Association for Information Systems
AIS Electronic Library (AISeL)

ICIS 2009 Proceedings

International Conference on Information Systems (ICIS)

2009

An Integrative Design Methodology to Support an Inter-Organizational Knowledge Management Solution

Amandine Pascal
Aix Marseille University, amandine.pascal@univmed.fr

Catherine Thomas
University of Nice Sophia Antipolis, thomas@gredeg.cnrs.fr

A. Georges L. Romme
Eindhoven University of Technology, a.g.l.romme@tue.nl

AN INTEGRATIVE DESIGN METHODOLOGY TO SUPPORT AN INTER-ORGANIZATIONAL KNOWLEDGE MANAGEMENT SOLUTION

Completed Research Paper

Amandine PASCAL
Aix Marseille University
Institute of Labour Economics and Industrial Sociology
35 Avenue Jules Ferry, 13625 Aix en Provence Cedex, France
Phone: +33 6 20 32 70 52 ;
e-mail: amandine.pascal@univmed.fr

Catherine THOMAS
University of Nice Sophia Antipolis
Research Laboratory GREDEG
250, rue Albert Einstein, Bt. 2 – 06560 Valbonne, France
Phone: +33 4 93 95 43 86 ;
e-mail: thomas@gredeg.cnrs.fr

A. Georges L. ROMME
Eindhoven University of Technology
Department of Industrial Engineering & Innovation Sciences
P.O. Box 513, 5600 MB Eindhoven, The Netherlands
Phone: +31 40 247 4510 ; Fax: +31 40 246 8526
e-mail: a.g.l.romme@tue.nl

Abstract

Design research develops knowledge to respond to real-world challenges and solve authentic problems. In this paper, we adopt a pragmatic and semantic design approach to combine the best of two separate design discourses: the discourse about developing science-based design rules and the discourse on user-centered, participative, and experience-based design. We develop a methodology that combines both discourses and perspectives. Subsequently, this methodology is illustrated by means of a case study of designing and developing a portal for mapping competencies in the multi-stakeholder environment of an IT cluster. This case study suggests design research can become more effective if it adopts a deliberate focus on articulating design rules as well as engaging users in trying out prototypes, to create artifacts that support and drive the dialogue between user-practitioners and design-oriented researchers.

Keywords: design research methodology, IS design, IS Implementation, IT interfaces, user involvement, design rules

Introduction

The gap between theory and practice is a persistent and difficult problem in management and organization research. For example, Van Aken (2005) raises serious doubts about the relevance of management theory as currently developed in the academic community. Van de Ven and Johnson (2006) identify two ways to frame the gap between theory and practice: first, as the problem of knowledge transfer from theory to practice; the second approach considers theory and practice as distinct but complementary kinds of knowledge and interprets this gap as "a knowledge production problem" (Van de Ven and Johnson: 803). In line with the latter interpretation of the gap between theory and practice, a new form of engaged scholarship in which researchers and practitioners co-produce knowledge, has been emerging since the 1990s (Hatchuel 1994; David 2000; Van Aken 2005; Van de Ven and Johnson 2006). This approach, also known as mode 2 knowledge production (Gibbons et al. 1994), is multidisciplinary and focuses on solving complex and relevant field problems.

In this respect, several scholars suggest that 'design' is an ideal-typical form of mode 2 knowledge production (e.g. David 2000; Romme 2003; Van Aken 2005). In this respect, design research develops knowledge in the service of action, that is, to respond to real-world challenges and solve authentic problems. In this paper, we adopt a pragmatic and semantic design approach (Warfield 1984; Krippendorff 2006) to combine the best of two separate design discourses: the discourse about developing design rules based on organization science (e.g. Denyer et al. 2008; Romme 2003; Romme and Endenburg 2006) and the discourse on user-centered, participative, and experience-based design (e.g. Bate and Robert 2007; Mohrman 2007; Orlikowski 2004). We develop a methodology that combines both discourses and perspectives in order to develop an innovative solution for knowledge management in an information technology (IT) cluster. As such, this methodology addresses the challenge of producing both theoretical and practical knowledge.

The argument in this paper is organized as follows. First, we explore two design discourses and approaches in the field of management and organization studies. Subsequently, we describe the methodology adopted in this paper. The argument then turns to a case study of designing and developing a portal for mapping competencies in an IT cluster. Finally, the findings from this case study are discussed and implications for future research are explored.

Methods for Design

Design inquiry involves a particular mode of engaging in organization research. In the literature on design research and methodology, two distinctive approaches have been emerging. First, several scholars advocate a 'science-based' design approach to organization design. Second, other organization researchers emphasize the interactions between design processes and organizational practices, and advocate a human centered approach to these interactions.

Science-Based Design

Authors advocating a science-based design approach intend to connect organization science with design work in practice by developing design rules (Romme 2003; Andriessen 2007; Romme and Endenburg 2006; Denyer et al. 2008; Van Aken 2005; Carlsson 2005). In the same line, Walls *et al.* (1992: 38) argue that "the design embodies principles of the theory". These researchers share a common interest in the creation of explanatory as well as normative knowledge that contributes to the development of organizational theory, while at the same time enhancing organizational practice. In general, a design rule can be defined as "a general solution concept for a type of field problem" (Van Aken 2005: 23). Design rules serve to understand the contingencies of the design situation and the preferences of the people engaging in the design effort in order to "developing representations of the intended organizational system being (re)designed with help of the design rules" (Romme and Endenburg 2006: 289). The science-based design literature also advocates that designs are tested before full implementation and researchers evaluate the processes caused by those designs. Because organizational life is complex and unpredictable, any design project involves continual redesign efforts (Walls et al. 1992; Markus et al. 2002; Lindgren et al. 2004). In this respect, test and implementation processes (should) involve a set of feedback loops. Romme and Endenburg (2006), for instance, suggest a research cycle involving "construction principles and design rules grounded in organization science as well as organizational solutions implemented and tried out in real-life settings" (2006: 287).

Accordingly, the literature on science-based design mainly focuses on developing principles and rules. As such, Romme and Endenburg (2006) advocate the development of construction principles as well as design rules (or design propositions). Construction principles are defined as any coherent set of normative propositions, grounded in the state-of-the-art of organization science. They serve as a body of knowledge that will guide the elaboration of design rules and the context-specific design process at hand. Design rules are defined as any coherent set of detailed guidelines for designing and creating organizational processes and structures, grounded in a related set of construction principles (Romme and Endenburg 2006).

Likewise, Denyer et al. (2008) propose an extension of previous applications of the design rule notion. In this respect, Denyer et al. propose a "design-oriented research synthesis as an appropriate methodology for developing field-tested design propositions, following CIMO-logic" (2008: 408). The latter logic includes aspects of different research synthesis approaches. It involves four components of design propositions: (1) a problematic *Context*, in terms of the surrounding (external and internal environment) factors and the nature of the human actors that influence behavioural change, (2) which suggests a certain *Intervention* type that managers have at their disposal to influence behaviour, (3) to produce, through specified generative *Mechanisms*, the processes that in a certain context generate (4) the intended *Outcomes* (Denyer et al. 2008).

This stream in the literature thus emphasizes the creation of knowledge through a cycle of research processes and codification in rules. These rules incorporate two kinds of knowledge: scientific and practical knowledge. Resulting from a research synthesis, design principles and rules may contribute to organizational theory, notably by combining theoretical elements previously unconnected (Andriessen 2007; Kogut 2000) and by highlighting the generative mechanisms that make particular solutions, interventions and practices work (Denyer et al. 2008). As such, these rules are mid-range theories (Van Aken 2005). In addition, rules also contain "user instructions connecting the solution concept with the field problem, including indications and contra-indications" (Van Aken 2005: 23).

Thus, science-based design approaches share a strong interest in the development of explanatory and prescriptive knowledge that serves to improve professional practice. The knowledge contained in rules involves a general heuristic to be translated and applied to the specific problem at hand. Walls et al. (1992) and Van Aken (2005) stress the idea that design rules are not tied to a specific solution or a specific situation, but pertain to a general prescription for a class of problems. Indeed, Ackoff (1999: 181) argues design principles and rules provide a "theme on which each organization must write its own variation. It is not cast in concrete". Moreover, users need a "thorough understanding both of the rule and the particulars of the specific case and they need the skills to translate the general into the specific" (Van Aken 2005: 23).

Finally, design rules serve as conceptual frameworks for structuring the interaction between practitioners and academics. For Romme and Endenburg (2006), explicit rules are boundary objects between organization researchers and organization development work by practitioners. Evidently, design rules can only represent and incorporate selective bits of the practical experience and scientific information in a particular domain (Van de Ven and Johnson 2006).

Human-Centered Design

Contrary to the previous approach, some authors argue that design solutions should emerge from design processes that involve the (future) users of these solutions (Bate and Robert 2007; Plsek et al. 2007; Buchanan 2004; Hatchuel et al. 2006). The field of human-centered design is represented by a vast literature which now spans several decades, a number of different academic disciplines and traditions using different methods such as usability engineering, user-centered design, participatory design, and experience-based design (Mohrman 2007). The main differences between these various fields arise from the degree to which users are able to influence the design process, i.e. in the form of user involvement. This involvement can be informative, that is, users – or experts representing users – provide information which can serve in guiding the design process. Alternatively, the involvement can be consultative: users comment, and advise on, different solutions and proposals. Finally, participative involvement implies that users have a significant influence on the actual decisions taken in the different stages of the design process. According to Bate and Robert (2007: 44), participatory codesign takes this involvement a step further, the prefix *co* suggesting "a partnership, with internal staff and users meeting and engaging in 'service dialogues' with each other." Human centered design thus emphasizes the necessity to involve the people who will be left with the design when the designer walks away and to engage both practitioners and researchers in an iterative collaborative sensemaking process (Orlikowski 2004).

With reference to the aesthetics of user experiences, Bate and Robert (2007) propose a particular form of participatory design, Experience Based Design, that focuses on the user's experience of a product or service rather than the product or service itself. In this approach, interview and participant observation work serve to define 'key touch points' which serve as a basis for the development of grounded design rules. In this approach, researchers have to transform tacit knowledge of practitioners in explicit knowledge in the form of design rules. Similarly, Plsek et al. (2007) discuss four methods for extracting grounded design rules from experienced change practitioners: reviewing written documentation of change programs, convening groups of change experts, listening to stories of change efforts by practitioners, and posing hypothetical scenarios to see how practitioners would react.

As underlined by Hodgkinson and Healy, in these human centered approaches “designers can undertake design activities and generate workable knowledge solutions without having a fully formed theoretical understanding of the organizational components or systems they are designing” (2008: 436). Rather, researchers and practitioners develop a deeper theoretical understanding by engaging in iterative and interactive design processes. This has important implications for design. First, the organization has to be addressed in a holistic manner, acknowledging its complex, dynamic and interdependent nature. Second, the emphasis is on codesign and copartnership involving both users and researchers, and also other persons affected by the design process. According to Bate and Robert (2007), bringing together different perspectives at the same location gives human-centered design a special practical and scholarly value.

Science-Based and Human-Centered Design?

Design methods are rarely either purely science-based or human-centered. For example, in their work on circular design, Romme and Damen (2007) advocate science-based design combined with a participatory organizational development approach. Likewise, Bate and Robert (2007) propose to develop design rules grounded in human-centered practices. Nevertheless, most design research projects draw on either a science-based or human-centered approach.

In this respect, each of the two approaches raises fundamental problems if adopted in an exclusive manner. With regard to the science-based design approach, Hodgkinson and Healy (2008: 436) point out that “starting the design process by distilling principles and propositions from basic research can be problematic because choosing appropriate bodies of work leads to misguided choices”. The danger here is to engage in design far from practice and thus potentially ignore the expertise and experience locally available (Jelinek et al. 2008), and to be not aware of design rules elaborated by practitioners involved in other organizational change efforts (Plsek et al. 2007).

Advocates of the human-centered design approach answer these problems by integrating users in an interactive design process, to enable mutual learning between practitioners and researchers. However, this approach in itself is also problematic because it runs the risk of divorcing practice from research (Hodgkinson and Healy 2008). Moreover, designers focusing too much on current user needs run the risk of losing the edge of innovation (Bate and Robert 2007). In this respect, innovative solutions arise from ideation (idealized design methods), that is instrumental in generating new purposes, values and concepts very early in the design process (Banathy 1996; Romme 2003). That is, focusing on the system in which the problem situation is embedded tends to lock designers into the current system, although many effective solutions tend to lie outside of the existing system (Banathy 1996). Finally, in many situations, the design problem may be undefined, unstructured and ambiguous. In such instances, design rules cannot emerge from practitioners’ knowledge and designers have to draw on the (research) literature to help define the contour of the problem (Avison and Taylor 1997).

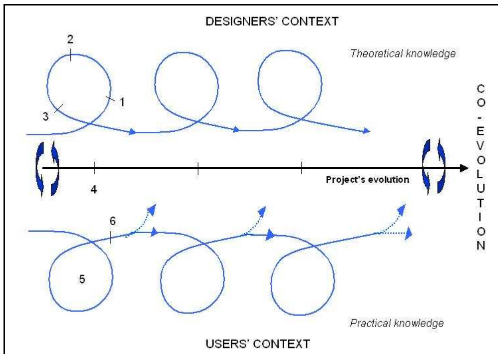
More precisely, Markus et al. (2002) outline that the design and the implementation of IT artefacts for emerging knowledge processes requires specific processes that rely on tacit as well as explicit knowledge and both general and contextual knowledge. Moreover, the use of these IT artefacts requires mobilization of these diverse kinds of knowledge and sharing them; in this case the IT artefact “guides users' deliberations in a desirable direction without restricting them to a prescribed process” (2002: 190).

Both the science-based and human-centered approach recognize that good design is “a recurrently enacted accomplishment provisionally and ongoingly achieved by human actors trying to use the design to get something useful done” (Orlikowski 2004: 93). Indeed, the science-based design approach advocates the importance of structuring the learning processes in design ventures and the human-centered approach emphasizes the need to interact with users. However, none of the approaches provide clues on how to actually shape the interactions between designers and users. The interaction with practitioners is particularly problematic when the design process takes place in a multi-actor environment.

In the remainder of this paper, we will therefore propose an integrative design methodology, which retains some of the benefits of the science-based and human-centered approaches, but also goes beyond a mere synthesis. In this respect, we will consider practice and research as two distinctive but interwoven settings, that are critical for producing theoretical knowledge as well as contributing to practical concerns and solutions. This approach acknowledges the huge (potential) epistemic gap between the designers' and users' contexts, and thus the need to connect both contexts in a systematic manner. Moreover, it positions the design as well as implementation phases as an opportunity for practitioners and designers engaging in a mutual learning process.

An Integrative Methodology

This section outlines the methodology developed and adopted in designing a knowledge management tool. As the literature reviewed in the previous section suggests, any design solution can be understood in terms of both the properties intended by the designers (defined in design rules) and the organizational practices in which the solution is, or will be, used. The objective of designers with an interest in research is to develop generalizable knowledge in ways that contribute to theory (Andriessen 2007). Users, however, have an interest in improving (i.e. knowledge management) processes and practices. As such, these different contexts and interests are typically dissociated (Van de Ven and Johnson 2006). The design methodology developed in this study is intended to contribute to both interests. Indeed, the effectiveness of any design project arises from the interaction of the designer and user contexts, and thus draws on the creation of a community that supports mutual learning between designers and user-practitioners (Mohrman 2007). Accordingly, their interactions and mutual learning may advance academic as well as practical inquiry. This implies that the arbitrage process is at the heart of the design process (Van de Ven and Johnson 2006), and therefore also is a key element of the methodology developed in this study. Figure 1 provides an overview of this methodology.



1: creating problem awareness

2: developing design rules

3: developing user scenarios

4: designing artifacts

5: experimentation

6: transformation

Figure 1. An integrative design methodology

The Designer's Context

According to the science-based design approach, designing solutions for complex problems involves (the development and codification of) theory-based rules. However, identifying theoretical knowledge to address a particular design problem or assignment requires a clear understanding of the nature of this problem/assignment, which in itself can be problematic – notably in the case of an ill-structured problem for which an innovative solution may be needed (Hodgkinson and Healy 2008). In this respect, the design methodology developed in this paper involves the following four steps: creating problem awareness, developing design rules, developing user scenarios, and designing artifacts. These steps are meant to be taken in an iterative manner.

Problem awareness is created by identifying and analyzing the specific managerial problem to solve. In this paper, the practical problem is to foster the cooperation and synergies between multiple actors inside a cluster. Based on this practical problem, we define the research goal in terms of understanding the generative mechanisms of knowledge creation inside a cluster (see next section for more details).

Second, the theoretical knowledge relevant to the key problem being addressed is identified and exploited by developing *design rules*. The theoretical fields that address our design problem and research goal are diverse and fragmented: knowledge-based, the competence-based, regional innovation and cooperation theory. We draw on the

CIMO logic (Denyer et al. 2008) outlined earlier to combine and synthesize these theoretical perspectives and to produce new insights regarding the generative mechanisms of knowledge creation inside a cluster.

Third, so-called *user scenarios* are developed. Since the late 1980s, researchers in human-computer interaction have employed scenarios as a tool to discover user needs and embed the (intended) artifact in work processes. In our case, user scenarios serve to convert and articulate tacit knowledge of practitioners, and as such, provide input for defining design rules (Plsek et al. 2007). The organizational context covered in the latter user scenarios is substantially larger than the context included in scenarios in human-computer interaction (Pascal and Rouby 2006).

Finally, a critical step in any design project is to *design the artifact* that (is intended to) solve(s) the initial problem. Artifacts are the tangible result from the design process and arise from contextualizing and applying design rules to particular practices. Moreover, for more complex problems designers typically develop a variety of knowledge artifacts that serve to represent, anticipate or question (elements of) the final artifacts: for example, written reports, pictures, models, and prototypes (Boland and Collopy 2004). These artifacts, as boundary objects, facilitate the coordination of many human activities across time and space (Jelinek et al. 2008). The case study later in this paper mainly draws on models, pictures and prototypes.

The User's Context

An artifact develops into an effective boundary object between two communities if it can be understood from the different perspectives of these communities, and moreover serves to create and sustain (commitment to) collaborative processes (Eckert and Boujut 2003; Henderson 1999). In this respect, artifacts evolve as a result of dialogues, compromises and negotiations between designers and users, enabling a process of mutual adaptation. This implies that producing artifacts is not sufficient: in a multi-actor environment, the dialogue and negotiations with users have to be deliberately created and managed. In the remainder of this section, we draw on *Actor Network Theory* (ANT) concepts to create and manage the interaction with users.

ANT has been used to investigate the success or failure of technological innovations, defined as the result of a collective activity and process rather than the initiative and effort of a single individual (Akrich et al. 2002). Here, the key to innovation is "the creation of a powerful enough consortium of actors to carry it through, and when an innovation fails to be taken up this can be considered to reflect on the inability of those involved to construct the necessary network of alliances (the socio-technical network) amongst the other actors" (Tatnall and Gilding 1999: 961). The network notion in ANT refers to shifting alliances of both human and non-human actors. That is, any innovation process has a collective dimension in which users are involved as well as participants in the process of conception and design. ANT thus implies that an innovation moves through time and space in the hands of the sociotechnical network of actors that may modify, deflect or betray, extend, appropriate, or drop it (Latour 1986).

This approach is relevant for designing any artifact supporting emergent knowledge processes inside a wide context. As Lindgren et al. (2004: 446) suggested, artifacts developed in this specific case are not "turn-key solutions but rather technologies that needed to be integrated into a social system of everyday work". Indeed, ANT considers both social and technical determinism to be flawed and proposes instead a socio-technical account (Latour 1986; Law and Callon 1988) in which neither social nor technical positions are privileged. Then, ANT serves to understand socio-technical compromises and negotiations as two key processes that facilitate the mutual adaptation and adoption of new technologies (Akrich et al. 2002). As such, the success of an innovation depends on a process of adaptation-adoption, which in turn is influenced by the socio-technical environment. This success also relies on the construction of a socio-technical network that will defend and support the process of designing and implementing an innovative artifact. This is also the active role played by spokespersons who negotiate to shape the design project and transform it until the innovative solution proposed is adopted (Akrich et al. 2002: 217).

In this perspective, we propose that – in addition to the steps outlined in the previous section – two other processes serve to manage the interaction and dialogue with users: experimentation and transformation.

Experimentation involves two complementary, largely simultaneous processes: first, building interest and commitment among a growing number of heterogeneous actors (e.g. users, IT professionals, managers, sponsors, etcetera); second, trying out and evaluating the successive artifacts in firms' practices. This involves an arbitrage process between the diverse viewpoints emerging from the designers' context as well as the users' context. This arbitrage process is at the heart of the knowledge creation process between practitioners and researchers (Van de Ven and Johnson 2006).

Transformation involves adoption and adaptation processes progressively changing the organizational context (or failing to do so). As a result of these processes, the initial managerial problem typically evolves, leading to redesign efforts or an entirely new design cycle. At the same time, these transformational processes modify, and possibly enlarge, the socio-technical network that supports and uses the tool.

The Knowledge Management Platform Project

This section describes a project in which the design methodology outlined previously was developed and tested. One of the authors actively participated in this project as the project leader. As such, she coordinated the work flow of the different designers' teams and the interaction between designers and users. Another author contributed to the project as a PhD student, by focusing on the design approach and the role of the 'map of competencies' portal as a collaborative artifact.

This so-called Knowledge Management Platform (KMP) project was conducted in the technology park of Sophia Antipolis (France). Sophia Antipolis is "one of the most highly publicized technology parks which combine establishments of multinational corporations, small and medium-sized firms, and large public research centers and universities, under the auspices of public regional authorities" (Castells and Hall 1994: 85). As a technopole, it was created from scratch in the 1970s and early 1980s, without any strong industrial or university traditions in the region (Longhi 1999). Over the years, the local Telecom cluster in Sophia Antipolis reached a critical mass and diversity that provide the foundations of a very innovative ecosystem, while the other poles (i.e. biotechnology and space) have not yet reached a similar level of development.

History of the Telecom Sophipolitan Cluster

The global economic downturn of the early 1990s had a considerable impact on Sophia Antipolis. First, it struck at the heart of the technology park's growth engine, its computer science activities, and led to downsizing activities in many large firms. Second, it raised important doubts with regard to the validity of the development strategy of Sophia Antipolis, based essentially on investments from large firms; moreover, the economic downturn also signalled the lack of local synergies among residents of the technology park (Longhi 1999; Lazaric and Thomas 2006). Hence, several clubs and associations were created to facilitate collaboration, to study the technology park's prospective in the IT and telecom sectors, and to implement collective innovation projects. One of the associations created was Telecom Valley, a non-profit organization founded in 1991 by eight leading firms and other organizations in the telecom cluster of Sophia Antipolis.

The main characteristics of the Telecom Valley (TV) cluster at Sophia Antipolis in 2000 can be summarized as follows. First, firms in this cluster were evolving in a diverse technological context, covering a wide range of industries (e.g. computing, multimedia, space, information processing, on-line services and networking, and microelectronics). Given that most parent companies were located elsewhere, the participants in the cluster had been developing strong external links. The cluster combined local and global dimensions in a modular way (e.g. some firms created products and services that are integrated in broader system solutions). The internal dynamics of the cluster arose from the interactions in several communities, associations, clubs, and so forth, but also revealed a huge potential synergy between agents in the cluster that was still largely unexploited.

In the early 2000s, it therefore became increasingly critical for firms in the cluster to not only establish external links with partners and parent companies, but also to create strong regional links with local high-tech SMEs and research institutes. This is the starting point of the KMP project, launched in 2001 by Telecom Valley (TV). The objective of this project was to build an interactive map of competencies to enhance knowledge exchange and combination within the cluster.

Main Actors

The project team was assembled from different academic disciplines, including economics, management studies, computer science, telecommunication science, and ergonomics. At the start of the project, users were represented by means of two TV working groups and by several pilot (lead) users. The latter users involved five firms (Amadeus, Arianne II, France Télécom, Hewlett Packard, and Philips-Semiconductors), one local development institute (CAD) and three research institutions (University of Nice, INRIA, GET). In 2003, when the design process of the artifact had really began, new pilot users joined the project: IBM, ATOS Origin, Transitiel, Elan IT, Qwam System, Cross Systems and one local development institute (CCI-IRT). Subsequently, many other actors participated in enlarging the socio-technical network around the project, but without a direct involvement as pilot user: all other TV members, several clubs and associations in the Sophia Antipolis territory, and IT firms located outside Sophia Antipolis. In the KMP project, users and other stakeholders are therefore not given *ex ante*, but their engagement in the project results from how the project coevolves with its sociotechnical environment.

How the KMP Project Evolved: Overview

The KMP project evolved in terms of four key cycles (Figure 2 provides an overview): the first cycle involves the kickoff and initial elaboration of the project and the last cycle involves embedding and integrating the KMP in the socio-technical network in and around TV. The period 2003-2004 is a critical episode in the design process resulting in prototypes 1 and 2 (P1 and P2 in figure 2). These first two prototypes provide three main functionalities: the first function is to describe an individual user's competencies, the second function is to look for a partner, and the third one involves exploring the dynamic of the TV cluster. Finally, the third prototype P3 is more sophisticated, in terms of its ergonomic qualities as well as data security. This prototype also included enhanced functionalities for building and managing collaborative ties, alliances and clusters.

During these four cycles, other artifacts were built such as models (model of competencies) and pictorial representations. The main pictorial representation was the representation of the common space which characterizes the TV cluster. This representation was improved at each cycle, starting from the representation of the main value chain of the cluster to an abstract representation of the entire cluster (see next section for more details).

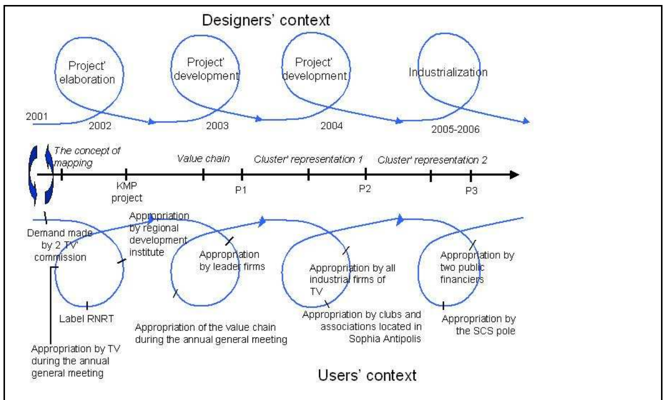


Figure 2. The Evolution of the KMP Project

As figure 2 illustrates, the users' context evolved starting from the interest and engagement of two TV committees, to all TV members, to all professional clubs and associations located in Sophia Antipolis, and finally the SCS pole (Secured Communication Solutions) and new public sponsors. During the first two cycles, the positive evaluation by the French Telecom program 'Réseau National de Recherche en Télécommunications' (RNRT), the support gained from the lead users (firms), and the adoption of TV's value chain (first pictorial representation of the common space) by the annual general meeting of TV played a critical role in creating interest and engagement. As a result of the growing interest of firms in the TV cluster, two public sponsors in charge of territorial development decided to support the full implementation by firms of the KMP project (in the last cycle in Figure 2). Early 2007, 412 competencies were registered in the portal by 63 firms and 4 public research labs. Mid 2007 the final version of the portal came online. Several critical events and episodes in these iterations will be discussed in more detail in the remainder of this section. (A more complete and detailed overview of all cycles in the KMP project is available upon request from the authors.)

Interaction Between Designers and Users

Interactions between designers and users occurred through three different modes: interviews, regular meetings and occasional meetings. Several kinds of interviews were conducted: 26 open interviews with key stakeholders that served to clearly define the context and the goals of the project (in 2001-2002), 52 semi-structured interviews with (lead) users to collect data on their needs, perspectives and experiences (in 2003-2004) to build user scenarios, and 21 interviews with users as well as other stakeholders to evaluate the last two prototypes of the portal (in 2004-2006). In addition, we set up an advisory board composed of users and members of the project team (designers). The main role of the advisory board was to achieve collective validation at each stage of the prototype's conception and development. Steering committee meetings were organized each three months (2002-2006) and we gained unrestricted access to minutes as well as all written documents exchanged and discussed in these meetings. Finally, we presented progress reports to diverse entities such as sophipolitan clubs, firms' and research centres' leaders, and regional founders in order to connect to, and enhance, the sociotechnical network around the portal being developed.

Results: Co-Production of Theoretical and Practical Knowledge

This section explores the knowledge created by the design methodology previously described. We will present the main design rules built during the KMP project. For each rule, we focus on the creation of theoretical knowledge, practical knowledge and the reinforcement of each kind of knowledge during the design process.

The KMP solution was developed to support emergent knowledge processes inside the TV cluster. Therefore, the implementation of a ready-made 'turn-key' IT solution was not an option for the project team. In this respect, the design evaluation method adopted involves an in-depth study of the (intended) artefact in its business environment (cf. Hevner et al. 2004). More precisely, the efficiency of the solution depends on practical knowledge generated by the KMP uses. In this purpose, each KMP prototypes were evaluated in real uses.

Preliminary Work

The first project cycle involved analyzing the context, to understand the practical and research problems and define the goals of the project. As observed earlier, in 2001 TV faced a lack of local links and synergies between its members, due to TV's history (focus on external growth) and the broad scope of technologies present in TV. These two characteristics lead to a rather heterogeneous and disconnected body of knowledge as well as an underdeveloped identity of TV and a lack of mutual understanding.

These issues raised a theoretical question with regard to the dynamics of knowledge creation inside a cluster. This question motivated the project team to study the literature on knowledge management. This literature (e.g. Nahapiet and Ghoshal 1998; Kogut 2000) suggested that knowledge creation involves social processes of exchanging and combining knowledge. An extensive review of the literature led the project team to conclude that four conditions facilitate these social processes: the incumbent community (1) perceives opportunities to exchange and/or combine knowledge; (2) is able to anticipate future value created from exchanging and combining knowledge; (3) is motivated to exchange and combine knowledge; and (4) is capable to combine heterogeneous knowledge resources.

Indeed, the aim of the project was to foster knowledge creation by increasing exchange and combination of knowledge in partnerships between the different actors of the cluster (i.e. firms and public research labs). In this respect, practitioners typically try to locate and find partners on the basis of their competencies. As such, practitioners tend to speak about 'competency mapping' rather than knowledge mapping. Once the competency (being searched) is identified in a partner, an effective partnership will facilitate the exchanges and combinations of specific knowledge elements embedded in the different competencies of the partners.

Based on these insights, we elaborated the following meta-rule:

> In a multi-actor cluster with a broad scope of technologies (*context)*, an interactive map of competencies *(intervention)* will serve to foster knowledge creation (intended *outcome*) by reinforcing the four conditions for exchanging and combining knowledge: opportunity, anticipation, motivation, combinatory capability *(generative mechanism).*

The latter set of conditions refers to the generative mechanisms for fostering knowledge creation inside a cluster. The meta-rule thus identifies a potential link between a specific intervention (interactive mapping of competencies) in a specific context and the generative mechanisms of knowledge creation, which in turn are likely to produce a particular outcome (knowledge creation). However, this rule does not specify the intervention modalities, in terms of what kind of solution is needed and how to develop it. Here, the precise and iterative analysis of the interactions between intervention and generative mechanisms may create both theoretical and practical knowledge on the dynamics of innovation inside a cluster.

Subsequent steps thus involved elaborating, on the basis of this meta-rule, more precise design rules with regard to the (intended) technical and organizational solutions that serve to foster the dynamics of knowledge creation inside the cluster. Developing these design rules implied the need for a deeper understanding of the generative mechanisms. In turn, the implementation and test in real uses of the solution will enrich knowledge on generative mechanisms on dynamic of knowledge creation inside a cluster.

Design Rule for Mapping Competencies

This first design rule developed involved building a 'competencies map' in order to foster the opportunity to exchange and combine knowledge. The main challenge here was to describe competencies across a cluster of firms in sufficient detail without disclosing strategic know-how. We responded to this challenge by both studying the literature and questioning several expert practitioners on their practices to find a partner.

In the literature, we looked for a competency framework would serve to describe actors' competencies and provide information needed by practitioners. Because this frame did not exist in the literature, we developed a competencies model based on the literatures regarding the competence-based view and human resource management More particularly, the following ideas were inferred from the literature. A competency involves four aspects: systemic composition, actionability, visibility, and finality (Rouby and Thomas 2004). A competency therefore results from an individual or collective action (actionability) that produces an output (visibility); moreover, it is composed of a combination of resources and abilities (systemic composition) and results from a strategic intention (finality) in response to a market need. In other words, the map of competencies would need to incorporate action, resources, delivery and business activity as the four key dimensions of competency.

At the same time, practitioners were interviewed to identify and describe their practices in finding partners and identifying the types of information needed for this inquiry (user scenario). On the basis of these interviews, the project team identified a set of queries that a map of competencies would need to be able to respond to: these involved simple queries on, for example, a particular technology (e.g. “which firms are working on J2ME?”), a delivery (e.g. “who has succesfully produced video games?”) or a business activity (e.g. “which firms are doing work for the 3G mobile sector?”) as well as more complex queries which combined several items such as technology and business activity.

In sum, by combining theoretical and practical knowledge we defined the first design rule (DR). This design rule focuses on how to locate competencies (intervention) in order to facilitate the search for partners, in other words, to foster opportunities to exchange and combine knowledge (i.e. generative mechanisms regarding the first conditions for knowledge creation):

> DR1: In a multi-actor cluster with a broad scope of technologies (*context*), building a map of competencies (*intervention*) will serve to foster knowledge creation (*outcome*) by reinforcing opportunities to exchange and combine knowledge (*generative mechanism*). A 'competency' is defined here as an *action* (cf. actionability aspect) that mobIilizes technical, scientific and managerial *resources* (systemic aspect) to produce a *deliverable* (cf. visibility aspect) that is expected to create value in a *business activity* (finality aspect).

It has to be noticed that knowledge is represented in the resources item of the competency model.

Indeed, by combining insights from the resource-based perspective (Wernerfelt 1984; Barney 1991; Dierickx and Cool 1989) and core competencies theory (Hamel and Prahalad 1994; Sanchez et al. 1996), we built a new model for describing competencies (Rouby and Thomas 2004). Here, codification played a key role in defining design rules. Indeed, this model, that serves to codify competencies, draws on the codification process described by Boisot and Canals (2004). As such, the codification effort is necessary for theoretical knowledge creation.

Once implemented in the various prototypes of the portal, DR1 served as a basis to produce practical knowledge in three different domains, supporting the effectiveness of the solution. First, the map of competencies in the portal created knowledge for participating firms regarding their own competencies. For example, one manager claimed “the KMP solution provides a better understanding of oneself, and therefore a better awareness of the firm’s competency wealth.” In many instances, people started using the prototype of the portal to provide the management of their firm as well as their parent companies with information on their competencies' domain and business activities.

For other users of the first version of the portal, this better visibility of their competencies has influenced "communication and development strategies". The following example illustrates the influence of the competencies map on the communication strategy of one of the firms in the cluster. This firm had been pioneering a particular technology, but had recently stopped with all marketing communications on this technology because it was perceived to be obsolete and no longer state-of-the-art. However, through a pilot version of the map of competencies in the portal, the senior management of the firm discovered that this particular technology ranked among the five most widely used technologies in the cluster. Therefore, senior management decided to re-integrate that particular technology in its communication strategy and product portfolio.

Finally, the creation and implementation of the KMP tool to track competencies appears to facilitate communication and enhance the ability of users to gain access to partners. For example, the executive of a large firm in TV was contacted by an external contact looking for the appropriate interlocutor in his firm with regard to a specific project. The executive had no idea regarding this request, but recalled the KMP tool of competencies tracking. By means of this tool, he was able to locate the most suitable contact in his firm.

A first prototype of the KMP solution was created (cf. second loop in Figure 2) and made available online to all firms in the TV cluster. The direct access to this prototype helped to sustain the initial commitment to the KMP project that participants in the cluster developed at an earlier stage. In 2003, 73 competencies were full described and registered by 9 pilot firms. These earlier real uses allowed to develop practical knowledge relying on the design rule 1.

Design Rules for the Common Space Representation

Another key issue in developing the portal for mapping competencies involved developing a shared identity of the cluster. This so-called 'common space representation' would need to enhance the identity of the cluster and to foster the motivation to exchange and combine knowledge. In this respect, the positive impact of a collective identity on motivation has been stressed in the literature (see Nahapiet and Ghoshal 1998; Kogut 2000). However, the question regarding how to improve this identity remains largely unanswered in the literature.

For members of TV's board, this lack of identity raised two problems. First, it led to a problem of visibility: "there has always been an ambiguity on whether Sophia is more telecom or computer." Second, it implies a problem of boundaries: "We never know when we have to accept the entry of a consultancy firm. Generally, the decision depends on the size of the firm. Thus, we lean more on political aspects than on industrial or innovation logics. We are not happy about this approach, but we don't know how to do it otherwise." Similarly, the president of TV observed a problem of geographical borders: "Do we have to accept a firm with a business activity that is in the core competency of TV, but which is situated kilometres away?"

These observations and also these theoretical analyses generated the idea that the representation of the cluster's common space may serve to improve the identity of the cluster. This representation was constructed by combining two distinct approaches. The first approach involved a strategic and economic analysis of the cluster: what is a cluster? How to represent it? The second approach focused on communities, in order to understand the concept of identity. In this respect, Wenger (1998) suggests that a common space representation has to clearly mark the boundaries of a cluster and to highlight its constitutive common elements.

As such, the common space representation was progressively constructed by successive iterations between theory and practice. In each loop, the cluster definition and its constitutive elements were improved.

Following the cluster definition proposed by Cook and Huggins (2003), we first represented the TV cluster in terms of its main value chain, focusing on the different firms that composed TV. This value chain representation needed to be instrumental in (1) locating actors and competencies and (2) detecting existing or potential interactions between actors in the value chain. As such, this representation underlined competencies complementarity as one key element of a cluster's constitution, but it did not clearly mark its boundaries because only firms were represented. A new representation was thus proposed. One of the objectives here was to represent all TV's members. According to the literature on regional studies (e.g. Keeble et al. 1998; Krafft 2004), the main actors of a cluster are firms, public research labs, and organizations providing support. These actors were categorized in terms of their main competency: relational, managerial, technical (Arrègle et al. 1998; Dyer and Singh 1998). The new representation thus served to identify three kinds of actors:

1. the stakeholders that participate in knowledge creation in the cluster (i.e. those who have technical competencies: firms and public research labs);

2. the facilitators including all associations, clubs or service providers whose goal is to help find partners (i.e. relational competencies),

3. support organizations in the area of law, finance and management; these help ensure partnerships (managerial competencies).

This second representation improved the visibility of the cluster boundaries. However, it did not specify its constituting elements. Indeed, only one value chain was represented, whereas other complementarities were not yet visible. Moreover, the collective work on this second representation generated new needs and ideas to explore. For example, the President of TV suggested the representation could also serve to improve mutual understanding (cf. second leverage to identity), in particular to analyze the strengths and weaknesses of the cluster and to design a collective strategy for cluster promotion and development. During the third cycle, we therefore also started developing the similarity and complementarity concepts (Richardson 1972) to propose a new representation. Indeed, the evaluation of the degree of similarity and complementarity of the cluster's competencies capital served to evaluate its coherence and to highlight potential combinations that would possibly create value in the future (Christensen and Foss 1997; Kogut 2000).

On the whole, the iterative work on the cluster representation constituted a key element in the users' appropriation of the KMP portal. This appropriation stems from both the extension of the sociotechnical network and the co-evolution of the portal's design and use.

For example, the first representation's building has largely mobilized actors and has consequently resulted in that, during the annual general meeting of TV, all firms were asked to position themselves on the value chain. As a result, members of TV (i.e. not only the pilot firms) adopted the proposed value chain, which extended the sociotechnical network around the portal to all members of TV. In the same way, the work on similarity and complementarity concepts thus extended the sociotechnical network from TV to other clubs and associations and finally to the SCS pole.

The successive discussions and pilot-tests of the cluster representation served to define the two following design rules:

> DR2: In a multi-actor cluster with a broad scope of technologies (*context*), building a common space representation (*intervention*) serves to foster knowledge creation (*outcome*) by reinforcing the motivation of actors to exchange and combine knowledge (*generative mechanism*).

A cluster representation that is instrumental in fostering identity and mutual understanding combines two design parameters: (a) all actors are represented in terms of their main competencies, that is scientific and technical competencies (stakeholders), managerial competencies (support), relational competencies (facilitators); (b) the competencies of stakeholders are positioned in technological poles (similarity concept) as well as value chains (complementarity concept).

> DR3: In a multi-actor cluster with a broad scope of technologies (*context*), evaluating the degree of similarity and complementarity of competencies (*intervention*) serves to foster knowledge creation (*outcome*) by reinforcing the ability to anticipate value that can be created by exchanging and combining knowledge (*generative mechanisms*).

To evaluate the similarity and complementarity of competencies, an interactive map of competencies draws on the following definitions: competences are similar when they share the same resources, and competences are complementary when they share the same business activity.

The two design rules DR2 and DR3 served to build an interactive representation of the TV cluster. In this last representation, value chains are not given, but dynamically built from the particular competencies described by the users in the platform. This cluster representation was positively evaluated by all users and also adopted by the SCS pole.

This representation of the cluster and its knowledge dynamics – as defined in the design rules previously described – contributes to the theory of network capabilities. Network capabilities are capabilities for creating, accumulating and transferring collective knowledge in a cluster Foss, 1999; Kogut, 2000). Drawing on the previous study of social capital by Nahapiet and Ghoshal (1998), we theoretically refined the concept of network capabilities by identifying the impact of a common space representation as well as the role of similarity/complementarity concepts in these capabilities (Lazaric and Thomas 2006; Barlatier and Thomas 2007; Lazaric et al. 2008).

Here again, once implemented and available in the diverse prototypes of the KMP portal, its uses produce practical knowledge in three different domains: it serves to map and categorize competencies across the cluster, develop the identity of the cluster, and manage the cluster. This practical knowledge is crucial to foster exchange and combination of knowledge inside a cluster.

First, cluster mapping enabled actors to make an assessment of the current situation concerning the knowledge base of the cluster and the interactions of different components of knowledge. These elements are necessary to build a diagnosis of the weakness and strength of the cluster in terms of the nature and number of competencies in particular domains. This resulted in a collective and shared understanding of collective strategies of the cluster’s development: fostering the entrance of new members where there are deficiencies, identifying newly emerging value chains to be reinforced in the future, and managing the boundaries. For example, TV’s actors decided to accept new members from other regions that potentially offered technical and scientific competencies mobilized in the different value chains of the cluster. They also decided to open the cluster boundaries by integrating multimedia firms, because they would be likely to enhance the value chains in the cluster.

Second, this type of diagnosis helped people develop a vision on current or future strategies and identities of (individual firms in) the TV cluster. That is, maps of the cluster enhance the capabilities of users to anticipate the creation of value through partnerships, as they are able to search for opportunities and competencies. A practitioner in the microelectronics domain observed that cluster mapping provides “a better understanding of the reason why actors work together”.

Finally, this collective vision also appears to support the management of the cluster (as an association of firms). On the one hand, as we have seen above, the collective vision creates a strategy towards (potential) new members of the cluster. On the other hand, it has an impact on the governance of the cluster, given that only the cluster's stakeholders are represented (i.e. participate) on its board. A member of the executive board recounted the example of the incubator director who asked for a seat on the TV board. This request was rejected because the representation of the cluster's identity in the portal positioned incubators as supporting functions rather than key stakeholders. Reflecting on this particular case, the same executive recently stressed that “today, TV is a well-structured association and the KMP project has helped to structure the association”.

The TV membership evaluated the KMP solution positively as a tool to foster innovation inside a cluster. Indeed, at the end of the third cycle, the TV association became the project leader and found new sponsors to institutionalize the solution (fourth cycle). As underlined by the R&D director of one of the IT firms in the cluster: “the portal gives information on actors' positioning, it also allows to discover and to understand partnerships' competencies. The most important is that the portal serves to identify domains where actors are complementary. For example, in the RFID domain, we want to develop a user approach and some local actors are suppliers. The portal is instrumental in developing this approach”.

Moreover, in 2008 @ctis-enginerie (a local SSII) bought the license to exploit the KMP portal. Their website[1] describes the capabilities of the KMP portal as follows: “The KMP tool is a new approach to skill management and to facilitate partnership detection in a network, through the development of collective competencies and a real mapping of the competence center”. In 2009, @CTIS-enginerie developed a new version of the KMP Platform: the Web Portal KMP 2.0, an updated tool that is more oriented towards valorization activities, with a different design and approach for competencies description than the original KMP skills concepts.

The Combinative Aspect of Design Rules

The findings from the KMP project can be summarized as follows. Clusters characterized by a large number of actors and a broad variety of technologies can reinforce knowledge creation via an iterative process that involves pilot testing and interaction with users, drawing on the following interventions (I) and generative mechanisms (M):

- building a map of competencies – defined in terms of action, resources, deliverables, and business activity (I^1) – to reinforce opportunities to exchange and combine knowledge (M^1);
- building a common space representation, by specifying the role of actors (stakeholders, facilitators and support organizations) and identifying similar and complementary competencies (I^2), to reinforce identity

1 See their web site on http://www.actis-ingenierie.com/versiongb/gbtitre3.htm

and foster motivation to exchange and combine knowledge (M^2);

- evaluating the degree of similarity and complementarity of competencies (I^3), to reinforce the capacity to anticipate value created through exchange and combination (M^3).

These design elements are interdependent and complementary. As Denyer et al. argued, “the design proposition is comprised of a combination of interventions (I^1 … I^n) that invoke particular generative mechanisms (M^1 … M^n)” (2008: 407). Indeed, in the KMP project the cluster representation draws on the capacity to identify similar and complementary competencies which in turn are based on the retained definition of competencies. In addition, the iterative process served to make the set of interventions defined in DR1 to DR3 sufficiently generic to be used in other clusters. For example, a French health care cluster recently adopted a similar set of interventions as developed in the KMP project (Semionoff-Bru 2008).

Discussion and Conclusion

Earlier in this paper, we identified two key design approaches: science-based and human-centered design. Subsequently, we set out to combine these two approaches by offering an integrative design methodology that articulates and produces both theoretical and practical knowledge in the specific case of designing an innovative solution relying on emergent knowledge processes in a multi-actor environment. Our study contributes to the literature in three ways, discussed in the remainder of this section.

A Systematic and Multi-Level Approach to User Involvement

The methodology developed in this study is to a large extent motivated by the science-based design perspective, which advocates the development of design rules that are grounded in theory and articulate generative mechanisms which produce desired outcomes (Van Aken 2005). Science-based design starts from an in-depth understanding of generative mechanisms as well as developing causal connections between interventions and generative mechanisms. The design methodology developed in this paper extends the science-based approach by systematically involving users at different levels of the design project. This is done in two ways.

First, in order to develop design rules, user scenarios are instrumental in inferring particular elements of generative mechanisms from practice (e.g. experience of practitioners). In our study, for example, user scenarios enriched the identity concept. Indeed, because practices bring new concepts such as common elements, membership or boundaries, researchers decided to question specific works on communities. Uncovering particular (hidden) aspects of generative mechanisms is crucial to define effective interventions and create positive feedback loops between generative mechanisms, interventions and outcomes. Plsek et al. (2007) argue that the main benefit of scenarios arises from the opportunity to systematically explore the space of the context and the desired outcomes. By contrast, our study emphasizes the value of scenarios in exploring the kind of generative mechanisms at work as well as the interventions that may trigger or reinforce these mechanisms. As such, the design methodology presented in this paper serves to develop design rules that draw on generative mechanisms resulting from theory and situated practices.

Following Bate and Robert (2007), a focus on pilot or lead users is not sufficient. Rather, the co-design perspective implies active participation by a broad variety of users as well as an in-depth understanding of the organization. Moreover, because some ideas and insights tend to be discovered only in action (Jelinek et al. 2008), the prototyped artifact must be placed and tried out in real world settings as early as possible in the design process. Indeed, Orlikowski (2004: 93) outlines that “designs are incomplete until realized in action, until integrated into the every day practices of human actors for whom the design are a means to an end”. At this prospect, our study involves building a sociotechnical network to mobilize users' interessement and to carry and support the design process. In the KMP project, thus, the three successive cluster representations play a critical role in creating and developing interest and momentum that supports the emergence and growth of a sociotechnical network around the project. This mobilization process is messy, dynamic, iterative, and highly responsive to particular circumstances (cf. Jelinek et al. 2008). Here, combining the science-based and human-centered design approaches may prevent the design process from becoming overly driven by users. Indeed, by returning to their knowledge base in each cycle, designers are more likely to steer the design process towards intended outcomes.

However, the network's growth combined with the iterative cycles in any major design project tend to increase the need to engage in compromises between different - possibly antagonistic - demands and preferences. Consequently, arbitrage and collective sensemaking are more difficult to accomplish (Van de Ven and Johnson 2006).

IT Interfaces and the Arbitrage Process

Artifacts, and its underlying design rules, can act as boundary objects in the arbitrage process (e.g. Romme and Damen 2007; Jelinek et al. 2008). Our study of the KMP project suggests IT interfaces can play a specific role in arbitrage processes.

In the KMP case, the application and contextualization of the design rules in successive prototypes served to build situated practices. However, these prototypes remained plastic enough to be continually adapted to the evolving demands of different users. For example, an important property of the KMP's interface is to provide the opportunity to describe one's competencies. These interfaces also provide the opportunity to specify queries when searching for particular competencies. Moreover, IT interfaces are reconfigurable and can evolve when the practices or contexts of users change.

In particular, the KMP project draws on IT interfaces, which has two implications. First, IT interfaces support the coordination and communication between users and designers. In this respect, IT interfaces integrate standardized representations (of competencies in the KMP project). According to Star and Griesemer (1989), these standardized representations play a critical part in this type of project by ensuring the integrity of the information collected from the multi-actor environment. For example, the KMP solution provides standardized methods for collecting, labelling and identifying competencies inside a cluster, as well as for representing and analyzing a cluster.

Second, IT interfaces play a key role in collective learning processes as they emerge and develop over time. Here, using and embedding these interfaces in the actual professional practices is essential to create both a deeper theoretical understanding and practical knowledge. Indeed, at each stage, IT interfaces draw on theoretical principles identified by designers. As such, they provide a working hypothesis, as Béguin (2003) suggests. Trying out the artefact in users' practical settings constitutes an opportunity for testing the working hypotheses of designers regarding this artefact, uncovering their consequences and possibly enriching, changing or falsifying them. In this respect, 'practising' the design tends to improve the pragmatic validity (Worren et al. 2002) of the underlying knowledge. In the KMP project, for example, the accessible database of competencies has increased the trust in the KMP tool – by describing competencies without revealing strategic know-how; moreover, it has proved useful in partner search and, in addition, has also produced unexpected benefits (e.g. self-awareness of competencies).

Coproduction of knowledge: the role of the design rules codification

According to the literature on science-based design, knowledge creation arises from the codification of rules in an iterative research process (e.g. Romme 2003). The codification of rules thus plays a key role. At the beginning of the KMP project, the development of a meta-rule helps to guide the design process by identifying the main generative mechanisms. However, because this rule is general and abstract, it does not specify how to conceive a specific solution.

Subsequent design cycles thus involve elaborating precise and enriched design rules for each generative mechanism. The codification process used follows a classic approach starting from concrete to abstract (Boisot and Canals 2004). The development of design rules regarding the common space (DR 2 and DR3) illustrates the initial interest in elaborating concrete rules, which become more abstract through the design process. The first representation of the TV cluster in terms of its main value chain supports users in appropriating the rule. Once implemented in a prototype, this rule has been the starting point of the interessement process of getting a large number of actors on board. According to Mohrman (2007) and Denyer et al. (2008), the diversity of actors involved stimulates new ideas and synergies with designers. In the KMP project, this results in the emergence of new concepts such as the similarity and complementarity concepts enriching the analysis of generative mechanisms by connecting theoretical elements previously unconnected. Finally, designers and users developed more and more abstract knowledge to build a solution to the problem of exchanging and combining knowledge inside a cluster. According to Lewis et al. (2005), an abstract representation of the underlying principles of the problem domain facilitates transfer to and also usage in other contexts. Because users in the KMP project participate in the progressive conception of these abstract representations of the underlying principles, it is easier for them to recognize problems with similar characteristics and to apply their knowledge in new contexts. Thus, the set of interventions defined in the design rules DR1 and

DR3 becomes sufficiently generic to be used in other contexts (e.g. in other clusters such as the French health care cluster).

In addition, our study shows the positive influence of a growing sociotechnical network on knowledge coproduction processes. First, the steady growth of the network enhances its diversity. This diversity can be used to generate new concepts, new ideas, and synergies (Mohrman 2007; Denyer et al. 2008). Second, growing the sociotechnical network also multiplies the contexts where rules can be tested and thus improves the robustness of the knowledge created.

Limitations and Conclusions

This study has several limitations. First, the empirical work described in this paper took place in the context of a network of firms that previously pioneered user-centered design projects. Following Bate and Robert (2007), this is likely to be a receptive context for a codesign approach. Second, the design method developed in this study has not yet been fully tested in another setting. This means that there is no direct evidence regarding the generalizability of the design method proposed in this paper as well as the design rules for mapping competencies in a technology cluster resulting from the TV case. Third, given the purpose of this paper, we did not describe the internal interactions in the project team, for example, between organization scientists and computer scientists. We also lean on the ANT to manage these interactions.

Notwithstanding these limitations, the approach taken in this paper opens up new avenues of researching and understanding how new practices are created in multi-stakeholder environments. The mapping competencies project discussed in this paper suggests design-oriented scholars may be able to engage directly in creating new practices in multi-stakeholder settings. It also suggests that the effectiveness of this type of design project arises from a deliberate focus on articulating design principles as well as engaging users in trying out prototypes, to create artifacts that support and drive the dialogue between user-practitioners and design-oriented organization researchers.

References

Ackoff, R. L. 1999. Re-creating the corporation: a design of organizations for the 21st century. New York: Oxford University Press.

Akrich, Madeleine, Michel Callon, and Bruno Latour 2002. 'The key to success in innovation'. International Journal of Innovation Management 6/2: 207-225.

Andriessen, D. 2007. 'Designing and testing an OD intervention: reporting intellectual capital to develop organizations.' Journal of Applied Behavioral Science 43: 89-107.

Arrègle, J.-L., T. Amburgey and T. Dacin 1998. 'Le rôle des capacités organisationnelles dans le développement des réseaux d'entreprises: Une application aux alliances'. Finance Contrôle Stratégie 1: 7-25.

Avison, D. E., and V. Taylor 1997. 'Information Systems Development Methodologies: A Classification According to Problem Situation.' Journal of Information Technology 12/1: 73-81.

Barlatier, P.-J., et C. Thomas 2007. 'Savoir-voir collectif et développement des capacities réseaux.' Revue Française de Gestion 170 : 173-190.

Banathy, Bela H. 1996. Designing Social Systems in a Changing World. Plenum, New York/London, U.K.

Barlatier, Pierre-Jean, and Catherine Thomas 2007. 'Savoir-voir collectif et développement des capacities réseaux.' Revue Française de Gestion 170 : 173-190.

Barney, Jay 1991. 'Firm resources and sustained competitive advantage.' Journal of Management 17/1: 9-120.

Bate, P. et G. Robert 2007. 'Toward More User-Centric OD: Lessons From the Field of Experience-Based Design and a Case Study.' Journal of Applied Behavioral Science 43: 41-66.

Béguin, P. 2003. 'Design as a mutual learning process between users and designers'. Interacting with Computers 15: 709-730.

Boisot M., Canals A., 2004, Data, Information and Knowledge: have we got it right? The Journal of Evolutionary Economics, 11, pp.43-67.

Boland, R. J., and F. Collopy 2004. Managing as designing. Stanford, CA: Stanford University Press.

Buchanan, Richard 2004. 'Management and design: Interaction pathways in organizational life.' in Managing as designing. Richard J. Boland and Fred Collopy (eds), 55-63. CA: Stanford University Press.

Carlsson S.A, 2005. 'Developing Information Systems Design Knowledge: A Critical Realist Perspective', *Electronic Journal of Business Research Methods,* Vol. 3, pp. 93-102

Carroll, J. M., M. B. Rosson, G. Chin, et J. Koenemann 1998. ‘Requirements Development in Scenario-Based Design’, IEEE Transactions on Software Engineering 24/12: 1156-1170.

Castells, Manuel, and Peter Hall 1994. Technopoles of the World: The making of 21st Century Industrial Complexes. London: Routledge.

Christensen, N. J., and J. F. Foss 1997. ‘Dynamic Corporate Coherence and Competence-based Competition: Theoretical Foundations and Strategic Implications.’ in *Competence-Based Strategic Management.* Ron Sanchez et Aime Heene (eds), 287-312. New York: John Wiley & Sons.

Cook, P., and R. Huggins 2003. ‘High-technology clustering in Cambridge (UK).’ in *The institutions of local development.* Fabio Sforzi (eds), 51-74. Aldershot, Ashgate.

David, A. 2000. ’La Recherche-Intervention: Cadre Général pour la Recherche en Management?’ in *Les Nouvelles Fondations des Sciences de Gestion: Eléments Epistémologiques de la Recherche en Management.* Albert David, Armand Hatchuel et Romain Laufer (eds.), 193-213. Paris: Vuibert-Fnege.

Denyer, D., D. Tranfield, and J. E. van Aken 2008. ‘Developing design propositions through research synthesis’. *Organization Studies* 29/3: 393-414.

Dierickx, Ingemar, and Karel O. Cool 1989. ‘Assets and stock accumulation and sustainability of competitive advantage.’ Management Science 35/12 : 1504-1511.

Dyer, J. H. and H. Singh 1998. The relational view: Cooperative strategy and sources of inter-organizational competitive advantage. *Academy of Management Review* 23: 660-679.

Eckert, C., and J.-F. Boujut 2003. ‘The role of objects in design co-operation: communication through physical or virtual objects.’ *Computer Supported Cooperative Work* 12/2: 145-151.

Foss, J. F. 1999. ‘Networks, Capabilities, and Competitive advantage.’ *Scandinavian Journal of Management* 15. 1-15.

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, and M. Trow 1994. *The new production of knowledge: The dynamics of science and research in contemporary societies*. London: Sage.

Hamel, Gary, and C.K. Prahalad 1994 Competing for the Future. Boston, MA: Harvard Business School Press.

Hatchuel, A. 1994. 'Les savoirs de l’intervention en entreprise.' *Entreprises et Histoire* 7: 59-75.

Henderson, K. 1999. On line and on paper: Visual representations, visual culture and computer graphics in design engineering. Boston: MIT Press.

Hevner A.R., S.T. March, J. Park, et S. Ram, 2004 “Design Science in Information Systems Research,” *Management Information Systems Quarterly*, vol. 28, pp. 75-106

Hodgkinson, G. P., and M. P. Healey 2008. ‘Toward a (pragmatic) science of strategic intervention: Design propositions for scenario planning.’ *Organization Studies,* 29/3: 435–457.

Jelinek, M., A. G. L. Romme, and R. J. Boland 2008. ‘Introduction to the special issue: organization studies as a science for design: creating collaborative artefacts and research’. *Organization Studies* 29/3: 317-330.

Keeble, D., C. Lawson, B. Moore. and F. Wilkinson 1999. ‘Collective learning processes, networking and ‘institutional thickness' in the Cambridge region.’ *Regional Studies* 33: 319-332.

Kogut, B. 2000. ‘The network as knowledge: generative rules and the emergence of structure.’ *Strategic Management Journal* 21: 405-425.

Krafft, J. 2004. ‘Entry, Exit and Knowledge: Evidence from a cluster in the info-communications.’ *Research Policy* 33/10: 1687-1706.

Krippendorff, K. 2006. *The semantic turn: A new foundation for design.* Boca Raton, FL: CRC Press

Latour, B. 1986. 'The powers of association.' In J. Law (ed.), Power, action and belief: A new sociology of knowledge? *Sociological Review Monograph* 32: 264-280. London: Routledge & Kegan Paul.

Law, J. and Callon, M. 1988. ‘Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change’. Social Problems 35(3): 284-297.

Lazaric, N. and C. Thomas 2006. 'The coordination and codification of knowledge inside a network, or the building of an “epistemic community: The 'Telecom Valley' case study.' In *Reading the Dynamics of a Knowledge Economy.* Wilfred Dolfsma et Luc Soete (eds.), 129-156. Cheltenham, UK: Edward Elgar.

Lazaric, N., C. Longhi, and C. Thomas 2008. ‘Gatekeepers of Knowledge versus Platforms of Knowledge: From potential to realized absorptive capacity.’ *Regional Studies* 3/2: 45-63

Lewis K., Lange D., Gillis L., 2005, Transactive Memory Systems, Learning, and Learning Transfer, *Organization Science*, Vol.16, N° 6, novembre – décembre, pp. 581-598.

Lindgren R. O. Henfrdsson et U. Schultze, 2004. ‘Design principles for competence management systems: a synthesis of an action research study’, *MIS Quarterly,* Vol. 28 n°3 pp. 435-472.

Longhi, C. 1999. 'Networks, collective learning and technology development in innovative high technology regions: The case of Sophia Antipolis.' *Regional Studies* June, 33 (4): 333-342.

Markus M.L., A. Majchrzak, et L. Gasser, 2002. 'a design theory for systems that support emergent knowledge processes.', *MIS Quarterly*, vol. 26, pp. 179-212.

Mohrman, S. A. 2007. 'Having Relevance and Impact: The Benefits of Integrating the Perspectives of Design Science and Organizational Development.' *Journal of Applied Behavioral Science* 43: 12-24.

Nahapiet, J., and S. Ghoshal 1998. 'Social capital, intellectual capital, and the organizational advantage.' *Academy of Management Review* 23/2: 242-266.

Orlikowski, W. J. 2004. 'Managing and designing: attending to reflexiveness and enactement.' in *Managing as designing*. Richard J. Boland et Fred Collopy (eds), 90-95.

Pascal Amandine and Rouby E., 2006. Construire des scénarios d'usage : une approche gestionnaire - Le cas KMP -, *Actes de la SdC 2006 (Semaine des Connaissances), Tome 2,* Éditeurs : Rémi Lehn, Mounira Harzallah, Nathalie Aussenac-Gilles, Jean Charlet.

Plsek, P., J. Bibby, and E. Whitby 2007. 'Practical Methods for Extracting Explicit Design Rules Grounded in the Experience of Organizational Managers.' *Journal of Applied Behavioral Science* 43: 153-170.

Richardson, G. B. 1972. 'The Organisation of Industry.' *The Economic Journal* September: 883-896.

Romme A. G. L., et I. C. M. Damen 2007. 'Toward science-based design in organizational development: codifying the process.' *Journal of Applied Behavioral Science* 43: 108-121.

Romme, A. G. L. 2003. 'Making a difference: Organization as design.' *Organization Science* 14: 558-573.

Romme, A. G. L., et Gerard Endenburg 2006. 'Construction principles and design rules in the case of circular design.' *Organization Science* 17: 287-297.

Rouby, E., and C. Thomas 2004. 'La codification des compétences organisationnelles: l'épreuve des faits.' *Revue Française de Gestion* 149 (2): 51-68.

Rouby, E., and C. Thomas 2009. 'Des compétences individuelles aux compétences stratégiques : quelles propositions ? Vers une solution innovante de gestion articulée des compétences.' *Intervention Economique.* In press.

Sanchez, Ron, Aime Heene, and Howard Thomas 1996. Dynamics of Competences-Based. Oxford, U.K: Elsevier Science & Technology.

Semionoff-Bru, Thierry 2008. Interview available at http://www.actis-ingenierie.com/titre3.htm

Star, S. L. and J. R. Griesemer 1989. 'Institutional ecology, translation and coherence: Amateurs and professionals in Berkeley's museum of vertebrate zoology, 1907-1939.' *Social Studies of Science* 19: 387-420.

Tatnall, A. and A. Gilding 1999. 'Actor-network theory and information systems research.' Paper presented at *10th Australasian Conference on Information Systems (ACIS),* Wellington, Victoria University of Wellington.

Van Aken, J. E. 2005. 'Management research as a design science: Articulating the research products of mode 2 knowledge production in management.' *British Journal of Management* 16: 19-36.

Van de Ven, A. H. et P. E. Johnson 2006. 'Knowledge for theory and practice.' *Academy of Management Review* 31: 802-821.

Walls, J. G., G. R. Widmeyer and El Sawy, O. A.1992. 'Building an Information System Design Theory for Vigilant EIS', *Information Systems Research,* 3(1): 36-58.

Warfield, J. N. 1984. *A science of generic design: managing complexity through systems design.* Ames, IA: Iowa State University Press.

Wenger E., (1998). Communities of Practice, Learning, Meaning, and Identity. Cambridge University Press.

Wernerfelt, Birger 1984. 'A Resource-Based View of the Firm'. Strategic Management Journal 5/2: 171–180.

Worren, N. A., K. Moore, and R. Elliott 2002. 'When theories become tools: Toward a framework for pragmatic validity.' *Human Relations*, 55: 1227-1250.