PRactices of High-Maturity Organizations

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The Software Engineering Institute
Practices of High Maturity Organizations
1999

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Applications of Software Measurement & Software Management 2000
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Topics

Introduction

Common Practices of High Maturity Organizations

• enterprise-level issues
• customer interaction
• project management
• product and process assurance
• process automation
• training and mentoring
• capturing product and application domain knowledge
• verification and validation
• statistical thinking

Conclusion
## Software CMM v1.1 Key Process Areas

<table>
<thead>
<tr>
<th>Level</th>
<th>Focus</th>
<th>Key Process Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Optimizing</td>
<td>Continuous process improvement</td>
<td>Defect Prevention Technology Change Management Process Change Management</td>
</tr>
<tr>
<td>4 Managed</td>
<td>Product and process quality</td>
<td>Quantitative Process Management Software Quality Management</td>
</tr>
<tr>
<td>3 Defined</td>
<td>Engineering processes and organizational support</td>
<td>Organization Process Focus Organization Process Definition Training Program Integrated Software Management Software Product Engineering Intergroup Coordination Peer Reviews</td>
</tr>
<tr>
<td>2 Repeatable</td>
<td>Project management processes</td>
<td>Requirements Management Software Project Planning Software Project Tracking &amp; Oversight Software Subcontract Management Software Quality Assurance Software Configuration Management</td>
</tr>
<tr>
<td>1 Initial</td>
<td>Competent people and heroics</td>
<td></td>
</tr>
</tbody>
</table>
1999 Survey of High Maturity Organizations
Survey conducted in November 1999

Preliminary results online at
  • http://www.sei.cmu.edu/cmm/cmm.articles.html#hmp99

As of November 1999
  • 40 level 4 organizations
  • 21 level 5 organizations
  • 26 non-US high maturity organizations
    - 24 organizations in India (14 level 4, 10 level 5)
    - 1 level 4 organization in India
    - 1 level 4 organization in Israel

32 respondents to the survey
Key Words for Empirical Data

Small sample - not statistically significant

“High maturity organizations *typically*…”
  • implies 90% plus

“*Most* high maturity organizations …”
  • implies 60-90%

“*Many* high maturity organizations …”
  • implies 40-60%

“*Some* high maturity organizations …”
  • implies more than one
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Enterprise-Level Issues (1 of 2)

High maturity organizations cover a wide range of businesses - defense, commercial, even some shrink-wrap.

No particular kind of organizational structure seems correlated to high maturity.
Enterprise-Level Issues (2 of 2)

Most high maturity organizations align process improvement with Total Quality Management initiatives at enterprise level

• some high maturity organizations began process improvement before initial publication of the Software CMM

Most high maturity organizations have multiple process and quality improvement initiatives

• systems engineering issues
• people issues - good people crucial to success

Most high maturity organizations also have ISO 9001 certification
Organization Structure

- Matrix: 17
- Product: 16
- Functional: 15
- Customer group: 12
- Territorial: 5
- Process: 3
- Other: 2

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1999 High Maturity Survey
TQM or Similar Program  \((N=31)\)
Other Quality/Process Initiatives

- Other
- People CMM
- Software Acquisition CMM
- FAA iCMM
- EIA SE-CM
- INCOSE SE-CAM
- SEI SE-CMM
- ISO/IEC 15939
- ISO/IEC 15288
- ISO/IEC 15504
- ISO/IEC 12207

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1999 High Maturity Survey
Customer Interaction

High maturity organizations typically use incremental and/or evolutionary life cycles
• obtain mutually better understanding of needs and requirements

Use data to communicate/persuade customer
• customer liaison engineer

Most high maturity organizations measure customer and user satisfaction

Do the right thing - even if customer resistance
Most high maturity organizations use cost models.  
- some high maturity organizations use cost models to negotiate with customers  
  - fixed functionality, schedule $\implies$ cost as result

Many high maturity organizations use Delphi methods for estimating. 

Many high maturity organizations use earned value for tracking progress.
Product and Process Assurance

High maturity organizations *typically* have an independent SQA group *and* embed the SQA function in the process

- process assurance performed by an independent SQA group
- product assurance embedded in process (e.g., a defined role in peer reviews, prerequisite for baselining)
Use of Management Practices (1 of 2)

9  Independent SQA group
1  Cost models
5  "Top 10" risks lists
12 Process ownership teams
11 Proactive management of evolving customer requirements
13 Project evaluation and review techniques (PERT)
14 Project teams empowered to define and use non-reported measures
4  Activity based costing
Use of Management Practices (2 of 2)

3 Earned value
16 ETX, ETVX, or EITVOX for process definition
10 SQA function embedded in process
8 Chief architect / chief engineer

7 Integrated product & process development (IPPD)
2 Delphi methods for estimation
15 IDEF0 or SADT for process definition
6 PSPsm and/or Team Software ProcessSM
Process Automation

High maturity organizations typically use Internet, intranet, and/or World Wide Web to deploy process assets.

Many high maturity organizations have built or acquired extensive process automation and automated data collection support for their processes.

Some high maturity organizations use process modeling to help understand the process and make trade-off decisions.
Process Formality

*Most* high maturity organizations use consistent, but not formal, process notations.

- *some* high maturity organizations use IDEF0 or SADT

*Some* high maturity organizations explicitly support multiple views of the process

- for example, project manager view, SQA view
Feedback on Process Value

*Most* high maturity organizations do customer satisfaction surveys on their processes.

- customers of process outputs
- users of processes

*Many* high maturity organizations track employee satisfaction and morale.
Training and Mentoring

Wide range of rigor practiced in high maturity organizations
- eight weeks induction training for new hires + mandatory continuing education requirements
- minimal formal training, with heavy emphasis on mentoring

Many high maturity organizations have established formal mentoring programs
- mentors trained, knowledgeable, respected
- explicit expectations
- long-term mentoring relationship (~ year)
- mentoring tracked and evaluated
### Required Training

- **Team building**: 23
- **Principled negotiation**: 16
- **Interpersonal skills**: 25
- **Domain knowledge**: 25
- **Management skills**: 30
- **Technical skills**: 32

#### Number of organizations

- 0 5 10 15 20 25 30 35
Capturing Product and Application Domain Knowledge

High maturity organizations typically are doing systematic reuse with domain engineering and/or product lines/families.

Variety of ways to capture product knowledge
- development and maintenance organizations capture product knowledge in different ways
- "Organization Software Asset Commonality" was a draft KPA in Software CMM v2
Use of Engineering Practices (1 of 2)

Practice Percent of Responses
6  Peer reviews 90%
2  Independent test groups 70%
7  Formal methods 80%
9  Product lines 60%
3  Code coverage 90%

Legend:
- DK
- NA
- Not used
- Common use
- Standardized
**Use of Engineering Practices (2 of 2)**

8  Domain specific software architectures  
10  Other systematic reuse  
1   User interface prototyping  
5  Frequent (e.g., daily) build & smoke tests  
4  Reliability models
**Statistical Thinking**

*Most* high maturity organizations are using control charts.
- *most* are using XmR charts
- *many* are using XbarR, u-, and/or Z-charts

*Many* high maturity organizations are using prediction intervals.

*Many* high maturity organizations are using cost of quality.
### Use of Quantitative Analysis Practices (1 of 2)

<table>
<thead>
<tr>
<th>Practice</th>
<th>Percent of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost of quality analysis</td>
</tr>
<tr>
<td>7</td>
<td>Prediction intervals</td>
</tr>
<tr>
<td>8</td>
<td>Confidence intervals</td>
</tr>
<tr>
<td>5</td>
<td>Control charts</td>
</tr>
<tr>
<td>6</td>
<td>Other charting methods to understand “acceptable limits” of variation in predictability of performance</td>
</tr>
<tr>
<td>12</td>
<td>Pareto analyses</td>
</tr>
<tr>
<td>4</td>
<td>Other defect taxonomies</td>
</tr>
</tbody>
</table>

December 1999
Use of Quantitative Analysis Practices (2 of 2)

<table>
<thead>
<tr>
<th>Practice</th>
<th>Percent of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Six sigma</td>
</tr>
<tr>
<td>13</td>
<td>Analyses of variance</td>
</tr>
<tr>
<td>3</td>
<td>Orthogonal defect classification (ODC)</td>
</tr>
<tr>
<td>2</td>
<td>Quality function deployment (QFD)</td>
</tr>
<tr>
<td>15</td>
<td>Process modeling or simulation</td>
</tr>
<tr>
<td>14</td>
<td>Other multivariate methods</td>
</tr>
<tr>
<td>9</td>
<td>Designed experiments</td>
</tr>
<tr>
<td>10</td>
<td>Quasi experimental methods</td>
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December 1999
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Next Steps

Further analysis of survey data continues
- follow-up on questions such as the interpretation of “formal method”
- multivariate analysis
- integration with high maturity workshop observations
Challenges

The biggest challenge for high maturity organizations is to protect their process maturity during organizational restructuring - buyouts, mergers, acquisitions, rapid growth, etc.

The biggest challenge for the software community is to become an engineering discipline...
Internet Access to SEI

SEI Web pages
• www.sei.cmu.edu
• www.sei.cmu.edu/cmm/
• www.sei.cmu.edu/cmm/cmm.articles.html

The 1998 survey
• www.sei.cmu.edu/cmm/cmm.articles.html#hmp98

The 1999 survey
• www.sei.cmu.edu/cmm/cmm.articles.html#hmp99
Mark Paulk

Mark is a Senior Member of the Technical Staff at the Software Engineering Institute. He has been with the SEI since 1987, initially working with the Software Capability Evaluation project. Mark was the “book boss” for Version 1.0 of the Capability Maturity Model for Software and was the project leader during the development of CMM Version 1.1. He is also actively involved with software engineering standards, including

- ISO 15504 (aka SPICE -- Software Process Improvement and Capability Determination), an emerging suite of international standards for software process assessment
- ISO 12207, Software Life Cycle Processes
- ISO 15288, System Life Cycle Processes

Prior to joining the SEI, Mark was a Senior Systems Analyst for System Development Corporation (later Unisys Defense Systems) at the Ballistic Missile Defense Advanced Research Center in Huntsville, Alabama.

Mark received his master’s degree in computer science from Vanderbilt University. He received his bachelor’s degree in mathematics and computer science from the University of Alabama in Huntsville.

Professional society memberships and certifications
- Senior Member of the Institute of Electrical and Electronics Engineers (IEEE)
- Senior Member of the American Society for Quality (ASQ)
- ASQ Certified Software Quality Engineer
- SEI Lead Assessor

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