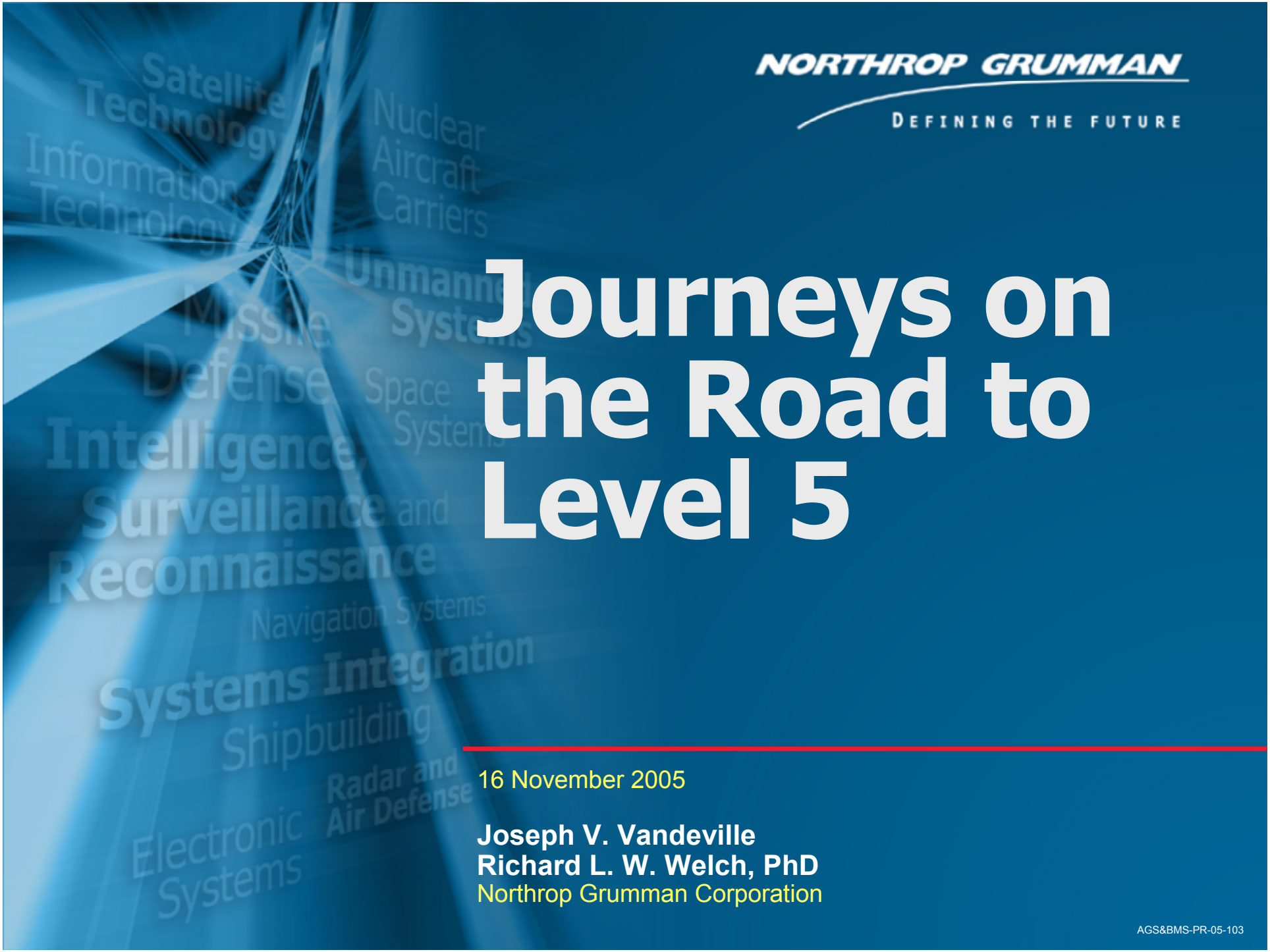

Journeys on the Road to Level 5

16 November 2005

Joseph V. Vandeville
Richard L. W. Welch, PhD
Northrop Grumman Corporation

AGS&BMS-PR-05-103

Agenda

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

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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

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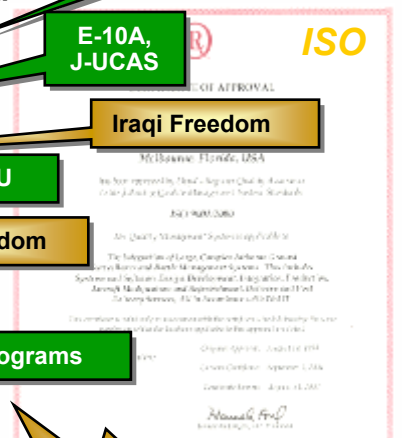
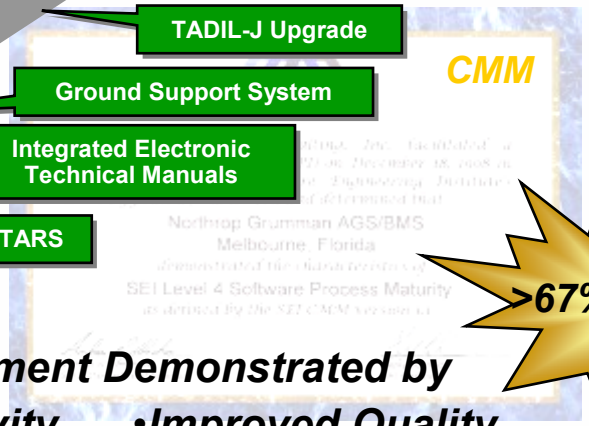
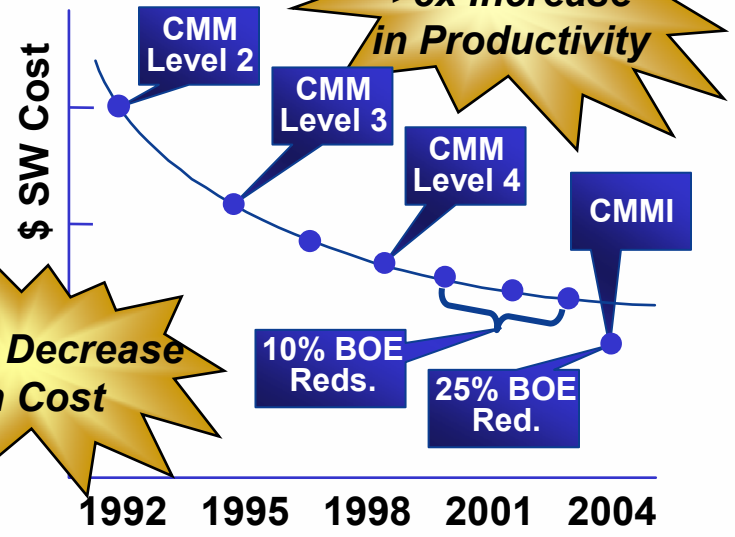
Process Improvement History





1991 Desert Storm
1992 Process Group Established
1993 SW CMM – Level 2
1994 CSIP SCE
1995 SW CMM – Level 3
1996 SE CMM Level 3
1997 ISO 9001 Compliance
1998 Lean Program Initiated
1999 SW CMM – Level 4
2000 ISO 9001:1994 / TickIT
2001 CMMI SE/SW Level 3
2002 ISO 9001:2000 / TickIT
2003 CMMI SE/SW Level 4
2004 CMMI SE/SW Level 5
2005+ CMMI IPPD/SS - Goal

Integrated Electronic Technical Manuals
E-8C Joint STARS
Ground Support System
TADIL-J Upgrade
Joint Endeavor I & II
Computer Replacement
Allied Force
SATCOM
TSSR
Enduring Freedom
Link 16 ASU
Iraqi Freedom
E-10A, J-UCAS
COS



>3x Increase in Productivity

>67% Decrease in Cost

Return on Investment Demonstrated by

- ***Higher Productivity***
- ***Improved Quality***
- ***Competitive Pricing***
- ***Faster Time to Market***

Since Our Work Is Primarily Cost-Plus, These Benefits Accrue to Our Customers

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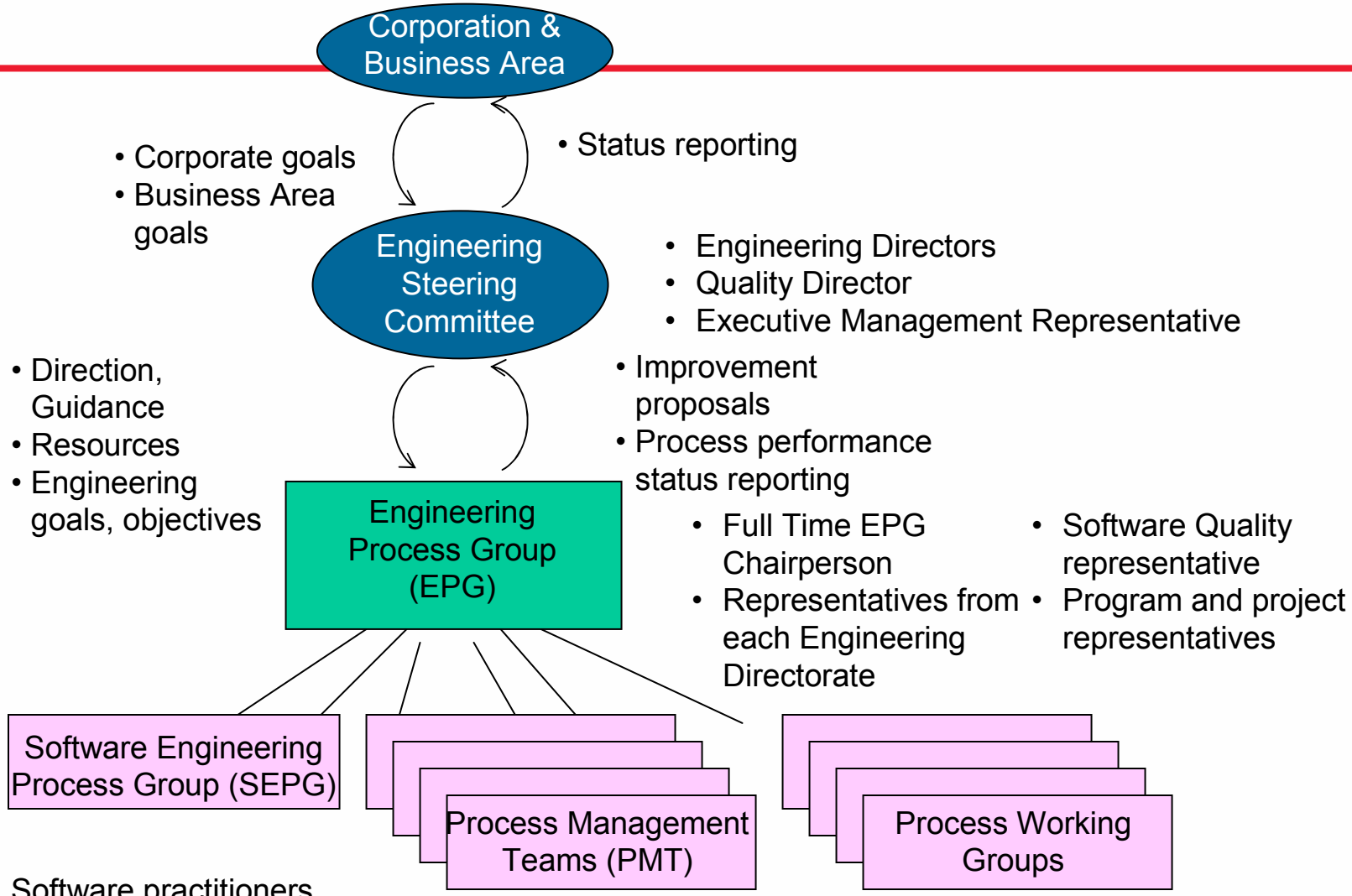
Infrastructure for Innovation



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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**

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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

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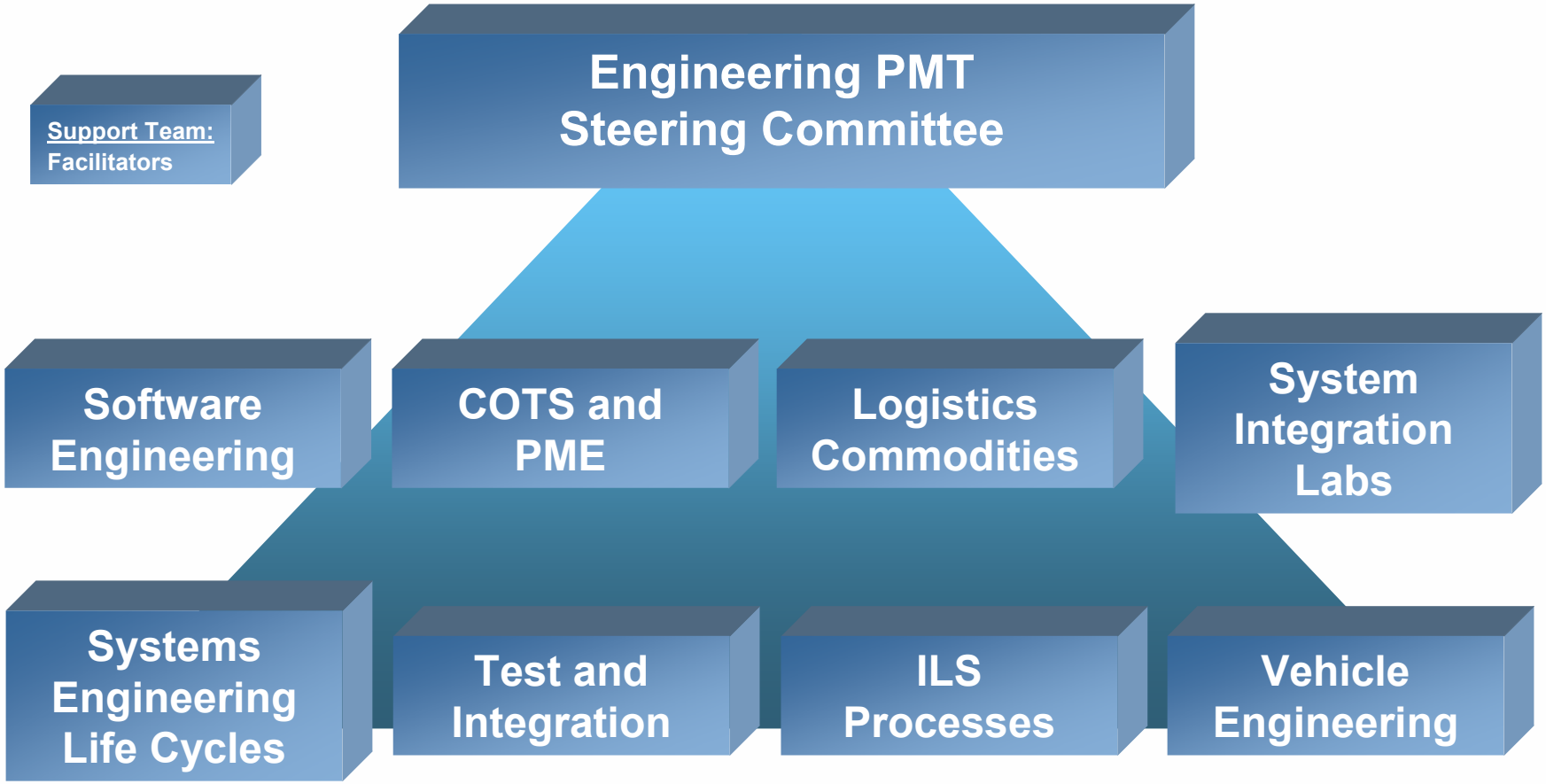
Process Management Teams

Focusing Lean on Significant Issues



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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**

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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

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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

Higher Maturity Uses of Metrics

- **Quantitative Management**
  - Determine Whether Project Objectives Are Likely To Be Met
- **Process Improvement**
  - Determine Whether Process Changes Have Improved Performance

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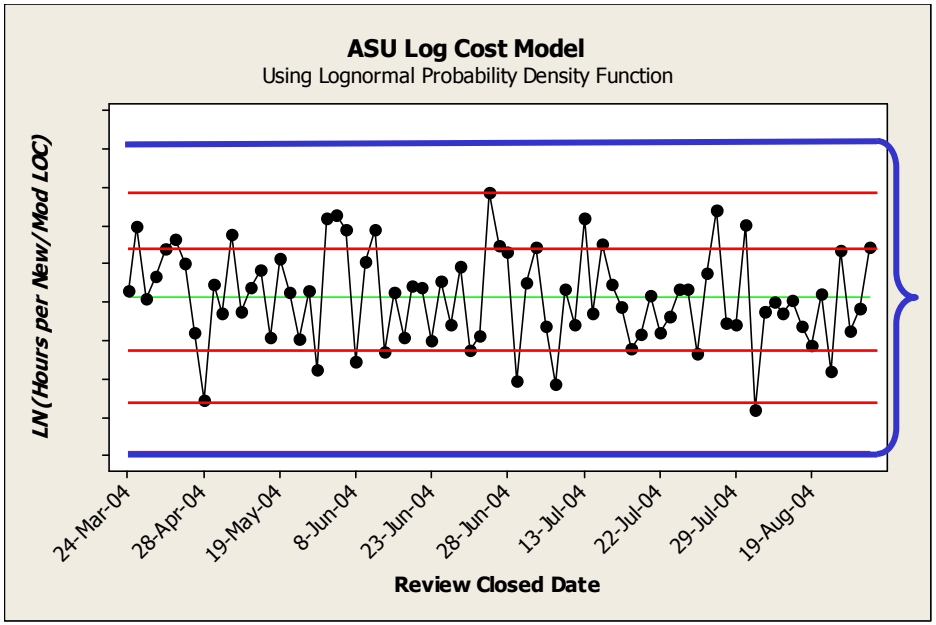
Voice of the Process

Quantitative Sub-Process Management



Upper Control Limit

Average performance

Lower Control Limit

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

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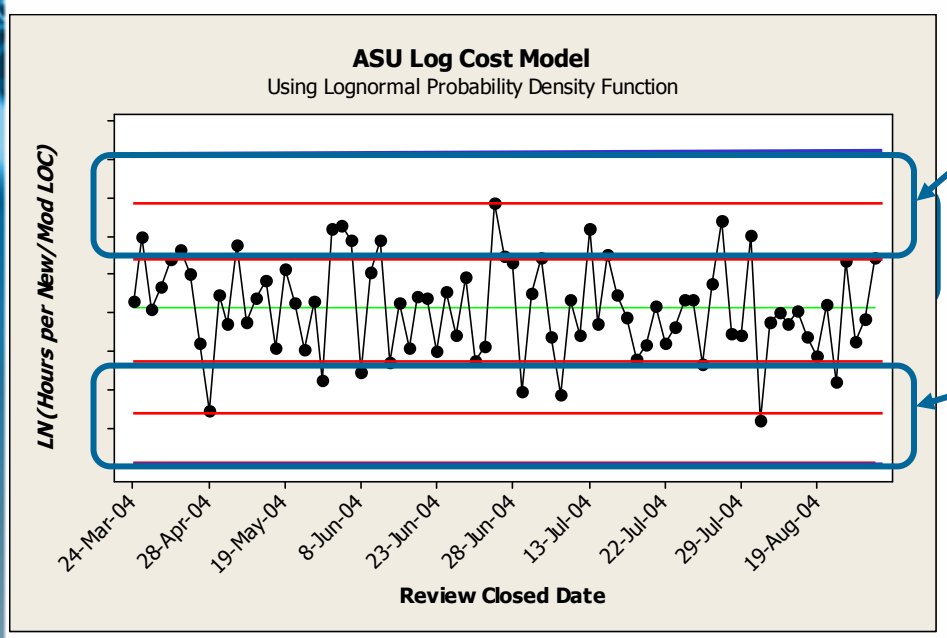
Improving the Process



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?

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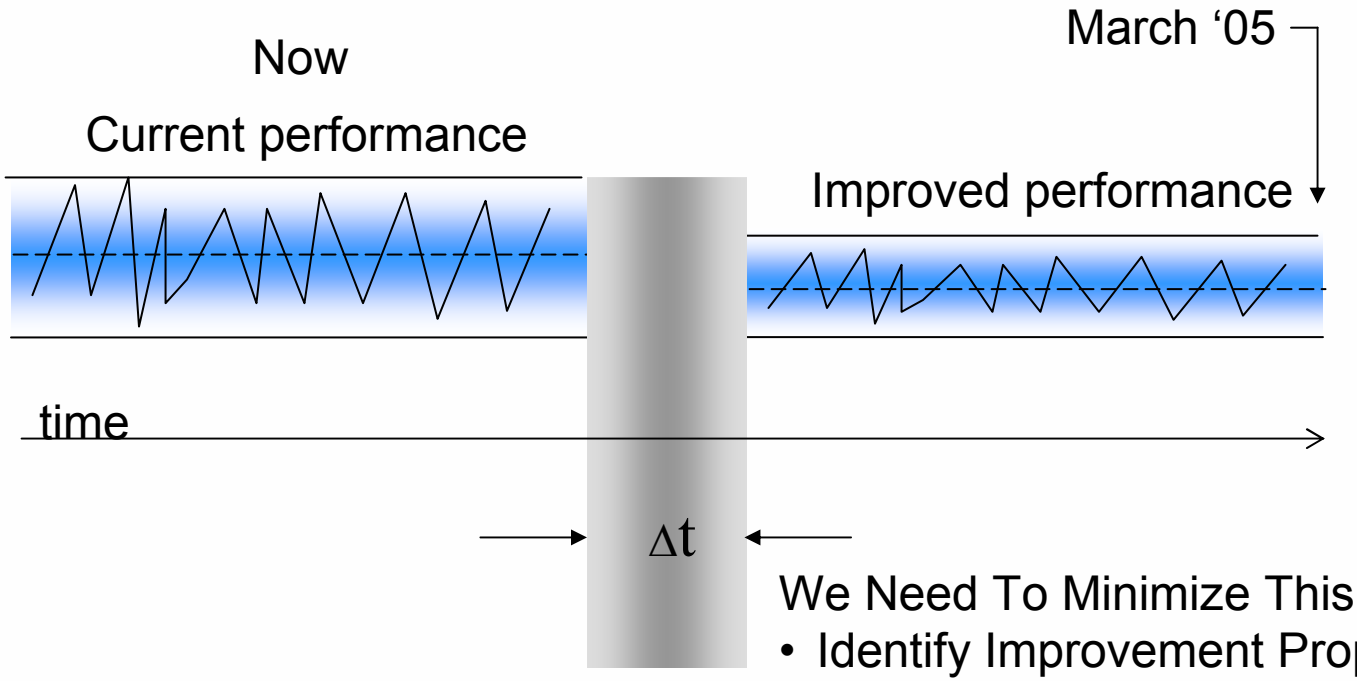
Develop Candidate Solutions (Example)

Proposed Solution	Comments for Evaluation
Count the actual code reviewed (vs. just new or modified code)	This is a potential BOE issue and needs criteria for setting boundaries for code to be reviewed
Increase the complexity factor for small reviews	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
For small reviews, select a different verification method	The different verification method will need definition. Q: Are these all Engineering Checks? More analysis may be needed.
Automate the administrative work Required to set up peer reviews (e.g., create diff files, place files into a directory/CMS, . . .)	This change would impact all reviews – not just the sub-population. Need to evaluate the impact to the overall population

Improvement in Process Performance



We Need To Minimize This Time:

- Identify Improvement Proposals
- Evaluate & Prioritize Proposals
- Select Improvement
- Pilot Improvement
- Deploy Improvement

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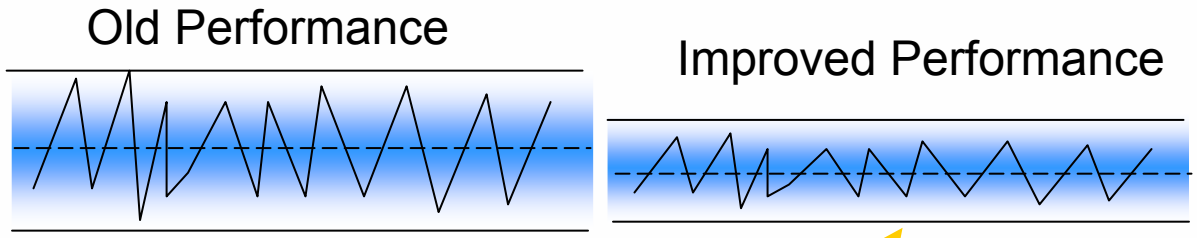
Deploying Improvements

- **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**



58 – 75% Reduction in Variation

10 – 14% Reduction in Cost

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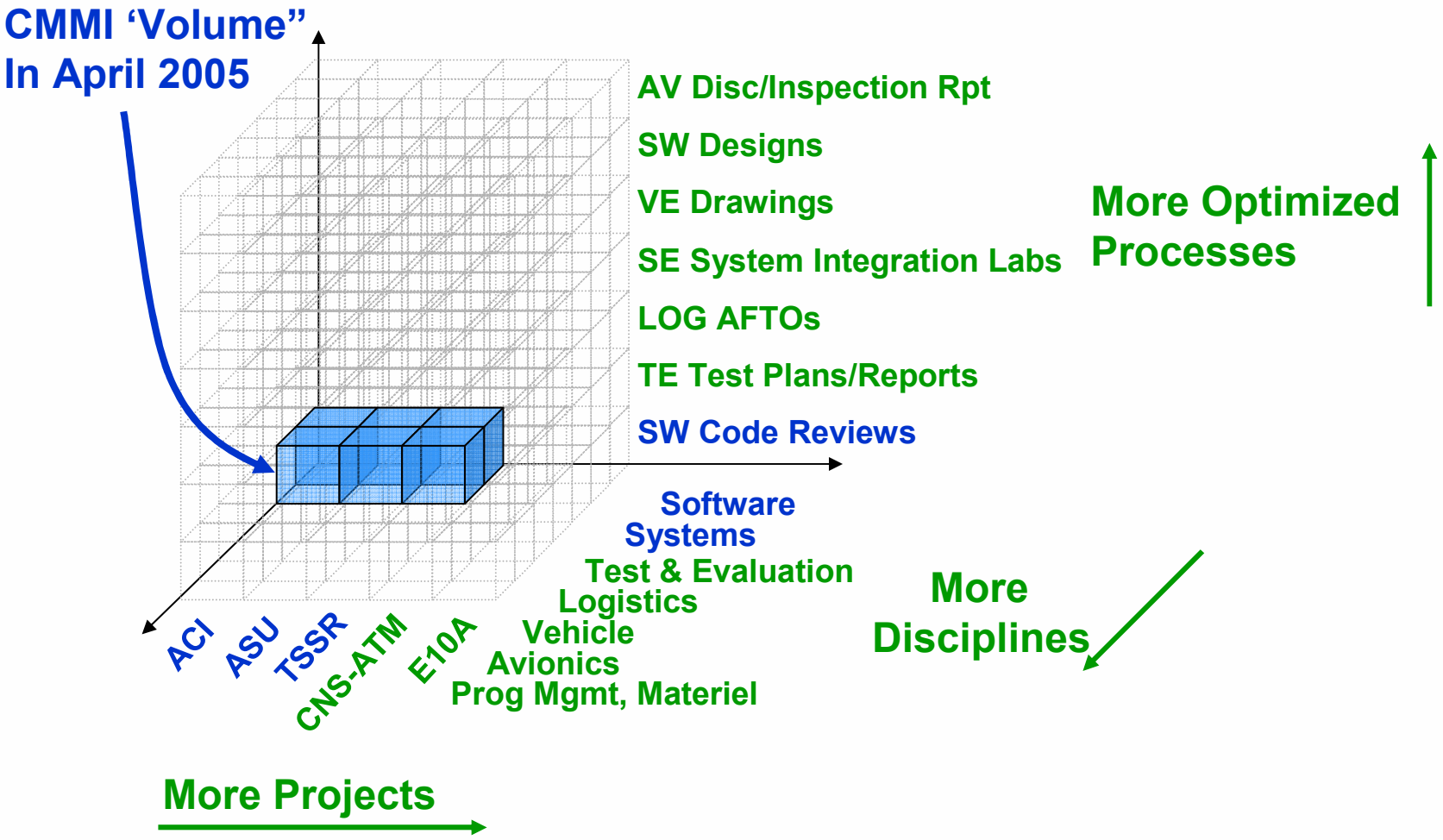
Growing the Capability

What happens after Level 5 . . .



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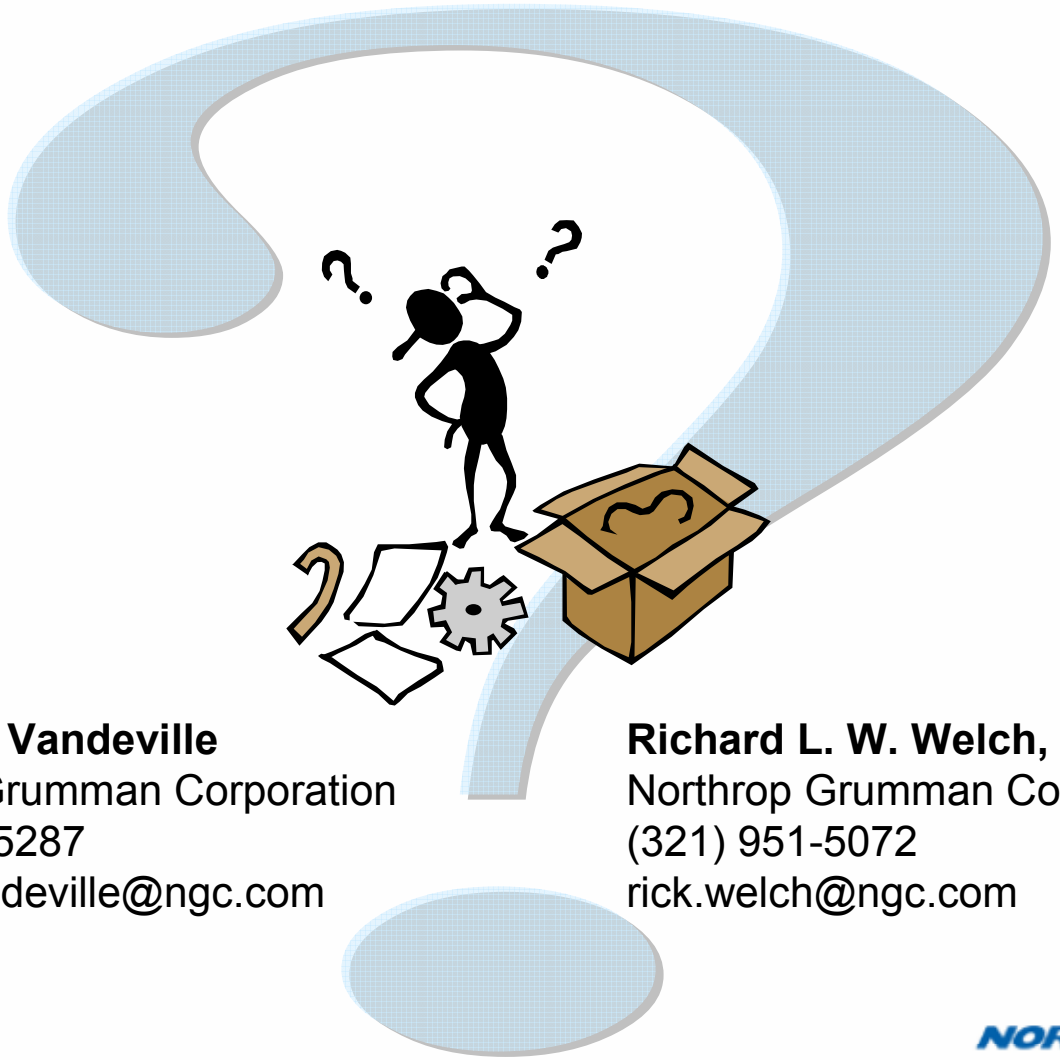
QUESTIONS



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