Quality Assurance Involvement Compared to Program Results

Jill A. Brooks
Network Centric Systems
Agenda

• Introduction
• Software Engineering Institute Insight
• Raytheon North Texas Data
  – Cost Performance
  – Schedule Performance
  – Quality
• Lessons Learned
• Other Considerations
• Next Steps

Quality Assurance Involvement Compared to Program Results
Introduction - Raytheon

• Raytheon is an industry leader in defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft

• Network Centric Systems (NCS) develops and produces mission solutions for networking, command and control, battlespace awareness, and air traffic management

• Space and Airborne Systems (SAS) provides electro-optic/infrared sensors, airborne radars, solid state high energy lasers, precision guidance systems, electronic warfare systems, and space-qualified systems for civil and military applications

• Raytheon-specific data examined for this presentation draws on both NCS and SAS programs executed in North Texas. Data is from software programs
Introduction – Raytheon continued

• For NCS North Texas:
  – 8 QE engineers
  – 145 Software Engineers
  – 30 Programs (including maintenance efforts)
Introduction – Raytheon continued

Level 4

RTIS Policies & Procedures

RTIS Integrated Product Development Process

RTIS Software Operating Instructions

Baldridge Award Level 2

Level 3 Defined

10x Fault Density Improvement

Software Sigma & Cycle Time

1997 - 1999

1997 1999-

Level 3 Baseline Validation

Level 5 IPI

1994

1995

1996

1997

1998

1999

2000

2001

2002

2003

Raytheon Acquisition & Transition

1994

1995

1996

1997

1998

1999

2000

2001

2002

2003

Level 4/5 Managed/Optimizing

• Self-assessment
• Software Improvement Team Formed

IPI     CMM-based Internal Process Improvement Assessment
RTIS    Raytheon/TI Systems
CMMI    CMM Integrated
Introduction – The Burning Platform

• Although the CMMI introduces Quality Assurance (QA) at Level 2, and QA is further expanded at higher levels of maturity, QA functions still have to “prove” their worth as QA is often viewed as an “overhead” function.
• Quality Assurance is introduced at Level 2 of the Capability Maturity Model Integrated (CMMI)
• Quality activities are in all process areas
• As organizations move up the maturity ladder, there are improvements in program performance
• SEI has both qualitative and quantitative data to support the previous statement

The SEI has collected data which illustrates the correlation between organizational maturity and improved performance
SEI Insight

- Performance results summarized by the Software Engineering Institute, March 4, 2005

<table>
<thead>
<tr>
<th>Performance Improvement Category</th>
<th>Low</th>
<th>Median</th>
<th>High</th>
<th>Number of Data Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>4.5%</td>
<td>38%</td>
<td>87%</td>
<td>14</td>
</tr>
<tr>
<td>Schedule</td>
<td>20%</td>
<td>50%</td>
<td>90%</td>
<td>14</td>
</tr>
<tr>
<td>Productivity</td>
<td>11%</td>
<td>50%</td>
<td>376%</td>
<td>13</td>
</tr>
<tr>
<td>Quality</td>
<td>29%</td>
<td>50%</td>
<td>94%</td>
<td>16</td>
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<tr>
<td>Customer Satisfaction</td>
<td>10%</td>
<td>14%</td>
<td>55%</td>
<td>5</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>2 : 1</td>
<td>3 : 1</td>
<td>13 : 1</td>
<td>8</td>
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</table>

Reference: [http://www.sei.cmu.edu/cmmi/results.html](http://www.sei.cmu.edu/cmmi/results.html)
Raytheon North Texas Data – Cost Performance

• QE Involvement is measured as a percentage of the total effort on the program.

• Cost Performance Index (CPI) is measured as the ratio of the Budgeted Cost of Work Performed (BCWP) to the Actual Cost of Work Performed (ACWP).

\[
\text{CPI} = \frac{\text{BCWP}}{\text{ACWP}}
\]
There is a positive correlation between QE Involvement and Program Cost (measured via CPI).
• QE Involvement is measured as a percentage of the total effort on the program

• Schedule Performance Index (SPI) is measured as the ratio of the Budgeted Cost of Work Scheduled (BCWS) to the Actual Cost of Work Performed (ACWP)

\[
SPI = \frac{BCWS}{ACWP}
\]
Raytheon North Texas Data – Schedule Performance

No apparent correlation between QE Involvement and Program Schedule (via SPI)
• QE Involvement is measured as a percentage of the total effort on the program

• Defect Containment (DC) is measured as the ratio of the number of defects which were detected “in phase” versus the total number of defects

\[
DC = \frac{\text{In-phase Defects}}{\text{Total Number of Defects}}
\]
There is a positive correlation between QE involvement and Defect Containment.
Raytheon North Texas Data – Quality Defect Density

• QE Involvement is measured as a percentage of the total effort on the program

• Defect Density (DD) is measured as the ratio of the number of defects which were detected post delivery versus the size of the product. Note the Equivalent Lines of Code was used to adjust for programs with significant amounts of legacy code

\[
DD = \frac{\text{Post Delivery Defects}}{\text{Equivalent Lines of Code}}
\]
There is a negative correlation between QE involvement and Defect Density, which is a good thing!
Lessons Learned

• Data, data, data
  – Multiple data repositories
  – The color of money

☐ Level of granularity: QE sometimes counted as part of management, planning and control

☐ QE may perform expanded role activities (non-traditional QE activities) which are sometimes counted in the QE “bucket”
Other Considerations

• Execution of QE improved (QE productivity/efficiency)
  – Don’t currently have a formal metric for this
  – Process has matured
  – QE staff has had very little attrition
  – Getting more “bang” for the QE buck?

QE productivity / efficiency is an opportunity for future analysis
Other Considerations

• Customer value of QE involvement
  – Don’t currently have a formal metric for this (have customer satisfaction scorecards, but it is not clear if these have the level of granularity required to examine customer perceived value of QE activities)
  – QE involvement required by some contracts
  – QE often has established long-standing relationships with customers
  – Customers request QE participation in various activities

Customer Value of QE Involvement is another relationship to examine
Next Steps

• Continuous Improvement continues…
  – Data repository consolidation
  – NCS is moving towards standardized cost collection system with increased granularity
  – Metrics are being standardized across disciplines: Systems Engineering, Software Engineering, and Hardware Engineering

Although there is evidence that increased QE involvement has a positive impact on program success, there are opportunities for improvement of the data and more analysis in the future!
Contact Information

- Jill Brooks
  - 972-344-3022
  - Jill_A_Brooks@raytheon.com
Questions