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Boundary Objects or Coordination Mechanisms?

Klaudia Çarçani
Østfold University College, klaudia.carcani@hiof.no

Harald Holone
Østfold University College, harald.holone@hiof.no

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Klaudia Çarçani[1]and Harald Holone[2]

[1] Østfold University College, Halden, Norway
[2] Østfold University College, Halden, Norway
klaudia.carcani@hiof.no, harald.holone@hiof.no

Abstract. Boundary Objects (BOs) and Coordination Mechanisms (CMs) are terms with a long history in CSCW. They have both been used widely since their initial definition. We find the concepts used in the same settings to describe some form of cooperation among different peoples or group of people. Sometimes it seems that the choice of concepts has not been thought through. Thus, in this paper, we give a detailed description of both concepts, and then we discuss them side by side by highlighting six issues that researchers should take in consideration before defining an object as a coordination mechanism or a boundary object.

Keywords: Boundary Objects, Coordination Mechanisms, CSCW

1 Introduction

Computer Supported Cooperative Work (CSCW) is the scientific field concerned with how cooperative work can be supported by means of computer systems [1, 2].

During more than three decades of the establishment of the field [2], many concepts and theories have been articulated in CSCW. Boundary Objects (BO) and Coordination Mechanisms (CM) are terms with a long history in CSCW. In this paper, we aim to discuss both concepts and clarify what constitutes one or the other. Moreover, we aim to define some important issues to consider when evaluating if an object used among different actors or groups of actors is a coordination mechanism or a boundary object.

Our interest in this discussion originated during a conversation about the application of these concepts in a research project where we were investigating how technology could support a patient journey. The journey starts at the hospital and moves into the local community and local care services, and sometimes back to the hospital. Initially, we were discussing the concept of BOs as the right notion for a system that would support the communication and cooperation among the hospital and the local care as two different social worlds. Further, we started considering the concept of CM as an object that facilitates cooperative work. We noticed that the CM concept could have more articulative power in our case. Thus, we see the need for a thorough review of the two concepts and their use in CSCW. Reviewing literature in CSCW conferences and journal, we found that in papers where both concepts are mentioned, the

authors seem to have applied it to their respective cases without paying much attention to the details of the concept definitions.

In this paper we aim to make a concept review for both concepts, analyse the differences and similarities, and come up with some central issues that need to be discussed once a researcher chooses to apply the concepts of BOs or CMs.

In the rest of the paper, we present why the clarification of what is CMs and BOs can be beneficial, followed by a description of our methodology. Further, we present a detailed analysis of both concepts as they have been defined in the seminal papers: Boundary Objects in Star and Greisemer (1989) and Coordination Mechanisms in Schimdt and Simone (1996) [3, 4] and how the concepts have been interpreted by other authors. The purpose of this analysis is to provide a clarification of the concepts. Finally, we discuss six main issues that should be considered while discussing both concepts and how the concepts differ from each other in each of these issues.

2 Boundary Objects or Coordination Mechanisms?

The role of artefacts has been conceptualized in different ways within CSCW. In this paper we discuss what constitutes CMs and BOs, referring to the seminal definitions in [3] and [4] and what differentiates and unites these concepts. Both concepts have affiliations to symbolic interactionism and the work of Strauss [5], but provide different contributions to the understanding of artefacts. The usage of both concepts in analysing different cooperative work settings is not new. Many authors have used the concepts in their analysis, for example [6-10].

The curiosity sparked by the discussion of the usage of these concepts in our research project and increased after trying to find clarification in the literature. For example, reading about BOs in Trompette and Vick's paper [11:1]. In the introduction, they write: *"Susan L. Star and James R. Griesemer (Star and Griesemer, 1989) introduced the notion of boundary object on the basis of an ethnographical study of the coordination mechanisms of scientific work."* They use the "*coordination mechanisms*" two more times in their paper, without referencing to Schmid and Simone [4]. This makes us think that they use the term in its daily meaning, and not as a defined concept. However, within the field of CSCW both concepts have relevance, and thus, it is important to use them accurately in order to avoid confusion. Moreover, an illustration on how the choice of the concept can influence the analysis and conclusion are the papers [12, 13]. They both study emergency medical services, but while Kristensen, Kyng [13] focuses on analyzing the Common Information Space (CIS) and the coordination mechanisms in place, Zhang, Sarcevic [12] analyses the emergency services by considering the patient as the BO. This shows how the choice of the concept influences the analyses of a situation. Symon, Long [14] discuss work coordination in a hospital context. One of the objects used at the hospital is what they call the "report form". The authors describe the report form as a boundary object. However, the form coordinates the work among different actors who are in consensus with each other and influence each other's work. This is more in line

with the definition of CMs. The lack of reflected use of the concepts reinforces the relevance of this paper.

Schmidt and Bannon's [4] paper was written after Star and Griensemer's [3] paper. Star and Griesemer's paper is not referenced at all by Schmid and Bannon. However, when Schmid and Bannon state that the concept of CMs is a generalisation for the many different ways in which the artefacts for coordination purposes has been used in different work domains, we find a reference to a paper of Bowker and Star [15]. So what Bowker and Star discuss as a BO in Schmidt and Bannon is inserted under the umbrella of CMs. However, there is no explicit discussion of the concepts side by side. Star revisited the concept of BOs in [16], without mentioning or referencing CM which by that time was defined and widely used in CSCW literature. Cabitza and Simone [17] in their paper on Computational Coordination Mechanism (CCM) refer to BOs and Boundary Infrastructure (referring to the book of Bowker and Star [27]) when they talk about categorical work. While they articulate the connection with the categorical work, they don't make any analysis or reflections on how the concept of BOs could relate to the CCMs that they present in the paper.

Zhang, Sarcevic [12] defines material and immaterial coordination mechanisms compounding a common information space (CIS). Within the material coordination mechanism, they list the common artefacts, which they identify as boundary objects [12].

Bossen and Markussen [6] dedicate a section to clarifying both concepts, BOs and CMs. They state that "*boundary object focuses on different social worlds (or communities of practices) and emphasizes how communication across these is achieved through standardization and formats that strike a balance between plasticity and robustness. On the other hand, the concept of a coordination mechanism focuses on how articulation and coordination of action among distributed actors within a social world are enabled and stipulated"* [6:620-621]. Moreover, they conclude that none of the concepts are good enough to explain the system they are analysing and the system actually shows characteristics of both. This is an example on how a clarification of the concepts can help the analysis of systems used in cooperative settings.

A similar discussion of both concepts is present in Hertzum [18] "Small-Scale Classification Schemes: A Field Study of Requirements Engineering". Both concepts are used to analyze and discuss the classification schemes. He states that *"while coordination mechanisms focus on how classification schemes enable cooperation among people pursuing a common goal, boundary objects embrace the implicit consequences of classification schemes in situations involving conflicting goals"* [18:35]. In a final analysis Hertzum [18] concludes that none of the concepts are able to describe the characteristics of classification schemas. Thus, he states that they become complementary in the analysis.

The cases presented above show that while the concepts have been used widely there is a need for clarification. In this paper we aim is to clarify the two concepts and highlight some issues that should be considered while discussing the concepts and how the concepts differ from each other in each of these issues.

3 Methodology

We did a systematic literature review in order to better understand the concept of coordination mechanisms and boundary objects, looking for how the concepts had been used, interpreted and amended in comparison to the seminal definition given by the authors that coined these terms. We used he following search terms for boundary objects: (“boundary object” OR ”boundary objects”) AND "Star", and for coordination mechanisms: ("coordination mechanism" OR “coordination mechanisms”) AND “Schmidt”. This decision for searching for articles that had the concept and the first author of the seminal paper, was made after a general literature search which showed that both concepts have been used in the literature as well as general terms, without referring to their definition in the seminal papers where they were coined as concepts. We decided to look for papers in ACM (which includes CHI, the CSCW and GROUP conferences, among others), the CSCW journal and ESCW conference as the main venues where the concepts have been used in the context of communication and cooperation in work settings.

We noticed that some of the main papers from Star herself were not published in these venues. Thus, we went back to Google Scholar to get a general overview of the most cited literature regarding the two concepts. We made an initial screening of the articles, and noticed that papers directly contributing with understanding or expanding/amending the concept of BOs and CMs had the name of the concepts in their titles. Thus, in Google Schoolar we serached for the concepts only on the title of the publications. The resulting list of publications was comprehensive. Hence, we decided to focus only on those papers that had a high number of citations. The result (after removing duplicates) was 185 articles to review for the concept of boundary objects and 81 articles to review for the concept of coordination mechanisms.

The initial screening of each article was based on the abstract and on a search of the respective concept within the article. We were looking for the following elements: Was the concept developed? What was considered a Boundary Object/Coordination Mechanism? Was the analysis of the concept aiming to influence the design of some sort of system? How was the concept used? In what context? Based on these elements we decided if the paper should be considered further. The main influence in the selection of articles to read further was if the concept has been analyzed or amended in the paper. Moreover, as the case that sparked our discussion was in healthcare, we decided to read papers with a healthcare context in order to see what was considered as BOs and CMs.

After the initial screening, 44 articles from BOs and 29 from CMs were selected for full reading. In the list of each concept, we found a group of articles that were the same, meaning had been using or at least referring to both concepts. The results of the literature review are included in the explanation of the concepts in the following section, and common usage of the concepts as described in the previous section.

To assure that no relevant paper was left out we did a Google Scholar search with the terms (“boundary objects” AND “coordination mechanisms”), resulting with no additional papers to be included in our review. We thus concluded that our paper selection was sufficient for the purpose of our analysis.

In the following section we present and analyze both concepts and reflect on both concepts vis a vis by defining six main issues to discuss for a better understanding of whether a given object is a CM or a BO**.**

4 Concepts presentation

In this section, we will discuss the concepts of BOs and CMs. Both have been relevant in CSCW in studying the cooperative work in organisations.

4.1 Boundary Objects

Leigh Star and Griesemer introduced the concept of BOs in their 1989 paper: "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkley's Museum of Vertebrate Zoology, 1907-39" [3]. Since that seminal article, the concept has enjoyed a vigorous academic career, being deployed in different disciplinary fields [11, 19]. Different authors have used the concept of BOs as defined by Star and Griesemer [3] especially for descriptive, explanatory or analytical purposes in their research projects [20-24].

In this section, we state and discuss the concept of BOs as initially defined by Leigh Star in the seminal paper [3]. Further, we strengthen the concept understanding by referring to several other papers where Star revisits the concept of BOs [3, 16, 25-27] as well as how other authors have interpreted the Star and Griesemer [3] definition of the concept. Moreover, we present the main contributions in the literature that have attempted to amend the BOs concept.

Trompette and Vinck [11:9] state that *"the notion is sometimes employed in an anecdotal manner to refer to any artefact which is involved in coordination between actors or which is at the boundary of two worlds"*. The *"interpretive flexibility"* [16:602] that characterise the concept has been essential in deploying the concept in other disciplines.

In Leigh Star's and Griesemer's initial defininition of BOs [3], they write:

"This is an analytic concept of those scientific objects which both inhabit several intersecting social worlds and satisfy the informational requirements of each of them. 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 recognisable, a means of translation. The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds." [3:393]

We now extract and analyze parts of the above definition more thoroughly.

The BOs are defined as scientific objects which inhabit intersecting social worlds. While initially defined as scientific objects which relate well to the context in which Star and Griesemer [3] did their study, in the second sentence the word "scientific" is not there, and BOs are defined merely as objects. The other part of the sentence builds

on a concept defined by Strauss [28], social worlds. Strauss [28:119] defines social worlds as *"... an arena in which there is a kind of organization. Also, each is a "cultural area," its boundaries being" set neither by territory nor formal membership but by the limits of effective communication".* In her later work Star uses the concept of "communities of practice" along with social worlds. In Bowker and Star [27:294] they state "*We are all in this sense members of various social worlds—communities of practice-that conduct activities together*". The concept of communities of practice was coined by Lave and Wenger [29]. Wenger state that *"Communities of practice are formed by people who engage in the process of collective learning in a shared domain of human endeavour"* [24:1]. Communities of practice are based on the interest of people involved in learning collectively through partaking in a common practice. Thus, while a social world is a group of people connected through effective communication, in communities of practice that effective communication should be with the goal of learning a skill or practice. It is difficult to understand what Star meant by putting the two concepts along each other. However, in Bowker and Star [27] both concepts are used synonymously. Participation in a social world is considered as a daily learning process and in our view, this is a use of CoP that is too lose.

Moreover, the definition above states that BOs satisfy the informational requirements of each intersecting social world. The concept does not imply that the intersecting social worlds are necessarily collaborating in the sense of working toward a common goal [18]. BOs should be able not to infringe the autonomy of social worlds but at the same time facilitate communication between worlds. Referring to their case study Star and Griesemer [3] states that consensus is not always required in scientific works. In order to solve scientific problems, actors from different social worlds establish a mutual "modus operandi" [3, 28]. Thus, BOs allow communication among different social worlds even in the absence of consensus [30]. BOs serve as a means of translation among the social worlds, and each social world interprets it in their own way. Boundary objects are working arrangements, adjusted as needed. They *"are not imposed by one community, nor by appeal to outside standards"* [31:322]. BOs have the characteristic of bridging intersecting practices [32].

Star and Greisemer [3] define not only BOs but also methods standardization as the mean for communication among intersecting social worlds. Standardization is integral to the definition of BOs. It is due to this standardization that BOs are established and used. In Star and Greisemer [3] "method standardization" was initially established by one of the social worlds, by building on a common goal among all the involved social worlds. "*Preserving California's native fauna*" was the common goal shared by different social worlds and that was the incentive for the different social worlds to establish a common (standart) way to work together while still preserving their identity.
As state above in the definition *"boundary objects are plastic enough to adapt to local needs of these social worlds they are mediating but at the same time robust enough to be able to maintain a common identity across sites"[3:393]*. As Star refer to this in [26], BOs are *"weakly structured in common use but strongly structured in individual site use"*. Other authors have looked closer at the plasticity and robustness of BOs. For example, Fujimura emphasizes the need to augment the robustness rather than the plasticity of Boundary Objects, when these have to travel between diverse social worlds, and suggests the term 'standardized package' as an alternative to more

robust boundary objects [21]. "Information objects and knowledge artefacts" are as other concepts developed to expand on the term and the rigidity of the boundary objects [33]

BOs, as defined above, may be abstract or concrete objects. Pennington [34] refer to BOs as material artefacts. Meanwhile, other research refer to more abstract and immaterial nature of BOs (e.g. [13]).

Moreover, BOs are not static. They change due to changes in involved social worlds or communities of practice [35, 36].

Two decades after the initial BO paper, Star writes an article titled "This is not a BO" [16]. She aims to clarify the concept that she and Greisemer defined and it is now mostly synonymised with interpretive flexibility. She sheds light on what boundary means to her: "*a shared space, where exactly that sense of here and there are confounded*" [16:602]. Moreover, she explains what object means for her: *"In common parlance, an object is a thing, a material entity composed of more or less well-structured stuff. In the term ''Boundary Objects'' I use the term object in both its computer science and pragmatist senses, as well as in the material sense. An object is something people (or, in computer science, other objects and programs) act toward and with. Its materiality derives from action, not from a sense of prefabricated stuff or ''thing''-ness.*" [16:603]. Thus, Star claims materiality of the boundary objects but expanding the term of materiality into something that derives from actions and is not indispensably prefabricated stuff.

Star and Griesemer [3:410-411] list four types of BOs:

- Repositories – piles of objects indexed in a standard way.
- Ideal type or platonic objects – an object which is abstracted from all domains and can be vague.
- Terrain with coincidence boundaries – objects that have the same boundaries but a change in the internal compounding.
- Forms and labels – these are objects that serve as methods for common communication among disperse workgroups.

Bowker and Star [27] later added the classification system as an additional type of BOs.

In the definition above and the explanation, we notice that the rhetoric used considers BOs as concepts or material artefacts that have already emerged as a means of translation among social worlds. Thus, a wide range of research has been concerned with how these objects are actually created and manipulated to establish a shared understanding with different audiences [30, 37-39].

One of the main contributions comes from Lee [40] who coined the concept of boundary negotiating artifacts. Lee refers to those artefacts that are used to negotiate and develop understandings among distinct perspectives between social worlds. She states that "*artefacts and boundary objects are likely to be related and to vary in prevalence along a continuum from routine to non-routine work"* [40:314]. Lee suggests that the term Boundary Negotiating Artifacts might be better suited for projects that are non-routine and complex. Boundary Negotiating Artifacts are created when collaborators lack standardized processes and objects for collaboration (ibid.). However, the Boundary Negotiating Artifacts addressed by Lee can primarily be consid-

ered to be auxiliary artefacts, in the sense that they mediate work on a specific object, rather than being the object of work itself. They serve as mechanisms of pushing boundaries, and through negotiation build a common base of reference [41].
Other relevant concepts that refer or build on BOs will be listed below, as a way to open up the opportunity to the readers to search further how BOs are positioned regarding other relevant concepts in CSCW. However, these concepts are not part of the scope of the paper and will not be referred further.

"Assemblage" as a complex system that includes boundary objects, the practices around these objects (including organizational policies), work processes and coordination mechanisms within these objects, and special functions for designated groups [42].

Bowker and Star [27] introduce the concept of boundary infrastructures. Boundary infrastructures serve multiple communities of practice simultaneously and often contain a selection of boundary objects. Boundary infrastructures are developed over the course of time to provide stable support for collaborative activities.

Boundary zones, coined by [43]. It refers to the alignment of interests among stakeholders. It doesn't necessarily include boundary objects. It is the area where the social worlds interact, and the continuous collaboration of the social worlds can result in boundary objects or boundary infrastructures.

Boundary specifying objects - Pennington [34] defines two classes of boundary objects: 1) those that specify viewpoints and fully mediate their interaction which she calls boundary specifying objects, and 2) those that negotiate interaction between viewpoints on which she refers to the concept of boundary negotiation objects. Thus, she refers to boundary objects as an umbrella term including both boundary specifying objects and boundary negotiating objects. She states that the concept "boundary object" should refer to any artifact that is used to cross community boundaries, whether it is used for negotiation, for specification, or for any other boundary crossing process. Regardless of how it is used, it is an artifact at the boundary between communities. Moreover, the seminal definition of BOs is considered by Pennington as a boundary specifying object.

4.2 Coordination Mechanisms

The initial definition on CMs is presented by Simone, Divitin and Schmidt [44]. However, most subsequent use of the concept references "Toward a Conceptual Foundation of CSCW Systems Design" by Schcmidt and Simone as the seminal publication of the concept [4:165-166]. They define CMs as:

"a specific organisational construct, consisting of a coordinative protocol imprinted upon a distinct artefact, which, in the context of a certain cooperative work arrangement, stipulates and mediates the articulation of cooperative work to reduce the complexity of articulation work of that arrangement."

One of the main pillars of the concept is the articulation of cooperative work. Thus, making cooperative work and articulation work two important concepts to explain and understand CMs. *"Cooperative work is constituted by multiple interdependent actors, which interact through changing the state of a common field of work*" [4:158]. In

order to restrain the distributed nature of complexity interdependent activities, the actors need to articulate the distributed work [4].

In cooperative work, there are individual interdependent activities, which are distributed in time and space. The actors who cooperate with each other are "*semiautonomous in terms of the different circumstances they are faced with in their work as well as in terms of their strategies, heuristics, perspectives, goals, motives, etc."* [4:158]. The change in state of one's individual field of work consequently changes the common field work where others also operate. Thus, to avoid confusion, there is a need to articulate the individual and still interdependent activities (which is how articulation work has been defined by Strauss [5]). Articulation work becomes complex in really interdependent and complicated work arrangements. Thus, to reduce the complexity of articulation work specialised artefacts are needed. This is where the CMs enter the scene.

In the definition, we notice that two elements constitute a CM. One is the coordinative protocol which denotes procedures and conventions stipulating the articulation of interdependent distributed activities and ways of achieving cooperation among different actors. The other is the artefact, which is a distinct and persistent symbolic construct where the protocol is imprinted and objectified. It has an ad-hoc nature [4].
Cabitza and Simone [17] in their paper on Computational Coordination Mechanisms state that the term coordination mechanism can be interpreted, in the most general terms, as any kind of construct that is at least in principle computable and whose aim is to organize activities performed by a group of actors that are called to cooperate for some purpose or reason.

CMs are rooted in symbolic interactionism. Thus, they are a valuable resource for situational action. They provide actors with some predefined procedures that they can act upon. In this way it reduces the range of possibilities for action by identifying a valid and yet limited set of options for coordinative action in any given situation [4]. CMs can be weak stipulations, which serve more as a guideline of how actors should behave, or they can be a strong stipulation in the role of a script where the actors get a set of instructions on how to behave in a cooperative setting in order to get the job done [4]. However, the artifactually imprinted protocols do not represent what actually happens in the work setting, and there will always be a situation which will go beyond the boundaries of a CM [4]. It is important for the CMs to be flexible enough that it allows the deviations of workflow from the protocol, without being totally discarded.

Referring to the definition of a CMs presented above, the CMs is called so only in the case of an artifactually imprinted protocol. The artefact is central in denoting the changes in the protocol. It may be the information in the artefact itself or its location etc. that might constitute the change in the protocol and consequently the change in the state of work. In most work situations, there will be more than one CM. They might interrelate with each other and influence the execution of each other.

Finally, it is important to understand what the artefact is in a CM. It can be a paper artefact. a kanban system [4], or a computational artefact [17].

The concept of the coordination mechanism, as defined, clearly describes material artefacts. This approach has been considered to be narrow by Bossen in [7], who em-

phasizes that organizational structures and divisions of labour also facilitate coordination of work since they explicate who does what and when. Thus, Bossen uses the term immaterial mechanisms of interaction for these other constructs which facilitate articulation of cooperative work [7].

Ordering systems are considered a special case of coordination mechanisms defined as the work that helps people create an order from a vast collection of items. However, Cabitza and Simone [17] state that the genesis of ordering system is described by the concept of categorical work presented in Bowker and Star [27] and their work on the classification schemas.

Some important related concepts with coordination mechanism are:

Awareness – "*while the property of awareness is conceptually distinct, it is brought about through accountable acts of communication and the operation of some types of coordination mechanism*" [45:533]; B

Common information spaces – A concept applied to *"examine how understanding of shared information or objects is constructed in particular settings"* [12:935].

5 Discussion

In this section, we will present six issues to discuss and consider when deciding to make use of the concepts of Boundary Objects or Coordination Mechanisms. Table 1 is a summary of the terms of discussion elaborated below.

Table 1. Summary of the discussion.

BOUNDARY OBJECTS	COORDINATION MECHANISMS
Helps the translation of information among Social Worlds/Communities of practice	Facilitates the articulation work for cooperative work among Actors
The social world preserve autonomy by pooling in the intersection only the necessary information • Enhance communication but without interfering in each social world activities • The changes made in one social world do not necessarily trigger actions in the others	Semi-autonomous actors • The activities of actors will change based on their cooperation • CM will serve as the incentive of changing the status of an activity happening in a cooperative work setting, thus triggering other activities for other actors
Social worlds do not need to achieve consensus regarding the individual goals of each social world, but they should agree on the effort put in translation and cooperation among the intersection social worlds	The consensus is required among actors in order to get the work finished

It may be an abstract concept or a concrete artefact	Imprinted coordination protocols - constituted by the coordination protocol AND the artefact
Weakly structured in common use, strongly structured in individual use	Strongly structured in common use

Who is involved? BOs are defined in the intersection of social worlds or communities of practice, while CMs aim to support the articulation of cooperative work among different actors. Thus, the actors in CMs could belong to the same social world as Bossen and Markussen [6] state or could be used to coordinate work among actors that belong to different social worlds or communities of practice.

In the case of CMs the focus are actors that cooperate for a common work goal. In BOs the reference to social worlds and later communities of practice creates difficulties in envisioning the role of the concept due to the flexibility in interpreting what can be considered a social world. In Bowker and Star [27:294] social worlds and communities of practice have been used as synonyms. Wenger defines communities of practice as collaborative learning communities by focusing on improving practice [24]. While communities of practice are focused on collaborative learning, social worlds is a more general term. The aim in this paper is not trying to define social worlds or communities of practice and when is the correct way of using them. However, we want to clarify that when researcher uses the BOs concept they should have a clear understanding of their social worlds or communities of practice. In this way, their analysis of the objects that sit in the intersection of these social worlds or communities of practice will be more rigorous.

Application. Even though Star in [16] restates the focus of BOs in the work setting, the usage of the social world as a term borrowed by Strauss or communities of practice from Wenger gives it a more general spectrum of applications than the clear positioning of CMs within work settings and cooperative work.

If we narrowly analyze the definition of BOs and the terminology used, we can relate BOs with scientific collaboration settings where researchers have different research interests. Leigh Star initially defines BOs as scientific objects. In the case of the Museum of Vertebrate Zoology [3] she also refers to the attempt to create scientific knowledge. Moreover, communities of practice focus on learning, and might intersect with other communities of practice in order to help to achieve some information that can increase their knowledge. Based on this analysis we could argue that BOs can be found more in cross-disciplinary research and are objects aimed to facilitate scientific collaboration. However, Star also defines BOs as objects which intersect many social worlds. This definition adds interpretive flexibility to the concept , and Leigh Star [16] emphasizes the interpretive flexibility in her last paper regarding BOs. The conclusion is that we find CMs in cooperative work settings and BOs in a broader set of situations, perhaps with a special focus in scientific work.

The relation between actors and activities. In CMs actors and their activities are semi-autonomous. The activities of one actor could change the common work space and consequently change the state of the work space for the other actors. Meanwhile, BOs facilitate the communication and translation of information between social worlds without infringing their autonomy. Only those parts of the work which are essential for maintaining coherent information across the social worlds are pooled in the intersection. The work of one social world does not stop the workflow in the other social worlds. However, Star and Greisemer state that "*Each world is willing - for a price - to grant autonomy to the museum and to conform to Grinnell's information-gathering standards."* [3:407]. Thus, by using BOs, the actors keep their autonomy focusing on the ability to pursue the individual goals in each social world, whilst still contributing towards a common shared goal or for a price. With CMs people need to work together to make the job done. They don't choose to do so as part of a bigger goal; the do so because that is the only way for having the work finished.

BOs are used to support the communication between different worlds but without radically changing the routine activities that happen in each of the worlds. The social worlds preserve autonomy in their activities. Maintaining BOs can be a small extra part of their activities that they do due to the common goal. The modification made in the information that BOs carry between social worlds will be visible for the other social worlds. However, it will not trigger any specific activity in another social world.

Meanwhile, CMs can be weak stipulations of cooperative protocols, which might serve as guidelines for its actors, or it can be strong stipulations where actors have to follow the instruction to get the work done. A CM introduced in a working place will influence and change the activities of each actor in order to comply with the coordinated work. The protocol associated with a CM will define the working procedures and how each of the actors works with the CMs. CM will serve as the incentive of changing the status of an activity happening in a cooperative work setting. It might trigger another actor to initiate an activity.

Achieving Consensus. Star and Griesemer [3] states that when using BOs different social worlds do not need to achieve consensus among each other. They are interdependent, but they might enter in collaboration even without a consensus by establishing a modus operandi. Reflecting on these issues we would argue that social worlds do not need to have a consensus regarding indiviadual goals in each social worlds, but they need to create a consensus on how the translation and collaboration with each other will be. Lee [40] defined Boundary Negotiating Artifacts as a concept to refer to objects that were used in the phase where social worlds negotiate boundaries and consensus. That can lead to established BOs. Instead, establishing CMs require the actors to be in consensus first regarding the protocol and how the work will be done, and then how this work could be facilitated through CMs.

Materiality. Based on the definition of BOs in Star and Griesemer [3], boundary objects may be abstract terms or concrete objects. That is as well how the BOs have been used in the literature both as an abstract and concrete object. Moreover, Star tries

to shed light on this part of the concept in [16], saying that an object is something people act toward and with and does not relate to it ting-ness. Instead, a CM cannot be a concept. It is an imprinted coordinative protocol, constituted by the coordination protocol AND the artefact. Thus, BOs create more flexibility in materiality than CMs.

Structure. BOs as shown in the definition presented above in the section Concepts Presentation, "*are weakly structured in common use but strongly structured in individual use"[3:393]*. They are robust enough to be recognized among social worlds and flexible enough to be used in each of the social worlds. While they have a vague definition on a larger scale, once applied in the specific social world, it gets its well-defined shape [26]. The BO is then used individually, without intervening with work in other social worlds. This is illustrated by the example of the field note form used by Star, which shows that the forms are understandable among social worlds, but they are used specifically in each of the worlds for supporting internal social world activities. This is different with CMs. The changes that one actor does in a CM are reflected in the common work field and would influence the work of others. Thus, it needs to be strongly structured in common use.

6 Conclusion

This paper aims to clarify the concepts of BOs and CMs. We present a thorough analysis of each of the concepts, and we discuss them side by side by emphasizing six issues that a researcher could refer to before using the concepts. The issues have been analyzed in detail above. It would be beneficial for the researchers to discuss these issues and be clear what each of them pertain in their case. Hence, they can use the concepts in an adequate way and make use further of the strength of each of the concepts in analysis.

While the above-mentioned issues help in clarifying if the researcher refers to a BO or a CM the analysis could be influenced by the scope and scale of the analysis and from which perspective the analysis is conducted. Star [16], while discussing what is not a Boundary Object defines scope and scale as two main elements in influencing what could be considered or not a boundary object. The aim for future work is to apply the concept analysis in a practical case and discuss how they might be interrelated with each other.

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