Community Sourced Knowledge: Solving the Maintenance Problem

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In response to the maintenance problem, the delta between the knowledge on hand and the knowledge required, many system maintainers have self organized into a collaborative community to bridge this knowledge gap. There is evidence that this community of maintainers is succeeding. Our research examines a community of about 1000 system maintainers that includes stakeholders from every aspect of the software life cycle. These members generate community-sourced knowledge to address the maintenance problem. This multidisciplinary research provides insight into the behavior of practitioners who operate in a dynamic and often unorganized post-development environment. We also describe the ethnography of the group and patterns of behavior that emerge through the collaboration process and detail how information and knowledge are validated. From the coalescing of the discoveries, we develop benchmarks of performance for collaboration and knowledge sharing for the system-maintenance domain.
Background

**The Maintenance Quagmire**

Maintenance of software intensive systems is in a quagmire and is influenced by social-technical issues (Northrup, et.al., 2006), developmental frameworks (Sheard, 1997), and the fact that software evolves (Pfleeger and Atlee, 2006).

**The Maintenance Problem**

The maintenance problem is the knowledge gap; the delta between the knowledge available and the knowledge required to resolve a maintenance problem.
The Maintenance Problem

- Is costly: \(~\text{half of the maintenance effort is spent understanding the problem} \) (Pfleeger and Atlee, 2006)
- Is compounded by documentation and operating procedures that are non-existent, incomplete, or outdated
- Communication once, F2F, now has a myriad of communication channels to include IP, RF, and satellite communication to all corners of the globe

Response by the Individual and Organizations

Maintainers have become part historian, part detective, and part clairvoyant (Condi, 1989)

Inverse Peter Principle ‘People rise to an organizational position in which they become irreplaceable, and get stuck there forever’ (Boehm, 1981)
The Paradigm Shift

System maintenance is plagued by the knowledge gap and currency/relevance of the knowledge. In response to the knowledge gap, the community of maintainers has self organized to tackle the maintenance problem. The normative behavior of the community of system maintainers is experiencing a cultural shift from a culture of need-to-know, a practice that restricts the information flow, to a culture of need-to-share that puts the information and potential knowledge in an open forum for public consumption in a form of Mass Collaboration that enables Knowledge to Flow.
Architecture for Maintenance Support
How the work gets done
The Published Process for an Ultra Large DoD Organization

Four Separate Processes
- Tier I support 14 (steps)
- Tier II Support 12
- Tier III (>3 days old) 15
- Tier III (>7 days old) 15

42 steps for advance technical or managerial support (Tier II/III)
The Process for an Ultra Large DoD Organization

Four Separate Processes

- Tier I support: 14 steps
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- Tier III (>3 days old): 15
- Tier III (>7 days old): 15

42 steps for advance technical or managerial support (Tier II/III)

Cost of Customer Interaction Support

Assisted Support

$250/case\(^1\) for Tier I

40% of Tier II/III remain unresolved due to funding\(^2\)

\(^1\)Consortium for Service Innovation

\(^2\)Software Engineering Center
Community Sourced Knowledge: Mass Collaboration
The Alternative
Bridge the Knowledge Gap: Eliminating the Blind Spots

- Have the conversation with the extended community (Denning & Dunham, 2010)
- Connect the people that have an interest in your operating environment
- Develop a maintenance support structure that is Flat or Federated vs. Hierarchical
Mass Collaboration

One to Many: Many to One
One Information Request is “Pushed” to all subscribers
Community members self-select what they will respond to based on their expertise and level of interest

Broadcast or net-call to all subscribers
Europe-Theater Network Operations Security Center (E-TNOSC) conducts NetOps activities required to support BCT.
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How Responsive is the Community?

How fast are they?
They do it really Fast

51% of the responses are within 1 Hour
99% of the responses are within 48 Hours

54% Reported savings of 3-4 Hours over other options (hours saved)
43% Reported saving 1-2 Days over other options (days saved)
What does the Community do?

What type of problems do they solve?
They Satisfice* Problems and Reduces Complexity

They mash up problems with solution that reduces the complexity

- 72% Fully Resolved, Reduced to Type I
- 79% Complexity Reduced to Type I or II

<table>
<thead>
<tr>
<th>Categorization of problems</th>
<th>Known Solution</th>
<th>Unknown Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Known Problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type I (Tier 0 or I)</td>
<td></td>
<td>Type II (Tier II/III)</td>
</tr>
<tr>
<td>Unknown Problem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type III (Tier II/III)</td>
<td></td>
<td>Type IV (Tier III/Wicked)</td>
</tr>
</tbody>
</table>

12% to 19% improvement over the 60% SEC resolution rate

*Simon, 1996
How effective is the process

What type of help are you going to get?
Experts and Expertise

Informants were asked to rate the quality of the dialogue/response.
83% reported that they provided expert* advice (does everyone think they are an expert?)

77% of those who received the information classified the response as expert knowledge

*An expert was defined to the respondents as someone who has special skills, talent, knowledge or know-how in the domain in question
Who are the experts?
~ one thousand members of a community sourced knowledge group

<table>
<thead>
<tr>
<th>Answer Options</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive</td>
<td>4.1%</td>
<td>11</td>
</tr>
<tr>
<td>Senior Supervisor, Manager</td>
<td>20.1%</td>
<td>54</td>
</tr>
<tr>
<td>Senior Professional/Analytical</td>
<td>7.1%</td>
<td>19</td>
</tr>
<tr>
<td>Senior Scientific, Engineering</td>
<td>12.7%</td>
<td>34</td>
</tr>
<tr>
<td>Mid Level Supervisor, Manager</td>
<td>24.3%</td>
<td>65</td>
</tr>
<tr>
<td>Middle Professional/Analytical</td>
<td>5.6%</td>
<td>15</td>
</tr>
<tr>
<td>Mid Level Scientific, Engineering</td>
<td>11.6%</td>
<td>31</td>
</tr>
<tr>
<td>Junior Supervisor, Manager</td>
<td>1.1%</td>
<td>3</td>
</tr>
<tr>
<td>Junior Scientific, Engineering</td>
<td>0.4%</td>
<td>1</td>
</tr>
<tr>
<td>Administrative staff</td>
<td>0.4%</td>
<td>1</td>
</tr>
<tr>
<td>Special staff</td>
<td>2.6%</td>
<td>7</td>
</tr>
<tr>
<td>Support staff</td>
<td>1.9%</td>
<td>5</td>
</tr>
<tr>
<td>Student</td>
<td>1.1%</td>
<td>3</td>
</tr>
<tr>
<td>Retired</td>
<td>0.7%</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>6.3%</td>
<td>17</td>
</tr>
</tbody>
</table>

answered question 268
## Resource Comparison

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Community Sourced Knowledge</th>
<th>Hierarchal Support Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>&lt;$1 per member</td>
<td>$230 per incident (Tier I support)</td>
</tr>
<tr>
<td><strong>Problem Solvers</strong></td>
<td>Experts</td>
<td>Novice (Tier I) until escalated</td>
</tr>
<tr>
<td><strong>Resolution Rate (type II or III)</strong></td>
<td>72-79%</td>
<td>60%</td>
</tr>
<tr>
<td><strong>Time to Respond (type II or III)</strong></td>
<td>50% w/ in 1 hour avg 6 responses</td>
<td>No data available (Data not collected by difficulty)</td>
</tr>
</tbody>
</table>

- 3-4 hours to 1-2 days
Summary

• Create an architecture that is people centric
• Capitalize on the knowledge base that resides in the community
• Dialogue is not limited to traditional organizational boundaries
• Focus on fixing the problem, not identifying fault
• Discussions/dialogue are with impunity

The result is a faster, expert informed community, with more time for action and less time searching for understanding at an almost zero cost to stakeholders.
References


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