Software Maintenance and Support: Identifying Routine Work Artifacts as Boundary Objects Across Time

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Our background:

Dr. Carolyn Seaman is an Assistant Professor of Information Systems at UMBC. Her research generally falls under the umbrella of empirical studies of software engineering, with particular emphases on maintenance, organizational structure, communication, measurement, COTS-based development, and qualitative research methods. Dr. Seaman is also a Scientist at the Fraunhofer Center for Experimental Software Engineering, Maryland, where she participates in research on experience management in software engineering organizations and software metrics. She holds a PhD in Computer Science from the University of Maryland, College Park, a MS in Information and Computer Science from Georgia Tech, and a BA in Computer Science and Mathematics from the College of Wooster (Ohio). She has worked in the software industry as a software engineer and consultant, and has conducted most of her research in industrial and governmental settings (e.g., IBM Canada Ltd., NASA).

The work that most motivates Dr. Seaman's interest in boundary objects and their role in software engineering is her studies of software maintenance and the information sources most important to maintainers (Seaman, 2002). The overall aim of these studies was to investigate and improve the ways that software maintainers gather the information they need to make maintenance changes to software systems. One of the studies was a survey of maintainers, augmented with interviews, in which we tried to learn more about how maintainers currently gain information about systems. In particular, we wanted to learn what information sources are efficient, effective, and available in different situations. Although identifying boundary objects was not a goal of this study, much of the qualitative data gathered points to potential boundary objects that facilitate communication between a system's development organization and its maintenance organization. The results of the study included the not-so-surprising fact that maintainers overwhelmingly rely on source code as an information source. Source code is an obvious potential boundary object in a development/maintenance environment, but much work needs to be done to determine how best to contextualize and package it. Other code-related artifacts should also be investigated as possibly more effective boundary objects, if packaged appropriately. Also, there was evidence in the study data that effectively implemented lessons learned repositories would be of great benefit to maintainers, by decreasing their reliance on human sources of information, but current systems are not effective. Thus, great potential lies in evolving current approaches to lessons learned, with an eye towards a boundary object approach, to better facilitate information flow to maintainers.

Dr. Wayne Lutters is an Assistant Professor of Information Systems at UMBC. His research interests are in the intersection of CSCW, HCI, and knowledge management. Specifically, his contemporary research has centered on the role of memory and expertise, as mediated by information artifacts, in collaborative problem solving. He has significant academic and industrial experience conducting field research (esp. requirements gathering and *in situ* evaluation) on collaborative information systems, including projects at both Microsoft and Boeing. Dr. Lutters earned his MS and PhD in Information and Computer Science from the University of California, Irvine and his BA in Cognitive Science from Connecticut College.

Dr. Lutters has an ongoing interest in technical support environments. These have proven rich venues in which to explore the interplay of memory and expertise in time critical collaborative problem solving. His thirteen month field study of aircraft service engineers (Lutters & Ackerman, 2002), identified myriad information artifacts functioning as boundary objects. These mediated the interactions between the manufacturer's design, customer support, and service engineering teams, the airline's flight operations and maintenance teams, third party vendors, and federal regulatory agencies. Two important contributions of this work to the theory of boundary objects were viewing their negotiations *across time*, focusing on the requisite processes of decontextualization for archiving and recontextualization for reuse, and understanding them as *crystallizations of action* within ongoing event streams.

In line with the disciplinary domain of this workshop, Dr. Lutters conducted earlier field work examining patterns of collaboration between product development and support teams within a mid-sized medical software development firm. This study identified many critical expertise artifacts that mediated the interaction between the teams, most notably inline source code comments (McDonald & Ackerman, 1998; Lutters, et al. 2000; Ackerman, et al. 2003). Thinking across these studies has sparked personal interest in revisiting the software engineering domain with the boundary object construct in order to better understand the capability of these artifacts to bridge disparate work groups and improve their work processes. Dr. Lutters is well versed in the boundary object literature and continues active research into their role in collaborative work, with an emphasis on routine work artifacts (Lutters, 2004).

Our position:

Together, Drs. Seaman and Lutters share a common interest in the later lifecycle stages of information systems, notably maintenance and support. In these activities information needs are complex and demanding, yet the information resources required to do the job are almost universally impoverished and sparse. Boundary objects (Star & Griesemer, 1989) are a valuable theoretical construct that helps us better understand the nature and dynamics of these information resources. Based on our collective experience, we intuit that the following three areas are rich with research potential and are likely to have significant impact on the design of systems to better support these late lifecycle activities.

1.) Examine and leverage routine work artifacts serving as boundary objects

Much attention is paid to introducing new information artifacts into the workplace to function as boundary objects bridging between collaborating teams. Adoption stories of these are varied, but are generally unfavorable. It is very difficult to engineer boundary objects, introduce them into complex work situations, and foster long term acceptance. Fortunately, our research has shown that most workplaces are already rife with robust boundary object candidates. These work-a-day artifacts already exist as the epiphenomena of collaborative work. We have found that these routine artifacts are more information rich than their artificially introduced counterparts, because they themselves have been the locus of negotiation. We believe that effort is better spent learning to leverage these existing artifacts. One approach could be to capture the state of an artifact at the appropriate time and augment it with relevant contextual data as it is handed off or stored for future reuse. Much work has already been done on the proper contextualization of experience "packages" for software development organizations (Holz et al., 2001). Other related findings from the software experience management literature may be very valuable to this endeavor.

2.) Understand boundary objects' value as pointers to the right people

The focus of much boundary object research has been on the information content of specific objects and how they are perceived by others (e.g., role in classification and standardization). Our research has shown that there is additional value in boundary objects for expertise identification. "Information fingerprints" are traces of the individuals involved with the negotiations surrounding the creation and use of the object.

Later, when the object has traveled far from its point of origin or across time, these fingerprints serve as useful pointers to the individuals most relevant for interpreting the boundary object. For example, in the previously mentioned studies of software maintenance, several of the subjects mentioned that often the most useful piece of information they can glean from a stored software artifact is the name of the author. Identifying experts in this manner is critical for reuse.

3.) Conceptualize boundary objects' use trajectories across time

A temporal gulf, sometimes quite large, exists between the maintainers of a system and its designers. The most central concern for maintenance and support is the quality of the information resources available to them as they wrestle with reconstructing the design context of the system (Seaman, 2002). Frequently much of the original design information has been lost or has decayed to the point of being unusable. Finding ways to improve the quality of this information, such as packaging design artifacts into a historical repository to serve as boundary objects later in the lifecycle, are critical to improving performance in maintenance. In doing so it is important to capture the correct contextual elements. As the future users of this information are unknown at the time of archival (Ackerman & Halveson, 1999; 2000), this can be a challenging process.

Sample Materials:

We are in the formative stages of our "boundary objects in software maintenance and support" project and as such do not yet have a host of sample materials. General information artifact categories, as identified in (Seaman, 2002), can be discussed at the workshop, as well as the following two boundary object candidates:

- "Records of Conversation" (ROC) forms from aircraft service engineers. Each ROC is a summary of an airline repair request, the complete workflow details of the request resolution, the regulatory approval, and the ultimate solution. All of these are archived for future reuse. Collectively they form the foundation for a successful organizational memory system at this organization.

- A collection of code inspection data forms from the development of a spacecraft mission planning software tool for the US space agency, NASA. These forms document the subsystems and components that were inspected, the personnel involved, the numbers and types of defects found, and other administrative information. This information is interesting from a boundary object perspective, as it is used for different (and sometimes conflicting) purposes by different people during the project, as well as from a historical documentation perspective, as it gives clear pointers to people with potentially relevant knowledge for maintainers.

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