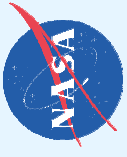


Abstract:

This presentation describes how the NASA Glenn Research Center planned and implemented a process improvement effort in response to a radically changing environment. As a result of a presidential decision to redefine the Agency's mission, many ongoing projects were canceled and future workload would be awarded based on relevance to the Exploration Initiative. NASA imposed a new Procedural Requirements standard on all future software development, and the Center needed to redesign its processes from CMM Level 2 objectives to meet the new standard and position itself for CMMI.

The intended audience for this presentation is systems/software developers and managers in a large, research-oriented organization that may need to respond to imposed standards while also pursuing CMMI Maturity Level goals. A set of internally developed tools will be presented, including an overall Process Improvement Action Item database, a formal inspection/peer review tool, metrics collection spreadsheet, and other related technologies.

The Center also found a need to charter Technical Working Groups (TWGs) to address particular Process Areas. In addition, a Marketing TWG was needed to communicate the process changes to the development community, including an innovative web site portal.



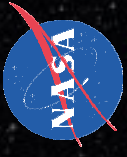
Process Improvement in a Radically Changing Organization

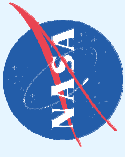
NASA Glenn Research Center
Software Engineering Process Group

SEPG 07 Conference
March 26–29, 2007

Topics of Discussion

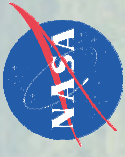
- NASA Glenn Research Center
- Process Improvement Strategy
- A Change in Focus
- NASA Software Requirements
- Implementation
- Tools
- Getting the Word Out
- SEPG Products
- Results and Moving Forward





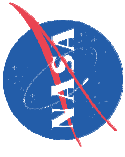
About NASA Glenn Research Center

- Comprises over 150 buildings containing a unique collection of world-class test facilities
 - Lewis Field, 350-acre main campus is adjacent to Cleveland Hopkins International Airport
 - Plum Brook Station, 6400-acre site is near Sandusky, Ohio, 50 miles west of Cleveland
- Staffed by ~3300 people, including civil service employees and support service contractors
 - >50% are scientists and engineers
 - Other staff consists of technical specialists, skilled workers, and administrative staff
- Performs world-class research in aeronautics, space power and propulsion, and microgravity science



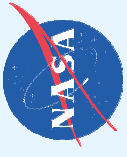
Introduction

- NASA Glenn Research Center (GRC) implemented a CMM-based process improvement effort in 2002
- A Presidential Directive redefined NASA's mission in January 2004
 - Many ongoing projects were canceled
 - Future projects would be awarded based on relevance to the Vision for Space Exploration
- This presentation outlines how the NASA Glenn Research Center SEPG responded to better position the Center for new work



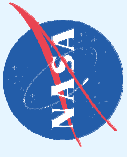
Background

- Agency-wide Software Engineering Initiative began in 2000
- NASA GRC formed local SEPG in 2002
- Flight Software Engineering Branch assessed at CMM Level 2 in December 2004
 - Branch consisted of 15 software developers
 - Projects were mostly flight and ground software for space shuttle science experiments
- Goals at that time were
 - Improve software development capability
 - Move towards CMM Level 3, and possibly into CMMI
 - Share processes and practices throughout the Center
 - Maintain and reinforce collaboration across NASA



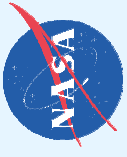
A Change in Focus

- President Bush announces Vision for Space Exploration in January 2004
 - Develop new launch vehicles to return to the Moon and eventually go to Mars
- Columbia Accident Investigation Board (CAIB) report
 - Renewed emphasis on quality and safety
- NASA funds redirected towards new Exploration projects
 - Emphasis on inter-Center collaboration
- New NASA requirements for software development
 - Address recent mission failures attributed to software



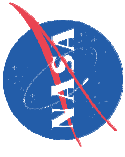
The Strategy

- Refocus software process improvement on new NASA Procedural Requirements for Software Engineering
 - Incorporate the requirements into GRC processes
 - Address CMMI practices where practical
- Update Center-Level Procedure for Software Development
 - Local procedure to encapsulate new requirements
- Build supporting elements
 - Organizational processes, templates, and training
 - Web Site/Process Asset Library (PAL)
 - Coaching from SEPG members
- Complete incorporation of CMMI practices



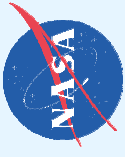
Our Motivation

- Desire to have a significant role in the development of software for the Exploration Initiative
- Improve our practices so we can develop mission critical software in a more predictable, reliable manner
- Improve our ability to add new people to the development team
- Reduce the stress on our developers if schedule and budget problems occur
- Respond to the newly mandated NASA Procedural Requirements for Software Engineering



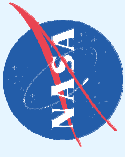
New NASA Software Requirements

- **NASA Procedural Requirements for Software Engineering (NPR 7150)**
 - Agency-level document levying 129 requirements on projects containing software
 - Based on CMMI, IEEE 12207, and MIL-STD-498
 - Classifies software by its usage (manned space flight, robotic space flight, business applications, etc.)
 - Requirements apply to projects based on classification
 - Mandates compliance with other NASA requirements and standards for project formulation, systems engineering, software assurance, and software safety



Summary of 7150 Requirements

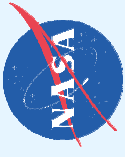
- 129 total requirements
- 114 apply at project level
 - Software Life Cycle Planning (14)
 - Project Formulation (7)
 - Acquisition & Supplier Monitoring (11)
 - Software Life Cycle Execution (34)
 - Documentation Requirements (18)
 - Peer Reviews, Configuration Management, Metrics, Training, and Other (30)
- Projects required to maintain a compliance matrix



7150 Requirements Example

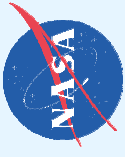
3.1.1.4 The project shall perform, document, and maintain bidirectional traceability between the software requirement and the higher level requirement. **[SWE-052]**

Note: The project should identify any orphaned or widowed requirements (no parent or no child) associated with reused software.



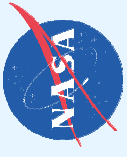
Implementation (1)

- Performed gap assessment of existing processes to NPR 7150
- Chartered Technical Working Groups (TWG) to tackle specific areas
 - Existing TWGs based on CMM L2 KPAs (e.g., CM, RM)
 - Created new TWGs to better match CMMI (e.g., PMC)
 - Created Compliance TWG to allocate NPR requirements to TWGs
 - TWGs updated software processes to be compliant with allocated requirements
- Updated the process for developing processes
- Involved process improvement consultant throughout implementation



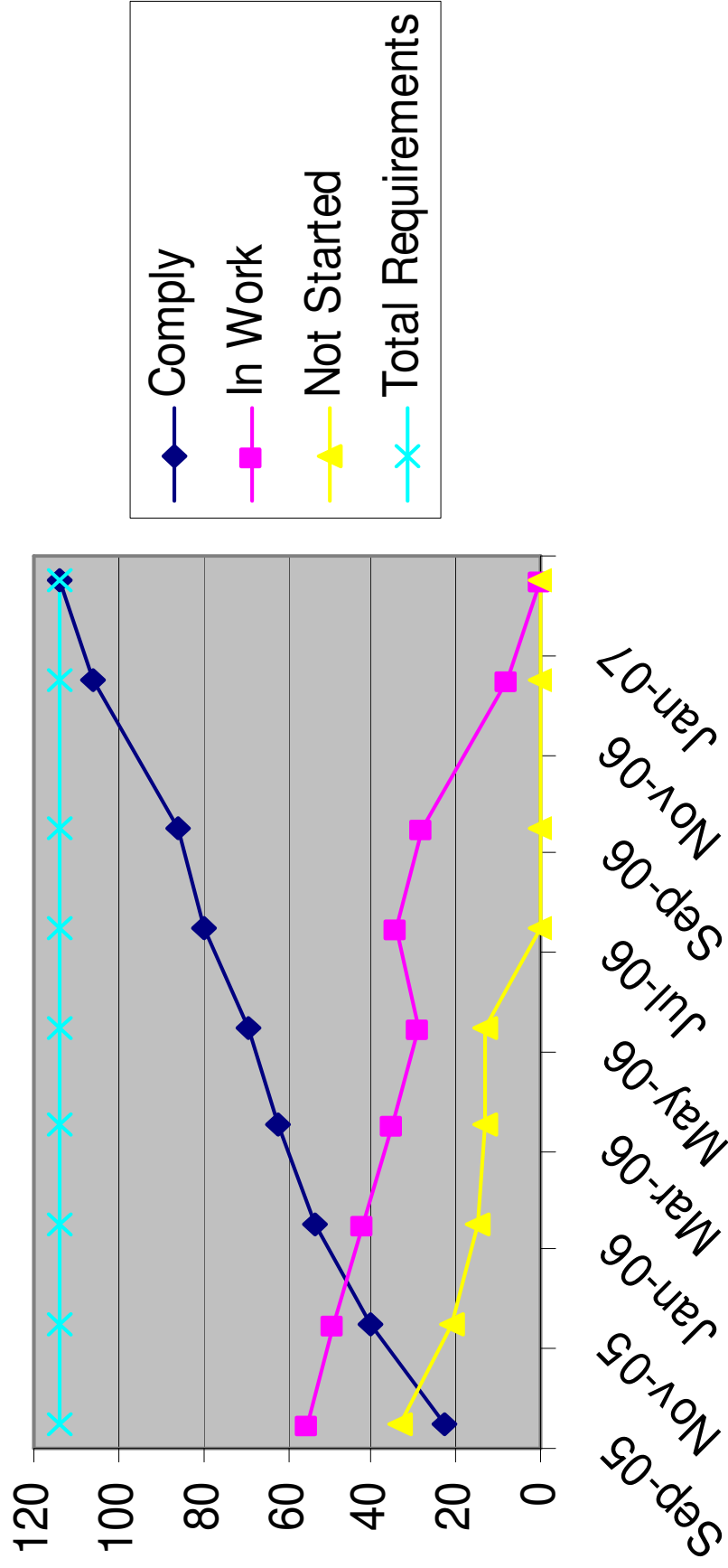
Implementation (2)

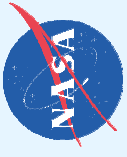
- TWGs worked to achieve compliance with requirements
 - Reviewed and modified or created new processes
 - Created templates for software products
 - Developed training for each process
 - Peer-reviewed processes, templates, and training
- Technical writer provided consistency across TWGs
- SEPG and MSG provided final review before release
- Completed processes, templates, and training released to internal Web Site and NASA PAL
- Center-Level Procedure for Software Development updated and released for Center-wide review



The Results

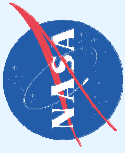
Progress Towards Compliance





Tools (1)

- MS Access database to help track 7150 compliance
 - Contains one record for each 7150 requirement
 - For each requirement, allows for
 - Assignment to a TWG
 - Assignment and tracking of action items to individuals
 - Tracking compliance status
 - Entry of additional comments and issues
 - Relationship indication to CMMI ML2
 - Location of compliance
 - Allows for various reports to be generated



Requirements Database Screen Shot

NPR 7150 - Noncompliance

NPR Info
 Requirement: SWE-013 Responsibility: Project Descriptor: SW Plan
 Paragraph: 2.2.1 Paragraph Topic: Life Cycle Planning
 NPR 71502 Requirement Text: The project shall develop software plan(s). [SWE-013]

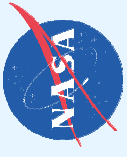
Notes
 Note: The requirement for the content of each software plan (whether stand-alone or condensed into one or more project level or software documents) is defined in Chapter 5. These include, but are not limited to:
 a. Software development or management plan.
 b. Software configuration management plan.
 c. Software test plans.

Comment:
 Maint Plan needs to be added to 2.6.4.
 ISSUE: Phases are not addressed in 7150 but are in the Engineering of Systems NPR. Major disconnect between the two documents.

TWG Info
 Primary Twg: [9MC] Secondary Twg: [] Location: [PPP 2.6, GRC-P2.6.4 7.0, Transition Process]
 TWG Approved
 Compliance Comply with Procedure Change
 Noncompliance
 Action Items:
 Action ID: 9 Action: Map to classes of software
 Date Assigned: 7/6/2005 Action Description: Add wording to 2.6.4 that any software that files is at least Medium control. Assumption: Medium control level and above covers classes A, B, C and F.
 Actionee: Varga
 Date Promised: 10/4/2005 Status: 7/13/05 Meet but need to map to classes of SW
 Record: 1 of 42 Last Updated: 7/6/2006 Level 3

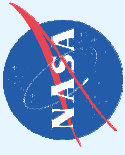
*** Application to Software Class**
 A B C D E F G H

*** Legend**
 X=Project is required to meet the requirement as written in NPR
 X1=Project is required to meet the requirement as written in NPR per a single plan per Center
 N=Project is required to meet the requirement as written in NPR except for OTS software
 C=Per Center defined process
 P=As defined in the project or software development plan
 1=The scope of this requirement is contained in the source MPD or NPR
 2=This requirement can only be waived by the OSMA ITA
 3=For Class B software, in lieu of a CMMI/CMMI certification by a developer, the project will conduct a software capability evaluation in the seven process areas listed in SWE-032 and mitigate any risk, if deficient.



Tools (2)

- InSpec
 - Web-based formal inspection tool based on Fagan process
 - Plan inspections
 - Notify participants by e-mail
 - Enter defects into online inspection logs
 - Collect and collate inspection logs
 - Track defects and open items to closure
 - Collect metrics
 - Developed in collaboration with the NASA IV&V Facility



InSpec Screen Shot

InSpec
Integrated software metrics, Inc.

My Account Help Logout

Inspection Defect List

Inspection Defect List

Inspection ID#: SEPG-OTH-9

Estimated Person Hrs For Rework: 0.00

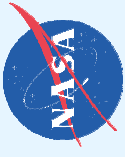
Estimated Rework Completion Date: 6/19/2006

Scheduled Follow-up Date: 6/19/2006

Actual Rework Completion Date: 6/19/2006

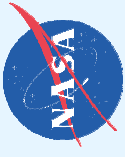
Meeting Hours: 2.00

#	Location*	Description*	Suggested Classification*	Suggested Actions	Details
0151	Page: All Section: Other:	Remove unnecessary acronyms in parenthesis. If the acronym is never used, it isn't needed.	<input type="checkbox"/> Major <input checked="" type="checkbox"/> Minor <input type="checkbox"/> Open <input type="checkbox"/> Missing <input type="checkbox"/> Wrong <input checked="" type="checkbox"/> Extra <input type="checkbox"/> Typo Type: Interfaces Origin: Duplicate Of:	<input type="checkbox"/> Open->Defect <input type="checkbox"/> Open->Closed <input checked="" type="checkbox"/> Accept <input type="checkbox"/> Reject	Finder: Varga, Denise Comments: Rob Correction Locations: QA Notes: Closed: <input type="checkbox"/>
0155	Page: All Section: Other:	When links are clicked, the color does not change to show that they have been viewed.	<input type="checkbox"/> Major <input checked="" type="checkbox"/> Minor <input type="checkbox"/> Open <input checked="" type="checkbox"/> Missing <input type="checkbox"/> Wrong <input checked="" type="checkbox"/> Extra <input type="checkbox"/> Typo Type: Interfaces Origin: Duplicate Of:	<input type="checkbox"/> Open->Defect <input type="checkbox"/> Open->Closed <input checked="" type="checkbox"/> Accept <input type="checkbox"/> Reject	Finder: Varga, Denise Comments: Herb will fix CSS Correction Locations: QA Notes: Closed: <input type="checkbox"/>



Getting the Word Out

- Created a Marketing TWG
 - Published a tri-fold brochure to highlight NPR 7150, Center-Level Procedure, and supporting elements available from the SEPG
 - Released a newly designed “Software@Glenn” Web site as our PAL
 - Planned a “Software Fair” to spread the word about SEPG software products and services across GRC
- Conducted training on new processes as they were released
- Offered coaching to assist new projects in using our assets



Software@Glenn Screen Shot

The screenshot shows a web browser window with the URL <http://software-tt.grc.nasa.gov/index.html>. The page features a navigation menu on the left with links: Getting Started, Planning, Requirements, Configuration Management, Design, Code & Test, Assurance, Tracking, Metrics, Tools, Training, and Related Links & References. A search bar is located at the top right, with links for [FAQ](#), [Feedback](#), and [Contact SEPG](#). The main content area is titled "Software Development at GRC Processes – Templates – Tools" and includes a "Purpose" section. The central diagram is a circular flowchart with "Getting Started" at the center, surrounded by eight stages: Planning, Requirements, Configuration Management, Design, Code & Test, Assurance, Tracking, and Metrics. A large blue arrow points from "Getting Started" to "Code & Test".

Software@Glenn

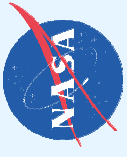
Search:

[FAQ](#) | [Feedback](#) | [Contact SEPG](#)

Software Development at GRC Processes – Templates – Tools

Purpose

The purpose of the Software@Glenn Web site is to provide tools/processes not only to improve the software development, but also to ensure compliance to NASA Standards. The goal of this Web site is to help software engineers use predictable, repeatable, consistent, and measurable processes leading to high quality software at reduced cost. Software@Glenn is maintained by the [Software Engineering Process Group \(SEPG\)](#).



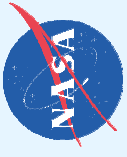
Other SEPG Products

Processes

- Center-Level Procedure
- Project Planning
- Project Monitoring and Control
- Requirements Development
- Requirements Management
- Configuration Management
- Managing Software Process and Product Measurement
- Performing Software Process and Product Measurement
- Software Acquisition Statement of Work Guidelines
- Transition of Software to a Higher Classification

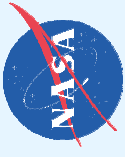
Templates

- Software Management Plan
- Software Maintenance Plan
- Software Users Manual
- Software Version Description Document
- Requirements Traceability Matrix
- Software Requirements Specification
- Software Test Plan
- Software Test Procedure
- Software Test Report
- Software Configuration Management Plan
- Software Metrics Report
- Software Data Dictionary
- Interface Design Document
- Software Change Request
- Software Design Document



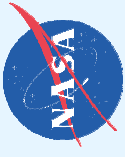
What Went Right

- Use of 7150 database gave us an extremely versatile tool for tracking and reporting
- Use of process improvement consultant provided us with a broad background of experience in process improvement
- Use of configuration management tool for processes and products helped manage multiple simultaneous changes
- Use of local Subject Matter Experts (SME) and commitment from dedicated SEPG team sustained effort



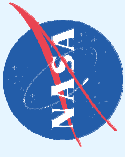
Obstacles to Success

- Lack of evidence for SCAMPI appraisals
 - Existing mature pilot projects were canceled
 - New projects have not had sufficient time to fully use processes
- Transition from CMM to CMMI was confusing
 - Processes and TWGs had name changes
 - Difficult to relate between “legacy” and “new” processes
- Difficulty in getting broad participation from software developers across the Center
- Limited funding and turnover of personnel



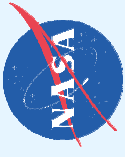
Next Steps

- Identify new software projects and assist in the use of processes, templates, and tools
- Collect metrics and feedback on use of processes, templates, and tools
- Perform gap analysis of our processes and practices against CMMI ML2
- Update processes to meet CMMI ML2
- Perform pre-assessment of Flight Software Engineering Branch against CMMI ML2 in late 2007
- Assist GRC Engineering Process Group in becoming compliant with the new NPR 7123 Systems Engineering Requirements



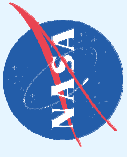
Lessons Learned (1)

- Utilize the processes and tools you create and recommend
 - Much easier to get projects to follow your lead
 - An excellent opportunity for improving your own processes
 - Helps with organizing and streamlining activities
- Make extensive use of peer reviews and inspections
 - Great communication tool
 - Means of including expertise external to the SEPG
 - Common repository for document changes, status, and metrics



Lessons Learned (2)

- Share products and processes
 - Collaboration with other organizations leverages work
- Use process improvement consultant
 - Regularly scheduled week-long visits focus efforts
 - Provides SEPG with outside perspective
 - A source of “on-the-spot” training
 - Helps maintain alignment with CMMI
 - Provides another pair of hands and eyes



Contact Information

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