



# Process Improvement at NAVAIR using TSP and CMM

Prepared For:  
**The 1<sup>st</sup> Annual TSP Symposium**  
**San Diego, CA**

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# Agenda

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- NAVAIR Overview
- Why NAVAIR does Process Improvement
- Process Improvement Accomplishments to Date
- Future of Process Improvement at NAVAIR



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# NAVAIR Overview



# Software Engineering Div.

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- 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



# NAVAIR 4.0





# The Teams

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- 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



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# Why NAVAIR Does Process Improvement



# The Setting

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- 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

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- 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

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- 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

Organization	Process Improvement Tools					
	CMM	CMMI	TSP	EVMS	HPO	TSPm
AV-8B						
E-2						
EA-6B						
P-3C						
TACAIR EW						
F/A-18 SWDTT						

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

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

EVMS: American National Standards Institute ANSI/EIA-748-A

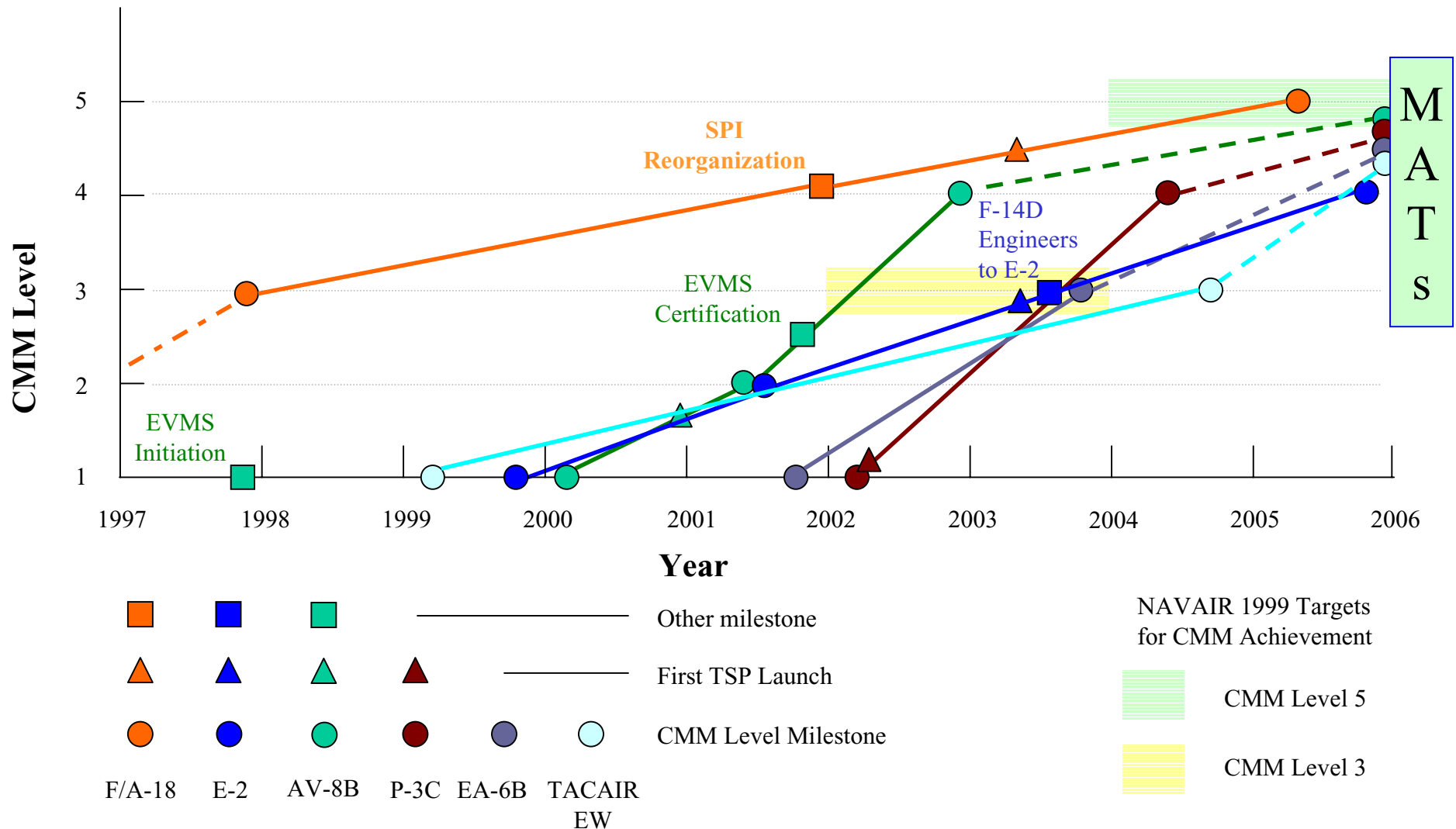


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# **Process Improvement Accomplishments To Date**



# The Timeline





# The Results

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- 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

<sup>SM</sup> SEI is a service mark of Carnegie Mellon University.



# CMM and PSP

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- 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

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- 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

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- 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

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- 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

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- 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 - 1<sup>st</sup> TSP Project

	Product size (KSLOC)	Defect density (defects/KSLOC)	Number of defects	Cost of addressing defect	Cost of addressing all defects
WARP (before TSP)	443	1.13	501	\$8,330	\$4,169,831
AVJMPS (after TSP)	443	0.59	261	\$8,330	\$2,177,169
Cost saving from reduced defects					\$1,992,663
Cost of TSP training & support					\$225,300
Total cost savings from reduced defects					\$1,767,363

KSLOC: One thousand source lines of code



# AV-8B Schedule & Cost

## Schedule and Cost Variance

Project	Date	Schedule Variance	Cost Variance	Used EVMS ?	Used TSP?
OSCAR	At 7/98	17.6% overrun	28.3% overrun	NO	NO
WARP	Complete 4/02	50.0% overrun	300.0% overrun	NO	NO
OPSTA OC1.2	Complete 5/04	5.0% overrun	8.1% overrun	YES	NO
AVJMPS	As of 7/04	0.5% overrun	1.5% overrun	YES	YES
H2.0	As of 5/04	1.1% overrun	6.9% overrun	YES	YES



# AV-8B: Defect Densities

<b>S/W Development Projects</b>	<b>Date Completed</b>	<b>S/W Defects During V&amp;V</b>	<b>KSLOC</b>	<b>S/W Defects per KSLOC</b>	<b>Used TSP?</b>
WARP	4/02	36	32	1.13	NO
OPSTA OC1.2	5/04	66	89	0.74	NO
AVJMPS	7/04	260	443	0.59	YES
<b>S/W Maintenance Projects</b>	<b>Date Completed</b>	<b>STR Defects During System Test</b>	<b>STRs Resolved</b>	<b>STR Defects per 10 STRs Resolved</b>	<b>Used TSP?</b>
H2.0 S/W Cycle 1	3/04	10	88	1.13	YES
H4.0 S/W Cycle 1	9/04	2	40	0.5	YES



# P-3C ROI - 1<sup>st</sup> TSP Project

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



# The Overall Benefits

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- 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





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# **Future of Process Improvement at NAVAIR**



# Next Steps

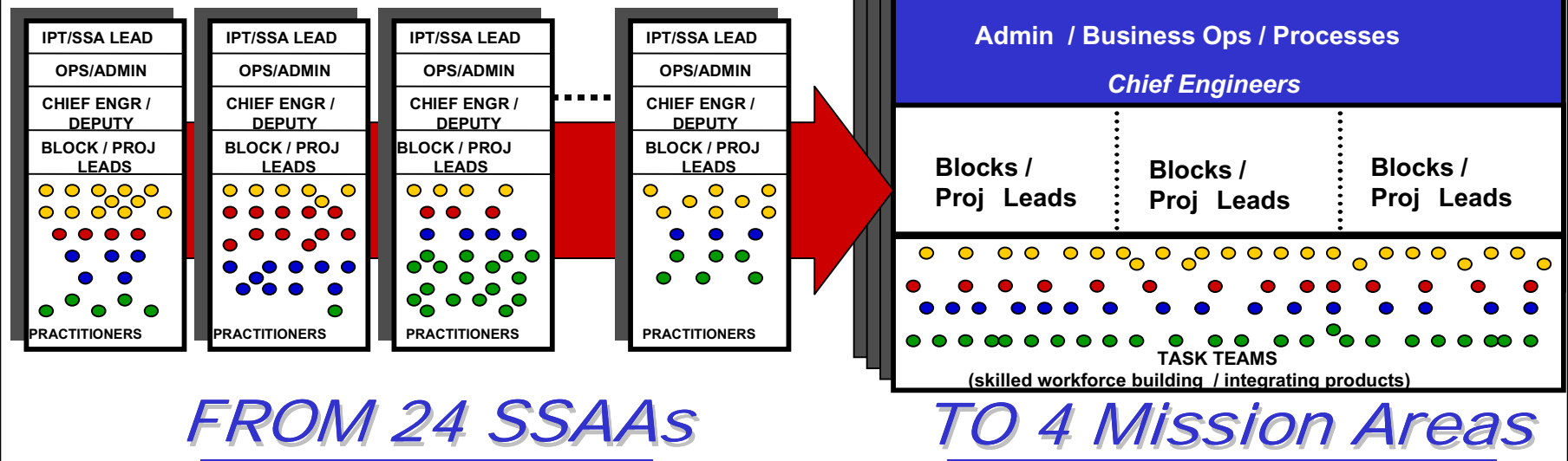
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- Reorganizing NAVAIR 4.0
  - Mission Area Teams (MATs)
- SPI Support and Sustainment
  - The NAVAIR Software and Systems Support Center (NSSC)
- CMMI as an overall architecture to guide SPI within the MATs



# The Mission Area Teams

## Transformation to MATs



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

- 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

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- 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

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- 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

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- 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

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