice, SEI Technical Report, September 2003
Time to Advance from ML1 to ML5

Source: Software Engineering Institute
CMM Problems

- No simple model could precisely measure process maturity and complex models are not useful in guiding improvement.
- CMM consciously focused on what organization should do, not on how they should do it.
- The teamwork practices and personal disciplines required for quality software work are almost entirely issues of how, and not just what.
- Because engineers will not change the way they work without very specific guidance, the CMM does not change engineering behavior.
The Real Need

- The need is not for lots of process data but for engineers who gather and use that data

- What would happen if software professionals used sound engineering practices?
  - made and followed detailed plans
  - gathered and used historical data
  - measured and managed quality
  - analyzed and improved their processes

- The need is for a Level 5 Process at the individual level
Self Improvement
From Project To Project

“You can not stand still, so you should treat every project as a way to build talent rather than merely treating your talent as a way to build projects.”

Watts Humphrey
Self Improvement
Personal Software Process - 1

PSP3
Cyclic development

PSP2
Code reviews
Design reviews

PSP2.1
Design templates

PSP1
Size estimating
Test report

PSP1.1
Task planning
Schedule planning

PSP0
Current process
Time recording
Defect recording
Defect type standard

PSP0.1
Coding standard
Size measurement
Process improvement proposal (PIP)

Team Software Process
Requirements
Configuration management

- scaling up PSP methods to larger projects
- defect and yield management
- size, resource, and schedule plans
- establishing a measured performance baseline

Source: Software Engineering Institute

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At the end of the PSP training, developers know how to:

- Consistently gather size, time, and defect data
- Make commitments based on historical data
- Analyze personal data to answer questions
  - Where am I spending my time?
  - What are my common defects?
  - Where do I inject the defects?
  - What goals do I need to set to improve?
Results ï Schedule

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Schedule Deviation Individual Value Control Chart - Commercial Systems

Date of Project Phase Start

<table>
<thead>
<tr>
<th>% Deviation</th>
<th>01/88</th>
<th>01/89</th>
<th>01/90</th>
<th>01/91</th>
<th>01/92</th>
<th>01/93</th>
<th>01/94</th>
<th>01/95</th>
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<th>01/97</th>
<th>01/98</th>
<th>01/99</th>
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<td>Upper Natural Process Limit</td>
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<td>One Standard Deviation</td>
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</tbody>
</table>
PSP Results - Defects

User Acceptance Defects /KLOC

Defects/KLOC

0.2
0.4
0.6
0.8
1

May-90
Sep-91
Jan-93
Jun-94
Oct-95
Mar-97
Jul-99
Dec-99
Apr-01
Sep-02

Project Start Date

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PSP Problems

- To do quality work, engineers need a detailed plan and a defined process.
- Without the process, they cannot make detailed plans, take consistent measurements, or track their work against the plan.
- However, when engineers have a project to deliver, they are rarely willing to take the time to define a complex process, even when they know how.
The Real Need

- Need a mechanism to guide teams through defining their processes and making complete, precise, and detailed plans

- Need a vehicle to help organizations capitalize on the potential benefits of disciplined teamwork
The speed with which organizations form and deploy teams is the single most important factor in determining their competitive success.

Jelled teams are the most powerful tool ever devised for doing challenging work.

Watts Humphrey

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Team Improvement
Self-directed Teams

- Characteristics of self-directed teams
  - Sense of membership and belonging
  - Commitment to a common team goal
  - Ownership of the process and plan
  - The skill to make a plan, the conviction to defend it, and the discipline to follow it
  - Dedication to excellence
Building Self-directed Teams

The TSP Launch Process

Day 1
1. Establish product and business goals
2. Assign roles and define team goals
3. Produce development strategy and process

Day 2
4. Build overall and near-term plans
5. Develop the quality plan
6. Build individual and consolidated plans

Day 3
7. Conduct risk assessment
8. Prepare management briefing and launch report

Day 4
9. Hold management review
Launch postmortem

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

Project Tracking Issues - 1

- With PSP training, developers know how to plan, schedule, and track their work
- TSP teams use these PSP-learned methods to make detailed plans
  - Tasks are no more than 10 task hours each
  - Task time is recorded daily
  - EV is measured weekly
- You can tell project status to within 10 task hours
- TSP teams regularly report their status
Self-directed Teams
Project Tracking Issues - 2

- Project schedules slip a day at a time
- If you cannot precisely measure project status, you will not know where projects stand
- Without such knowledge, you cannot address schedule problems in time to fix them
- With the TSP, you can
  - closely monitor team performance
  - address problems in time
  - consistently meet schedules
Average Task Hours Per Team Member

Source: Allied Signal
TSP Results - Defects

Defect Density of Delivered Software

- CMM Level 1: 7.5
- CMM Level 2: 6.24
- CMM Level 3: 4.73
- CMM Level 4: 2.28
- CMM Level 5: 1.05
- TSP: 0.06

Ref: SEI Technical Report 2003-014
### Table 1: P-3C Process Improvement Results

<table>
<thead>
<tr>
<th>Source Lines of Code (SLOC)</th>
<th>Before Process Improvement</th>
<th>Early Stages of Process Improvement</th>
<th>Process Improvement and the PSP/TSP</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td>27,880</td>
<td>32,780</td>
<td>36,690</td>
<td>n/a</td>
</tr>
</tbody>
</table>

| Productivity (SLOC/hr)     | 2.7                        | 2.7                                 | 4.9                                | + 81%             |
| n/a                        | n/a                        | n/a                                 | 105                                | n/a               |

| Development defects        | 128                        | 69                                  | 12^{1}                             | -91%              |
| n/a                        | n/a                        | n/a                                 | 2.1                                | -78%              |

| Test defects               | none^{2}                   | 12/4/2001                           | 1/26/2004                          |                   |
| Actual Release Date        | 5/29/2001                  | 2/5/2004                            |                                    |                   |

Source: SEI Technical Report Case Study: Accelerating Process Improvement by Integrating the TSP and CMMI
NAVIAIR Timeline to Advance to ML4

March 2000          began CMM-based improvement effort
October 2000       began PSP/TSP introduction
January 2001       launched first TSP team
May 2001            reached Maturity Level 2
June 2002            launched second TSP team
September 2002   reached Maturity Level 4 (SW-CMM)

Source: SEI Technical Report Case Study: Accelerating Process Improvement by Integrating the TSP and CMMI
Source: From MCC to CMM©, Dr. Bill Curtis, DC SPIN, April 2006
Empowered Culture
Process Improvement Proposals (PIPS)

PROCESS IMPROVEMENT PROPOSAL (PIP)

PIP# :
Written By: 
Date : 
Author(s): 
Project : 
Key Process Area :

Process Name :

Improvement Description :

Improvement Benefits (Check One):

☐ Document Improvement  ☐ Reduced Cycle Time
☐ Improved Quality  ☐ Reduced Risk

Benefits Description (Quantify Where Possible):
(Attach files if needed)

Attach the PIP Pilot Report here (if applicable):

Submit

▼ SPEG Evaluation

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Lessons Learned - 1

- While models are useful to indicate where improvements are needed, only committed people can make the improvements.
- A supportive management environment that rewards disciplined behavior is absolutely essential.
- Timely feedback on the status and disposition of the PIPs is important to sustain the PIP mechanism and feeling of empowerment.
- Do not need to wait till level 5 to start implementing process change management.
Lessons Learned - 2

- While CMM is necessary as an organizational capability improvement model, it is not sufficient to change engineering behavior; the PSP provides the detailed "how to" for improvement at the individual level.

- The TSP provides the management framework for continuously improving self-directed teams. The PIP mechanism is key for team ownership of the project's process and commitment to improve.

- CMM, TSP, and PSP all three are needed for an integrated approach to model-based improvement at the organization, team, and individual levels without the risk of sub-optimization.
Study of 3700 findings from assessments ï More than half negative

High capability and maturity do not guarantee program success

Programs fail because ñwe donât start them right, we donât manage them rightõì

Developers often at lower maturity level than organization

CMM, TSP, PSP ï Why we need all three
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- TSPSM
- Personal Software ProcessSM
- PSPSM

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Contact Information

Girish Seshagiri
Advanced Information Services Inc.
(703) 286 0781
Email: girishs@advinfo.net
Website: www.advinfo.net