Today's Talk

Background: The SEI Annual Survey Series

Purpose & scope of the 2007 survey

Results

- The respondents & their organizations
- Measurement resources & infrastructure
- Value added by measurement
- Software measures used
- Data quality & integrity
- Organizational perspectives on software measurement

Summary, lessons learned & next steps
Understanding the State of Measurement Practice

Careful & well executed use of measurement & analysis

- Is a well accepted tenet in many fields of endeavor
- Including of course CMMI

Basic aims

- To inform management & technical decisions based on empirical evidence
- & to judge the results of those decisions once made

But, how well, and how frequently, are measurement practices put into effect in our own field?

Surveys & Benchmarking

Benchmarking: The current state

- Some professional & consulting organizations maintain repositories they use for establishing benchmarks & facilitating benchmarking activities
- However, their measures & measurement definitions differ in many ways
- In that sense, one cannot yet speak confidently about “industry standards”

The state of the practice surveys

- Aim to provide data that’s not yet widely available
  - Updates of trends in typical use of measurement in software & systems engineering
  - To help projects & organizations judge their progress relative to others
- But there also will be a continuing need to track qualitative as well as quantitative descriptions about the quality & frequency use of measurement in our field
The SEI Series

First one completed in 2006
2007 survey discussed in depth here

The 2008 survey:
- Discussed briefly earlier this week
  - In the panel on Advanced Measurement Analysis Techniques
  - Fuller, more detailed description of the study design & initial results forthcoming
  - Come to Denver in November for the CMMI Technology Conference
- Parallel samples
  - A short set of questions for tracking the diffusion of measurement over time through the broader software & systems engineering community
  - With a focus on issues faced with respect to the adoption & use of high maturity measurement & analysis practices
  - Done in concert with new series of SEI sponsored workshops on high maturity measurement and analysis

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Summary, lessons learned & next steps
2nd Annual SEI Measurement Practice Survey

New in 2007

- Screening question to identify respondents whose organizations develop software but rarely if ever do measurement
- Questions about
  - Resources & infrastructure devoted to measurement
  - Practices to ensure data quality & integrity
  - Value added by doing measurement
  - The kinds of measures used by the responding organizations

Among other things, these questions allow us to make some useful comparisons by CMMI maturity level

Trends over Time

Similar results in 2006 & 2007

- Moderately strong relationships exist when comparing the replies of respondents based on:
  - Management versus staff roles
  - Industry versus government organizations
  - The United States versus other countries
  - Organization size

But that’s a topic for another time
CMMI Measurement Capabilities & Performance Outcomes

Today’s focus
- Provide evidence about the circumstances under which measurement capabilities and performance outcomes are likely to vary
- As a consequence of achieving higher levels of CMMI maturity

Most differences are consistent with expectations based on CMMI
- Which provides confidence in the validity of the model structure & content

However, the results also highlight areas where sometimes considerable room for improvement remains
- Even at maturity levels 4 and 5
- For example
  - A rather strong overall relationship between maturity level & use of measures about quality attributes
  - Little attention to quality attributes at the lower maturity levels
  - Yet, almost half of maturity level 4 & 5 respondents’ organizations track quality attributes only occasionally at best

The Sample

Random sample of SEI customers
- 944 valid email invitations to participate

Data collected 20 February through 10 April 2007
- Two reminders

Response rate
- 41% completed all or part of the questionnaire
- N = 384
- Individual questions answered by 75-97% of respondents
  - ~29 – 39% of the sample invitees
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Summary, lessons learned & next steps

Role in the Organization

- Executive: 42%
- Program manager: 10%
- Project manager: 13%
- Engineer: 12%
- Programmer: 9%
- Analyst: 4%
- Other: 10%

N = 366
Who are the others?

- Quality: 26%
- Process: 24%
- Process + Quality: 15%
- Consultant: 9%
- Management: 6%
- Other Others: 6%

N = 155

= 8% of all those responding

And who are the other others?

- Process + Measurement: 3
- Measurement Specialist: 1
- Process + Quality + Measurement + Training: 1
- Quality + Process + Measurement: 1
- Training: 6
- Architect: 4
- Security: 2
- Testing: 2

One each:
- Administrative support
- Coach
- Consultant + researcher
- Engineering Manager + Process
- Process + Project engineer
- Program / team lead
- Program manager + Quality + Process
- Project manager + Quality
- Project manager + Engineer
- Not specified

N = 31
Measurement and Analysis in High Maturity Organizations: What's the Difference?

Dennis R. Goldenson, July 2008

Sector

- Commercial shrink-wrap: 11%
- Custom software development: 4%
- In-house or proprietary: 13%
- Defense contractor: 37%
- Other government contractor: 4%
- Defense or military organization: 5%
- Other government agency: 1%
- Consultancy: 16%
- Other: 4%

N = 366

Country

- United States: 48%
- India: 23%
- Japan: 2%
- France: 2%
- Germany: 2%
- United Kingdom: 3%
- Canada: 3%
- Netherlands: 3%
- All others: 12%

N = 363
Measurement and Analysis in High Maturity Organizations: What’s the Difference?

Dennis R. Goldenson, July 2008

FTE Staff

<table>
<thead>
<tr>
<th>Percent</th>
<th>50 or fewer</th>
<th>51-100</th>
<th>101-200</th>
<th>201-500</th>
<th>501-2000</th>
<th>More than 2000</th>
</tr>
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<tbody>
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<td></td>
</tr>
</tbody>
</table>

Maturity level

<table>
<thead>
<tr>
<th>Percent</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
<th>Don’t Know</th>
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<tbody>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Differences by Maturity Level:
Use of Measurement in the Organization

Interpreting the results:
The Respondents’ Measurement Roles
Today’s Talk

Background: The SEI Annual Survey Series

Purpose & scope of the 2007 survey

Results

• The respondents & their organizations

  Measurement resources & infrastructure

• Value added by measurement

• Software measures used

• Data quality & integrity

• Organizational perspectives on software measurement

Summary, lessons learned & next steps

How Measurement Work is Staffed

<table>
<thead>
<tr>
<th>Level</th>
<th>ML1&amp;DK (N=78)</th>
<th>ML2 (N=60)</th>
<th>ML3 (N=58)</th>
<th>ML4&amp;5 (N=60)</th>
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</thead>
<tbody>
<tr>
<td>Project level</td>
<td>34%</td>
<td>34%</td>
<td>28%</td>
<td>28%</td>
</tr>
<tr>
<td>Organization wide group</td>
<td>19%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>A few key experts</td>
<td>13%</td>
<td>13%</td>
<td>12%</td>
<td>7%</td>
</tr>
<tr>
<td>Other</td>
<td>9%</td>
<td>7%</td>
<td>12%</td>
<td>20%</td>
</tr>
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</table>

p < .006

3%, 1%, 2% & 3% respectively
Earmarked Budgets for Measurement

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<tr>
<th></th>
<th>ML1&amp;DK N = 76</th>
<th>ML2 N = 68</th>
<th>ML3 N = 50</th>
<th>ML4&amp;5 N = 61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earmarked</td>
<td>21%</td>
<td>18%</td>
<td>22%</td>
<td>28%</td>
</tr>
<tr>
<td>Not earmarked</td>
<td>72%</td>
<td>65%</td>
<td>56%</td>
<td>34%</td>
</tr>
<tr>
<td>Don't know</td>
<td>18%</td>
<td>22%</td>
<td>34%</td>
<td>38%</td>
</tr>
<tr>
<td>No</td>
<td>21%</td>
<td>22%</td>
<td>22%</td>
<td>38%</td>
</tr>
<tr>
<td>Yes</td>
<td>5%</td>
<td>18%</td>
<td>5%</td>
<td>21%</td>
</tr>
</tbody>
</table>

\( p < .0001 \)

Availability of Qualified Measurement Staff

<table>
<thead>
<tr>
<th></th>
<th>ML1&amp;DK N = 76</th>
<th>ML2 N = 65</th>
<th>ML3 N = 50</th>
<th>ML4&amp;5 N = 61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rarely, never &amp; don't know</td>
<td>30%</td>
<td>35%</td>
<td>36%</td>
<td>28%</td>
</tr>
<tr>
<td>Half the time &amp; occasionally</td>
<td>51%</td>
<td>26%</td>
<td>28%</td>
<td>61%</td>
</tr>
<tr>
<td>Almost always &amp; frequently</td>
<td>18%</td>
<td>34%</td>
<td>36%</td>
<td>22%</td>
</tr>
</tbody>
</table>

\( \text{Gamma} = .44 \) \( p < .0001 \)
Similar Results

For:

- Automated measurement support for data collection, data management, data analysis & reporting
- Use of commercial measurement packages & tools
- Existence of common, integrated organizational measurement repositories
- Availability of measurement related training

Proportions sometimes vary across the distributions. But there are consistent differences by maturity level.

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Summary, lessons learned & next steps
### Effects of Measurement on the Organizations \(^1\)

#### Better Project Performance

<table>
<thead>
<tr>
<th>Measurement Level</th>
<th>N</th>
<th>Gamma</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML1&amp;DK</td>
<td>74</td>
<td>.41</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>ML2</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML3</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML4&amp;5</td>
<td>56</td>
<td></td>
<td></td>
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</table>

#### Better Product Quality

<table>
<thead>
<tr>
<th>Measurement Level</th>
<th>N</th>
<th>Gamma</th>
<th>p</th>
</tr>
</thead>
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<tr>
<td>ML1&amp;DK</td>
<td>74</td>
<td>.34</td>
<td>&lt;.0002</td>
</tr>
<tr>
<td>ML2</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML3</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML4&amp;5</td>
<td>56</td>
<td></td>
<td></td>
</tr>
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</table>

### Effects of Measurement on the Organizations \(^2\)

#### Better Tactical Decisions

<table>
<thead>
<tr>
<th>Measurement Level</th>
<th>N</th>
<th>Gamma</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ML1&amp;DK</td>
<td>74</td>
<td>.35</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>ML2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ML3</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML4&amp;5</td>
<td>56</td>
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</table>

#### Better Strategic Decisions

<table>
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<tr>
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<th>N</th>
<th>Gamma</th>
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</thead>
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<tr>
<td>ML1&amp;DK</td>
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<td>&lt;.0008</td>
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<tr>
<td>ML2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ML3</td>
<td>49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML4&amp;5</td>
<td>55</td>
<td></td>
<td></td>
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</tbody>
</table>
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Summary, lessons learned & next steps

Project & Organizational Measurement Results Reported

Cost Performance

<table>
<thead>
<tr>
<th></th>
<th>ML1&amp;DK</th>
<th>ML2</th>
<th>ML3</th>
<th>ML4&amp;5</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>70</td>
<td>55</td>
<td>45</td>
<td>51</td>
</tr>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>21%</td>
<td>24%</td>
<td>11%</td>
<td>10%</td>
</tr>
<tr>
<td>Occasionally</td>
<td>23%</td>
<td>24%</td>
<td>27%</td>
<td>53%</td>
</tr>
<tr>
<td>Frequently</td>
<td>33%</td>
<td>38%</td>
<td>38%</td>
<td>10%</td>
</tr>
<tr>
<td>Regularly</td>
<td>15%</td>
<td>7%</td>
<td>19%</td>
<td>34%</td>
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</table>

Gamma = .25 p < .03

Schedule Performance

<table>
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<tr>
<th></th>
<th>ML1&amp;DK</th>
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<th>ML3</th>
<th>ML4&amp;5</th>
</tr>
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<tr>
<td>N</td>
<td>70</td>
<td>56</td>
<td>44</td>
<td>51</td>
</tr>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>14%</td>
<td>19%</td>
<td>11%</td>
<td>11%</td>
</tr>
<tr>
<td>Occasionally</td>
<td>34%</td>
<td>48%</td>
<td>48%</td>
<td>48%</td>
</tr>
<tr>
<td>Frequently</td>
<td>33%</td>
<td>34%</td>
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</tr>
<tr>
<td>Regularly</td>
<td>4%</td>
<td>7%</td>
<td>16%</td>
<td>33%</td>
</tr>
</tbody>
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Gamma = .37 p = .0006
Project & Organizational Measurement Results Reported₂

### Business Growth & Profitability

- ML1 & DK: N = 70
- ML2: N = 55
- ML3: N = 45
- ML4 & 5: N = 51

<table>
<thead>
<tr>
<th></th>
<th>Gamma</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>.20</td>
<td>.2244</td>
</tr>
<tr>
<td>Occasionally</td>
<td>.29</td>
<td></td>
</tr>
<tr>
<td>Frequently</td>
<td>.31</td>
<td></td>
</tr>
<tr>
<td>Regularly</td>
<td>.36</td>
<td></td>
</tr>
</tbody>
</table>

#### Project & Organizational Measurement Results Reported₂

- ML1 & DK: N = 70
- ML2: N = 55
- ML3: N = 45
- ML4 & 5: N = 51

<table>
<thead>
<tr>
<th></th>
<th>Gamma</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>.37</td>
<td>&lt; .0008</td>
</tr>
<tr>
<td>Occasionally</td>
<td>.55</td>
<td></td>
</tr>
<tr>
<td>Frequently</td>
<td>.41</td>
<td></td>
</tr>
<tr>
<td>Regularly</td>
<td>.485</td>
<td></td>
</tr>
</tbody>
</table>

Product & Quality Measurement Results Reported₁

### Requirements / Architectures

- ML1 & DK: N = 70
- ML2: N = 55
- ML3: N = 45
- ML4 & 5: N = 51

<table>
<thead>
<tr>
<th></th>
<th>Gamma</th>
<th>p</th>
</tr>
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<tbody>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>.37</td>
<td>.0002</td>
</tr>
<tr>
<td>Occasionally</td>
<td>.48</td>
<td></td>
</tr>
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<td>Frequently</td>
<td>.55</td>
<td></td>
</tr>
<tr>
<td>Regularly</td>
<td>.51</td>
<td></td>
</tr>
</tbody>
</table>

### Quality Attributes

- ML1 & DK: N = 70
- ML2: N = 55
- ML3: N = 45
- ML4 & 5: N = 51

<table>
<thead>
<tr>
<th></th>
<th>Gamma</th>
<th>p</th>
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<tbody>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>.32</td>
<td>&lt; .008</td>
</tr>
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<td>.4</td>
<td></td>
</tr>
<tr>
<td>Frequently</td>
<td>.5</td>
<td></td>
</tr>
<tr>
<td>Regularly</td>
<td>.52</td>
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Measurement and Analysis in High Maturity Organizations: What's the Difference?

**Product & Quality Measurement Results Reported**

<table>
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<tr>
<th>Defect Density</th>
<th>Defect Phase Containment</th>
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<td>ML1&amp;DK N = 70</td>
<td>ML1&amp;DK N = 70</td>
</tr>
<tr>
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<td>Gamma = .44</td>
</tr>
<tr>
<td>N = 45</td>
<td>N = 56</td>
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<td>N = 52</td>
<td>N = 51</td>
</tr>
<tr>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>13%</td>
<td>30%</td>
</tr>
<tr>
<td>11%</td>
<td>27%</td>
</tr>
<tr>
<td>4%</td>
<td>8%</td>
</tr>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>Occasionally</td>
</tr>
<tr>
<td>Occasionally</td>
<td>Frequently</td>
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<tr>
<td>31%</td>
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<tr>
<td>14%</td>
<td>27%</td>
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<tr>
<td>31%</td>
<td>8%</td>
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</tbody>
</table>

**Customer Satisfaction**

<table>
<thead>
<tr>
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<th>ML2 N = 56</th>
<th>ML3 N = 45</th>
<th>ML4&amp;5 N = 52</th>
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<tbody>
<tr>
<td>Gamma = .31</td>
<td>p &lt; .005</td>
<td></td>
<td></td>
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<tr>
<td>N = 70</td>
<td>N = 56</td>
<td>N = 45</td>
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<tr>
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<td>13%</td>
<td>29%</td>
<td>21%</td>
<td>14%</td>
</tr>
<tr>
<td>11%</td>
<td>10%</td>
<td>38%</td>
<td>49%</td>
</tr>
<tr>
<td>12%</td>
<td>14%</td>
<td>48%</td>
<td>31%</td>
</tr>
<tr>
<td>Rarely, never, DK, or NA</td>
<td>Occasionally</td>
<td>Frequently</td>
<td>Regularly</td>
</tr>
<tr>
<td>36%</td>
<td>27%</td>
<td>40%</td>
<td>17%</td>
</tr>
<tr>
<td>38%</td>
<td>31%</td>
<td>31%</td>
<td>17%</td>
</tr>
<tr>
<td>36%</td>
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<tr>
<td>36%</td>
<td>27%</td>
<td>40%</td>
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Similar Results

For:

- Adherence to work processes
- Effort applied to task
- Estimation accuracy
- Cycle time

Proportions sometimes vary across the distributions.
But there are consistent differences by maturity level.

Today’s Talk

Background: The SEI Annual Survey Series

Purpose & scope of the 2007 survey

Results

- The respondents & their organizations
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- Value added by measurement
- Software measures used

- Data quality & integrity
- Organizational perspectives on software measurement

Summary, lessons learned & next steps
### Differences by Maturity Level:
#### Practices to Ensure Data Quality

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### Differences by Maturity Level:
#### Practices to Ensure Data Quality

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Rearrangement for clarity: Rarely, never, or DK, Half time or on occasion, Always or frequently.
Similar Results

For:
- Out of range & illegal values ... Number & distribution of missing data
- Missing data not treated as zero ... Precision & accuracy tests
- Other aspects of alignment & coordination of measurement activities
  - Understandable & consistent measurement definitions
  - Understandable & interpretable measurement results
  - Use of "standard" measurement methods
  - Measurable product & service criteria
  - Measurement used to understand product & service quality
  - Documented data collection process
  - Documented process for reporting results
  - Corrective action taken when thresholds exceeded
  - Understands purposes of the data collected/reported

Proportions sometimes vary across the distributions. But there are consistent differences by maturity level.

Today's Talk

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Summary, lessons learned & next steps
Organizational Perspectives

Not Relevant for Decision Making

- ML1&DK: N = 102
- ML2: N = 61
- ML3: N = 41
- ML4&5: N = 53

- 23% Hardly at All
- 39% Limited
- 44% Some
- 56% Largely
- 5% Entirely

Gamma = .27 p = .0002

Onerous or Burdensome

- ML1&DK: N = 110
- ML2: N = 67
- ML3: N = 45
- ML4&5: N = 52

- 4% Hardly at All
- 13% Limited
- 37% Some
- 55% Largely
- 11% Entirely

Gamma = .17 p < .45

Similar Results

For:
- Stated negatively
  - Inappropriate collection & use of data
  - Resistance to “extra” work
- Stated positively
  - Understandable & interpretable results
  - Data collected are regularly analyzed
  - Measurement an integral part of the business
  - Objective results highly valued

Once again:
- Proportions sometimes vary across the distributions.
- But there are consistent differences by maturity level.

Yet resistance to measurement still exists in our field.
- Even in high maturity organizations
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Summary, lessons learned & next steps

Summary of Results

Characteristic differences associated with CMMI Maturity level achieved

- Measurement capability & performance outcomes
- Common stair step pattern up the maturity levels
- Some quite substantial

Still, some of the results imply room for improvement

- Sometimes substantial room

Even in higher maturity organizations

- Although the expectations for quality & “goodness” may well be higher there too
- Jim Herbsleb & I saw a similar pattern years ago
  - For process champions versus practitioners & managers
Sampling Issues

Lower than desired response rate
- Lower maturity level respondents less likely to finish the questionnaire
- Some drop off in higher maturity level respondents later in questionnaire

Not surprising in a relatively long questionnaire ... but exacerbated by:
- Spoofed email invitations & reminder message errors
- Related problems with incremental saving
  - Cookie flushing & assignment of multiple URLs by COTS web survey product
  - Leading to “lost” information
- & (possibly) lack of feedback on time/length remaining

Recurring anomalous dip at maturity level 3
- May be due to bias from relatively small number of ML3 respondents
- Or learning curve effects ... or higher expectations

Measurement Issues

There always is noise in survey (& other measurement) data, e.g.
- Differing interpretations of intended meaning of questions
- Use of “vague quantifiers” in closed ended response categories

“Don’t know” & other off scale responses
- Most common at lower maturity levels
- But they also exist at the higher maturity levels
- Perhaps because some folks in larger organizations truly don’t know

Regardless, the survey results are consistent with expectations based on CMMI
- a.k.a. predictive validity
The Future

Relatively little data yet exist for meaningful comparisons among software & systems engineering projects & organizations
  • Hence tendency to cover too much at once in a single sample survey

Considering variants on matrix sampling strategies for future surveys
  • Answer only a subset of questions ... to avoid over-burdening the respondents

“State of the practice” can refer to very different target populations
  • The SEI customer base ... the broader software & systems engineering community ... or those organizations that more routinely use measurement?
  • Of course, the answer depends on the purposes of the survey

Tracking Trends in State of the Practice
Still to be resolved...

Sampling criteria for valid comparisons
  • Software & systems engineering organizations in general …
  • The SEI customer base ... Routine users of measurement & analysis …
  • Projects or Organizations … Respondent roles

Questions to be tracked
  • Settling on the right starter set
  • Processes for modification over time

Frequency of published updates
  • Yearly ... or less frequently?
  • Rolling updates online? (Based on matrix sampling variants)
Next Steps

Our plans

- We will continue to track change over time & go into further depth about focused topics from the perspective of current measurement practitioners
- Surveys on Program Office acquisition capabilities also in plan

Of course, there is no shortage of additional topics for the future

- In the SEI series or in those that we hope to see done by others