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

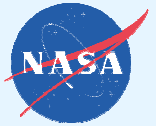
- Refocus software process improvement on new NASA Procedural Requirements for Software Engineering
  - Incorporate the requirements into GRC processes
  - Address CMMI practices where practical
- Update Center-Level Procedure for Software Development
  - Local procedure to encapsulate new requirements
- 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

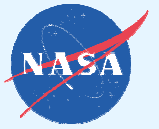


Summary of 7150 Requirements

- 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)

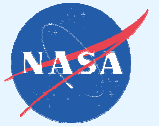
- Projects required to maintain a compliance matrix



7150 Requirements Example

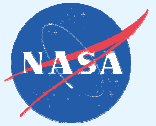
3.1.1.4 The project shall perform, document, and maintain bidirectional traceability between the software requirement and the higher level requirement. **[SWE-052]**

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



Implementation (1)

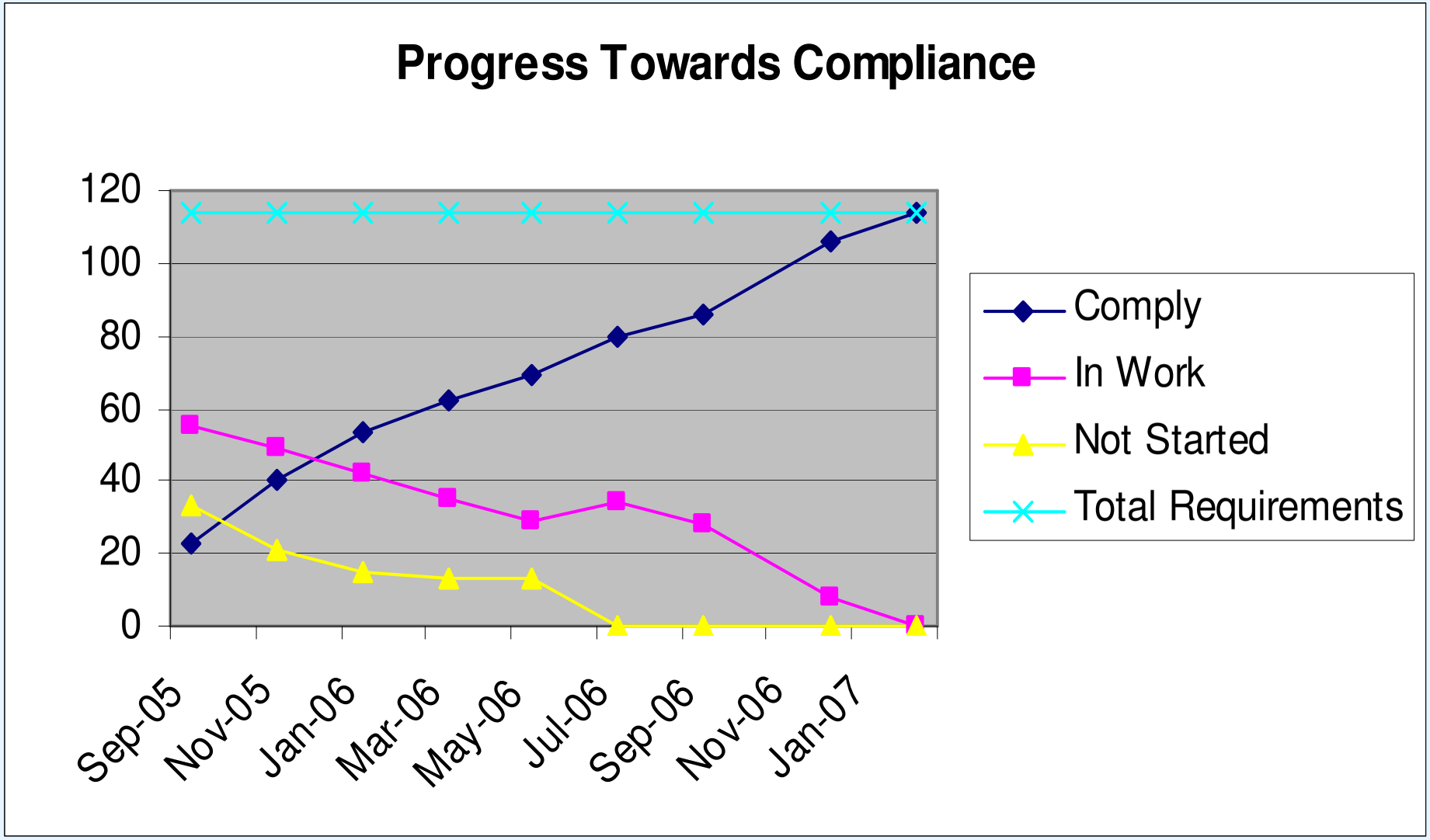
- Performed gap assessment of existing processes to NPR 7150
- Chartered Technical Working Groups (TWG) to tackle specific areas
  - Existing TWGs based on CMM L2 KPAs (e.g., CM, RM)
  - Created new TWGs to better match CMMI (e.g., PMC)
  - Created Compliance TWG to allocate NPR requirements to TWGs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

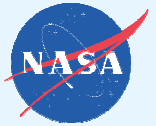


Implementation (2)

- 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

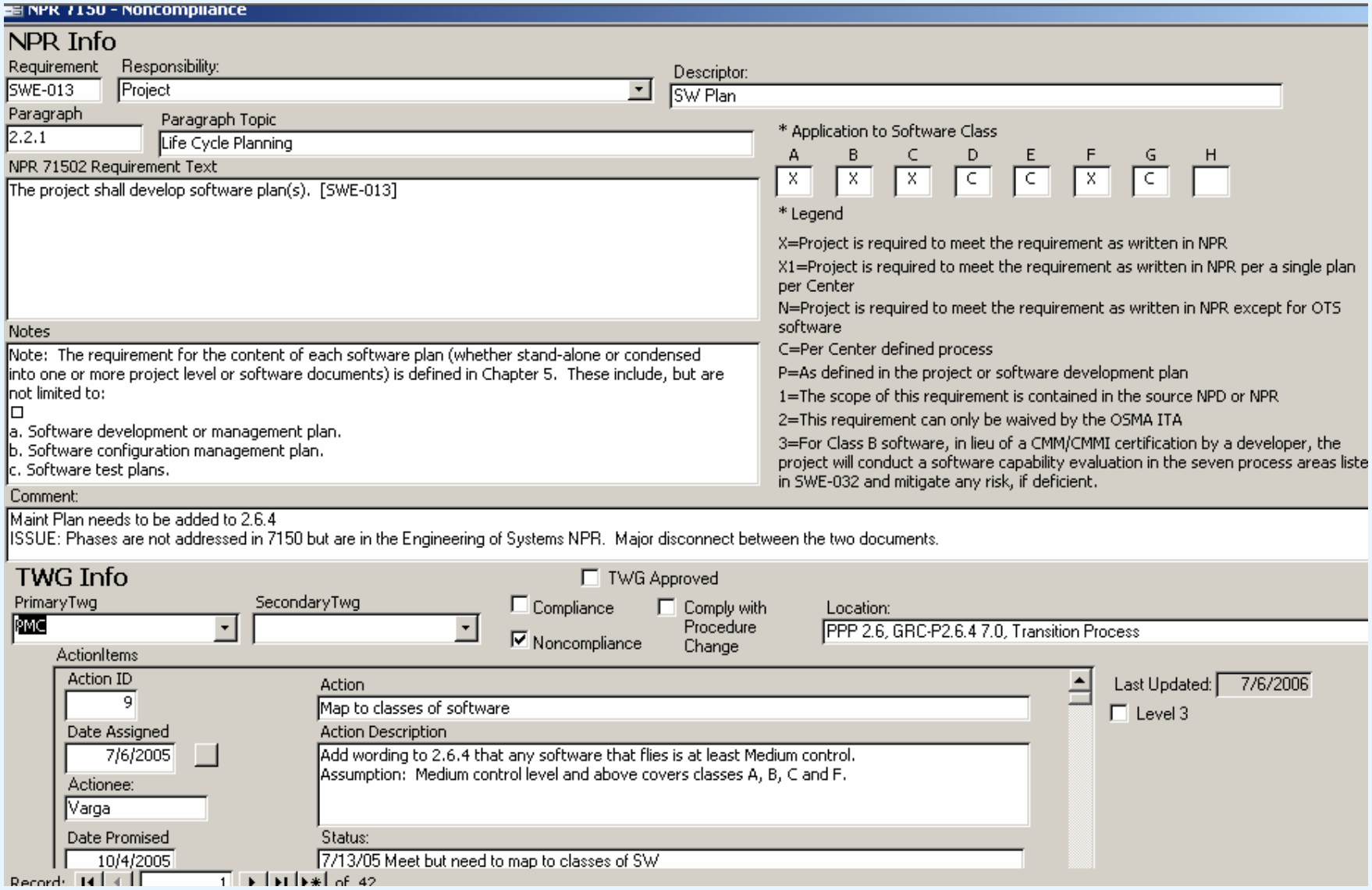

Progress Towards Compliance
120
100
80
60
40
20
0
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Comply
In Work
Not Started
Total Requirements

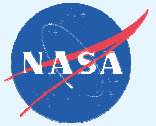


Tools (1)

- 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

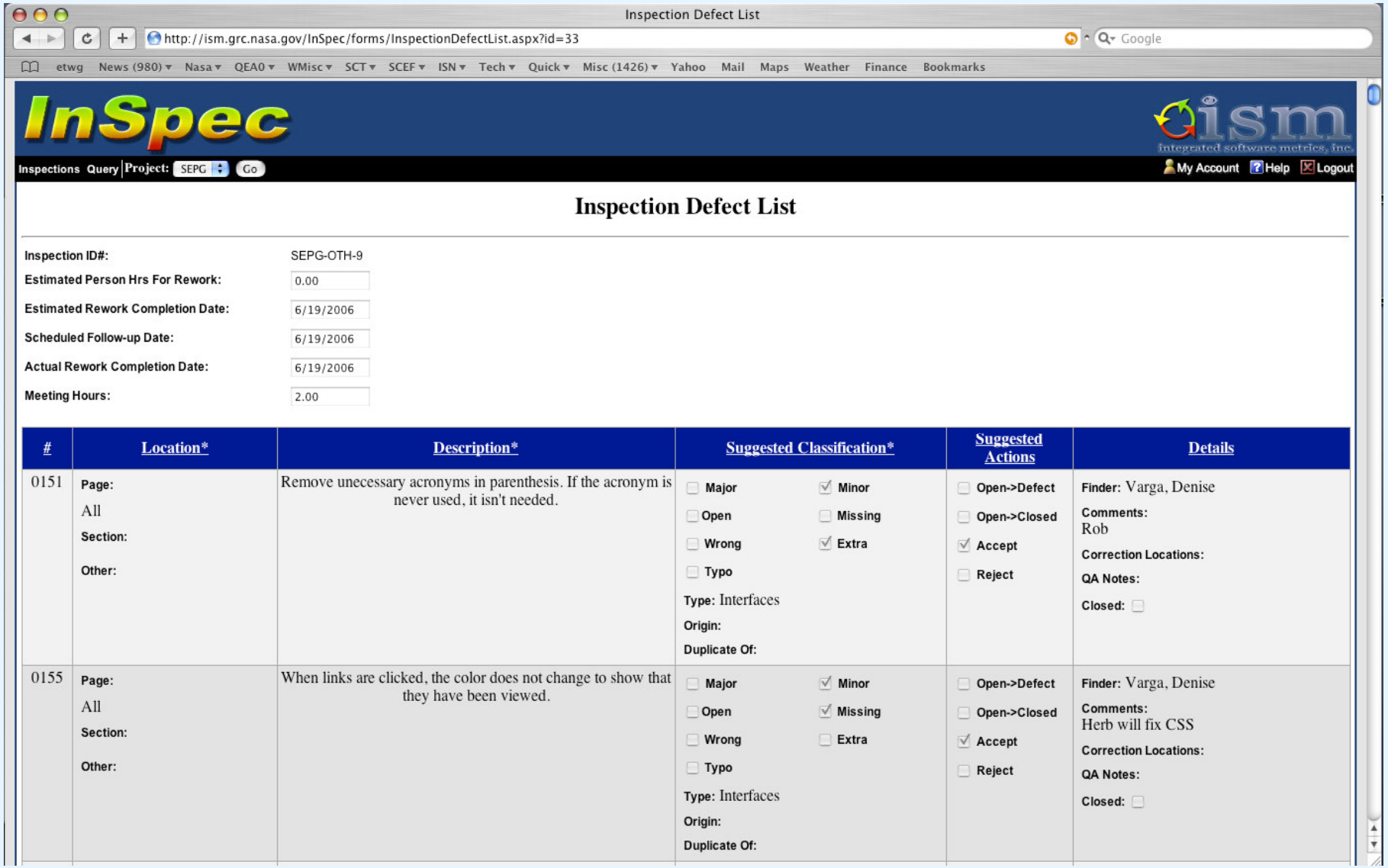


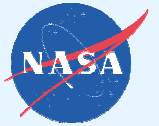


Tools (2)

- 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

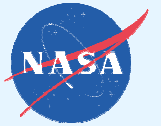




Getting the Word Out

- 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



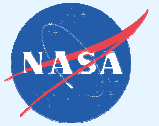
Other SEPG Products

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

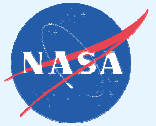
Templates

- 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



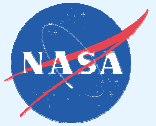
What Went Right

- 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



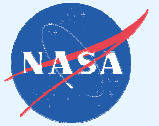
Obstacles to Success

- 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

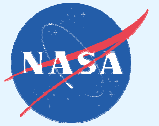
- Identify new software projects and assist in the use of processes, templates, and tools
- Collect metrics and feedback on use of processes, templates, and tools
- Perform gap analysis of our processes and practices against CMMI ML2
- Update processes to meet CMMI ML2
- Perform pre-assessment of Flight 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)

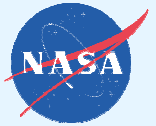
- Utilize the processes and tools you create and recommend
  - Much easier to get projects to follow your lead
  - An excellent opportunity for improving your own processes
  - Helps with organizing and streamlining activities

- 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



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