The Process of Creating Boundary Objects: The Case of a Knowledge Management IT Artefact

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Introduction

The analytic concept of *boundary objects* has attracted the significant attention of scholars who aim to explain complex phenomena of communication and cooperation across different social worlds. Boundary objects are instantiated by *artefacts*, which enable the coherent translation of the divergent interests of those worlds, and also satisfy the information requirements of each of them (Star & Griesemer 1989). Any artefact that constitutes a linchpin between diverse groups is qualified as a boundary object. An increasingly important category of those objects concerns information and communication technologies (ICTs); they are considered common reference points and are locally useful by multiple users within an organisation (Pawlowksi & Robey 2004). Most studies examine what boundary object do in various settings, while very few accounts investigate how boundary objects, and especially ICTs, are actually *created* in practice (Levina & Vaast 2005). However, the activity of *creating* boundary objects, is "…a key process in developing … coherence across intersecting worlds" (Star & Griesemer 1989, p. 393).

We thus intend to address that gap in the literature by examining how a knowledge management (KM) IT artefact[1] was gradually envisioned as a meaningful *boundary object* in an organisation. We explore the dynamics evolving around the *creation* of the "boundary capacity" of that technology, which would become locally usefully and with common identity across different worlds (Star & Griesemer 1989). Drawing on the perspectives of recent process-based studies that examine boundaries and boundary objects, (Carlile 2002, 2004, Carlile & Rebentisch 2003, Bechky 2003a, b), we seek to answer the following questions: (1) what are the dimensions of, and which factors condition the development/creation of the boundary capacity of an IT artefact, and (2) in what way do they shape and are shaped by the actions and interactions of organisational actors throughout that process?

We use the term *dynamics* to emphasise our focus on the recursive activities that take place throughout the processes of creating a boundary object. We examine those processes on the premise that it isn't *either* the characteristics of the artefact *or* the

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[1] We use the term KM artefact or technology to refer to a software/IT application embedding KM principles.

situated context that condition whether the artefact will acquire a boundary capacity. To avoid that dualism of objectivity versus subjectivity (Black et al 2004), we use a *relational lens* and argue that "artefacts develop their properties only *in relation to* (emphasis added) other subjects, social groups, or networks (Østerlund & Carlile 2005, p. 92)". Engaging in an "interpretive discourse" (Schultze & Leidner 2002), we assume that a KM artefact will become a boundary object in an organisation, not because of its functionalities, but because meaningful *relations* between the artefact and the organisational practices will develop; it is the *relations* in which the "boundary capacity" of an artefact is inscribed. By observing the actual relational processes, we endeavour to understand the various structuring patterns that emerge. Furthermore, laying an emphasis on dimensions not only of convergence (Carlile 2004, Bechky 2003a), but also of divergence of those processes, we seek to understand the influence of *time* and *uncertainty*, because they appear to constitute significant "macro influences" (Schultze & Orlikowski 2004) on the structuring of emergent organisational phenomena (Huy 2001, Crossan et al 2005).

Contextualising our investigation, we explore the relational dynamics during the process of relating a KM artefact in a big banking organisation, and of envisioning benefits in relation to its future use. IT based KM has recently become the focus of both scholars and practitioners (Schultze & Boland 2000, Davenport & Glaser 2002) because supporting processes of knowledge sharing and creation have been recognised as critical for acquiring and sustaining competitive advantage (Massey et al 2002). In essence, KM technologies need to acquire the qualitative characteristics of boundary objects. As Alavi & Leidner argue "…the very essence of knowledge management challenge is to amalgamate knowledge across groups for which IT can play a major role" (2001, p. 112). Yet, there have been hardly any studies studying the creation of their boundary capacity, which faces additional challenges due to the complexity of those technologies (Newell et al 2000). Using a relational lens, we explore to offer potential explanations and shed more light on that important process.

In what follows, we first lay out the multiple perspectives on the ways boundary objects have been used. We then outline our own perspective by emphasising the need for a relational perspective in studying the processes of creating such objects, and by exploring the concepts of time and uncertainty in relation to our investigated

phenomenon. We elaborate our perspective by drawing on our longitudinal study, which was conducted in a big Greek banking organisation, which we name after the pseudonym "New Bank". Focusing on the efforts of New Bank's managers to relate a KM artefact with their organisational context, we investigate possible explanations on the relational dynamics. Finally, we conclude the paper by discussing broader implications for studying settings, where the creation of boundary objects is desired.

An Overview of Perspectives on Boundary Objects

The concept of boundary objects appears to have increasingly magnetised the investigation and analysis of boundary spanning phenomena in organisations. Boundary spanning describes activities that occur at the *boundaries* between different groups with different tasks and activities and with a need to cooperate for a common goal. For example, new product development usually requires the cooperation of many different groups, such as designers, manufacturers, technicians and marketers; cooperation between those groups inevitably faces significant challenges. There are usually challenges associated with transferring (von Hippel 1994, Szulanski 1996) and translating information from one world to another; there are problems of information integrity and translation (Dougherty 1992). The more complex those problems are, the higher the complexity faced at the boundaries between diverse groups. In essence, the importance for studying boundaries stems from the *diversity* which characterises different social worlds and makes problematic the integrity of information and/or knowledge as it flows from one world to another, i.e. when people attempt to cross those boundaries. Star & Griesemer (1989) argue that boundary objects enable the shifting and spanning of boundaries between diverse intersecting social worlds due to their capacity to ensure coherence of translation of their divergent concerns. Such objects are "…both plastic enough to adapt to local needs and 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" (Star & Griesemer, 1989, p. 393).

Since its original conceptualisation by Star & Griesemer (1989), boundary objects have been widely used to explore a broad range of settings where boundary spanning

activities are critical. Examples are: engineering drawings and sketches as enablers of communication across different occupational communities, (Henderson 1991), "perspective taking" processes between different communities of practice (Boland & Tekansi 1995, Karsten et al 2001), classification systems (Bowker & Star 1999), computer supported cooperative work (Lutters & Ackerman 2002), enablers of the knowledge brokering work of IT professionals (Pawlowski & Robey 2004) and of management accounting change (Briers & Chua 2001), knowledge sharing and integration across communities of practice in new product development settings (Carlile 2002, Bechky 2003a). In addition, a few studies have also utilised the concept to investigate multiparty activities of design and development of information systems, since "design is a collective activity, where several people work together" (Bødker 1998, p. 109). Various artefacts and representations in design practices mediate the communication between different groups and the process of synthesising their diverse interests; e.g. between designers, between designers and managers, between designers and end-users. Goodwin and Goodwin (1997) posit that the multitude readings of a design representation, a fundamental property of boundary objects, is the place from where the future technology and its use must be understood and developed. Tudhope et al (2000) also illustrate that prototypes are important in design activities, since they facilitate negotiation and communication practices between users and developers.

Although most scholars examine what boundary objects do in different settings, our approach for studying boundary objects is more in keeping with Carlile's (2002, 2004) and Bechky's (2003a, b) perspective that boundary objects develop their properties with respect to the *boundaries*. We were sensitised by those studies on the grounds that they have a similar (to ours) focus on the *processes* of shifting and spanning boundaries between different groups. More than that, they both examine new product development settings, in which, like ours, novelty and the possibility of change is significantly high. By focusing on the boundaries and on the efforts of organisational actors to cross those and relate different social worlds, we hope to offer explanations about what may take to develop a "boundary capacity" of an artefact. Below, we elaborate on previous work on *relational perspectives*, i.e. perspectives that focus on the boundaries.

A Relational Perspective on Boundary Objects

A number of recent practice-based accounts on boundary objects examine their use in processes of knowledge sharing and integration in new product development settings (Carlile 2002, 2004, Carlile & Rebentisch 2003, Bechky 2003a, b). Those studies show that, in new product development, *relational* problems arise because of the deep differences in language and work practices across diverse occupational communities (Bechky 2003a). To frame it in an alternatively way, they illustrate that boundaries across those communities are raised due to the differences in knowledge, which is structured and develops differently in relation to their diverse practices (Lave & Wenger 1991). Relational problems emerge because organisational actors from different occupational communities need to shift those "knowledge boundaries" (Brown & Duguid 2001) in order to accommodate *relations* across each others' work. The delineation of relations is vital, since they have a shared task, i.e. new product development, which requires *across* community collaboration and joint problem solving.

Focusing on the efforts of organisational actors to identify and shift those boundaries, and create relations for their joint problem solving activities, those studies show that the impact of specific factors could explain the outcome of those efforts. In particular, the spanning of "knowledge boundaries" was conditioned by the way key *differences* in work contexts were represented (Bechky 2003a). The shifting of boundaries was also capacitated when significant *dependencies* that were of consequence between the works of different groups were defined (Carlile 2002). More than that, the influence of differences and dependencies was moderated by *novelty*; if novelty and the consequences it created in differences and dependencies were not considered, the shifting of "knowledge boundaries" and the delineation of relations for joint problem solving was problematic. Bechky (2003a) illuminates how those factors have an important impact, in her description of an event between an assembler and an engineer on the production floor of an engineering firm. Illuminating the situated processes, she shows that the assembler spoke a different language from the engineer, and had a different conceptualisation of the product (semiconductor). It was only when the engineer gave a physical illustration of how the assembler did his job that afforded

him a better understanding of the assembler's work context. The *differences* in the assembler's work practices were effectively represented by the physical demonstration and facilitated the shifting of the "knowledge boundary". In addition, the engineer identified how assembler's work "…could fit within the context of his own design practice" (Bechky 2003a, p. 324). The *dependencies* between the two communities could be defined, enabling the delineation of relations between them. Finally, such delineation was afforded because the engineer addressed the consequences of *novelty*, which were manifested when *differences* and *dependencies* between his and assembler's work were unclear.

In those contexts, boundary objects need to provide the basis or common ground, which different groups share and use to shift their "knowledge boundaries" in order to solve their joint heterogeneous problems. The adequacy of various objects to serve as that basis or common knowledge (Carlile 2004) stems from their capacity to represent not only the *differences* in work contexts, but also the *dependencies* that arise between their diverse activities (Carlile & Rebentisch 2003). When *novelty* changes the content of work in one domain or requires changes in the way different work practices are interrelated, boundary objects may not be effective because "…they do not invoke the key differences in work contexts between the groups… they do not create common ground" (Bechky 2003a, p.326). In essence, those practice-based studies show that boundary objects develop their properties when they make the shifting of "knowledge boundaries" across occupational communities and the delineation of relations between those affordable; such a relational process is conditioned by the capacity of boundary objects to account for and invoke the special properties of those boundaries, i.e. difference, dependence and novelty. Without an explicit focus on the situated processes of those boundary spanning activities, such an increased understanding of their structuring patterns would not have been afforded.

Understanding a Key Process: The Creation of Boundary Objects

Most of the aforementioned studies have advanced our understanding about the role of boundary objects in boundary spanning phenomena. However, not much light has been shed on the critical issue of how those objects are actually created. It was not

until recently when Levina & Vaast (2005) and Levina (2005) illustrated that such a process is naturally emergent and dynamic, and is not necessarily dependent on the characteristics of potential boundary objects, such as tangibility, concreteness, accessibility and up-to-datedness (Carlile 1997). Some artefacts may have some of those characteristics, yet different actors may not use them as boundary objects in practice in their heterogeneous problem solving endeavours. The scholars engage in a "dialogic discourse" in that, "it focuses not only on the constructed nature of reality and the role of language in this construction process, but also on the fragmented and multi-vocal nature of this never-ending construction process" (Schultze & Leidner 2002, p. 217). The emergence of boundary objects appears to be a matter of control over social, economic and cultural capital (Levina & Vaast 2005), which essentially constitutes a source of power. The exercise of power, as a relational resource, influences the actions and interactions at the boundaries (Levina 2005).

An Alternative Perspective

On the other side of the coin, the development of a perspective, other than dialogic, in investigating the emergence of boundary objects would advance our understanding about that important process. On the basis of that claim stands our engagement in an "interpretive discourse", which assumes a constructed nature of reality and "…focuses on the integrative values that allow organisations and communities to function in harmony" (Schultze & Leidner 2002, p. 217). Our alternative interpretive perspective employs a relational lens on the creation of boundary objects. We explore that phenomenon on the ontological premise that an artefact gains the qualitative characteristics of a good boundary object, only if organisational actors identify and deal with the *boundaries* and their properties that emerge during that process. We adopt a "…dynamic relational thinking where the boundaries between the different entities are not predefined" (Østerlund & Carlile 2005, p. 93), and argue that outside of its actual use in a specific context[2] an artefact cannot develop such characteristics.

Committed to an interpretive discourse, we also laid no emphasis on "the desirability of convergence rather than divergence at a boundary" (Carlile 2004, p. 566).

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[2] In our case, by context we mean the social and physical locus where activities of exploring and justifying envisioned uses for the KM artefact take place.

*C*onvergence, which is the refinement of a chosen solution or "exploitation" (March 1991), may be sought, yet *divergence*, which is the "exploration" of new possibilities of action or experimentation (March 1991), may also come into play. The creation of boundary objects, especially such as ICTs (Luna-Reyes et al 2005), is an inherently emergent process, in which an interplay between divergence and convergence may be unfolded.

In our efforts to understand any "macro influences" (Schultze & Orlikowski 2004) on the two situations of divergence *and* convergence at the boundaries, we believed that a temporal lens may be a useful guide in our investigation (Ancona et al 2001a). *Time* appears to have attracted the attention of both practitioners and researchers, since "social phenomena occur in time, evolve in time, and are shaped by humans whose perceptions, experiences, and interactions are formed in time" (Antonacopoulou & Tsoukas 2002, p. 857). More than that, time inherently structures events of change, yet its influence has been literally unexamined when emergent phenomena are studied (Huy 2001). Surprisingly, time has been peripherally connected to different processes of divergence and/or convergence that may emerge in circumstances of change or creation (Crossan et al 2005), such as that of creating the boundary capacity of an artefact. We explored the dimension of time, primarily motivated by the way time was *conceived* by organisational actors, and by the time pressures which may have impacted their actions (Ancona et al 2001b). Did they perceive time as *chronos*, measured by the chronometer without any purpose (Clark 1985), or as *kairos*, which is "the time not of measurement, but of human activity, of opportunity" (Jacques 1982, p. 15) and represented by events, e.g. launch of a new product, installation of an IT system etc.? Were their actions shaped by specific temporal orientations and different levels of time pressure at the boundaries that were faced?

In addition to time and in alignment with our balanced emphasis on divergence *and* convergence at the boundaries, we sought to attend to the concept of *uncertainty* in our investigation. The reason being that, during the process of creating a boundary object, the organisational actors may be faced with high and low levels of uncertainty, especially when there is no prototype to interact with (Tudhope et al 2000). Unlike novelty, uncertainty allows us to rest on the premise that what is new is easily recognised as something unknown. Uncertainty refers to the situation where "all is not

known in a given environment" (Carlile 2004, p. 557). We thus sought to investigate the influence of uncertainty on the relational dynamics observed at the boundaries characterising that process. Did different levels of uncertainty influence people's actions to create the boundary capacity of the KM artefact, and in what way? How did uncertainty impact the interplay between divergence and convergence at the boundaries?

Drawing on our empirical study, we use a dynamic relational perspective and deal with the issues of time and uncertainty in order to illuminate the process of creating boundary objects. By exploring the character of the boundaries that lie between the KM technological artefact and the organisational context, we report on the recursive actions and interactions of organisational actors to shift those in order to delineate relations.

Research Methods

Research Site

The case study we present evolved in a big Greek banking organisation, New Bank, over a period of approximately two years (February 2000 – March 2002). The bank participated in a 2 million euro research consortium[3], which aimed at developing a knowledge management (KM) system (methodological framework, software tools etc.). The system was initially envisaged as a knowledge management platform that would support work-based leaning in the workplace. The 12 participants of the project[4] were: academic institutions, technology vendors and user organisations. User organisations, such as New Bank, were companies charged with the responsibility to feed the project with user requirements, as part of the technical design process, and to evaluate the

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[3] It concerns an EU Information Society Technologies (IST) research project (http://www.cordis.lu/ist), the objectives of which were: (1) to identify factors which enable and constrain the capture, structure and diffusion of knowledge across the organisation and over time, (2) to develop an organisational methodology which facilitates the capture of both explicit and tacit knowledge, (3) to develop software applications which can store and structure the captured knowledge, (4) to develop a learning platform (including methodological guidelines and S/W applications) which nurtures at both individual and organisational levels the knowing Capability, i.e. the capability to enact the skills which are associated with putting knowledge into practice, (5) to test the system in a real-life organisational environment through action research with private companies and academic operators specialised in executives training.
[4] We use the term R & D consortium and research project interchangeably.

software application after conducting a pilot use of the system. The second author took part in the consortium as a leading member of a participating university (department of information systems development). The university's role was to inform New Bank about the software development process, to facilitate the installation of the technical system, and to assist New Bank members to conduct the pilot use[5]. The participation of New Bank was instantiated by the involvement of the vice president, the managing director, the marketing manager, a marketing employee and a technical development employee from the e-banking division, the director and assistant director from the human resource development (HRD) division, and the directors from the IT and the organisational division[6].

The year 2000 was a turning point for New Bank. It had recently completed the merging with and acquisition of two other banking groups and had transformed itself into one of the biggest and rapidly developed banking groups in Greece. The motto of the new business schema was technological and business innovation. According to the marketing manager of the e-business division:

"It is our priority to be the first to exploit every new technological challenge, which has the potential to develop to a new banking service".

The above statement was evident in almost every new initiative in New Bank, and electronic banking (e-banking) was at the forefront of those initiatives. In particular New Bank was the first bank to offer a complete e-Banking package to the Greek market in March 2000. In informal discussions with members of New Bank we were told that E-banking was just the first step towards the vision of a "virtual bank". In the words of a manager:

"The reason behind the creation of e-Banking is top management's vision to transform New Bank into a virtual bank; and the time has come for this transformation to commence."

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[5] For the pilot use, user organisations had to position the system in a specific business operation, enrich the system with context specific information and, then, conduct the test. The assistance of participating universities mainly referred to the enrichment process.

[6] Interestingly, the involvement of some of them was the result of New Bank acquiring a real interest in the KM system developed by the consortium; the events that led to their involvement are described later in this paper.

However, it turned out that such transformation was easier said than done. New Bank's preoccupation with technology excellence had been the roadblock for the effective implementation of the "virtual bank" vision, since there had been hardly any organisational preparations to support the new e-banking initiative. The employees resisted to embrace e-banking as a new business practice because they had not received appropriate training and guidance about what the new operation advocated and how it would be integrated into existing banking practices. The result was: delays in processing customer applications, breakdown of communication between branches and headquarters, and in general inability to capitalise on customers' enthusiasm, which had been cultivated by New Bank's marketing campaign for e-banking. The director of e-banking division admitted that weakness in a meeting before the launch of the research project:

"…it is a mistake to start selling the new services and products to customers when our own employees have not registered or know how to use them first."

New Bank was faced with significant challenges related to the implementation of e-banking. The participation in the R & D project was seen as an opportunity to investigate emerging KM information technologies. In the very beginning though, the members of New Bank had hardly regarded their involvement in the consortium as an opportunity to gain any tangible benefits for their rapidly changing business, affected by a highly uncertain business environment.

Data Collection and Analysis

The data were collected in a 2 year study conducted between February 2000 and March 2002 (throughout the entire life of the research project). The second author actively took part in the R & D consortium as a member of a participating university and was present at all meetings and interactions between the university and New Bank's members throughout the two-year period. He engaged in both consulting and research roles interchangeably, making him an insider participant observer (Labaree 2002). Data were collected by participating in all project meetings, the purpose, duration and composition of which varied (university – bank meetings, R & D consortium meetings,

progress review meetings). After every meeting, observations and events were documented in notes. Due to the highly subjective nature of data collection techniques, the second author also conducted formal and informal interviews with New Bank's members, analyses of documents, and project presentations and deliverables to ensure triangulation of the data (Yin 1994).

To give an estimate of the interactions over the period of the study, the second author took part in meetings with New Bank managers and employees, which took place 2-3 times per month throughout a two-year period and lasted from 2 to 6 hours. In those meetings only people from the participating university and New Bank were present. The second author also participated in 15 project consortium meetings (usually for two days and with the participation of New Bank), in 4 meetings with technology vendors (at the beginning of the research project and without the participation of New Bank), and in 8 meetings to discuss the input of New Bank in project's tasks and deliverables (spread over the 2 years).

Our analysis was underpinned by an interpretive evaluation of all available data sources (Miles & Huberman 1994). Our aim was to understand the evolution of New Bank managers' perceptions and efforts as to how they could utilise the KM artefact in their organisational context. At first, motivated by the concept of boundary objects, we tried to explore whether and how the KM technology would actually be considered by New Bank managers a good boundary object. Considering our process focus, we were particularly interested in analysing the processes by which the KM artefact would/wouldn't become an object, which is locally useful and with common identity across different worlds (Star & Griesemet 1989). Our results from that analysis led us to further analyse our data with respect to the *boundaries* that were present and need to be shifted in the process of transforming the designated boundary object – KM artefact – into a useful boundary object[7] (Levina & Vaast 2005).

Therefore, we used a relational lens and developed an alternative perspective, as aforementioned, to investigate the relational forces that condition such transformation. Exploring the relational dynamics, i.e. the recursive actions and interactions of the

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[7] Useful, at least, in the sense that New Bank managers regarded its future use in the workplace as beneficial to meet specific business needs.

people involved around the *boundary* between the KM technology and the organisational context, we sought to identify any relational forces that would emerge, and to understand the influence of time and uncertainty on those dynamics. We observed that in different phases different *processes* around the boundary were instantiated. In the beginning of the research project, we saw a process of *nominating* a boundary role for the KM; then, we identify a different process of *improvising* a new boundary role, which, in the next phase, was under a *resolving* process; at last, we saw a process of *enhancing* the boundary capacity of the KM artefact to "fit" specific organisational needs. In the following section, we present our results and our own interpretations.

Results

In this section, we provide rich descriptions of the project events and episodes in a chronological order. We give meaning to those episodes by utilising the concept of boundary objects and by employing a relational perspective as outlined above. In table 1, we summarise the most important events throughout the life of the project.

Phases	Phase 1: *Nominating*	Phase 2: *Improvising*	Phase 3: *Resolving*	Phase 4: *Enhancing*
Duration	1st – 2nd month	3rd – 5th month	6th – 12th month	13th – 24th month
Actors involved	Vice president; e-banking managing director, marketing manager, technical development employees	Human resource development (HRD) managing director and assistant director; e-banking managing director, marketing employees	HRD managing director and assistant director; e-banking managing director, marketing and technical employees; IT director	HRD managing director and assistant director; e-banking managing director, marketing director, marketing and technical employees; Organisation division director
Key events	• Research Project kick-off • Launch of e-banking • Positioning KM software in e-banking	• HRD involvement • Conception of "e-banking agent" role • Decision to support that role with KM software	• Mock-ups of the system • Completion of the software • Pre-installation meeting	• Installation of the system • Development of "e-banking agent" role • Meeting with organisation division

Chronology of Events

PHASE 1: Nominating a boundary role for the KM artefact

In the beginning of 2000, when New Bank was already invited to participate in an R & D consortium, the university members[8] engaged in informal discussions with the New Bank's vice president. Before the project kick-off, the university members described the aim of the project as follows:

"…to develop a system, which would support on the job learning and would capitalise on the work experiences of the employees. We intend to do that by utilising the concept of case studies, which is a widely used and effective method in business education."

Those discussions cultivated a specific image of KM, which was manifested by top management's later decisions. The vice president and the e-banking director recommended that New Bank's experimentation and evaluation of the system should start from e-banking, since it was a new initiative for the bank, and capitalising on everyday learning (what KM promised to offer) was a critical issue. Approximately at the same temporal point of the project launch (February 2000), New Bank started offering e-banking services (March 2000). That coincidence appears to have created a momentum for New Bank's involvement in the research project. Formal and informal talks with people from the e-banking division confirmed what New Bank expected from KM. KM's central proposition of experience capturing, retention and transfer, seemed to well suit the bank managers' priorities for continuous improvement of e-banking services, according to their confessions. Supporting an environment for sharing experiences and fast problem solving, KM was envisaged as a potentially useful tool to increase operational efficiency in terms of product and service improvements and, thus, customer satisfaction. Two months after the project kick-off, according to the director of the e-banking division:

"A technological application for KM is extremely useful in the start of e-Banking to enable the monitoring of our experience. The bank wishes to create a memory of the customer cases that used this service, in order to take advantage of the failures or the successes of the past. Besides, the e-Banking division will be able to standardise the process and, therefore, will have the chance to create multiple

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[8] From now on, we will use the term "university members" to refer to the people from the Greek university, who took part in the R & D consortium and interacted with New Bank's people.

scenarios for new customers. The electronic capturing, storage and organisation of explicit as well as tacit knowledge will provide better judgment and new opportunities for the bank. We would like e-Banking division to have all its core services run electronically to be able to increase the quality of services given to customers."

Interpretation of the *Nomination* Process

The KM technology, which was still under development[9], seemed to have found a place in New Bank's e-banking initiative. Accounting for the formal structures imposed by the R & D consortium, New Bank had to provide a business context for the KM artefact. New Bank's managers chose e-banking because it looked promising. Without having any concrete evidence of what actually the system would do, they *nominated* the KM artefact as a *boundary object,* which would potentially link, in particular ways, two different social worlds, i.e. future e-banking workers, and e-banking managers. The way in which the KM artefact was represented to the vice president, and, at a later point, to people from the e-banking division appears to have significantly mediated the nomination of KM as a potentially value adding technology for e-banking. The university members articulated the offerings of the future system in a manner which demonstrated some relevance to and benefit for New Bank's needs for e-banking. The director of e-banking puts in plain words how he imagined the KM artefact could satisfy his information requirements, i.e. *creation of a memory, development of scenarios for customers, supporting decisions for new opportunities, and improvement of customer services through computerisation.*

A Relational View of the *Nomination* Process

A relational focus on the nomination process will further allow us to understand the underlying factors that conditioned its evolution and outcome. A relational analysis essentially requires the decomposition of the relative complexity of the *boundary*, which in our case "sits" between the KM artefact and the organisation. Initially, New Bank members started *working on* that boundary by understanding what the technology was about. The unpacking of the knowledge embodied in the future artefact by the

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[9] The development of the system, which was software based, was planned to take place for a period of approximately one year (February 2000 – February 2001). In the development phase, mostly universities and technology vendors were involved. The contribution of user organisations, like New Bank, was minimal as to what functionalities the system would have and how it would support knowledge processes, i.e. capture, storage, structure and representation of knowledge, for dynamic learning in the workplace. Mock-ups were available around six months before the accomplishment of the system development.

university members allowed New Bank members to identify the fundamental elements of the KM technology; they recognised generic *differences* between what the technology could do and what their organisation was in the need for (Carlile & Rebentisch 2003). More than that, New Bank members were able to see *how* the technology could fit their business context; they were able to define generic *dependencies* between the KM artefact and the e-banking activities. Yet, there was high *uncertainty* with respect to the actual technological offerings and the ways that e-banking work practices would be supported. During that initial phase, what emerged as important was to identify a possible boundary to work on; New Bank members defined that boundary as lying between the KM artefact and e-banking.

In addition, the nomination process appears to have been conditioned by *time* orientations of organisational actors. New Bank's managers enacted specific temporal structures (Orlikowski & Yates 2002) throughout their decision process, the outcome of which was to position the KM artefact in e-banking. We observed that time was represented by organisational actors as events (Clark 1985), e.g. start of e-banking, research project kick-off etc., rather than as clock time. It was the right time or *kairos* to nominate the KM artefact as a potential boundary object in the business context of e-banking. New Bank members grasped the opportunity to support their newly introduced services, since the moment was suitable.

In essence, under high levels of uncertainty and *low time pressures*, organisational actors chose to make a decision, which they would further explore; it wasn't a final decision to converge on. It was simply a first step towards delineating relations between the KM artefact and the organisational context, seemingly conditioned by the factors of difference, dependence, and time orientation.

PHASE 2: Improvising a new boundary role for the KM artefact

Faced with considerable problems in the implementation of e-banking in the organisation, New Bank's managers realised that without any support from the employees, the vision of transforming the bank into a "virtual bank" should simply be abandoned. The employees may have had the burden, but neither the motives nor the capacity to execute the necessary everyday e-banking activities. Two months after the launch of e-banking services (and three months after the initiation of the research

project), it was decided that the re-design of the organisational environment was required. Such a laborious task would span the boundaries of the e-banking division, and would envelop other departments.

The Human Resource Development (HRD) division would now be responsible for the creation of appropriate roles and processes that would support the new e-banking operations. The solution they proposed was that a new role for human resources in e-banking be designed. Initially, the "e-banking agent" role was envisaged to involve promotion and selling of e-banking products as well as customer navigation for using those products (because customers would be unfamiliar with those). People from the e-banking division commented:

"E-banking needs someone to act as the physical link with the customers in order to better monitor their opinions of their products' and services' quality."

In addition to that responsibility, the HRD division was leading a project, the aim of which was to convert New Bank into a competence-driven organisation. Every business activity would be mapped and profiled based on the competences and skills required to do the job. The project comprised planned organisational changes in work processes, roles, even hierarchy; a far-reaching re-organisation of human resources. The creation of the new "e-banking agent" role inevitably had to incorporate the competency-driven principles of HRD.

Since the KM application would fundamentally embrace e-banking activities, the HRD managers were debriefed by the university members about the research project. The latter described the project's idea:

"…to design, implement and validate knowledge management tools for the creation of learning modules based on the concept of interactive case studies. Those studies will inscribe Business Process Logic."

The HRD people considered appealing the learning dimension of the project, which seemed to overlap some of their own initiatives. Further formal and informal meetings with the university members involved detailed discussions about the general

principles of KM. The content of those was not part of the R & D consortium specifications; rather, the HRD people expressed an interest in better understanding what KM advocated, and the university members were willing to share their knowledge. The latter also elaborated on the projects' objectives[10], and illustrated various mock-ups of the future software. Their efforts were made possible by their capacity and ability to translate complicated technical terms into simpler terms, which were easily absorbed by New Bank people. The HRD members, thus, developed a more thorough understanding of what the whole project was about and what the prospective system could do.

Their advanced comprehension of the potential of the KM artefact appears to have stimulated their imagination; they made novel linkages and associations between what the KM artefact could offer and what they aspired to achieve with the re-design of the organisational environment (competence-driven organising of human resources). The new "e-banking agent" role, which would be the solution to the existing internal implementation problems of e-banking, could greatly benefit from the support of such technology. The KM artefact would be a vehicle for materialising HRD people's plans for a competency-driven organisation. It was envisaged as a supporting tool for workplace training and learning – a fundamental component of the vision, which HRD had for the human resources needed for the role. At the same time, it could dynamically facilitate the "e-banking agent's" work practices, by capturing experiences with customers in the form of case studies, which the system could animatedly create; hence, it would also enable the realisation of e-banking people's business objectives. The KM artefact was now imagined to be locally useful for both the HRD and e-banking division, and to have a common identity across them (Star & Griesemer 1989).

Interpretation of the *Improvisation* Process

The decision to contextualise the KM artefact for the support of e-banking activities appears to have catalysed the evolution of the artefact's "life" in relation to its possible utilisation in an envisioned working environment. The involvement of the HRD people, who were responsible for the organisational restructuring of e-banking, in the research project created a mandate for the university members; to develop common ground (Bechky 2003a) with regard to the KM offerings with the HRD members as

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[10] The project's aims and objectives were firmly fixed. There were hardly any strategic deviations from those during the two year life of the project.

well. The university members' efforts were conditioned by the way they *chose* to share their knowledge about what the KM system is about[11], providing, from their own angle, possible supporting scenarios. They made specific decisions with respect to using particular means (i.e. words, such as *learning*, *interactive case studies* and *business process logic*, and mock-ups, which demonstrated the imaginary KM system) to represent their knowledge of the KM artefact to the HRD people. They were acting as "provocateurs" and were using specific linguistic expressions and visual objects to challenge HRD members to consider new possibilities for the KM artefact (Mogensen 1992); they created a market of expectations (Tudhope et al 2000). Capitalising on their expertise in KM and on their capacity to understand and translate technical issues into a language understandable by non-technical people, university members were also extensively engaged in knowledge brokering activities (Pawlowski & Robey 2004). As a result of those activities, sufficient common ground between those two groups was developed.

The HRD people developed a considerable understanding about what the KM system could do. Such an understanding appears to have been an enabler for *improvisation*. We use improvisation to analyse the conception of the new boundary role for the KM artefact with respect to supporting the "e-banking agent", because the definition of improvisation qualifies the term as very suitable for explaining our empirical observations: "…the creative and spontaneous process of trying to achieve an objective in a new way" (Vera & Crossan 2005, p. 205). The HRD people, already burdened with the responsibility for the restructuring of e-banking roles and processes, responded to the uncertainty of the situation and, on the spur of the moment, came up with a new idea; the KM artefact with its enhanced learning and other offerings could extensively support future "e-banking agents". The creative part of the improvisation process refers to their combinative efforts to associate what the KM system could do with their own concerns. HRD members believed that the KM system could satisfy their needs for a competence-driven organising of human resources, since it promised workplace training and learning in the form of interactive case studies. Their creativity was also manifested in that, their new solution would account for the interests and

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[11] In fact, the "choice" of how their knowledge would be represented and shared was in part determined by the fixed research project aims and objectives.

concerns of three different social worlds, i.e. future e-banking workers, e-banking managers and HRD managers.

A Relational View of the *Improvisation* Process

During the improvisation process, the boundary between the KM artefact and New Bank evoked different properties. First of all, we observed that the involvement of an additional group at the front of the stage had a remarkable impact. HRD members' involvement created new requirements to work on the boundary. Some common ground needed to be created with the university members about the KM artefact; the boundary problem space *expanded*[12]. The university members, having the translational abilities, played a very important role in invoking the *differences* of the KM technology; the HRD people developed a good idea of what the KM artefact could do. They acted in a creative way because they were also able to recognise how the technological offerings could fit their own concerns. They delineate *generic dependencies*, not only with regard to their division, but also with regard to e-banking division. However, the lack of a concrete image of the KM artefact as well as of the competence-driven characteristics of the "e-banking agent" role instantiated high levels of *uncertainty*; those organisational actors were prevented from thoroughly delineating differences and dependencies.

In addition, the enactment of specific temporal structures (Orlikowski & Yates 2002) by New Bank members significantly conditioned the relational dynamics. Again, *time* was defined by HRD members as event time (Clark 1985). They grasped the opportunity to associate two initiatives taking place at the same temporal point; the research project concerning the KM artefact *and* the competence driven project. Although the two elements of improvisation are mutually constituted, we may argue that, time pressure, i.e. to deal with intra-organisational problems, along with uncertainty significantly influenced spontaneity (Crossan et al 2005); at the same time, the delineation of differences and dependencies appeared to have had an impact on their creativity.

In essence, organisational actors decided to re-define the boundary they would be working on; they decided to diverge, rather than converge on their previously taken

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[12] The expansion of the problem area is frequently an issue in information systems design and development (Gasson 2005) and on occasions of innovation (Majchrzak et al 2004).

decision. The improvisation process literally describes the spontaneous and creative imagination of a new boundary role for the KM artefact and appears to have been conditioned by the expansion of the problem space, the invoked differences and dependences, and time orientation; those forces had a particular impact under conditions of high uncertainty and time pressures.

PHASE 3: Resolving the boundary role of the KM artefact

Having agreed to create the new "e-banking agent" role, people from the HRD and e-banking divisions collaborated extensively to enhance the content of the role. Ultimately, they shared the same vision: to design a dynamically enhanced and competitive e-banking workplace. Regarding the KM artefact as an important supporting tool, they worked closely with the university members[13], since the latter had knowledge of the KM principles embedded in the artefact as well as technical knowledge of the system's functionalities. After a few discussions, the assistant manager of the HRD division illustrated on a piece of paper how they (HRD people) envisaged the fit between their goals for the competence driven organisation, and the functioning of the particular KM system in the workplace. The graph was borrowing concepts from the design of the KM system, presented by the university members over a period of 3-4 months, and was matching those with their ideas on competences. Having no interest in "selling" the KM artefact, the university members warned the HRD people about the limitations of the system, by further elaborating on what the KM artefact could do.

A fundamental constituting element of the interactions between university members and HRD people was the fact that more detailed mock-ups of the KM artefact were also available at the time (beginning of 6th month). Those representations of the future computer application system created a relatively tangible understanding of the underlying principles embedded in the system. In particular, the system offered constructs for descriptions of the workplace, which instantiated business process elements, i.e. tasks, activities and resources. Those constructs would also be the basis

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[13] After the improvisation phase, mainly (though not exclusively) people from the HRD were involved in discussions with the university consultants. The reason is that new role dictated fundamental restructuring of the ways employees would execute their job. Behind the "e-banking agent" initiative was the design of supporting mechanisms for continuous development and learning. Those issues could be better addressed by HRD, rather than by e-banking people.

for the animated creation of cases studies by the software application. All those features, which were further explained by university members, appealed to the HRD people. Their vision for a competency-driven organisation was based on a business process image of the workplace consisting of people, roles, processes, artefacts, and space. They were working to exploit the capacity of the system to construct the workplace in similar business process elements in order to meet their departmental needs. Without the physical prototype though, i.e. an installed software application, the HRD people were still deprived of interacting with the actual KM system, which would afford a more concrete understanding of its boundary potential.

At the end of the first year of the project[14], the KM software application had to be installed in New Bank. Before the installation, a meeting was held with the participation of the managers, assistant managers and some employees from the e-banking and HRD department, the university members, and the IT manager of New Bank (who hadn't been involved in the project before). The participation of the latter was not fully comprehended by the university members. The e-banking director explained to them that the information, which would be available in the system, was confidential. A new need emerged, i.e. to ensure information security, which spanned the areas of the IT department. Some of the decisions (made by members of the HRD, e-banking and the university members) included online access to the system and the installation of the system server at the e-banking headquarters. Those decisions were made based on criteria for wider use of the system, and for greater autonomy and control by the e-banking department. The IT manager persistently objected to those decisions on the grounds that there was a high risk for New Bank's sensitive information. The IT manager was in a politically stronger position. Both in terms of hierarchy and authority (IT management was under his exclusive control), he enforced his power to "block" the specific initiatives by the HRD, e-banking people and the university members. Consequently, the idea of online access and server installation at the e-banking headquarters had to be abandoned.

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[14] The development of the technical part of the project had been completed. What remained was the development of a methodology for introducing such an application in organizations, and general evaluation of the system by user organizations.

Interpretation of the *Resolution* Process

The conception of the new "e-banking agent" role and of the new boundary role for the KM artefact was followed by intensive and iterative collaborative actions. Those actions were also facilitated by the use of visual representations, which gave the opportunity to the university members to reflect on the accuracy of HRD people's understanding of the KM system's capabilities. In other words, those visual objects represented the common ground as perceived by the HRD people. The university members, also lacking opportunistic motives, were thus able to identify flaws in the way HRD people perceived the dependencies between the KM system and their own objectives. In addition, the detailed mock-ups of the future computer application enhanced the common ground between the two groups.

The HRD people were able to relate more concretely the KM intervention in the workplace, since the process based principles of the system were better manifested in the mock-ups; the university members decisively influenced that relational process by further explaining those mock-ups. When interacting with New Bank's members, university members drew both on their knowledge of the embedded in the system principles of KM and of the technological characteristics, and on their good grasp of New Bank's members limited capacity to understand complex technical issues. They instrumentally connected three different groups, i.e. technology vendors, university members, and user organisations by translating elements of the technology groups' work into terms, which were understandable by New Bank people. University members kept on engaging in knowledge brokering roles (Brown & Duguid 1998).

In addition, the involvement of the IT manager created pragmatic constraints during the phase of resolving the boundary role of the KM artefact. Without participating in the first year of the project, the IT manager neither shared a collective identity with respect to the research project (Hardy et al 2005) with people from HRD, e-banking and the university members, nor saw any merit in exploring new ways of transforming his knowledge (Carlile 2004). Using his symbolic capital and power (Bourdieu 1998), he simply chose to make a decision, which served only his interests, since in that short meeting he was presented with no evidence of potential benefits for his departmental goals.

A Relational View of the *Resolution* Process

New Bank members had defined the boundary between the KM artefact and their organisation as a boundary "sitting" between the KM artefact and the e-banking business activities, which the HRD and e-banking members had a stake for. The *convergence* on that boundary was now desirable. What now came out as important was to determine with higher precision how the different technological offerings would be interrelated with divergent interests of HRD and e-banking division in order to support the envisioned e-banking workplace. The detailed identification of the *differences* and *dependencies* became a critical task. The use of visual representations significantly facilitated that task, because it advanced the development of common ground among the different groups, i.e. university members, HRD and e-banking people. In addition, the ability of the university consultants to travel easily between different worlds, to early understand possible roadblocks to the implementation of potential decisions, and to effectively phrase complex technological concepts in non-technical terms had a catalytic impact on the invokeness of differences and dependencies.

Finally, the enactment of the temporal structure of the event of KM installation manifested a differential relational impact of *time* (Clark 1985). The concerns of the IT managers had now to be considered. However, the conditions didn't allow for the development of common interests (Carlile 2004) among the different groups; there was neither sufficient time nor the capacity to create "win-win" solutions to the issues that arose. The actor with the greater *power*, i.e. the IT manager, determined the outcome of that meeting.

In essence, the resolution process describes the efforts of New Bank members to concentrate on and converge on the boundary they had defined at the end of the improvisation process. Under conditions of lower uncertainty and high time pressures, they had to deal with "knowledge boundaries" (Carlile 2002); to delineate thoroughly differences and dependencies between the KM artefact and the e-banking business activities, and to take the IT managers perspectives into account.

PHASE 4: Enhancing the boundary role for the KM artefact

After the installation of the KM system, members from the HRD and e-banking division started experimenting with the application in order to define how it would

finally satisfy their business needs for the new "e-banking agent" role. They again relied heavily on the technical knowledge of the university members during this process. The usual pattern of their interaction involved "question asking" about specific characteristics of the KM application (by HRD and e-banking), and "question answering" with respect to clarifying the meaning of those characteristics (by the university members). Simultaneously, New Bank people were intensively working on the development of the "e-banking agent" role. They were working towards identifying required skills and employees with the appropriate qualifications to do the job. They were also constantly developing very accurate descriptions of the "e-banking agent" role in elements of work process, i.e. tasks, activities and information resources. Those descriptions were then used to enrich the content of KM system, which had acquired a particular supporting role in the work processes of future employees. There were multiple iterations in order to precisely design the future workplace of "e-banking agents" and the envisioned uses of the system. In their efforts to understand the intervention of the KM artefact in the workplace, the university members and HRD people jointly developed a visual representation of the imaginary workplace in terms of roles, competences and work practices (figure 1).
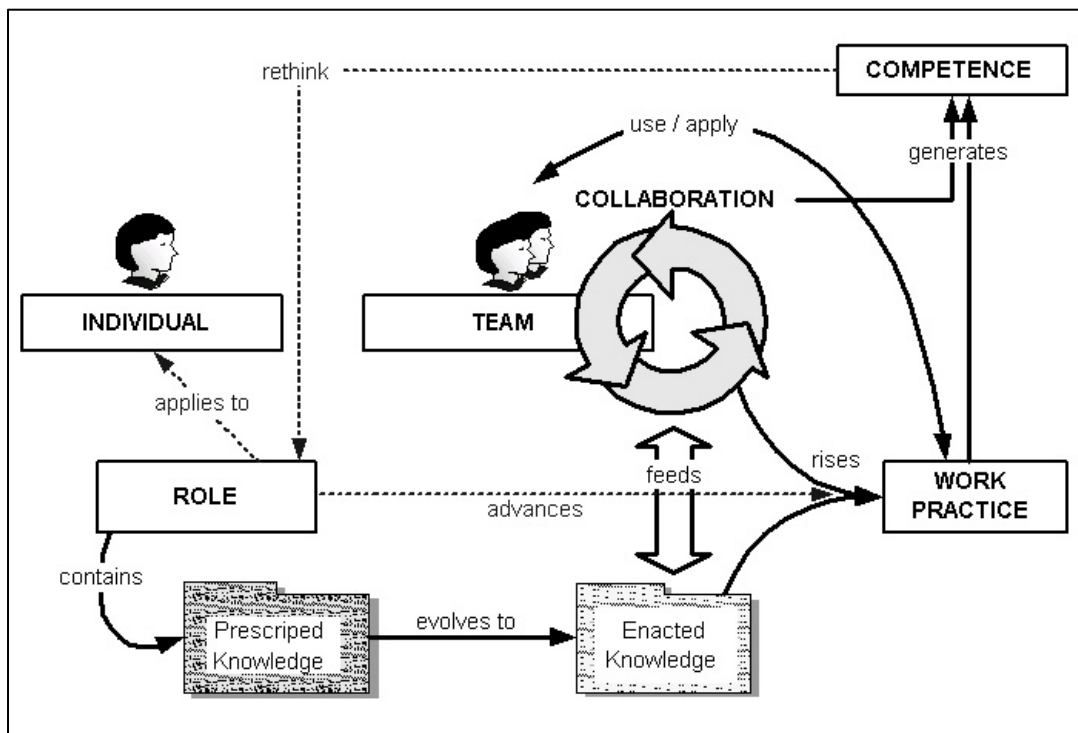

Figure 1. The conception of the intervention of the KM artefact in the workplace (Samiotis & Poulymenakou).

New Bank people intensified their efforts to enhance the content of the future organisational intervention, and also considered necessary that additional information resources, such as company policies and memos, be attached to specific processes in the KM system. The Organisation division had considerable authority and control over the dissemination of that information. One of the main responsibilities of that division was to check the quality of the documents distributed company wide. In its director's words:

"My division has a central role in everything that takes place in the bank. From documents to projects, we have to make sure that everything is consistent with company policies. We are even responsible for the format of the documents that go to the employees or published on the company's portal or website."

Consequently, specific information resources in the KM system had to comply with Organisation division's standards[15]. Any adjustments were made quickly after and almost effortlessly achieving consensus between HRD, e-banking and Organisation division people.

Towards the end of the enhancement process New Bank members developed a capacity of the KM artefact to be used as a boundary object in the envisioned workplace of "e-banking agents". Table 2 illustrates how they imagined the generic "boundary role" of the KM technology in it future enactment by "e-banking agents" in terms of roles, work practices and competences; the triptych of roles, work practices and competences were the foundations of its boundary capacity.

	e-Banking Managers	Human Resources Managers	e-banking Agents	
Roles	*Monitoring* coherence of strategy through role content	*Creating* descriptions of work content	*Guiding* work	*KM artefact's envisioned boundary roles anchored in the triptych of roles, work practices and competences*
Work Practices	*Developing* best practices	*Capturing* workplace activities for training and learning purposes	*Enabling* learning and group problem solving	
Competences	*Affording* strategic vision formulation by boosting specific skills	*Affording* human resource development by cultivating competences	*Improving* the execution of work	

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[15] The Organisation division was involved in the development of the "e-banking agent" role only at that time. No other participation in meetings was observed.

Table2. The information requirements of the three different worlds, which the KM artefact would satisfy in a flexible way (adapted by Samiotis & Poulymenakou, forthcoming).

Finally, it should be noted that the "agents" were not included in the development of that role, which might have transformed the KM artefact into a roadblock to the integration (Schultze & Boland 2000) of the interests of the three worlds, i.e. e-banking managers, HRD Managers, and "e-banking agents". The boundary capacity of the technology might not be adequate for them, and they might not have the ability to use it (Black et al 2004).

Interpretation of the *Enhancement* Process

Having spent more than a year working on and discussing about the project, New Bank members and the university members had already made decisions about the fundamental envisioned uses of the KM artefact. After the implementation of the system, the capacity to design the KM driven workplace of "e-banking agents" was enlarged. The interaction with the actual software application by New Bank people afforded the capitalisation on their existing understanding about the system's capabilities, which had been cultivated by university members' talks and mock-up presentations. New Bank people were now able to associate the system's characteristics with what they had learnt so far very efficiently. Working also intensively on the enrichment of the content of the new role, New Bank members developed very exact boundary roles for the KM artefact in the future workplace. Again, the knowledge brokering activities of the university members were really important during that phase. Table 2 illustrates the importance of the triptych of roles, work practices and competences for the development of the boundary capacity of the KM artefact; that triptych served as the common ground to share and assess each other's concerns with respect to the boundary role of the technology.

On the other hand, the involvement of the Organisation division illustrates one more time the unpredictability of the process of designing boundary roles for IT artefacts. In this latter case, the expansion of the problem area was minimal and the creation of common ground so as to accommodate the new requirements imposed by people from the Organisation division was an easy task. Their concerns could be easily

incorporated without any significant transformation of the existing solutions decided by members from the HRD and e-banking division and the university members.

A Relational View of the *Enhancement* Process

From a relational perspective, the pre-existence of common knowledge conditioned the evolution of the enhancement process. New Bank's interaction with the actual software application enabled them to get the most out of the common ground, which they had created in previous phases. That interaction invoked the key *differences* of the technological offerings, which were further clarified by the university members who were very good translators. The HRD and e-banking members were thus able to understand how those offerings could concretely fit their goals; they identified detailed *dependencies* between the KM artefact and their business needs. In addition, we observed an *expansion of the problem space*, while the relative absence of *uncertainty* as well as the limited impact of *time pressures* afforded hardly any radical influences on the process of enhancing the boundary capacity of the KM artefact. New Bank people could also identify and plan how the concerns of the Organisation division would be accounted for.

In essence, the enhancement process describes a situation, in which the desirability of convergence at the boundary between the KM artefact and the organisation is very high. "Knowledge boundaries" (Carlile 2002) become more and more important; people needed to delineate precise relations, of which differences and dependences constituted fundamental properties.

Discussion

The use of the analytic concept of boundary objects has been fruitful in explaining problems of communication and cooperation across different intersecting social worlds (Star & Griesemer 1989). Most studies on boundary objects employ a research lens focusing on what those objects do, whereas the process of creating boundary objects, despite its key role, has surprisingly attracted limited attention. We argue that this very important process deserves much more serious consideration. Demonstrating the

circumstances and events by which a KM artefact was transformed into an *envisioned boundary object* between e-banking and HRD managers and e-banking workers in New Bank, sheds more light on the dynamic nature of the process of creating boundary objects. Engaging in an "interpretive discourse" (Schultze & Leidner 2002), we show that a *relational perspective* appears to be a promising avenue for studying that process. A focus on the *boundaries* in the development of the boundary capacity of an artefact illuminates what may matter most in such context. Using also the diptych of *time* and *uncertainty*, we illustrate how those important factors may condition the actions and interactions of organisational actors at the boundaries.

The results inducted from the study in New Bank contribute to the *relational thinking* (Østerlund & Carlile 2005) by building upon and extending insights gained from other studies (Carlile 2002, Bechky 2003a). Our findings provide evidence that the character of the boundaries between the designated boundary object and the organisational context may not be attributed to knowledge only. Although "unpacking" and integrating knowledge embedded in complex technologies is critical (Newell et al 2000), highlighting the interplay between *divergence* and *convergence* at the boundaries gives us insights on when and how knowledge matters. "The process of assessing the relevance of the knowledge…in part defines the relation between the two domains" (Carlile & Rebentisch 2003, p. 1189); yet, we attempted to offer possible explanations not only about what other parts might be, but also about the differential importance of that process. We demonstrated that there are relational forces other than *difference*, *dependence* and *novelty* (Carlile & Rebentisch 2003), i.e. the challenging properties of "knowledge boundaries" (Brown & Duguid 2001) which may call for processes of translating and transforming knowledge (Carlile2004)[16].

Being sensitive to issues of time and uncertainty and following a grounded fashion (Glaser & Strauss 1967), we witnessed the unfolding of four different phases, which may represent four different scenarios. Those scenarios bear significant similarities with the improvisation scenarios provided by Crossan et al (2005), and may allow us to

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[16] In a recent paper, Carlile (2004) provides a prescriptive framework, which literally expands on the theory of communication developed by Shannon & Weaver (1949). In their breakthrough work, Shannon & Weaver (1949) develop a *syntactic* approach to communication and also acknowledge the limits of their work because effective communication has interpretive or *semantic* and political or *pragmatic* dimensions as well. Carlile (2002, 2004) addresses those limitations by building upon and integrating other theories, and claims the need for *translation* and *transformation* processes.
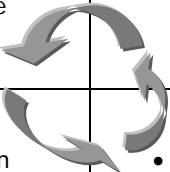
better understand the relational dynamics, and the interplay between divergence and convergence at specific boundaries. We argue that, different levels of uncertainty and time pressures and with certain temporal orientations (Ancona et al 2001a) may lead to the emergence of four different processes.

Nomination processes may emerge when there is high uncertainty and low time pressure; people simply"…act first and then make retrospective sense of their experience in order to act again" (Crossan et al 2005, p. 133). In other words, they are in a need to "define" the boundary they are dealing with, even if there is not enough evidence to justify their decision. Knowledge boundaries (Carlile 2002) are not so important because organisational actors weigh divergence more than convergence in their efforts to create a boundary object; the common ground between the two "entities" is sufficient as long as *very generic* differences and dependencies are identified. Also, with a view to maintaining flexibility, people are more likely to represent time as events (Eisenhardt & Brown 1998).

When uncertainty and time pressures are high, people need to improvise in a full-scale (Crossan et al 2005). Full-scale *improvisation* usually requires the "redefinition" of the boundaries and entails spontaneous and creative behaviour. Spontaneity may call for event time orientation, while creativity may also involve the use of other people's knowledge, unknown at the boundaries; "divergence and *lack* (emphasis original) of shared experiences are critical for developing new ideas" (Majchrzak et al 2004, p. 175). Knowledge boundaries (Carlile 2002) are not so important because organisational actors need to explore or diverge on their solutions, rather than refining or converge on those.

A third scenario may arise, when uncertainty is low and time pressures are high; people put more emphasis on convergence and seriously work on shifting knowledge boundaries (Carlile 2002). During such a *resolution* phase, there may also be issues of redefining the boundaries, which actors attempt to deal with in a spontaneous way (Crossan et al 2005). Finally, *enhancing* processes may emerge when both uncertainty and time pressures are low; organisational actors concentrate their actions on knowledge boundaries; convergence represents the most critical task. The following table illustrates the four different scenarios that may occur at the boundaries.

		Time pressure	
		Low	High
Uncertainty	Low	**Enhancement:** • Convergence/exploitation • Limited flexibility • Precise delineation of differences and dependencies - High influence of knowledge boundaries	**Resolution:** • Convergence/exploitation • Limited flexibility (time orientation) • (Expansion of problem space) • Precise delineation of differences and dependencies - high influence of knowledge boundaries
Uncertainty	High	**Nomination:** • Divergence/exploration • Flexibility (event time orientation) • Generic delineation of differences and dependencies - Limited influence of knowledge boundaries	**Improvisation:** • Divergence/exploration • Flexibility (time orientation) • Expansion of problem space • Generic delineation of differences and dependencies - Limited influence of knowledge boundaries

Inevitably, our study bears some limitations, which should be accounted for. Firstly, we have not been able to study the implementation of the KM technology. The boundaries with future "e-banking agents" were only hypothetically shifted, since neither there were discussions and negotiations with future users, nor was the system implemented and actually used in practice by them. Very frequently, that boundary is the most difficult to overcome (Schultze & Boland 2000, Orlikowski 2000). Secondly, representing more a precaution, rather than a limitation, we describe the events taking place in setting where the adoption of KM technologies was *not* planned. Change didn't proceed in a teleological way towards a goal and driven by purposeful individuals (Huy 2001). Finally, "adopting a particular paradigm is like viewing the world through a particular instrument such as a telescope" (Mingers 2001, p 244), which deprives the researcher of gaining different insights when using other instruments.

Implications

Clearly, the actions and interactions of New Bank members that are described (e.g. a competence-driven project was associated with a KM research project) in the case study cannot be generalised beyond the research project. Those concern situated circumstance and we claim no evidence for their generalisation. However, the four scenarios we illustrate could be usefully applied to analyse other settings, since they constitute theoretical constructs (Lee & Baskerville 2003), and not events. Those

generic scenarios describe a dynamic perspective on the development of the boundary capacity of a KM artefact, which may enable researchers and practitioners to identify and deal with the *boundaries*. We encourage further research on validating those scenarios. In addition, we offer an alternative view of looking at improvisation processes. Focusing on the boundaries may advance our understanding about how *improvisation* processes actually emerge. More than that, we incorporate the concept of *time* in our boundary analysis and suggest that more research on processes of relational phenomena account for that important factor. Finally, we show how KM technologies could be studied under the prism of boundary objects, and encourage further investigation on the processes of developing their boundary capacity.

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