ENTERPRISE ARCHITECTURE ARTIFACTS AS BOUNDARY OBJECTS – A FRAMEWORK OF PROPERTIES

Abraham, Ralf, University of St. Gallen, Müller-Friedberg-Strasse 8, 9000 St. Gallen, Switzerland, ralf.abraham@unisg.ch

Abstract

This paper uses the concept of boundary objects to derive hypotheses for the design of Enterprise Architecture (EA) artifacts, with the goal of supporting communication and coordination in enterprise transformation projects. Boundary objects are a useful concept to understand the coordinative role of artifacts in practice. Since enterprise transformation projects typically involve multiple communities of practice, communication and coordination are important success factors.

First, a set of 11 boundary object properties is identified via a structured literature review. After a focus group consisting of nine EA practitioners, the set is extended to 12 properties: Modularity, Abstraction, Concreteness, Annotation, Versioning, Shared Syntax, Accessibility, Up-to-dateness, Malleability, Stability, Visualization, and Participation.

Finally, the set of boundary object properties is linked to three classes of EA artifacts (repositories, matrices, and diagrams) from the TOGAF framework, and three hypotheses are derived for the design of EA artifacts in order to become boundary objects capable of crossing a given knowledge boundary (syntactic, semantic, and pragmatic). The hypotheses argue for a common syntax, community-specific views, and joint editing and collaboration capabilities.

Keywords: Boundary Objects, Enterprise Architecture Management, Literature Review
1 Introduction

Enterprises face an increasingly complex environment which forces them to undergo fundamental change, in other words transform themselves (Rouse, 2005). The causes for such transformation efforts range from business- or IT-driven initiatives inside the enterprise to external events such as the changes in customer behavior or regulatory requirements. Transformation involves a wide and diverse variety of stakeholders, from business to IT to corporate functions, and thus highlights the need for coordination. Yet despite the relevance of enterprise transformation, reports indicate high failure rates across a broad range of domains (Dietz and Hoogervorst, 2008). Dietz and Hoogervorst (2008) name a lack of coordination in enterprise transformation projects as a key reason for the high failure rates.

Several approaches exist that aim at improving organizational communication and coordination. One of these approaches is enterprise architecture (EA). EA highlights two key aspects: Next to providing principles that guide design by restricting design freedom, EA aims at providing a high-level overview of enterprises in the form of models, e.g. as-is models, to-be models, or roadmaps. Thus, EA is considered to be a supplier of information, capable of highlighting dependencies and supporting coordination of enterprise transformation (Harmsen et al., 2009; Ross et al., 2006; Tamm et al., 2011). However, in practice, EA artifacts often fail to be used by communities other than IT to communicate.

To better understand how coordination can be supported via artifacts – in this case EA artifacts – the concept of boundary objects from sociological literature is used. Boundary objects provide interfaces between different organizational communities of practice and thus are considered to be “a useful theoretical construct with which to understand the coordinative role of artifacts in practice” (Lee, 2007). Star, who coined the term in 1989, asserts that the concept is most useful at the organizational level (Star, 2010). Thus, the boundary object concept may help support a partial aspect of coordination in enterprise transformation, namely: Supporting cross-boundary communication via artifacts.

This paper uses a two-step research approach: First, a structured literature review identifies a set of boundary object properties. Second, properties of architectural artifacts that already take the role as boundary objects are discussed in a focus group of enterprise architects. Based on these inputs, properties are mapped to architectural artifacts of the TOGAF framework, and hypotheses are derived to design EAM artifacts as boundary objects. Since EAM artifacts shall eventually be designed to implement certain properties (based on contextual factors), the properties should be understood as desired rather than defining properties. The research questions of this paper are the following:

1) Which properties do boundary objects have?
2) How can these properties be applied to EA artifacts, in order to turn them into boundary objects?

The remainder of this paper is structured as follows. Section two introduces conceptual foundations, particularly on boundary objects. Research Methodology and results are discussed in sections three and four, respectively. Section five discusses implications for EA artifact classes as boundary objects. The paper ends with a section discussing limitations and offering a conclusion.

2 Conceptual Foundations

2.1 Communities of Practice

"Communities of practice” is a term coined by Wenger (2000) to describe a community of people that (1) share a joint area of concern (e.g., share the same tasks in an organization or are interested in the same topics), (2) regularly interact within a set of community-specific norms and relations, and (3) possess a shared repertoire of resources such as languages, methods, tools, stories or other communal artifacts. In an organizational setting, such communities may correlate with certain departments, like
business analysis or data warehouse architecture. However, also people working in different departments may form a community of practice, for example project managers. The essential characteristic of a community of practice is “practice” – regular interaction and a shared repertoire of resources to work the joint area of concern – rather than the same job title.

2.2 Boundary Objects

Since boundary objects are the central theme of the following literature review, they will be given special attention (Webster and Watson, 2002). The term “boundary object” was originally introduced by Star and Griesemer (1989). Boundary objects are abstract or physical artifacts that support knowledge sharing and coordination between different communities of practice by providing interfaces. Table 1 gives a chronologically ordered selection of definitions.

<table>
<thead>
<tr>
<th>Source</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Star and Griesemer, 1989)</td>
<td>Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation.</td>
</tr>
<tr>
<td>(Karsten et al., 2001)</td>
<td>Boundary objects (Star &amp; Griesemer, 1989; Star, 1993) are physical objects such as design drawings, maps, contracts, learning materials, etc that are used to facilitate cooperation while allowing diversity in interpretation.</td>
</tr>
<tr>
<td>(Dodgegon et al., 2007)</td>
<td>Boundary objects mediate interactions between different communities of practice by providing a common basis for conversations about solutions to problems.</td>
</tr>
<tr>
<td>(Winter and Butler, 2011)</td>
<td>By identifying “lowest common denominators,” critical points of agreement, or shared surface referents, boundary objects provide a sufficient platform for cooperative action – but they do so without requiring the individuals involved to abandon the distinctive perspectives, positions, and practices of their “base” social world.</td>
</tr>
<tr>
<td>(Nicolini et al., 2012)</td>
<td>Boundary objects are defined by their capacity to serve as bridges between intersecting social and cultural worlds. Anchored in, and thus meaningful across, these worlds, they create the conditions for collaboration while, by way of their interpretive flexibility, not requiring “deep sharing.”</td>
</tr>
</tbody>
</table>

Table 1. Selected definitions of the concept “boundary object”.

These definitions highlight the two central aspects of boundary objects: Interpretive flexibility and retaining a community’s identity. (1) Interpretive flexibility: Boundary objects provide interfaces between communities of practice who are thus able to coordinate their work. When they are used for a common purpose of multiple communities of practice, boundary objects provide a common point of reference and are thus “weakly structured” (Star and Griesemer, 1989). However, each of the communities involved uses the boundary object, on a more detailed level, for its specific purposes, therefore making the object “strongly structured in individual site use” (Star and Griesemer, 1989). (2) Retaining identity: While providing lowest common denominators, a shared point of reference, boundary objects do not aim to level the differences between the involved communities (i.e., to replace any other objects or practices the communities work with): They rather acknowledge each community’s individual identity and allow it to preserve the practices of its social world.

Carlile (2002) identified four classes of boundary objects based on Star and Griesemer’s (1989) original classification: First, repositories provide a common reference point by making available uniform data, measures, and labels (e.g., a shared database). Second, standardized forms and methods provide a shared format or template (e.g., a D-FMEA form in engineering, or any other template), or a common methodology such as SCRAM. Third, objects (e.g., physical prototypes) and models (e.g., sketches, assembly drawings, mockups) are simple or complex representations of real-world things.
Fourth, maps (e.g., Gantt charts, process maps, simulation tools) that identify dependencies and boundaries between different objects and models. Maps support cross-functional problem solving. For example, a group of engineers with different professional backgrounds negotiate a design solution using a computer simulation model.

Carlile (2004) further distinguishes three types of knowledge boundaries between communities of practice that become increasingly difficult to cross: Syntactic, semantic, and pragmatic boundaries. Syntactic boundaries exist due to different vocabulary between communities of practice; they can be crossed by providing communities with a common lexicon, thereby introducing common terminology. To cross semantic boundaries, the involved communities must additionally create common meaning by identifying their differences and dependencies (e.g., with the help of a boundary object, they can identify where their perceptions differ). A pragmatic boundary finally adds differences not only in meaning, but also in interests – each involved community has its own political agenda and sees its knowledge "at stake" (Carlile, 2004). Boundary objects in this case support a negotiation process, where the involved communities attempt to find a mutually acceptable solution to reach common interests.

Crossing a higher-level boundary invariably involves crossing lower-level boundaries: In order to identify differences in meaning at a semantic boundary, a common terminology must be provided first. Being able to negotiate common solutions at a pragmatic boundary also involves crossing syntactic and semantic boundaries. At a syntactic boundary, a common repository may suffice to establish common terminology, whereas at a semantic boundary, standardized forms and methods allow identifying differences in meaning and dependencies (Carlile, 2002). At a pragmatic boundary, "jointly transformable" (Carlile, 2004) boundary objects like physical objects and prototypes allow for direct modification and provide immediate feedback to the involved communities of practice, thereby supporting the negotiation process. This is why this class is reported to be most effective when faced with pragmatic boundaries (Bechky, 2003; Carlile, 2002).

In any case, boundary objects emerge from concrete, existing objects in organizations. The adoption of an object as a boundary object depends on a wide range of contingency factors, and an object that has in one situation success as a boundary object may fail to do so when the situation changes: E.g., when new communities are involved or concerns change (Carlile, 2002). In fact, Levina and Vaast (2005) explicitly distinguish between "designated boundary objects" and "boundary objects-in-use". Thus, boundary objects alone are not sufficient to enable communication and coordination between different communities of practice; rather they are tools that are used at the discretion of organizational actors.

These properties also set boundary objects apart from taxonomies or ontologies: A taxonomy may be an instance of the boundary object class of repositories, while an ontology, describing the construction of a complex system like an enterprise (Dietz and Hoogervorst, 2008), may be an instance of the boundary object class of maps. However, in order to work as boundary objects, taxonomies and ontologies must be actually used by communities of practice to cross the knowledge boundaries between them: Only when they are locally useful to each community, while at the same time provide a common point of reference for several communities, can taxonomies or ontologies act as boundary objects.

### 2.3 Enterprise Architecture Management

"Architecture", according to the ISO/IEC/IEEE Standard 42010, is concerned with describing a systems fundamental structure, as well as providing guidelines for its evolution (ISO/IEC/IEEE, 2011). Enterprise architecture management (EAM) aims at purposefully designing an enterprise’s architecture in pursuit of its strategic goals. Due to its enterprise-wide focus, EAM typically involves many diverse communities of practice (Dijkman et al., 2004; Kurpjuweit and Winter, 2007) and is considered a means to support the coordination of enterprise transformation (Harmsen et al., 2009; Ross et al., 2006; Tamm et al., 2011). Concentrating on the descriptive aspect of architecture (a
system’s fundamental structure), enterprise architecture (EA) supports coordination by providing a high-level overview of enterprises in the form of models, e.g. as-is models, to-be models, or roadmaps. EA models are thus potential boundary objects that could improve communication between different communities of practice. One of the most widely distributed EA frameworks is TOGAF (The Open Group, 2011).

3 Research Methodology

3.1 Literature Review

In order to focus on boundary objects in the organizational context and to highlight an information systems perspective, the search scope was set to include highly recognized journals from the fields of information systems, organizational studies, and general management. In addition, major information systems (IS) conferences have been included. Focusing on journals seemed appropriate because existing boundary object literature dates back over two decades, and has therefore, unlike cutting-edge developments, had time to evolve from conference papers to journal articles. This quality-oriented approach, focusing on leading journals but reaching beyond the field of IS proper, is also recommended by Webster and Watson (2002). The search term used was “boundary object” (including the plural form “boundary objects”), and the searched fields were title and abstract. Table 2 summarizes the searched outlets. The journal “Organization Science” is included in both the second and the third literature source, therefore hits from this outlet only count towards the second category.

<table>
<thead>
<tr>
<th>No.</th>
<th>Literature Source / Topic Focus</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AIS Senior Scholars’ Basket of Journals (Association for Information Systems, 2010) / IS</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>“Leading Management Journals” (Barreto, 2010, p. 258) / General Management</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Jourqual 2 Ranking, Top 10 Journals in “Human Resources and Organization”, (Schrader and Hennig-Thurau, 2009, pp. 194-195) / Organizational studies</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Sources included in the literature review.

This search yielded a total of 25 articles. 4 articles have been removed as they only marginally covered boundary objects and gave little indication on their properties. A forward and backward search added 5 articles, thereby bringing the final set to 26 articles. These articles were thoroughly analyzed in order to identify boundary object properties. All candidate properties were collected, and the final list was continuously refined by adding, renaming or deleting properties while scanning the articles. When the final set of properties had reached a stable state, the scanning process was ended.

3.2 Focus Group

Boundary object properties have been discussed in a two-hour focus group session that took place in September 2012 in Switzerland. Focus groups are a valuable tool to evaluate researchers’ analytical conclusions (Tremblay et al., 2010) and to measure the level of consensus within a group (Morgan, 1997). The group consisted of nine panelists from different German and Swiss enterprises mainly in the financial services or energy industry. The panelists had several years of working experience in the fields of enterprise architecture, data architecture, IT architecture or IT strategy.

First, the boundary object concept was briefly introduced. The panelists were then asked to name EA artifacts from their enterprises which they considered boundary objects. In order to have an open discussion and gain additional insights, the panelists were not presented with the list of properties.
identified from the literature review; instead, boundary object properties were collected in a bottom-up manner based on concrete boundary objects from the panelists’ enterprises. After several examples had been collected, all participants engaged in an open discussion on properties of these EA artifacts and factors that influenced their usage as boundary objects. The discussion was moderated by the author. At the end of the session, the boundary object properties identified in the discussion were consolidated by the moderator.

4 Results

4.1 Literature Review

In the following, a consolidated definition of the identified boundary object properties is given. Figure 1 provides a summary of the literature review, giving concrete examples of boundary objects and the communities of practice involved, and mapping the identified properties to literature sources.

Modularity. In the context of boundary objects, modularity enables involved communities to attend to specific areas of a boundary object independently from each other, like attending to individual portions of an ERP system. Communities may use the boundary object for aspects of specific importance to them, without disturbing or interfering with other communities’ use of the boundary object (Pawlowski and Robey, 2004; Star, 2010).

Abstraction. Boundary objects are “weakly structured in common use” (Star and Griesemer, 1989). Boundary objects serve the interests of all involved communities of practice by providing a common reference point on a high level of abstraction. Local contingencies are eliminated from high-level views, in order to highlight the commonalities. (Gasson, 2006; Levina and Vaast, 2005)

Concreteness. Boundary objects are “strongly structured in individual site use” (Star and Griesemer, 1989). Boundary objects are able to address specific problems for specific communities of practice. Communities are able to specify their concerns and express their knowledge related to the problem at hand. Thus, interpretive flexibility is provided. Applying the boundary object to their concrete problems, communities are able to learn about their differences and dependencies (Carlile, 2002; Pawlowski and Robey, 2004).

Annotation. Boundary object can be enriched with additional information by individual communities of practice in order to provide context for local use. Boundary objects are durable and stable, yet give the involved communities the option to add local information. (Karsten et al., 2001; Yakura, 2002)

Versioning. Changes can be traced and additional context is provided by reconstructing the chronological evolution of the boundary object. This is similar to the use of a software versioning / revision control system in software engineering. A history of changes can be reconstructed, along with their rationale. (Karsten et al., 2001; Mark et al., 2007)

Shared syntax. A common schema of information elements is provided, so that local use of information objects is uniform across communities of practice. Shared syntax may be supported by a common information model, or shared notation conventions (e.g., standardized bug tracking forms that are used across an organization, or common modeling notations such as UML). (Dodgson et al., 2007; Pawlowski and Robey, 2004)

Accessibility. The boundary object is readily accessible for the involved communities (i.e., they are granted access rights or they are supplied with physical representations such as printouts). This also includes informing interested communities about the boundary object using appropriate communication channels and other measures aimed at helping communities use the boundary object, such as training measures. (Boland and Tenkasi, 1995; Levina, 2005).
### Figure 1: Identified boundary object properties in the literature review.

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Boundary object example(s)</th>
<th>Communities of practice involved</th>
<th>Modularity</th>
<th>Abstraction</th>
<th>Concreteness</th>
<th>Annotation</th>
<th>Versioning</th>
<th>Sharing</th>
<th>Accessibility</th>
<th>Up-to-dateness</th>
<th>Malleability</th>
<th>Stability</th>
<th>Visualization</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Barrett and Oborn, 2010)</td>
<td>Software specification, timelines</td>
<td>Jamaican and Indian software development teams</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Becky, 2003)</td>
<td>Technical drawings, machines</td>
<td>Engineers, technicians, and assemblers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Boland and Tenkasi, 1995)</td>
<td>No specific example; conceptual paper</td>
<td>No specific example; conceptual paper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Carlile, 2002)</td>
<td>D-FMEA forms, CAD models</td>
<td>Design, engineering, and production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Carlile, 2004)</td>
<td>3-D car model</td>
<td>Engineering groups for different car components</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Dodgson et al., 2007)</td>
<td>Simulation tools</td>
<td>Fire fighters, building engineers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Doolin and McLeod, 2012)</td>
<td>Prototype for database solution</td>
<td>Project manager, outsourcing contract manager, vendor representative, senior developer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Gal et al., 2008)</td>
<td>3-D CAD model</td>
<td>Architects, building contractors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Gasson, 2006)</td>
<td>Electronic document library</td>
<td>Business process redesign, IT system analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Henderson, 1991)</td>
<td>Sketches, CAD models, data bases</td>
<td>Management, design, production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Karsten et al., 2001)</td>
<td>Technical specifications document</td>
<td>Engineering project team, customer organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Levina, 2005)</td>
<td>Sales presentation, web page mockups</td>
<td>Internet consulting company, publishing company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Levina and Vaast, 2005)</td>
<td>Case 1: use case scenarios; case 2: best practice database, FAQ</td>
<td>Case 1: internet consulting company, publishing company; case 2: headquarters, local offices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mark et al., 2007)</td>
<td>Project fact sheets, project plans</td>
<td>Project managers, systems engineers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Mattila et al., 2012)</td>
<td>Enterprise system for project staffing</td>
<td>Managers: Staffing, line, project; Employees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Newell and Edelman, 2008)</td>
<td>Project documentation (lessons learnt)</td>
<td>Projects (sewage / enhanced water treatment)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Nicolini et al., 2012)</td>
<td>Prototype: bioreactor; visual slides with experimental results</td>
<td>Biologists, sensor engineers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Osterlund, 2008)</td>
<td>Whiteboard</td>
<td>Doctors, nurses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pawlowski and Raven, 2000)</td>
<td>Environmental information system</td>
<td>Engineers, lawyers/lobbyists, auditors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Pawlowski and Robey, 2004)</td>
<td>Shared IT system</td>
<td>Sales, accounting, risk, IT departments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Puri, 2007)</td>
<td>Geographic information systems (GIS)</td>
<td>Scientists, local authorities, local communities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Rajão and Hayes, 2012)</td>
<td>Geographic information systems (GIS)</td>
<td>Scientists, federal authorities, local rangers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Star, 2010)</td>
<td>No specific example; conceptual paper</td>
<td>No specific example; conceptual paper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Star and Griesemer, 1989)</td>
<td>Species descriptions, maps</td>
<td>Museum administrators, scientists, laymen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Winter and Butler, 2011)</td>
<td>Human genome map</td>
<td>Biologists, data analysts, administrators</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Yakura, 2002)</td>
<td>Visual timelines</td>
<td>IT consultants, client firm (utility industry)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Up-to-dateness. The information contained in the boundary object is up-to-date. This includes timely communication of changes to the involved communities, as well as responsibilities and processes for updating the boundary object. (Carlile, 2002; Karsten et al., 2001)

Malleability. Boundary objects are jointly transformable to support detecting dependencies and negotiating solutions. Communities of practice thereby receive immediate feedback on changes and see the dependencies of their work with other communities’ areas of concern. (Carlile, 2004; Doolin and McLeod, 2012)

Stability. The structure and underlying information objects of a boundary object remain stable over time. Despite different local uses and annotations, boundary objects are brought to closure, i.e. they provide a stable reference frame. Closure reflects an agreement on the parts of the boundary object that is of interest to all involved communities. (Karsten et al., 2001; Yakura, 2002)

Visualization. The boundary object does not rely on verbal definitions, but possesses a graphical or physical representation (e.g., a drawing or a prototype). A graphical representation of boundary objects helps acquire interpretive flexibility and foster dialogue between communities of practice, supporting deliberations about further actions. By using techniques to improve the cognitive effectiveness (Moody, 2011), a boundary object can be made more accessible to different communities and easier to use and understand. (Boland and Tenkasi, 1995; Henderson, 1991)

4.2 Focus Group

During the focus group session, the examples of boundary objects provided by the panelists fell primarily into the categories of repositories, models, and maps. Examples of repositories are various fact sheets or enterprise-wide information object catalogues. Examples of models were business object models or data warehouse layer models, while the most frequent examples of maps were capability maps (establishing a link between business and IT capabilities) and process maps. For example, a sheet concerning figures in an insurance company is used both on the business side to identify attributes of an insurance contract (e.g., premiums and conditions), but the same sheet is also used in the IT department to map those attributes to database fields. As a boundary object, this sheet crosses the syntactic boundary between business analysts and the IT department by providing a common lexicon. Perhaps the most visible indication of the boundary object character of this sheet is the fact that it hangs both in the CFO’s and the developer’s office.

In the case of models and maps, panelists called for a “less is more” approach, warning against cluttering process maps or capability maps and thereby compromising clarity and ease-of-understanding. Instead, they opted for a use of detailed views to render models useful to individual communities of practice that require information at a greater level of detail, while offering the higher level of abstraction to address the common concerns of multiple communities of practice. Panelists also mentioned that a clear and appealing visualization (e.g., color coding or distinctive shapes), particularly in the case of models, as essential for the adoption and the use of boundary objects.

Another aspect the panellists stressed is stability: A constantly changing object fails to gain legitimacy and tends to be ignored. On the other hand, a wide focus involving many communities of practice and changes in the business mandate periodic updates, otherwise information would be outdated and the concerns of certain communities could no longer be addressed. To balance between the desired properties of stability and up-to-dateness, panelists recommended a dedicated change management and release process. With such a process, change requests are collected, discussed, evaluated and periodically lead to new releases. Thus, there is always an official version available, while the object can still be updated regularly.

The panel also stressed that boundary objects need to involve a broad range of communities of practice, and should also be used by top management. Their argument was that this would strongly increase acceptance and use of a boundary object. This property is named “participation” to reflect
both the participation of all relevant communities in the creation, maintenance and use of the boundary object, and to also emphasize the role of top management participation (cf. the construct of (EA stakeholder) participation by Schmidt and Buxmann (2011)).

**Participation.** Relevant communities if practice should be involved in the creation and maintenance of the boundary object. Boundary object users should also include top management.

While the properties of abstraction, concreteness, stability and visualization had already been identified in the literature review, the property of participation extends the final set to 12 properties.

5 Discussion

In order to examine the role of EA artifacts as boundary objects, the classification of EA artifacts from the TOGAF framework (The Open Group, 2011) is used. TOGAF distinguishes between three classes of architectural artifacts: Catalogs representing lists of things, matrices showing relationships between things, and diagrams depicting things. Catalogs can thus be mapped to the boundary object class of repositories, matrices to the class of maps, and diagrams to the class of objects and models.

Since the capability to cross a syntactic boundary is a precondition to cross either the semantic or the pragmatic boundary, catalogs form the foundation for the other classes of EA artifacts (matrices and diagrams). Catalogs help to establish the common lexicon required for different communities of practice to communicate. Important properties for these catalogs are stability, accessibility, and up-to-dateness. Release management processes can help to control the frequency of changes while regularly updating the contents (thus balancing between stability and up-to-dateness), however, the basic constructs in an enterprise (e.g., information objects and business concepts) are likely to have a higher degree of stability than more complex boundary objects such as matrices or diagrams. Accessibility may be supported by making catalogs centrally available and referencing them in matrices and diagrams. By providing official releases, synchronization problems with outdated local versions may also be avoided. Catalogs highlight the boundary object property of modularity: They represent objects at a given degree of abstraction, but allow different communities of practice to independently address those parts that are relevant to community-specific concerns (e.g., a shared database or the insurance company’s figure sheet introduced in section 4.2).

Communities of practice face a semantic boundary when enterprises are faced with environmental changes and have to transform. New requirements make differences and dependencies unclear and meanings ambiguous. Here, the EA artifact classes of matrices and diagrams can be helpful to arrive at a common meaning. In addition to the desired properties of catalogs like stability, accessibility and up-to-dateness, properties like annotation and versioning are helpful in enriching matrices and diagrams with context information and allowing comparisons with historical versions. This makes the provenance of these artifacts visible to the involved communities of practice and provides additional information to identify new differences and dependencies. Especially for the artifact class of diagrams, attention should be given to visualization properties, as these may be helpful in detecting and communicating dependencies to stakeholders (Moody, 2011; The Open Group, 2011).

Matrices and diagrams highlight the necessary balancing between the boundary object properties of concreteness and abstraction: In order to be useful to individual communities of practice, boundary objects have to be interpretable by individual communities to address their specific concerns. At the same time, they also have to contain information concerning several communities at a sufficiently high level of abstraction to form a common point of reference. Community-specific views can be used to provide this balance, where different communities of practice share a view that identifies their lowest common denominator, while individual communities rely on specific views for information on their particular concerns at a lower level of abstraction. Special consideration must be given to maintain consistency and smooth transitions between these views.
Finally, when communities of practice encounter pragmatic boundaries and are required to negotiate common interests and solutions, the boundary object property of malleability is central. This property is available in objects that can be jointly transformed and worked upon, such as physical objects, simulation models or prototypes. In the case of EA artifacts, this property is very hard to implement, due to the intangible and conceptual nature of these artifacts. One approach may be to provide a physical representation of these artifacts (e.g., printouts) in order to allow joint editing and annotating; or to provide collaboration capabilities to the same effect. However, crossing a pragmatic boundary usually involves significant political efforts, since powerful communities of practice are interested in protecting their knowledge and influence. Boundary objects in this case are tools that are manipulated by organizational actors in pursuit of their interests. Summarizing, the following hypotheses are derived for EA artifact classes to cross syntactic, semantic, and pragmatic boundaries, respectively:

(1) To cross syntactic boundaries, the EA artifact class of catalogs needs to provide properties like stability, accessibility, and up-to-dateness. (2) To cross semantic boundaries, the EA artifact class of matrices and diagrams needs to offer community-specific views and supply context information. (3) To cross pragmatic boundaries, the EA artifact class of matrices and diagrams needs to have joint editing and collaboration capabilities.

6 Summary

The contribution of this paper is the identification of a set of 12 boundary object properties by means of a structured literature review and a focus group with enterprise architects. This set provides the framework for a more detailed analysis of possible boundary objects encountered in practice, and design implications can be formulated referencing these properties. Three hypotheses have been derived for the design of various classes of EA artifacts as boundary objects.

Regarding limitations, the paper at hand is still predominantly conceptual, having collected boundary object properties primarily from literature. The properties are not equally distributed over the analyzed sources, with many properties mentioned only in a third of all sources. This implies that the properties vary in importance, and future research needs to identify which properties are relevant to cross which knowledge boundaries. Therefore, caution must be taken when using the identified properties as a basis for EA artifact construction. Also, the derived hypotheses have to be tested, by applying them to existing EA artifacts and examining their effectiveness in coordinating between communities of practice. Special consideration must be given to contingencies, e.g. between which communities of practice is coordination supported by an EA artifact, which knowledge boundaries are involved, and the overall characteristics of the transformation project. A general limitation of the boundary object concept must also be mentioned: Only some communication and coordination issues between communities of practice can be resolved by artifacts. Particularly when differing interests are involved and pragmatic boundaries exist, coordination is much more likely performed by humans, who perform a function as “boundary spanners” and may use certain boundary objects to support the negotiation process.

For researchers, determining where boundary objects have to be supplemented by other coordination mechanisms in an enterprise transformation project is an important avenue for further research, as well as how EA artifacts interact with other boundary objects in enterprise transformation. Moreover, the interdependencies between the identified properties have to be better understood. The set of boundary object properties is an initial one, yet it provides an important starting point for further research, which may lead to an evolution of this set. For managers, the derived hypotheses can give preliminary indications on how to enhance communication in their transformation projects.

Acknowledgement

This work has been funded by the Swiss National Science Foundation (SNSF).
References

Proceedings of the 21st European Conference on Information Systems


