Process Improvement at NAVAIR using TSP and CMM

Prepared For:
The 1st Annual TSP Symposium
San Diego, CA

Presented By:
David Saint-Amand
Software Engineering Division,
Naval Air Systems Command Contractor
September 2006

NAVAIR Public Release # 06-0199
Agenda

• NAVAIR Overview
• Why NAVAIR does Process Improvement
• Process Improvement Accomplishments to Date
• Future of Process Improvement at NAVAIR
NAVAIR Overview
Software Engineering Div.

- Naval Air Systems Command (NAVAIR), Air 4.0 Research and Engineering
- Provides
  - Life-cycle support of software intensive aircraft and weapons systems
    - Development
    - Maintenance
  - Acquisition support
The Teams

- 24 discrete software engineering teams
- Six early Software Process Improvement (SPI) adopters:
  - AV-8B Software Support Activity (SSA)
  - E-2C SSA
  - EA-6B SSA
  - P-3C SSA
  - Tactical Aircraft Electronic Warfare (TACAIR EW) SSA
  - F/A-18 Software Development Team
Why NAVAIR Does Process Improvement
The Setting

• Several decades of:
  – Tightening budgets
  – Decreasing labor pools
  – Increasing software complexity

• The Global War on Terrorism
  – Decreased cycle time to meet the needs of the warfighter
  – Deliver high quality product
The Approach

- NAVAIR 4.0 recognized SPI was necessary to the mission
  - SPI initiatives began to take shape in 1998
- NAVAIR organizational goals
  - Balance current and future readiness
  - Reduce our costs of doing business
  - Improve agility
  - Ensure alignment
  - Implement Fleet-driven metrics
The Guidance

- NAVAIR formal instructions and guidance on process improvement for software acquisition, development, and life cycle maintenance
  - Five from April to September 2002
- United States (U.S.) Federal Government statute, Public Law 107-314, the National Defense Authorization Act
  - December 2002
  - Section 804
The Toolset

<table>
<thead>
<tr>
<th>Organization</th>
<th>Process Improvement Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CMM</td>
</tr>
<tr>
<td>AV-8B</td>
<td></td>
</tr>
<tr>
<td>E-2</td>
<td></td>
</tr>
<tr>
<td>EA-6B</td>
<td></td>
</tr>
<tr>
<td>P-3C</td>
<td></td>
</tr>
<tr>
<td>TACAIR EW</td>
<td></td>
</tr>
<tr>
<td>F/A-18 SWDTT</td>
<td></td>
</tr>
</tbody>
</table>

® CMM; and Capability Maturity Model are registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

SM CMMI; CMM Integration; Team Software Processes; and TSP are service marks of Carnegie Mellon University.

EVMS: American National Standards Institute ANSI/EIA-748-A
Process Improvement Accomplishments To Date
The Timeline

- AV-8BE-2
- F/A-18
- P-3C
- CMM Level Milestone
- CMM Level 3
- NAVAIR 1999 Targets for CMM Achievement
- SPI Reorganization
- EVMS Certification
- F-14D Engineers to E-2
- EVMS Initiation
- Other milestone
- First TSP Launch
- CMM Level Milestone
- NAVAIR 1999 Targets for CMM Achievement
- CMM Level 5
- CMM Level 3
- NAVAIR Software/Systems Support Center (NSSC)
- Slide 13
- NAVAIR Public Release # 06-0199
The Results

• AV-8B received an EVMS certification, the second in the Federal Government at that time

• F/A-18 received a CMM Level 5 rating, the first in the Navy

• AV-8B and P-3C went from CMM Level 1 to Level 4 in less than three years
  – The Software Engineering Institute (SEI) reports that the average for this is six years
  – AV-8B attributed the pace to a culture of process improvement and TSP

SM SEI is a service mark of Carnegie Mellon University.
CMM and PSP

• CMM developed in the late 1980s and early 1990s to capture organizational best practices for software development
• SEI Fellow Watts Humphrey applies underlying principles of CMM to software development practices of a single developer
• The Personal Software Process (PSP) was the result
  – Designed to be a CMM level 5 process for individual software developers

(http://www.sei.cmu.edu/tsp/history.html)
PSP and TSP

• While PSP provided excellent results, it was difficult for individuals to maintain the discipline required for PSP

• To address this, Humphrey developed the TSP, designed:
  – For the typical smallest operational unit, the project team
  – To be a CMM level 5 process for teams

(http://www.sei.cmu.edu/tsp/history.html)
TSP as an Accelerant

• AV-8B Team Leader Dwayne Heinsma:
  “The recipe for accelerating AV-8B’s climb up the
  software maturity ladder centered around
  identifying champions and using process discipline
  as an enabler.”

• Lisa Pracchia, Naval Air Systems Command
  “In short, TSP was the singular reason why [the
  team] achieved a Level 4 rating in record time.”

• TSP provided a quick, flexible process framework

• The SEI Technical Report “Relating the Team
  Software Process to the SW-CMM” (TR-008-
  2002), helped focus and prioritize the effort
The Return on Investment

• From EA-6B’s SPI efforts:
  – Higher quality software delivered on schedule
  – Process savings: $ 135,000

• From AV-8B and P-3C’s first TSP efforts:
  – Gross savings: $ 3,782,153
  – Net TSP investment: $ 556,547
  – Return on Investment (ROI): $ 3,225,606
EA-6B’s Initiatives

- The savings from other SPI initiatives: $135,000 (1,231 labor hours)
  - **53%** Automating metrics reporting
  - **35%** Documenting and improving the lab engineering drawing and simulation CM process to be CMMI compliant
  - **12%** Upgrading a discrepancy reporting process to be CMMI compliant and utilizing Lean Six Sigma concepts
### AV-8B ROI - 1st TSP Project

<table>
<thead>
<tr>
<th></th>
<th>Product size (KSLOC)</th>
<th>Defect density (defects/KSLOC)</th>
<th>Number of defects</th>
<th>Cost of addressing defect</th>
<th>Cost of addressing all defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARP (before TSP)</td>
<td>443</td>
<td>1.13</td>
<td>501</td>
<td>$8,330</td>
<td>$4,169,831</td>
</tr>
<tr>
<td>AVJMP (after TSP)</td>
<td>443</td>
<td>0.59</td>
<td>261</td>
<td>$8,330</td>
<td>$2,177,169</td>
</tr>
<tr>
<td><strong>Cost saving from reduced defects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1,992,663</td>
</tr>
<tr>
<td><strong>Cost of TSP training &amp; support</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$225,300</td>
</tr>
<tr>
<td><strong>Total cost savings from reduced defects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1,767,363</td>
</tr>
</tbody>
</table>

KSLOC: One thousand source lines of code
### AV-8B Schedule & Cost

#### Schedule and Cost Variance

<table>
<thead>
<tr>
<th>Project</th>
<th>Date</th>
<th>Schedule Variance</th>
<th>Cost Variance</th>
<th>Used EVMS?</th>
<th>Used TSP?</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSCAR</td>
<td>At 7/98</td>
<td>17.6% overrun</td>
<td>28.3% overrun</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>WARP</td>
<td>Complete 4/02</td>
<td>50.0% overrun</td>
<td>300.0% overrun</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>OPSTA OC1.2</td>
<td>Complete 5/04</td>
<td>5.0% overrun</td>
<td>8.1% overrun</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>AVJMPs</td>
<td>As of 7/04</td>
<td>0.5% overrun</td>
<td>1.5% overrun</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>H2.0</td>
<td>As of 5/04</td>
<td>1.1% overrun</td>
<td>6.9% overrun</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
# AV-8B: Defect Densities

<table>
<thead>
<tr>
<th>S/W Development Projects</th>
<th>Date Completed</th>
<th>S/W Defects During V&amp;V</th>
<th>KSLOC</th>
<th>S/W Defects per KSLOC</th>
<th>Used TSP?</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARP</td>
<td>4/02</td>
<td>36</td>
<td>32</td>
<td>1.13</td>
<td>NO</td>
</tr>
<tr>
<td>OPSTA OC1.2</td>
<td>5/04</td>
<td>66</td>
<td>89</td>
<td>0.74</td>
<td>NO</td>
</tr>
<tr>
<td>AVJMPS</td>
<td>7/04</td>
<td>260</td>
<td>443</td>
<td>0.59</td>
<td>YES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S/W Maintenance Projects</th>
<th>Date Completed</th>
<th>STR Defects During System Test</th>
<th>STRs Resolved</th>
<th>STR Defects per 10 STRs Resolved</th>
<th>Used TSP?</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2.0 S/W Cycle 1</td>
<td>3/04</td>
<td>10</td>
<td>88</td>
<td>1.13</td>
<td>YES</td>
</tr>
<tr>
<td>H4.0 S/W Cycle 1</td>
<td>9/04</td>
<td>2</td>
<td>40</td>
<td>0.5</td>
<td>YES</td>
</tr>
</tbody>
</table>
## P-3C ROI - 1st TSP Project

<table>
<thead>
<tr>
<th></th>
<th>KSLOC added/changed for a project</th>
<th>Defect Density KSLOC</th>
<th># SPRs</th>
<th>Avg. SPR Fix Cost</th>
<th>Total SPR Fix Cost</th>
<th>Productivity (KSLOC/Hr)</th>
<th>Developer Hrs</th>
<th>Code Dev Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before TSP</td>
<td>27.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After TSP</td>
<td>38.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothetical Dev costs Before TSP</td>
<td>38.3</td>
<td>4.6</td>
<td>176</td>
<td>$8,432</td>
<td>$1,486,843</td>
<td>2.7</td>
<td>14,198</td>
<td>$1,334,568</td>
</tr>
<tr>
<td>Baseline Dev costs After TSP</td>
<td>38.3</td>
<td>0.6</td>
<td>23</td>
<td>$8,432</td>
<td>$193,936</td>
<td>4.3</td>
<td>8,915</td>
<td>$837,984</td>
</tr>
<tr>
<td>Cost Saving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1,292,907</td>
<td></td>
<td></td>
<td>$496,583</td>
</tr>
<tr>
<td>Combined Cost Saving*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1,789,490</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSP Training &amp; Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$311,247</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Saving on 1st Product</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$1,478,243</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SPR: Software Problem Report**
The Overall Benefits

• The early adopters
  – Meeting their missions
  – Producing higher quality products
  – Generating significant cost savings

• Inspiring other NAVAIR 4.0 SSAs
  – 21 of the 24 NAVAIR 4.0 SSAs now pursuing SPI

• Recurring savings
  – NAVAIR can direct additional monies to the procurement of aircraft
Future of Process Improvement at NAVAIR
Next Steps

• Reorganizing NAVAIR 4.0
  – Mission Area Teams (MATs)

• SPI Support and Sustainment
  – The NAVAIR Software and Systems Support Center (NSSC)

• CMMI as an overall architecture to guide SPI within the MATs
The Mission Area Teams

**Transformation to MATs**

**FROM 24 SSAAs**
- Pockets of excellence
- Resources largely localized to each SSA
- Little migration of expertise across SSAs – agility bounded within an SSA

**TO 4 Mission Areas**
- Shared knowledge, community of excellence
- Resources available to ALL projects in the MAT
- Migration from “reserve” workforce to “Redeployable” workforce
- Joint solutions for integration of new capabilities onto multiple platforms
NAVAIR Software/Systems Support Center

- Chartered to assist the MAT stand-up
- Sponsor of
  - NAVAIR SPI Community of Practice (SPI CoP) quarterly conference
  - NAVAIR TSP Community of Practice (TSP CoP) monthly meeting
- Working
  - to expand SPI across NAVAIR 4.0
  - with the SEI to develop TSP-based processes (TPI) for acquisition and systems engineering
CMMs & Processes at NAVAIR

- Long history of utilizing SEI models
- Achieved significant success in process improvement using the Software CMM (SW-CMM) and TSP
- MATs now transitioning to CMMI
  - Organizational processes exchange across many former individual product teams
  - TSP on many organic projects
  - Piloting TPI processes
- Memo from the office of the Assistant Secretary for Research, Development and Acquisition
Concluding Remarks

- The new process improvement culture of NAVAIR 4.0 should
  - Increase common software systems development, maintenance and acquisition practices
  - Increased productivity by shortening project cycle time
    - Good estimating, planning, and tracking capability
    - High quality products
  - Preclude the need for continuous heroic efforts
  - Enable 4.0 to continue to meet current and future missions of NAVAIR
Contact Information

• David Saint-Amand
  Synectic Solutions, Inc.
  Supporting NAVAIR
  (760) 939-2372
• David.Saint-Amand@navy.mil

Please use the email address above to request an electronic copy of this presentation.