COMPOSITE BOUNDARY OBJECTS IN INTER-ORGANIZATIONAL INNOVATION ACTIVITIES

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Abstract

Organizations are recognized today as part of business ecosystems that conduct activities with business partners in a cooperative fashion. In our research we focus particularly on activities related to innovation in such inter-organizational co-operations. The role of information systems (IS) in inter-organizational cooperative innovation activities is significant. Boundary objects are used to understand interactions between actors with varying information and knowledge needs. While the vital role of boundary objects has been recognized in IS literature, less attention has been paid to the process of emergence of boundary objects. Boundary objects are often studied in their manifestations as single IT artefacts such as a database or spread sheet. In this study, we offer the view of boundary objects as elements of a boundary infrastructure, comprising a portfolio of separate artefacts, which we refer to as “composite boundary objects” (CBOs). By means of a qualitative case study, we describe the process of emergence of CBOs and provide evidence of their role in coordination in the inter-organizational innovation project. We see our major contribution in a first conceptualization and definition of CBOs, as well as in describing their emergence and significance in the context of inter-organizational innovation activities.

Keywords: Boundary objects, composite boundary objects, inter-organizational innovation, new product development.
1 Introduction

Organizations are recognized today as part of business ecosystems that conduct activities with business partners in a cooperative fashion (Davenport et al., 2006). In our research we focus particularly on activities related to innovation in such inter-organizational co-operations. The role of information systems (IS) in inter-organizational cooperative innovation activities is significant (Carlsson, 2003). IS enable and constrain the sharing of knowledge and the production of new knowledge, within teams that originate from different communities of practice, across organizational and functional boundaries for a particular innovation project (Boland and Tenkasi, 1995; Brown and Duguid, 1991). Rarely are the systems used isolated pieces of software; they are more often parts of a larger portfolio of systems employed to accomplish cooperative activities (Alavi and Leidner, 2001). It is vital to understand, manage, design, and use these IS resources by establishing appropriate management processes (Krishnan and Ulrich, 2001; Nambisan, 2003; Saraf et al., 2007). A large body of literature exists that studies the significance of IS in cooperations through different methodological lenses. Adaptive structuration focuses on social structures and examines processes of appropriation and uses of IS (DeSanctis and Poole, 1994). Technology adaptation refers to the success of cooperations through alignment of technology, group and organization (Majchrzak et al., 2000). Thomas and Bostrom (2010) identify triggers for technology adaptation. Yet for our study, we do not focus on the level of structuration processes (Giddens, 1984), but on the level of communicative processes as effects of team interactions. Here, coordination between actors can be observed without examining appropriation processes. How IS influence the appearance and form of coordination, provides a largely unaddressed problem in this area. In general, coordinative effects can be triggered by changes in the cooperative behaviour of actors, in their decision-making, in their uses of artefacts, or in other alterations of work arrangements that influence the overall cooperation process.

In this paper, we study the knowledge exchange between actors in an inter-organizational innovation project team to better understand these coordinative effects. Our level of analysis is not an information technology (IT) artefact, a single user, team, or firm; rather it is the emergence of communicative structures during interactions. We term those structures “composite boundary objects”. This level of analysis helps explain coordinative effects that occur between the cooperating actors, across boundaries – taking into consideration the complexity of the work environment including IT artefacts, networks of actors, and their individual responses and behaviour in interactions, in the innovation context.

The concept of boundary objects is well established in literature on knowledge sharing and re-use (Carlile, 2002; Star and Griesemer, 1989). Boundary objects are used to understand interactions between actors with varying information and knowledge needs. Their vital role for coordination has been recognized in IS literature, and they are often studied in their manifestations as single IT artefacts such as a database or spreadsheet (e.g. Gal et al., 2008). In this study, we offer the view of boundary objects as elements of a boundary infrastructure, comprising a portfolio of separate artefacts, which we refer to as “composite boundary objects”.

We apply our theoretical framework of composite boundary objects to an innovation project case study. We conducted qualitative interviews with an inter-organizational innovation project team, in the early phases of New Product Development (NPD). Interestingly, we find evidence that composite boundary objects can explain the occurrence of coordinated interaction through the interplay of several artefacts, and even though no coordination was intended by the actors. We believe therefore that the concept of composite boundary objects is able to extend the explanatory power of the boundary object idea. Our research calls for a shift of focus in IS research on boundary management and on IS support of knowledge management, moving away from considering isolated artefacts, towards clusters or environments of communication. Our contributions include a conceptualization and definition of composite boundary objects as well as a discussion towards explaining their emergence and significance in the context of inter-organizational innovation activities.
2 Literature Review

2.1 Managing knowledge in inter-organizational innovation projects

Acquiring and integrating knowledge from the outside the firm is vital (Chesbrough, 2003). One way to gain access to external knowledge is through partnerships for knowledge co-creation (Davenport and Prusak, 2000). An important source of competitive advantage is a firm’s network of external relationships for technological, strategic and relational complementarities (Davenport et al., 2006; Emden et al., 2006). Substantial research exists on the cooperative, “open” flow of ideas and knowledge in inter-organizational partnerships (Chesbrough, 2003; O'Reilly III and Tushman, 2004). Surprisingly, relatively less attention has been paid to collaborative knowledge creation, or the processes, practices, and tools that support generation of new knowledge.

Such processes are particularly important in inter-organizational innovation project teams in the early phases of the New Product Development (NPD) process, which target at disruptive innovation. Primary characteristics of this context are the novelty of created knowledge and the novelty of resulting tasks to be carried out (Christensen and Raynor, 2003). The particular importance of tacit knowledge and expertise in these phases make it difficult to introduce highly formalized processes (Hansen, 1999). This creates uncertainty regarding the process and outcome of knowledge exchange, and generates high requirements for the management of such activities (Colombo et al., 2011; Tushman and Nadler, 1978). In general, the NPD context defines a set of unique boundary conditions (Dooley and O'Sullivan, 2007) and puts high demands on the dynamic capabilities of organizations (Eisenhardt and Martin, 2000). Particular attention must be paid to how to coordinate teams that collaboratively create knowledge with IS as a critical enabler (Malhotra et al., 2001).

Often, interactions that occur between actors during the early phases of innovation involve informal processes of networking and information sharing (Brentani and Reid, 2012; Nonaka and Takeuchi, 1995). Optimally, team members recognize each other’s competences and “accomplish tasks by acting as a coordinated unit” (He et al., 2007:2). In such phases, structuration processes occur, allowing for knowledge creation, sharing and transformation between actors (DeSanctis and Poole, 1994). A theoretical construct that describes such processes is “boundary objects”.

2.2 Boundary Objects

The concept of boundary objects was introduced by Star and Griesemer (1989) to explain how actors with different knowledge backgrounds or viewpoints establish a shared point of reference during interactions (Carlile, 2002). Boundary objects can be concrete objects like a spreadsheet or prototype, or abstract concepts like a symbol or shared experience, which possess some “interpretative flexibility” (Bijker et al., 1987). Star (2010) emphasizes that boundary objects are based in action, i.e., part of a process, and subject to reflection and local tailoring. Carlile (2002) points out that for boundary objects to be effective, they need to span three boundaries. The three boundaries are referred to as syntactic, semantic and pragmatic.

Syntactic knowledge boundaries arise due to inconsistencies in the terminology used, or due to lacking availability of facts and data that need to be shared between actors. Establishing a shared and stable syntax solves the information processing, or transfer, problems of such a boundary. Repositories such as databases provide a common reference point of data, measures, or labels across functional areas that establish shared definitions and (data) values for problem solving.

Semantic knowledge boundaries arise when, despite a common syntax, interpretations differ, maybe because of differing contexts (Tyre and Hippel, 1997), causing communication problems. Nonaka and Takeuchi (1995) suggest making tacit knowledge or implicit interpretations explicit. Techniques include story-telling (Brown and Duguid, 1998), or codifying knowledge in standardized forms and
methods, e.g. by establishing best practices (Davenport and Prusak, 2000). In general, translating knowledge between actors intends to overcome this boundary.

**Pragmatic knowledge boundaries** arise when knowledge needs to be transformed between actors to reach a shared understanding. Hence pragmatic boundaries are not limited to representing one’s knowledge for the purpose of communication, which includes syntactic and semantic differences, but also an individual development process. Thus, pragmatic knowledge boundaries shape boundary objects that are dynamic and enable collaborative sense-making. In terms of IT artefacts, this can comprise models or maps which are exchanged and collaboratively altered by the actors.

Carlile (2004) formulates suggestions for managing knowledge across each boundary, and uses a framework which is depicted in Figure 1. This framework illustrates the role of boundary objects with respect to cooperative tasks two actors need to accomplish. The pyramid shape in Figure 1 opens up a spectrum, or “continuum” (Star, 2010) of tasks between well-known and novel tasks. Actors A and B interact within this spectrum with correspondence to boundary objects that exist on the three levels.

![Figure 1. Framework for managing knowledge across boundaries based on Carlile (2004)](image)

The role of IS in spanning syntactic and semantic boundaries has been studied extensively (e.g. Levina and Vaast, 2005; Pavlovski and Robey, 2004; Boland and Tenkasi, 1995). Relatively less attention has been paid to the role of IS in spanning pragmatic boundaries. And, no research could be identified by the authors of this paper that studies the interplay between boundary objects that exist on different levels. Carlile (2002:453) states that in NPD the concept of pragmatic boundary objects “provides an infrastructure or process where current and more novel forms of knowledge can be jointly transformed, producing more shared knowledge or syntax at the boundary.” This motivates our adoption of boundary objects for the context of our study.

The significance of boundary objects for the design of information systems and IS architectures has gained only marginal attention so far although literature suggests that boundary objects can explain the knowledge exchange between actors. It is possible that such interactions occur at different times and levels, requiring a mix of boundary objects to achieve different objectives. Therefore, we extend the notion of boundary object as outlined in the following paragraphs.

### 2.3 Composite Boundary Objects (CBOs)

We adopt a boundary perspective on cooperative innovation activities, i.e. we take a look at the communication processes between actors cooperating across boundaries. Such boundaries can occur in inter-organizational as well as in intra-organizational settings, within teams that have members from the same or different departments in one organization. For our study we have chosen the context of inter-organizational cooperation, since we believe that the management of such activities in particular can profit from better understanding and considering the interplay between involved actors and
boundary objects. This interplay can include IT and physical artefacts, cooperation methods, management routines and coordination processes of actors as boundary objects on the one hand, as well as individual and team sense-making, or coordination of actors as effects across boundaries on the other hand. In this context, various different IT artefacts are usually used in parallel. Those groups of artefacts may comprise the description of a product idea in a document, data on materials or simulations in a database or technical files, a virtual prototype, a web-based cooperation platform, a work flow-based application software and others. Evidence suggests that several artefacts together can provide for coordinative effects across boundaries, whether or not they can individually be interpreted as boundary objects. We will refer to those artefacts as marginal objects. In particular cases, a single marginal object, e.g. a certain structure for describing a product, might be sufficient to coordinate between actors and form a boundary object (Bergman et al., 2007). In other cases however, this might not suffice, and the coordinative effect is established only by the interplay of several marginal objects.

While the concept of boundary objects has been applied in the context of IS, this idea of coordinative effects across boundaries occurring due to the interplay of multiple artefacts or marginal objects, has not been considered. We conceive of “composite boundary objects” as a portfolio of various different marginal objects, which can be artefacts including boundary objects, work arrangements and processes, or types of uses. Those sets or groups of artefacts can consist of abstract and concrete objects, which are used in, or emerge from, interactions. They can include for example physical IT artefacts like software tools, or abstract elements like a methodology for cooperation.

Thus, we define a composite boundary object (CBO) as a portfolio of artefacts, work arrangements, processes and uses that enable representation, learning, and/or transformation of knowledge between actors cooperating across boundaries. The emergence of composite boundary objects ought to be studied with respect to the particular set of conditions regarding the cooperation context, the actors and the tasks involved. We use this concept during a qualitative study of an inter-organizational cooperation in an innovation project team, described in the remainder of this paper.

3 Research Method

3.1 Theoretical position

Since we consider complex interaction scenarios of several cooperating actors, we have chosen to take an interpretive epistemological stance (Myers, 1997), because we wanted to understand how the actors involved to the inter-organizational team were influenced by, felt about, and evaluated, the developing project. We use case study research as a qualitative research method and conducted an in-depth study of an innovation network (Yin, 2002). We used episodic interviews as particular form of a narrative inquiry (Denzin and Lincoln, 2005). Episodes are commonly understood as detailed historical reconstructions of earlier experiences. During the interviews, we tried to get a general impression about the course of the cooperation and also to identify incidents—or events—that involved actors from different organizations, and that were momentous in changing the cooperation. These incidents serve as unit of analysis in our study. We formulated questions based on our theoretical lens that allowed us to look for evidence of crucial themes such as the existence of boundary objects. The presented framework helped to semi-structure the interviews (Corbin and Strauss, 2008).

3.2 Case selection and data collection

Our case site comprises of a network of three Italian small and mid-sized firms engaged in an innovation project. The companies are currently involved in a project for developing a new type of safety helmet. The first company is in the chemical industry; the second has experience in design and prototype development for safety products; and the third is an engineering service provider. For each company, the relevant project is just one of several on-going NPD projects.
This project provided us with a representative case for our enquiry in multiple ways. First, the team had not worked together in this network before, which made it possible for us to observe the learning curve regarding knowledge exchange and growth of relationships during this cooperation, which could be detected during the interviews. Second, the targeted new product represents a development that is sufficiently complex in that no “custom” procedure for its development could be chosen a priori, but the route towards reaching the common goal had to be worked out step by step. The project has started approximately two years ago and at this moment, is still continuing, with the expected duration to market entry at about four years. The interviewees were project leaders for their respective companies, two of them being General Managers and one being a researcher, all with multiple years of experience. They form the core of the project team of about 10-15 people. As the companies are located in different regions of Italy, they formed a virtual team, heavily relying on electronic communication and information exchange.

We held numerous conversations with the team throughout a two years time frame, both in personal meetings and via phone or teleconference, and accompanied the project within various project meetings. A central sequence of interviews took place at the central work place of each actor, within three consecutive days, in order to make sure that episodes brought up in the conversation would be fresh in the minds of the involved actors. These meetings were not conducted with time restrictions, but with an open-end agreement, lasting approximately 4 hours each. Questioning for the particular NPD task to be carried out currently, served as a starting point in the conversation for identifying relevant episodes. The interviews were recorded via a laptop microphone, and the audio files transcribed. After, distinguishable marginal objects were identified by the researchers, and their role during the cooperation was iteratively interpreted. Two more sequences like this and further interviews were conducted at other meeting places, adding up to 17 interviews with more than 24 hours of recordings.

4 Analysis

4.1 Marginal objects at different knowledge boundaries

Starting from the anecdotes about the progress and development of the innovation project reported during the interviews, we identified a total of 15 artefacts and methods serving as marginal objects that were significant to cooperation. They are enumerated in Table 1, where they are ordered according to the three types of knowledge boundaries and type of object. We distinguish between four types of objects, relating loosely to Star and Griesemer (1989).

<table>
<thead>
<tr>
<th>Type of Knowledge Boundary:</th>
<th>Pragmatic</th>
<th>Semantic</th>
<th>Syntactic</th>
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<tbody>
<tr>
<td>Pragmatic</td>
<td>• Shared product idea</td>
<td>• Prototype test results</td>
<td>• Captured information</td>
</tr>
<tr>
<td></td>
<td>• Advertising idea of final product</td>
<td>• Graphics and technical schemes</td>
<td>• Full technical specifications</td>
</tr>
<tr>
<td></td>
<td>• Safety helmet prototype(s)</td>
<td>• IT platform</td>
<td>• Material characteristics</td>
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<tr>
<td></td>
<td>• Activity orientation routine</td>
<td>• Over-information avoidance routine</td>
<td></td>
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<tr>
<td></td>
<td>• Frequent interaction routine</td>
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<td></td>
<td>• Joint visits to tests</td>
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<table>
<thead>
<tr>
<th>Type of object:</th>
<th>Abstract artefact</th>
<th>Material artefact</th>
<th>Method</th>
<th>Standardized method</th>
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<th>Testing procedure towards safety regulations</th>
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<td>Quality Function Deployment</td>
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Table 1. Overview of artefacts serving as marginal objects from case study
At the pragmatic knowledge boundary we could observe abstract artefacts in form of a shared idea of the final product, and a movie scene as advertising idea to trigger emotions with the consumer. Also the physical prototypes of the safety helmet and three routines belong to this boundary. The routines were reported in the interviews. They cover the unspoken agreements to frequently interact with each other, in order to keep up to date with new developments, to try to personally attend material tests in the project, and to organize one’s own work with respect to fulfilment of individual activities. The latter routine can be seen as an alternative to an outcome- or result-oriented work planning and organization. At the semantic knowledge boundary, we identified material artefacts as well as unspoken routines and explicitly, or technically, standardized methods. Among them were highly structured forms with prototype test results, graphics and technical schemes, and also an IT platform as an IT artefact. The IT platform was newly introduced and provided a central repository and wiki functionality. The interviews suggested that the platform itself provided a means for learning of cooperation routines, e.g. creation of shared task lists (described by Majchrzak et al., 2000). In addition, an unspoken arrangement regarding what pieces of information had to be shared between the partners, regulated for a cautious communication of presumably relevant information, so an over-information avoidance routine resulted between the partners. The testing procedure for the targeted product, which conformed to legal regulation, served as a shared reference point in order to transfer and in consequence jointly develop knowledge. At the syntactic knowledge boundary, we identified accumulated technical specifications, and material characteristics, both contained in the central repository (the IT platform), as well as information captured during the cooperation with other IS tools. This information comprised of messages sent via e-mail or other channels like instant messaging programs as well as further content of the central repository. In addition to these, each actor kept information in personal IS tools.

4.2 Formation of composite boundary objects

In view of the identified marginal objects, we analysed to what extent they changed, or influenced, the way the actors defined their goals, took decisions, or interacted with each other. We looked for actual incidents when this inference was traceable, and which could be comprehensibly interpreted. Such incidents could be spontaneous events, an unplanned episode, a story to tell, explicit or implicit behaviour patterns, or explicitly agreed procedures (e.g. introduction of the IT platform) in the context of the on-going NPD phase. We subsequently analysed these incidents to define several distinguishable coordinative effects which had been triggered by them. In context of each effect, marginal objects interacted with each other, thus together forming a composite boundary object. From the case study, we have identified three composite boundary objects, displayed in Figure 2.

**Figure 2. A map of the composite boundary objects (CBOs) within the research framework**
4.3 Composite boundary object A: “Prototype Performance Test”

In one of the scheduled tests, strong positive results were obtained for the overall performance of a prototype. High expectations and emotions were involved because the test determined the success or failure of the shared product idea, the value of the work done so far, as well as the previously applied solution strategies of each partner. The results would influence the future planning of tasks and eventually change the technologies or practices used by each partner.

Due to the positive results of the test, the shared product idea was reinforced with each actor. The IT platform was closely connected to this as it provided the semantic knowledge boundary incorporating the reference data (prototype test results) for such milestone events. As it turned out in the interviews, the important role of the IT platform was apprehended by the actors only a posteriori to the incident, because it turned out not only to be a central point of reference, but an instrument to bring forward the team from a coordinative point of view. This incident resulted in a high motivation to use the IT platform. Taken together, the incident provided for composite boundary object “A” in Figure 2.

Several of such tests were carried out during the first phase of the project. An iterative process emerged, enabling knowledge exchange between the involved experts, and triggered learning. One of the researchers involved in the interpretation formulated it in the following way:

“*The several tests enabled learning in each iteration, and subsequent transformation of the knowledge from knowing about the material and product separately, to knowing how product and material work together.*” (Text fragments have been shortened and smoothed).

An interviewee tells how he experienced the evolution of ideas:

“If Alex explains me now how usually [this part of the product] was produced, what the limits are, which materials they typically use. [One material] is the right one for a helmet. But it has limits, it’s heavy. [This usual material] is good for the application, it works. But it is also possible to use another material. It is not so heavy but has other limits. We test and publish results [on the IT platform]. Passing the test five times, we stopped testing because five times is... the fifth impact produced better results than the first because of the technical changes we made. And many, many of these steps enabled us to re-arrange and improve our goals. Because before that we had not imagined to produce a motorcycle helmet with this kind of technology. Because we just didn’t think about that when we started. Now, with our experience, we can imagine to do that. With my support and also with Alex's idea. Because he has his focus on production. This is an interesting exchange of information, to arrive to a point, because I need him for understanding what the market wants. I have my personal opinion, but it is not the market. Alex has different information about that. (...) Our vision is to stand in the first row of the motor cycle grand prix line-up <laughs>, and there are four drivers, three with the standard helmet and one with our helmet, and watching this you must ask yourself..."is this driver wearing a helmet?"”

4.4 Composite boundary object B: “External Event”

Another incident occurred when one of the actors noticed a market test which had been published in a national trade journal. This publication is a marginal object termed “captured information”. The relevant passages were forwarded between the actors and liberally discussed almost immediately in the team (frequent interaction routine). The results were favourable to the development pursued so far (shared product idea), but equally showed the difficulty of the market. In general, the test and the following discussion were interpreted by the actors as a motivation to carry on with the selected procedures and overall strategy. Also the advertising idea was reinforced, because the market proved to favour certain types of helmets, which was part of the shared vision (compare also the last passage of second quotation in 4.3). Thus, the individual approaches of the involved actors were not changed, but a reinforcement of the overall goal resulted. One of the experts formulated the connection between this incident, the interaction routines and the IT platform in this way:
“When I saw [from the published test] that some helmets had not passed the [necessary test], I was not surprised. Because I know who is doing a tricky business, and who is working in a serious way. It's normal, unfortunately. The customer doesn't know what happens. (...) I communicated the test results to the others through phone, through Skype call, because it was funny. And then I logged it in [the platform]. (...)”

Later, a meeting was arranged to further discuss the external tests:

“I decided to base my presentation totally on the platform. So, the PowerPoint was only four slides and every issue was linked and discussed on the model information because it is information in evolution. I wanted Frank and George, who were in the meeting, to see that some information that was running <constantly changing, new information added> – because the PowerPoint was built in a logic way, was not just a sequence, was explaining WHY we had to do the test. Just clicking, they could find the updated information on the platform, not just the ~pdf. That's the reason why I [understand the platform] not just as a show room, but also as a warehouse. I want to put inside every information. And then I decide what makes it useful. Because if you need to see something more, it is already there. And I do not need to have a second storage system. And that's it.”

4.5 Composite boundary object C: “Changing work arrangements”

Shortly after the start of the innovation project, a new collaboration platform was introduced in order to support the communication and coordination of the team. At this point of time, activities were already underway, and the team members were accustomed to each other, and had developed a certain kind of cooperative work arrangements. The introduction of the IT platform (seen as a marginal object) is a trigger to reflect on those procedures and interactions in between the partners (several of the “methods” mentioned in Table 1). There was a general feeling that the relevance of the platform within different phases of the cooperation might change, and that eventually, new tools might be discovered and applied in the future. A hope to learn from that experience and to improve competences in use of IT, and in collaboration, resulted from that. One of the experts was asked how he uses the platform. The answers show how the perception of the cooperative process changes.

“For example the last [technical diagram] was directly uploaded over the platform and I directly went over there to look at what had been obtained. Giacomo just called me by Skype and told me 'Daniele, I have some great news, we have obtained the diagram – take a look at it!' So, I went in the system, I found it and we discussed a little bit about possible issues, advantages, how to read the diagram and so on. Just being over there, both on the same page. For these kind of activities I think it is really useful.”

“The principle problem which arises in this kind of knowledge repository is how to structure it. Which is not simple and it will be simple if only one person had to look at it. But different persons especially with different knowledge backgrounds, with different mental approaches, and so on, will have or could have some problems in finding the right information on the site. For example what I have seen while Giacomo and me understand each other almost at first sight so if I tell him, okay, I found this important information, I already uploaded it on the platform, if it's not at first time, at second time Giacomo finds the page almost immediately. Well, with Alex, who has a completely different knowledge and approach, because he is a designer, not a chemist or scientist, he can have difficulties whenever he tries to reach the right location through browsing in the internal part of the platform and not using the search tool. So this is why for example on Tuesday I asked George if it is possible to build up a specific page with the site map of the internal [area of the platform] which will be of great help... Most times it is enough to see the title of the page. It is not necessary to go into it. But as soon as you have the whole structure of the internal area you can say: This information is not here, but it must be over here. And you are able to hit it immediately. I think this could help really a lot.”

As can be seen from Figure 2, each of the composite boundary objects identified comprises marginal objects from several knowledge boundaries (connections to marginal objects, in the figure). Starting
from incidents reported by the interviewed actors, it was possible to step by step inquire the relations between involved marginal objects. In the inquiry process the actors regularly reasoned about their actions with regard to these objects. We do not believe that this primary analysis will prove complete in the sense that all incidents, composite boundary objects, or coordinative effects have been identified by us. On the contrary, we believe that various other inferences have taken place, which cannot be sufficiently explicated. At the same time, we assert that our approach was able to make certain important correlations visible which had before not been reflected upon by the involved actors.

5 Discussion and Conclusion

We conducted an in-depth case study of an inter-organizational innovation project team in the early phases of NPD. In qualitative, episodic interviews, we identified several marginal objects used in the cooperation, and our interpretation suggests that most of them serve as boundary objects. In the interviews, various incidents were reported, leading to effects that were coordinated with help of these boundary objects. In order to characterize the emerging landscape of boundary objects, we built on a framework developed by Carlile (2002; 2004). With help of this framework we grouped the identified boundary objects into three knowledge boundaries. Other authors report that boundary objects themselves can provide for coordination (e.g. Bechky, 2003; Lee, 2007; Levina and Vaast, 2005; Koskinen, 2005). However, in our case study we found that coordination of the project team is not accomplished by the identified marginal objects separately. A reflection on incidents, events, and stories reported in the interviews suggested that several artefacts together provide for coordination of involved actors, thus suggesting the presence of composite boundary objects (CBOs).

We identified three CBOs in our analysis, which triggered various coordinative effects, each consisting of a different portfolio of boundary objects. We were able to see the following characteristics about CBOs: (i) They are abstract, and come into existence through incidents triggering complex interactions between marginal or boundary objects, actors, and the work environment. (ii) They exist temporarily, and are subject to dynamic processes during their lifecycle. We assume that they may dissolve with the finalization of the coordinative effect; a supposition that will need to be validated in future research. (iii) They are composed of several elements, and this composition might change during their lifecycle. In addition, we assert that a CBO also needs to comply with the definitions set forth by Star (2010), stating that they need to be “based in action”, as well as subject to reflection and local tailoring.

The CBO concept helps explain how coordination can take place even though single marginal objects do not provide for coordination by themselves. This helps to explain and retrace coordinated interactions, even though no coordination was intentionally arranged for by the actors. This in turn opens up new avenues for IS research. Apparently, a combination of different factors and types of objects – abstract and material artefacts, such as tools, as well as unspoken routines or standardized methods – can affect teamwork considerably, eventually leading to re-arrangements of the goal setting or solution strategies of involved actors. Our approach provides a way to make this yet invisible combination tangible. It calls for a shift of focus in IS research on boundary management from single artefacts to clusters or environments of boundary and marginal objects. While this insight is not new (Orlikowski, 1992), future research needs to further investigate the challenges emerging in this respect, bearing in mind that often a larger portfolio of systems is employed to accomplish cooperative activities. Better understanding the lifecycle, or temporality, of composite boundary objects might suggest further promising approaches.

We provide an alternative view on coordination via boundary objects. The dynamic processes leading to coordinative effects, which we have not detailed in our investigation so far, may be described in more detail by looking at approaches from adaptive structuration (DeSanctis and Poole, 1994) and appropriation (Thomas and Bostrom, 2010). We believe that this might help derive guidelines for an adaptive design of IS in the considered context (Hevner et al., 2004; Majchrzak et al., 2000). We see our major contribution in a first conceptualization and definition of CBOs, as well as in describing
their emergence and significance in the context of inter-organizational innovation activities. We also provide a method to map portfolios of boundary and marginal objects and artefacts, with the objective to explicate their distinct roles in coordination. We hope that future research on CBOs might bring new light into understanding better the management of cooperations in cases which so far were believed to be broadly unstructured, or uncoordinated.

Acknowledgments

The study outlined was supported by the European Commission’s Seventh Framework Programme within the scope of the SmartNets project.

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