Journeys on the Road to Level 5

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Agenda

- Our Process Improvement History
- The Infrastructure That Made It Work
- New Attitudes In Using Metrics
- Is Level 5 The End . . . Or The Beginning
Northrop Grumman Today

- 125,000 people, 50 states, 25 countries
- Largest manufacturing employer in Louisiana, Mississippi, Virginia, Maryland
- One of top three defense contractors
- Leading systems integrator
- Largest military shipbuilder
- Largest provider of airborne radar and electronic warfare systems
- One of two top IT providers to the U.S. Government
- One of three major contractors in military and civil space, missile defense

More than $31 Billion in 2004 Sales
On April 8, 2005, The Process Company, LLC completed a SCAMPI Class A Appraisal in accordance with the Software Engineering Institute’s Appraisal Framework using the SE/SW CMMI® version 1.1 and determined that Northrop Grumman AGS and BMS met the goals of SEI Level 5 Process Maturity.

Andreas R. Felschow, SEI Authorized Lead Appraiser
The Process Company, LLC

Kevin M. Cotherman, SEI Authorized Lead Appraiser
The Process Company, LLC

Since Our Work Is Primarily Cost-Plus, These Benefits Accrue to Our Customers:
- **Higher Productivity**
- **Improved Quality**
- **Faster Time to Market**
- **Competitive Pricing**
- **Return on Investment Demonstrated by**
  - >3x Increase in Productivity
  - >67% Decrease in Cost
  - ISO 9001 Compliance
  - SW CMM – Level 2
  - SW CMM – Level 3
  - ISO 9001:1994 / TickIT
  - Lean Program Initiated
  - SE CMM Level 3
  - CSIP SCE
  - Process Group Established
  - Desert Storm
  - E-8C Joint STARS
  - 1991
  - 1992
  - 1993
  - 1994
  - 1995
  - 1996
  - 1997
  - 1998
  - 2000
  - 2001
  - 2002
  - 2003
  - 2004
  - 2005
Infrastructure for Innovation

Corporation & Business Area
- Corporate goals
- Business Area goals

Engineering Steering Committee
- Status reporting
- Engineering Directors
- Quality Director
- Executive Management Representative

Engineering Process Group (EPG)
- Improvement proposals
- Process performance status reporting
- Full Time EPG Chairperson
- Representatives from each Engineering Directorate

Software Engineering Process Group (SEPG)
- Software practitioners and relevant stakeholders to improve software specific processes

Process Management Teams (PMT)
- Multi-disciplinary teams empowered to evaluate and continuously improve broad engineering processes

Process Working Groups
- Teams established as needed

Software Quality representative
- Program and project representatives
Steering Committee

- Comprises
  - Engineering Director
  - Directors from Each Engineering Directorate (Systems, Software, Test, Vehicle, Avionics, Logistics)
  - Quality Operations
  - Business Area Management Rep
  - Project Engineering Managers
  - Program Managers
  - Engineering Process Group

- Meets Every Week to Review Process Improvement Status with EPG and Project Practitioners
- Government Reps Invited to Meetings
Engineering Process Group (EPG)

- Made Up of Process Definition and Management Personnel in Each Engineering Directorate
- Facilitates Process Improvement across the Engineering Department
- Maintains Process Assets for Use by the Organization
- Coordinates with Organizations Outside of Engineering to Ensure Proper and Efficient Process Interfaces
- Facilitates Compliance with Appropriate Process Standards and Models (E.G., ISO 9001, CMMI)
- Manages Engineering Process Management Teams
- Develops and Maintains Relationships with Universities, Research Labs and Related Consortia to Support Engineering Goals
Process Management Teams

Focusing Lean on Significant Issues

Engineering PMT Steering Committee

- Support Team: Facilitators
- Software Engineering
- Systems Engineering Life Cycles
- COTS and PME
- Test and Integration
- Logistics Commodities
- ILS Processes
- Vehicle Engineering
- System Integration Labs

Focusing Lean on Significant Issues
Engineering PMTs – General Goals

- Map Process Value Stream for the Production of Relevant Products
- Determine Non-Value Added Activities
  - Recognize That Some of These May Be Required by Customers or Business Needs
- Identify Issues or Concerns Regarding the Process or Product
  - Execute Causal Analysis & Resolution Process As Needed
- Determine Alternatives to the Current Way of Doing Business
  - Propose “Best” Alternatives in Terms of Cost, Schedule, Quality or Productivity Improvements
- Present Alternatives to Steering Committee for Selection for Implementation
CMMI Higher Levels – Differences in Behavior

At Level 3.....
- **Management Reacts**
  - Comparative Rather Than Statistical Analysis
  - Process Capability Not Understood
- Measurement Program
  - Data Available for Analysis
  - Analysis at Project Level
  - Data Quality Often Still a Concern

At Level 4.....
- **Management Anticipates**
  - Predicting Results of Critical Processes
  - Evaluating Outcomes Relative to Capability
- Measurement Program
  - Data Relied on for Decision-making
  - Data Analyzed at Organization and Project Levels

At Level 5.....
- **Management Performs “Pre-emptive Strikes”**
  - Identifying & Removing Systemic Process Issues
  - Predicting Results of Innovative Improvements
- Measurement Program
  - Data Relied on for Cost/Benefit Analysis
  - Benefits Forecasted for Technology or Process Optimization
Using Metrics for Higher Maturity

- **Estimating**
  - Base Estimates Of Future Performance On Past Performance

- **Project Planning**
  - Determine Resources Needed For Project Execution

- **Project Tracking**
  - Determine Whether Actual Performance Matches Predictions

- **Quantitative Management**
  - Determine Whether Project Objectives Are Likely To Be Met

- **Process Improvement**
  - Determine Whether Process Changes Have Improved Performance
Voice of the Process

Quantitative Sub-Process Management

- **A Stable Process**
  - Operates Within the Control Limits 99.7% of the Time
  - Meets Budget
  - Offers Opportunities for Systematic Process Improvement

ASU Log Cost Model
Using Lognormal Probability Density Function

- **Upper Control Limit**
- **Average performance**
- **Lower Control Limit**
Improving the Process

Peer Reviews Greater Than 1 Standard Deviation Above the Average of Peer Review Performance

Peer Reviews Greater Than 1 Standard Deviation Below the Average of Peer Review Performance

Question: Is There a Common Cause for the Variation in Either of These Two Sub-populations of the Peer Review Data?
### Develop Candidate Solutions (Example)

<table>
<thead>
<tr>
<th>Proposed Solution</th>
<th>Comments for Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count the actual code reviewed (vs. just new or modified code)</td>
<td>This is a potential BOE issue and needs criteria for setting boundaries for code to be reviewed</td>
</tr>
<tr>
<td>Increase the complexity factor for small reviews</td>
<td>For 2 or less SLOC/unit set complexity to “10”. For other small reviews this may need a “calibration chart” to determine appropriate complexity factors</td>
</tr>
<tr>
<td>For small reviews, select a different verification method</td>
<td>The different verification method will need definition. Q: Are these all Engineering Checks? More analysis may be needed.</td>
</tr>
<tr>
<td>Automate the administrative work Required to set up peer reviews (e.g., create diff files, place files into a directory/CMS, . . . )</td>
<td>This change would impact all reviews – not just the sub-population. Need to evaluate the impact to the overall population</td>
</tr>
</tbody>
</table>
Improvement in Process Performance

Now
Current performance

Improved performance

We Need To Minimize This Time:
- Identify Improvement Proposals
- Evaluate & Prioritize Proposals
- Select Improvement
- Pilot Improvement
- Deploy Improvement

March '05

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Deploying Improvements

- Publish a New Organization Baseline for the Improved Process
- Deploy New Process Objectives To Project
- Deploy New Process To Project
- Monitor New Process Performance Against New Capability

Old Performance

Improved Performance

58 – 75% Reduction in Variation
10 – 14% Reduction in Cost
Growing the Capability

What happens after Level 5...

CMMI ‘Volume’
In April 2005

More Projects

More Optimized Processes

More Disciplines

ACI
ASU
TSSR
CNS-ATM
E10A

AV Disc/Inspection Rpt
SW Designs
SE System Integration Labs
LOG AFTOs
TE Test Plans/Reports
SW Code Reviews

Software Systems
Test & Evaluation
Logistics
Ve...