Return on Investment for Process Improvement

Jim Sturges
Director, Engineering Processes
Lockheed Martin Corporation
Introduction

• Extremely conservatively, the first year payout from a 3-year investment at one Level 4 company is documented at full amortization

• Benefits at other companies meet/exceed this for relatively similar investments

• This brief uses both software and system engineering results, but concentrates on software

• You should be able to take away some very good reasons why doing business with higher-maturity organizations is smart
# Software Process Maturity

**SW-CMM<sup>SM</sup> Version 1.1**

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Key Process Areas</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimizing</td>
<td>Continuous Improvement</td>
<td>Defect Prevention</td>
<td>Productivity &amp; Quality</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td></td>
<td>Process Change Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technology Change Management</td>
<td></td>
</tr>
<tr>
<td>Managed</td>
<td>Product and Process Quality</td>
<td>Quantitative Process Management</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong></td>
<td></td>
<td>Software Quality Management</td>
<td></td>
</tr>
<tr>
<td>Defined</td>
<td>Engineering Process</td>
<td>Organization Process Focus</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong></td>
<td></td>
<td>Organization Process Definition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integrated Software Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software Product Engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intergroup Coordination</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peer Reviews</td>
<td></td>
</tr>
<tr>
<td>Repeable</td>
<td>Project Management</td>
<td>Requirements Management</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong></td>
<td></td>
<td>Software Project Planning</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software Project Tracking &amp; Oversight</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software Subcontract Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software Quality Assurance</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Software Configuration Management</td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>Heroes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Software Capability Maturity Model (SW-CMM) is a service mark of Carnegie Mellon University.
Some Background

- The concept of “quantitative management” is fully developed only at Levels 4 and 5.
- Finding reliable measures of productivity and quality from low-maturity organizations is therefore unlikely. What we are just now beginning to obtain are some early measurement comparisons from Level 4 and 5 companies.
- There has been, generically, a legacy of mistrust between Government and suppliers which discouraged suppliers from embarking on comprehensive metrics programs, fearing that the answers would be used against them. The advent of PSM is helping to reverse this attitude.
If you do what you always did, the way you always did it....
SEI SW-CMM Process Maturity Profile As of December 1999

Organization Maturity Profile
March 2001

Based on most recent assessment, since 1996, of 1012 organizations. For a perspective, please see page 18.
Commercial companies don’t have “ACAT 1 Requirements”!

Based on most recent assessment, since 1996, of 1012 organizations
Trends in the Community Maturity Profile

Based on a cumulative view of the most recent assessments of organizations up through the year indicated. This accounts for the difference from the figures on page 10.
ROI Approach

- Evaluate others’ SPI/ROI presentations
  - Boeing
  - CSC
  - LM Federal Systems, Owego
  - Raytheon

- Identify ROI components and formulation
Benefits Definition for Return on Investment (ROI)

- **Benefits from software process improvement efforts**
  - Business Value
  - Productivity
  - Quality
  - Performance
  - Others

- **Some of these benefits can be quantified and measured**

- **ROI = Benefits/Investments**
Benefits
Business Value

- **Major contributor to new business:**
  - *SEI Software Process Capability is a key factor considered during Government source selection*
  - *Policy issued 26 October 1999 by the Under Secretary of Defense, Acquisition and Technology requires SEI Level 3 for prospective ACAT 1 contractors*
  - *Contribution to program awards*

Software process capability has been a key factor considered during Government source selection and contract awards.
Benefits
Business Value

- **Major factors considered during source selection:**
  - **Costs**
    - Non-recurring (development, pre-production)
    - Recurring (production, life cycle)
  - **Past performance**
  - Technical and management approach
  - **Risks**
    - Cost, schedule, technical, quality
    - Process capability

If our software process capability contributes only 5% to award fee pool, $5M would be added from current pool
Productivity – Company “M”

- **Cost Savings with current productivity rate (vs December 1999)**
  - Total ~ $1,019K

- **Productivity: 3.5% average increase over past two years**
Contributors:
- Increased Reuse (Domain Specific)
- Process Maturity & Compliance
- Process Consistency
- Increased use of High Order Language / 4th Generation Language / Object Oriented

Improvements Since 1982:
- 10.7% Average per Year
- 452.9% Overall Since 1982

* SLOC/LM = Source Lines of Code/Labor Month
Syracuse Productivity

PRODUCTIVITY INDEX
1991 - 2003
(21% GROWTH RATE)

HISTORICAL SOFTWARE
PRODUCTIVITY INDEX
(6% PER YEAR)
Quality – Company “M”

• Using an average of $3.0K to fix a problem found during functional test/ET&E, the following cost savings would be realized:
  – Total: $685K

• Defects: 18% average decrease annually over past two years

• Other quality improvement observed through implementation of software inspection on Specification Changes (SC)
  – 38% reduction in Program “A” SC Revisions
  – 87% reduction in Program “A” Multiple SC Revisions
The cost to fix a defect found during operation phase may be as high as 1000 times* the cost to fix it during requirements phase.

Quality -- DSMC

Cumulative Percentage Life Cycle Cost

- Concept Phase: 8%
- Design Phase: 15%
- Development: 20%
- Prod/Test Phase: 50%
- Operations Through Disposal: 100%

Cost to Extract Defects:
- Concept to Design: 3-6X
- Design to Development: 20-100X
- Development to Prod/Test: 500-1000X

Committed Costs:
- 70%
- 85%
- 95%

Time

Full Program Expenditures

Defense Systems Management College - 9/1993
Quality – Manassas
Major Defects per Million Lines

Manassas Delivered Quality

- Major Defects / MDSS
- 1980 to 2000
- 0 to 3000 major defects per million lines
Quality -- Moorestown
Major Reduction in Defects Delivered to System Test

Defect Density

- Historical Defect Density
- Goal
- Current (2/00)

Reference: Product Quality Goal Status February 2000
CPI/SPI – Level 4 SW (only) Company

“M”

Performance (Earned Value)

Reference: Organizational Metrics Analysis Report (OMAR) 4Q99
Basis for next slides
SI Business Area

- Plots CPI or SPI by company by month for 143 programs worth over $27B in total sales
- Each Program > $50M, or of strategic interest
- Less than 95% complete (Development) or 99% complete (Production)
- Any Red or Yellow Program
- First set does not include 20 programs with hardware, subcontractor, (but NOT software) problems
Programs w/o H/W, Subcontract issues - CPI

Level 5 (SW) Companies Highlighted
Programs w/o H/W, Subcontract issues - SPI

Level 5 (SW) Companies Highlighted
Level 4 (SW & SE) Company Highlighted

One point of CPI is worth $270 Million
CPI/SPI Conclusions

• Higher maturity is a valid predictor of variability
• Complementary high SE maturity may add disproportionate value
• CMMI and IEP offer a rational path to higher predictability, lower variability, and higher quality
Mission Systems Process Improvement

%On Time CDRLs

%On Time
SW/HW/Sys/Demos/Spares

%CDRLs Passed at Customer Acceptance

%SW Passed at Customer Acceptance

%HW/Demos/Spares Passed at Customer Acceptance


92.00% 93.00% 94.00% 95.00% 96.00% 97.00% 98.00% 99.00% 100.00%
Management & Data Systems
System Integration business

• **Only Software AND Systems Level 5 organization in the world**
  – **Entire business is SW Level 5, SE Level 4**

• **In last year,**
  – **Productivity increase is greater than 20%**
  – **Rework decrease is greater than 21%**

• **Correlates with similar results at LM Information Systems, Orlando**
Other Benefits Realized

- Improved communication and teamwork
- Increased awareness of training requirements
- Improved estimates to support new programs or baselines
- Provided a common organizational command media infrastructure with reusable process assets
- Increased technical awareness of software developers through a formal training program
- Improved planning and coordination of process improvement programs across the organization
- Increased focus on achieving organizational and project productivity and quality goals
- Improved data accuracy through metrics analysis
- Increased knowledge on process capability and correlation between process and product performance and quality
- Increased capability to absorb technology and process changes
Summary

- Lockheed Martin’s climb up the maturity ladder began in 1997 as a performance quality initiative, bolstered by strong conviction that savings would follow.
- Business leaders in high-maturity companies would not return to previous status quo.
- Government should consider:
  - Participating in our maturity assessments vs holding expensive “evaluations”
  - Giving additional credit in source selection for high-maturity companies.