Managing knowledge in large-scale virtual projects: a community-based approach

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Abstract

Purpose – This paper aims to investigate how virtual communities of practice (V-CoP) develop in large-scale virtual projects.

Design/methodology/approach – A case study of a large-scale ES implementation was conducted in Italy and in the USA.

Findings – It was found that management can encourage the formation of V-CoP if, along with the creation of virtual project teams they promote informal interaction between the team members, encourage commitment, and put together "the right mix of people".

Originality/value – Understanding how the technical and the functional communities communicated is meaningful to understand the extent to which different CoP can, virtually, overcome context-specific barriers.

Keywords Practice perspective of knowledge, Communities of practice, Virtual communities of practice, Large-scale projects, Knowledge creation, ES implementation, Knowledge management, Virtual work

Paper type Research paper

Introduction

Given that knowledge creation and sharing within and between teams is important during a project, a number of scholars have acknowledged the importance of considering communities of practice (CoP) (Lave and Wenger, 1991) to enrich our understanding of projects. These scholars have demonstrated how CoP are sources of situated learning within projects, but they have also identified barriers to the processes underpinning creation (and recreation) of knowledge among different CoP within a project (Bettiol and Sedita, 2010; Brensen *et al.*, 2003, 2005; Garrety *et al.*, 2003; Ruuska and Vartiainen, 2005). For example, literature shows that structural (Dubé *et al.*, 2005) as well as behavioral issues (Slevin and Pinto, 2004) can be associated with the development of a CoP within a project; and Bresnen *et al.* (2005) found that power relationships can interact with the formation of CoP in projects. The result is a body of literature on project management that has developed important insights on issues such as:

- the factors that positively and negatively affect the development of CoP during projects;

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- the relationship between CoP and project success; and
- how project management can cope with resistances to knowledge sharing within and between CoP.

More recently, scholars have turned their attention to considering CoP in virtual environments (so-called virtual communities of practice (V-CoP)), investigating how knowing (Cook and Brown, 1999; Wenger, 1998) is created and shared when members are not in the same physical space (Dubé *et al.*, 2005). This topic is interesting given that the knowing generated in a CoP is recognized as being embedded in a specific organizational context (Lave and Wenger, 1991; Zuboff, 1988), making the sharing of this knowledge in a distributed context particularly challenging. In other words, knowledge sharing, from a community-based approach, is not a straightforward process since knowledge is very context specific and, therefore, should be recreated in new contexts (Newell *et al.*, 2003).

Although the importance of taking a community-based approach to understand how knowledge is shared in projects is acknowledged, the scantiness of the literature that incorporates V-CoP into the project management debate is somewhat surprising (Bourhis and Dubé, 2010). Our paper is motivated by this gap and aims to identify the issues that can help the formation of V-CoP that are connected by information and communication technologies (ICT) (Ardichvili *et al.*, 2003).

Since the research, to date, is particularly scarce on virtual knowledge sharing from a community-based approach, the nature of our inquiry is exploratory, involving examination of a case study of a worldwide organization headquartered in Italy, whose management started to implement a large-scale enterprise system (ES) in 2004 and then attempted to replicate this in its US branch in 2008. Interviews, observations, and document analysis provided information over time that allows us to build a narrative of this large-scale ES project and to identify key organizational mechanisms and dynamics (if any) that encouraged the formation of V-CoP that enabled knowledge to be shared between Italy and the USA. The longitudinal and retrospective approach that we adopt aims to capture emergent processes that support knowledge sharing.

In terms of the structure of this paper, section two provides a review of the literature on project management involving CoP and V-CoP to introduce the framework for the current investigation. Following a discussion of the method/s (section three), we develop a case study narrative that takes a timeline perspective to help our understanding of the dynamics underpinning interactions between the Italian and US people who were involved in the ES implementation in North America. The fourth section analyzes the case study in light of our objective to understand how V-CoP emerged in the context of a specific project, and highlights important implications from our findings. The final section draws some conclusions and proposes avenues for further research on knowledge-intensive projects that consist of multiple (virtual) communities of practice.

Theoretical foundations

Gaddis (1959, p. 80) defined a project as:

> [. . .] an organization unit dedicated to the attainment of a goal – generally the successful completion of a developmental product on time, within budget, and in conformance with pre-determined performance specifications.

Nowadays, projects often involve several organizational departments (i.e. cross-unit projects) and/or different organizations (i.e. networked projects). According to a broader definition from Liebowitz and Megbolugbe (2003, p. 189) "project management is the process of creating value from an organization's intangible assets"; consequently, project management involves identification of "how best to leverage knowledge internally and externally" (Liebowitz and Megbolugbe, 2003, p. 189). In this paper we draw on the latter conceptualization to highlight the importance of knowledge creation and sharing during projects. Despite the fact that the research on project management is various and involves cross-disciplinary themes (i.e. culture, leadership, HR, performance, and strategy), in this paper, we concentrate on a specific stream of literature on knowledge management in projects from a community-based approach. In turn, we take a constructivist approach and adopt a "practice view" of knowledge.

Project management and communities of practice: the practice approach

The above overview suggests that many researchers have concentrated on the identification of "best practices" for "good project management" (i.e. project success), which, once identified, can be replicated easily in subsequent projects. Nevertheless, project management failures are not infrequent (Shepherd and Cardon, 2009) even when these "best practices" are being followed (Wagner and Newell, 2004). In turn, it is important to learn from past projects rather than to try to create project management "to do" lists. In this vein, research has concentrated on learning and project management (DeFilippi, 2001; Prencipe and Tell, 2001; Scarbrough *et al.*, 2004) identifying the ways that knowledge is created and shared from one project to another and showing how this learning can play a central role in the development of long-term capabilities that contribute to later projects. In particular, Bresnen *et al.* (2003, p. 158) highlight that:

> [...] problems of cross-project learning have wider implications for processes of organizational learning and, not surprisingly therefore, developing the capability to manage knowledge across projects is seen as an important source of competitive advantage for organizations.

Some who emphasize knowledge sharing (and associated barriers) in and across projects focus on the role of CoP (Bresnen *et al.*, 2003, 2005), especially for those projects that develop between two or more organizations (Huang *et al.*, 2002). Communities of practice (Brown and Duguid, 2001; Lave and Wenger, 1991) emerge among groups of people who share an interest or a professional practice and construct knowledge socially as they engage in their everyday practices.

The community-based approach has been used by researchers in the field of project management to investigate how knowledge is created and shared in CoP during projects, focusing on the social processes that play a crucial role in the diffusion of knowledge and the development of learning capabilities in these settings (Brensen *et al.*, 2003). For instance, Garrety *et al.* (2003, p. 357) suggest that CoP can help project participants "construct integrating institutions based on effective mental maps of the social landscapes in which projects are conducted". Ruuska and Vartiainen (2005) find that CoP that incorporate a degree of formality (i.e. are "visible" and explicit rather than hidden and informal) are more likely to facilitate knowledge sharing. Bresnen *et al.* (2005, p. 27), who examined the processes involved in changing practices and routines, and learning associated with the implementation of new practices in project-based

organizations, find that the "degree to which initiatives disrupt [the] knowledge/power balance" and the "degree to which initiatives interfere with project management practices" are the two dimensions that affect the nature and extent of changes in established practices and routines. Bettiol and Sedita (2010), who concentrate on the Italian creative sector, suggest that the development of CoP is a pre-requisite for successful knowledge creation and sharing in projects.

From an epistemological perspective, a communities of practice approach does not fit with the cognitive approach which assumes that knowledge can be transferred (Zollo and Winter, 2002; Nonaka, 1994). While the latter involves the assumption that individual project members "carry" knowledge and are able to move it about within an organization, the community-based approach is associated with the practice perspective on knowledge (Bourdieu, 1977; Turner, 1994). This perspective assumes that knowledge originates at the collective level and is difficult to share, not just because it may be tacit (Nonaka, 1994) and sticky (Szulanski, 1996) but because it is embodied in the social and cultural context in which it originated (i.e. everyday work) (Suchman, 2001). Thus, knowledge, or rather knowing, is the product of social and organizational activity; knowledge arises as a product of practice in a particular situated context (Cook and Brown, 1999). Embodied knowledge implies that knowledge is acquired by doing and practicing and as such that knowledge is "situated" or embedded in a specific organizational context (Zuboff, 1988). This means that knowledge transfer will not be straightforward since knowledge is not a commodity. As suggested by Newell *et al.* (2003), instead of attempting to transfer knowledge directly it might be better to share information about processes that facilitated knowledge creation, which can help socially recreating (new) knowledge in a different context. In sum, in this paper we emphasize the embodied and embedded nature of knowledge in practice: that is knowledge is equated with practice (and is context-specific).

It is evident that considering knowing as situated in practice raises an important issue for project management research: transferring knowledge between CoP is very difficult given the idiosyncratic characteristic of the practices underpinning the creation of such knowledge. Nevertheless, it is important to understand how to deal with knowledge barriers associated with the embeddedness of knowledge in projects since the taken for granted assumption that transferring key knowledge among project team members (or between two teams or projects) is often associated with project success (Munns and Bjeirmi, 1996; Pinto and Prescott, 1990) does not take into account the context-specific dimension of knowledge.

In sum, while we argue that the outcome-oriented approach to project management is helpful to identify the parameters of project success (Pinto and Slevin, 1988), project efficiency (Atkinson, 1999), and project analysis (Schindler and Eppler, 2003), concerns remain about the deterministic idea that following pre-defined (best) practices enables an organization to move knowledge about in a project as if it were a commodity. From a communities of practice view, managing knowledge in projects implies a more complex effort of iterative learning that can facilitate the sharing and re-creation (rather than transfer) of experience and perceptions; it is not sufficient to codify tacit knowledge and assume that this knowledge can then be readily applied in another context (Nonaka, 1994). Along these lines, we focus on how V-CoP emerge in a globally distributed project that allow knowledge to be shared, once it has been created socially and is situated in a specific community of practice. In this paper,

therefore, we take Lave and Wenger's (1991) perspective focusing on knowledge management in CoP and on the role of CoP in projects that are managed virtually.

Knowledge sharing in projects involving virtual communities of practice

Most of the research on the role of CoP in projects concentrates on face-to-face interactions as the typical ways of collaboration among members of a CoP (Brown and Duguid, 1991; Lave and Wenger, 1991; Wenger, 1999). However, many projects are managed virtually (Anantatmula and Thomas, 2010; Lee, 2009; Strang, 2011). According to Dubé *et al.* (2005, p. 146):

> [. . .] virtual communities of practice, while not excluding face-to-face meetings, rely primarily on new information and communication technologies (ICT) and internet capabilities, to allow their members to be creative and exchange what can sometimes be crucial pieces of information, in a virtual environment.

A CoP becomes a V-CoP if "its members use ICT as their primary mode of interaction" (Dubé *et al.*, 2005, p. 147). Ardichvili (2008, p. 541) argues that V-CoP exist "when community members share and co-create knowledge in online discussion and other forms of knowledge exchange". That is, we suggest that communities of practice are "virtual" when most interactions regarding knowledge issues happen remotely.

Some research has focused on such V-CoP, suggesting that a community-based approach can help us understand how knowledge may be managed in a distributed international environment, with virtual tools (ICT) allowing interactions to take place (Hildreth *et al.*, 2000). For instance, Dubé *et al.* (2006) acknowledge that it is more difficult to build mutual knowledge and trust among members of a V-CoP; however, they suggest that the exploitation of technology can recreate an environment that is quite similar to the physical proximity that is a characteristic of "traditional" communities of practice (Lave and Wegner, 1990). Moreover, Dubé *et al.* (2006) make a comparison between three V-CoP and identify how V-CoP can have different characteristics. For instance, V-CoP can vary in terms of life span, being more or less permanent; they can also arise spontaneously or arise intentionally based on knowledge management strategies; V-CoP can be more or less culturally diverse; and finally V-CoP may vary in terms of their ICT usage (high vs low reliance on ICT). In terms of the latter issue, the relative use of ICT was found to depend on, in particular, how many times per year the members meet. Thus, there are V-CoP whose members meet at the beginning of a project and then maintain only virtual interactions; in other cases members meet on a monthly basis, and collaborate virtually for the rest of the time. If face-to-face interactions are more limited, ICT is likely to play a bigger role. In conclusion, Dubé *et al.* (2006) argue that, although different characteristics of V-CoP create different challenges, it is possible to re-create a community of practice virtually once the knowledge that is generated by the participants' interactions is "embodied" in the virtual community. In turn, the support of ICT allows situated learning to develop "virtually", with physical proximity re-created by using the multi-media functionality of ICT, such as video-conferencing, chat, document sharing, etc. (Kimble and Hildreth, 2008). In sum, the very characteristic of a CoP and so also a V-CoP, is the context specific knowledge the members create and use in their everyday practice.

Some examples of research that has focused on V-CoP and projects include Ardichvili *et al.* (2003) who provide an empirical study on the motivations and barriers to employee participation in CoP that aim to share knowledge virtually; Lin and Hsueh (2006) who concentrate on knowledge management in CoP that collaborate

virtually making use of information retrieval and data mining techniques; Hibbert and Rich (2006) who focus on CoP that develop over distance projects/courses in professional education; and Bourhis and Dubé (2010) who identify culture, resources, and leadership as the management practices that affect the formation of V-CoP. Moreover, there is also a growing literature on virtual teams and scholars have explored a number of themes associated with (virtual) distributed teams such as structural/design factors (Evaristo and Munkvold, 2002), organizational mechanisms (Bourgault *et al.*, 2008; Desousa *et al.*, 2003), risks associated with the "virtual" component of projects (Damm and Schindler, 2002; Reed and Knight, 2010), the role of leadership (Lee, 2009; Strang, 2011) and success (Anantatmula and Thomas, 2010; Lee-Kelley and Sankey, 2008). This past literature on projects that are managed virtually is helpful to identify specific channels used to share knowledge (i.e. conference call, e-mails, intranet portals, online communities, forums, newsgroups and other ICT-based tools); moreover, it provides evidence that successful projects can be managed virtually (Davenport *et al.*, 1998; Nitithamyong and Skibniewski, 2004). Nevertheless, none of the above studies on (virtual) project and teams adopt the philosophical approach typical of CoP (i.e. knowledge, or knowing, is context specific and is not a commodity: therefore, it is not "simply" transferrable).

In sum, integration between the literature on V-CoP, virtual teams, and project management is almost absent. This suggests that it is important to study how V-CoP emerge in virtual projects and, more specifically, we aim to explicitly address our inquiry to the management of V-CoP in projects. An example of V-CoP is shown in Figure 1.

The case of Alpha

Our case study involves a worldwide organization (Alpha) with headquarters in Europe. In 2004-2008 it successfully implemented Uranus (an ES system) in one of its companies in Europe (EU-Truck) and in 2008 began implementation in one of its US subsidiaries (Agri-US). The case concentrates on two main topics: the initial project of ES implementation in Northern Italy, EU-Truck headquarters (2004-2008) and the subsequent project of system mirroring in Agri-US in Midwest US (in 2008-2009) which relied on the sharing of knowledge from EU-Truck to Agri-US. We chose to study a project that involves ES implementation because these projects are generally knowledge intensive; moreover, the knowledge developed to successfully implement ES is very firm specific (especially where the ES is customized for a specific organization, as happened at EU-Truck) and often develops in a local community of practice.

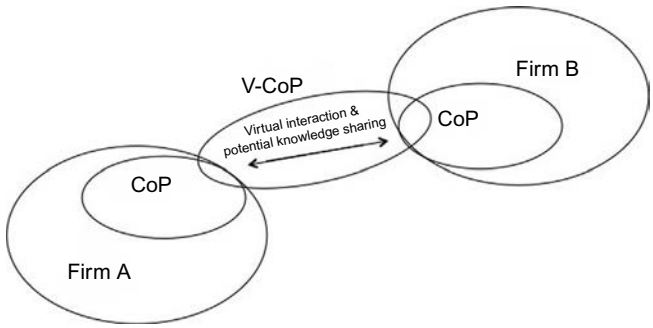

Figure 1.
Communities of practice and knowledge exchange in a virtual environment

In turn, focusing on these two projects allows us to understand the processes underpinning knowledge transfer across two communities of practice.

Case overview

Company description and ES features. EU-Truck is involved in the production and sale of different kinds of commercial trucks, from small-business vehicles to large articulated vehicles. Agri-US focuses on production and sales of specialized vehicles for agriculture (i.e. farm tractors). Agri-US is an automobile manufacturer that has diversified into several other fields, such as financial services, but whose core business is the production and sales of cars and industrial and agricultural vehicles. Both organizations are focuses on worldwide markets; however, EU-Truck concentrates mainly on European and Asian markets while Agri-US sells the majority of its products in North and South America. The main organizational characteristics of the two companies are quite similar from a corporate governance stand. However, at the operational level EU-Truck is mechanistic and rigid (i.e. it uses bureaucratic systems of control on sales and has tight budget control). On the contrary, Agri-US is more flexible and its controls are focused on outputs rather than processes (i.e. management by objectives (MBO)). Alpha is the holding company for several subsidiary companies based in other parts of the world that produce similar manufacturing outputs for trucks and agriculture. According to the IT vice president, responsible for both companies and the management of technical production efficiency, 30 percent of these companies' final products are the same.

Uranus is a large-scale, integrated ES designed to coordinate all the resources, information and activities needed to complete business processes. The successful adoption of Uranus is crucial for organizational performance since the ES (as many enterprise resource planning (ERP) systems), coordinates and supports all organizational processes and activities (i.e. sales, marketing, finance, and production). Therefore, a slow (or unsuccessful) adoption of the ES can lead to problems of communications between different departments, difficulties in developing accurate forecasting (i.e. for missing data on sales), and lack of control of production activities.

Problems associated with ES implementation. In general, an ES is a software package that integrates processes, activities, and disparate data from multiple departments (Davenport, 2000). ES have become popular based on the perception that they improve efficiency (Davenport, 1998). Their successful implementation can bring huge economic benefits including reduced cycle times, faster transactions, better financial management, and the ability to participate in e-commerce (Davenport, 2000). However, many firms find they cannot exploit this potential and are unable to realize all the benefits promised (Chan and Reich, 2006; Markus *et al.*, 2001). They generally have some built-in standard functionality that fits most organizations. An ES implementation usually requires modification to the organizational processes (Markus *et al.*, 2001) to fit the standard ES processes, but adopting organizations can customize the package so that it better mirrors existing firm processes. While vendors do not encourage this, one peculiarity in our case was that the ES – Uranus – that was developed at EU-Truck had a lot of customization.

ES mirroring. In order to save time on ES implementation in Agri-US, the IT vice president decided to replicate the live EU-Truck system. Although this management choice was made with a view to shortening the time to go-live and to save on the

start-up costs of a new ES platform, management recognized that while mirroring the hardware, network and infrastructures would be relatively easy, the capabilities developed by the people in Italy were not easily transferable. In fact, the customization that had been developed in Italy had incorporated firm-specific characteristics that at EU-Truck had been developed over a relatively long period of time based on everyday practicing with the new technology (2004-2008). The lens of virtual sharing helps us to explore how it was possible for the members of the Italian CoP to collaborate with the people in Agri-US in V-CoP.

Data collection and analysis

Our case study included fieldwork in Italy and the USA comprising a series of interviews and document analysis. The case study is longitudinal – the research took one year (mid-2009 to mid-2010) – and retrospective (2003-2009) – based on data acquired from the beginnings of the project in EU-Truck and Agri-US. We conducted nine audiotaped and transcribed interviews (seven in EU-Truck and two in Agri-US), three not audiotaped interviews, and made a number of not audiotaped observations (in EU-Truck and Agri-US). All the interviews were structured to allow the interviewees to tell their stories (their versions of particular events, e.g. related to particular decisions). Specific questions were posed only when some clarification was needed. For instance, we asked for details on dates or the identities of decision makers, and about how long an implementation phase took, etc. We collected 62 slides on Alpha in our interviews with three IT managers and one depicting EU-Truck's organizational chart. We gathered various documents from official web sites and other online sources. Our interviews were mainly with senior managers: we talked to Alpha's Chief Information Officer (who led the EU-Truck and Agri-US projects), and a functional manager and some technicians at EU-Truck, and to a project manager and a general manager at Agri-US. Table I presents the data collected through interviews, observations, and documentation.

The data analysis was made with Nvivo® software. Following Fereday and Muir-Cochrane (2008), in the first phase of our analysis we followed an inductive process to create a number of codes from the transcriptions; in the second phase we found representative constructs with the aim to identify issues associated with the knowledge creation and sharing processes during both the Uranus implementation project at EU-Truck and the Uranus mirroring project at Agri-US. We were driven by data in the phase of codes identification to let themes emerge while we were supported by the literature in the phase of node creation that gave us the opportunity to reflect on our assumptions, review the data analysis in the light of past research and develop a set of macro-constructs (in the data analysis we will call them "themes") that,

Type of data	Details on data	Contribution to the narrative
Nine interviews	681 minutes and 238 pages of transcription	Longitudinal and retrospective
Three interviews	3 hours – not audiotaped	
Observations	15 hours – not audiotaped	Longitudinal
Two sets of slides	63 slides	Retrospective
Company's web site	42 pages analyzed	Longitudinal and retrospective

Table I.
Data collection and contribution to Alpha's story

according to our analysis, represent the emerging issues associated with knowledge creation and sharing during Alpha's projects.

Alpha's narrative: the implementation of Uranus

The first part of the narrative concentrates on the initial implementation of Uranus in EU-Truck that started in 2004.The aim of the description of the implementation in Italy is to show that a community of practice led by the IT department, emerged during the period 2004-2008 when Uranus was developed, rolled out and, over time, exploited. The second part of the narrative concentrates on the Uranus implementation in Agri-US and highlights the barriers to knowledge sharing and the issues that helped the Italian and US teams to collaborate virtually during this second cross-country project.

Uranus implementation in EU-Truck

In 2003 EU-Truck started a deep review of its information systems (IS) processes and as a result decided that the company needed an integrated IS able to combine data in order to increase efficiency. The review involved "all the company's organizational departments, i.e. IT, finance, control, purchasing, sales, distribution, warranty, etc.". The project started in 2004 and by 2008 Uranus was implemented and customized in all departments.

The initial implementation (2004) was characterized by the definition of general objectives for the project such as:

(1) rolling out the software in the IT department (within six months); and

(2) implementing it gradually in all other departments (within two years).

According to an IT manager who followed Uranus' initial implementation, they were focusing attention on "performing the project in the best way both technically and economically [. . .] and respecting times, costs and quality". A lot of attention was paid in aligning IT with business and satisfying the business needs. The project manager highlighted the importance of having flexible team members who were skilled in technical issues but, at the same time who were able to understand (and deal with) suppliers and vendors. In other words, it was crucial that the project team members were able to understand the whole supply chain.

Although they rolled out Uranus at the end of 2004 in the IT department, in 2005 the project encountered several challenges due to the impact that Uranus was having on organizational processes. While, on the one hand, the technical aspects of the ES seemed to work fine in all departments (i.e. technical integration of databases), on the other hand, the implementation of new processes in finance, production, marketing, and sales, was quite difficult and slow. This happened because, as in the case with most ES, technology affects processes and activities. Once the system was being used, considerable feedback was provided about the limitations of the integrated package and, in response, a number of functionalities of Uranus were customized. In February 2008, the IT management, in agreement with the CEO, highlighted that "Uranus is now a completely custom solution". In other words, they had implemented a very flexible and customized system at the expense of the risks and costs that are generated by high customization (for instance, when a new version of the software is released by the vendor and all customizations need to be updated by the programmers). By the end of 2008 the VPs at Alpha concluded that the Uranus implementation was a success.

During interviews, the IT project management suggested that one of the issues that contributed to the successful implementation of Uranus was the extremely detailed process mapping that was undertaken of the whole Italian headquarters of Alpha. In January 2005 they had conducted extensive interviews in departments to ensure that all organizational processes were thoroughly analyzed. The aim of the interviews was to identify "unofficial" processes and procedures that, even if not formalized with written documents, were followed. They found that these "unofficial" practices were widespread in the sales department. In turn, they made the decision that the new system should be designed with a certain degree of flexibility – especially in the sales department. The IT VP told us that the main challenge was to implement a system that incorporated both rigidity (which is a common characteristic of centralized ES) and flexibility, to allow, for example the sales people to modify prices, apply *ad hoc* discounts, and customize offers. In fact, along with these business process interviews, at the end of 2005 the IT project management decided to create a joint team that involved people from the different departments. At the beginning, this cross-departmental team encountered problems associated with the different perspectives of, for example, the sales people (who were pushing for a very flexible system), the people from the finance department (who aimed to have "everything under control"), and the IT people (whose objective was to try and understand the needs of everyone). Over time, these problems were overcome, finding a balance between rigidity and flexibility, by using a lot of customization.

As described by the IT VP, the cross-departmental team included a number of boundary spanners whose role was to communicate with all departments, identify needs, and report to the core project team. According to an IT manager, having in the cross-departmental team "the right mix of people" with different but complementary skills contributed to the successful implementation of Uranus. The cross-departmental team was led by the "functional project manager" who had three main tasks: to lead the team and ensure that all team members were able to capture the needs of the organizational departments; to interact with the IT people (managers) who were designing the new characteristics of the system, from a functional perspective; and to interact with the IT technicians who were developing the software needed to technically implement the changes. Interestingly, EU-Truck extensively documented the processes followed by the IT department and by the cross-department team during the period 2004-2008. This documentation was created because, as indicated by an IT project manager at EU-Truck, "normally in [Uranus]-like projects you need to make the so-called business footprint to identify gaps towards the standard [system] and so on and formalize those details in documents".

Uranus implementation in Agri-US

In 2008 Alpha started implementing Uranus in Agri-US. The idea was to "define a common development environment, find areas of overlap, and try transferring both software and capabilities [from EU-Truck to Agri-US]". However, while some processes in EU-Truck and Agri-US are very similar, some others are quite different. Alpha decided to create two joint implementation teams focused around particular competencies. Those teams were called "competence centers" and included both EU-Truck people and Agri-US people who communicated virtually. In particular, the two teams included, for both organizations, people from the IT departments (the lead people) and people from other departments whose contribution was particularly

relevant in order for the ES to be implemented with respect to its customization features. The software competence center aimed to "define, monitor, and improve the way the software is managed from a very technical point of view"; in other words, the team was composed of IT technicians who focus on those parts of software that can be used by both the Italian and the US organizations and on those parts of the software that need modification in order to be installed in Agri-US. The functional competence center aimed to analyze the existing documentation on Uranus created by EU-Truck and identify those functional characteristics of the Italian ES that could be simply mirrored and those that needed to be modified.

The structure of the competence centers was very flat. This point was highlighted by the project manager, who in 2008-2009 led the Uranus implementation in Agri-US; as he said "they [all those involved in the project] are all reporting to me directly". Other IT project managers, both from the Italian and the US side emphasized the importance of avoiding complicated hierarchy in these "very operational" competence centers. According to these interviewees, this was helpful to create joint groups of people who could easily communicate virtually. In particular, the informality of these competence centers allowed people "to do something that they normally wouldn't be able to do on an individual basis" (US project manager of the IT department). Over time, the flat and informal structure helped to stimulate personal relationships and collaboration between team members. This type of flat and informal structure is a characteristic of traditional communities of practice. Moreover, as noted by the project managers, informality encouraged individuals to use their initiative and be more proactive.

Another factor related to the competence centers that, in the words of an IT manager at Agri-US, was a key issue "to make the people successful" was the strong leadership of the project managers. The two competence centers were led by project managers who facilitated "building strong relationships with the executive team". According to the lead project manager of the functional competence center, much of the influence that he could have over team members was because he had been able to choose the team members and, from an HR point of view, he managed their careers and stipends.

Having team members who were motivated and able to work well together was seen to be important. However, the technical and the functional competence centers needed to face the issues associated with a virtual project. As described by a manager who was involved in the functional competence center, "when you say meetings, when you say conference call, it's just that you're doing your day-to-day work with one of your colleagues, but you're not in the same location". In other words, the competence centers, just like a community of practice, aimed to recreate daily social interactions in a virtual environment. To manage the ongoing activities of the project they made use of the "Alpha-Portal", a content management web site where people from Italy and the USA could update tasks and see the progress of the project. This tool was also available for the IT VP to monitor the whole project. However, as he said, he preferred to talk directly with the project managers rather than checking the web site. The Portal was very helpful for the people involved in the competence centers because they could write notes on activities and it was an effective way to share comments and eventually track changes on procedures. Although they used the Portal also for virtual meetings where many people were involved, one-to-one conversations were made using Skype®. Interviews and observations suggested that "visual" meetings, even if virtual, helped develop tight interactions as per traditional communities of practice.

Those involved in the competence centers were required to be flexible – having "the right people in the right place" (IT project manager). For instance, the team members were not specialized in specific tasks and so covered different roles. This encouraged a broader understanding of the whole project and allowed them to be "open minded" and to be actively involved in the project, contributing with ideas. Moreover, the team members were available to work during the weekend and at night, if needed. Thus, the development of an environment, where there was little use of hierarchical control, created teams of people committed to the project and willing to take on diverse roles as needed. In sum, characteristics of the competence centers such as the flat structure, the informal environment, the daily interactions, and the video conference calls suggest that these groups can be classified as virtual communities of practice.

The competence centers supported the implementation of Uranus during the period 2008-2009. During these two years, the implementation process was not without problems. Mistakes were made that needed to be corrected – both in the software and in the functional competence center. Interestingly, the participants in both competence centers acknowledged the mistakes (and lessons learned) as important and, to some extent, necessary steps that led to them creating a working system in Agri-US (in November 2009). This suggests that the implementation process at Agri-US was not straightforward; instead, learning developed during the daily virtual interactions. And, as pointed out by an IT project manager, this learning was essential for Agri-US to develop capabilities that were similar to the ones developed a few years before by the cross-departmental team in EU-Truck.

Within the software competence center the technicians needed to learn how to redesign packages and introduce the system in Agri-US; within the functional competence center the process analysts followed the procedures that were previously developed in EU-Truck in terms of interviewing people and figuring out the necessities of different departments in Agri-US. Namely while Uranus was mirrored, the firm-specific characteristics of the system were recreated following the processes developed by the cross-department team in EU-Truck in 2004-2008.

The competence centers benefitted from the knowledge previously developed by the people who implemented Uranus in EU-Truck (the CoP that was active in Italy in the period 2004-2008 during the first implementation of the ES). This knowledge was incorporated in written documents. However, this knowledge was not transferred but only made available for its reconstruction within the two competence centers. One example is the analysis of Uranus documentation related to the process mapping made by the functional competence center during the initial phase of the joint work (2008). The documents were very clear on the procedures followed by the IT people in EU-Truck during their implementation in Italy. However, those documents did not say anything about how to transfer the procedures to a new environment. Nevertheless, the documents were interpreted by the functional competence center and a new understanding of how to implement Uranus in Agri-US was developed. In other words, the interactions between the Italian and US people in the virtual functional competence center was helpful because the people belonging to EU-Truck had already developed relevant knowledge that allowed them to successfully implement Uranus in Italy. However, they needed to review their knowledge and develop new knowledge with the people in the USA. It seems that the knowledge (and experience) that was shared by the EU-Truck people during the virtual interactions in the competence centers (along with the documentation) helped accelerate

the development of new joint knowledge – the project in EU-Truck had taken four years to be effectively exploited while in Agri-US they were exploiting the system after only two years. This latter theme will be developed in the next section where we discuss the Uranus implementation in light of our narrative.

Case analysis and discussion

The above narrative describes how Uranus was implemented in EU-Truck and then in Agri-US. In this section we aim to develop reflections on the narrative and integrate our findings with the literature.

The development of a community of practice in EU-Truck (2004-2008)

During the period 2004-2008 a number of interactions between people belonging to different departments of EU-Truck helped the IT people understand that the system could not be implemented without a careful process mapping and without interviewing people to identify those processes that, to some extent, were "hidden". The data collected for the EU-Truck implementation, although retrospective (we started our fieldwork in 2009), highlight that frequent interaction between the members of the cross-department team was very helpful. In particular, during the initial phase of the implementation (2004-2005) the involvement of representative people from sales, production, marketing, and finance was crucial to encourage employees from different departments to start using the system. This involvement of representatives from different departments was also helpful to identify issues that arose during implementation. For instance, during 2005 difficulties emerged because of the diverse needs of different departments. However, in the end the IT people, with the direct involvement of people belonging to different departments, were able to achieve a balance between those departments that required flexibility and those departments that required rigidity. The "stories" that we collected from the people involved in the EU-Truck implementation show that the capabilities needed to implement Uranus were created, socially, during the many meetings of the cross-departmental team. This indicates that long-term interactions helped the team to become a CoP, comprising of people involved in the implementation of Uranus in EU-Truck. In other words, the involvement of people from different departments gradually led to the formation of a community of practice at EU-Truck during the period 2004-2005. The community of practice, according to our interviews, positively affected the Uranus implementation. As noted by some scholars (Pan *et al.*, 2001, 2007; Newell *et al.*, 2008), knowledge integration processes during ES implementation is not taken-for-granted and the specific knowledge that develops in different departments can represent a barrier to implementation of an integrated system. However, the formation of a CoP where people with different backgrounds interacted and created new (socially-embedded) knowledge helped overcome this barrier. Making mistakes and learning lessons from these helped to develop a common understanding of the system (Marabelli and Newell, 2009). This collective knowing (Nicolini, 2010) was socially created and became embedded and embodied in the practices of the cross-departmental team. This knowing was, thus, very context-specific (Bate and Robert, 2002; Swan *et al.*, 1997). This highlights how the knowledge developed in the EU-Truck implementation project was not easily identifiable (since it was embedded in the social structure where it originated) or shareable (i.e. with the people in Agri-US), especially since knowledge sharing would need to take place virtually.

However, the second part of our narrative sheds light on some events that help us to understand the extent to which the 2004-2008 experience of the Uranus implementation in EU-Truck affected the 2008-2009 implementation of the (equivalent) ES in Agri-US.

The development of virtual communities of practices between EU-Truck and Agri-US (2008-2009)

Table II shows six constructs that inductively emerged from the analysis of the transcriptions related to the Uranus implementation in Agri-US. These constructs are characteristics that, in our understanding, helped to support the virtual interactions between the people involved in the ES project (implementation in Agri-US) during the 2008-2009 period.

The themes identified in Table II indicate that two V-CoP were formed during the Uranus implementation in Agri-US. One V-CoP managed the technical issues – and included the people involved in the software competence center; the other V-CoP managed functional issues – and included the people involved in the functional competence center. Below we discuss all themes and suggest that they played a role in encouraging the formation of these two V-CoP.

Theme 1: cross-departmental teams. Alpha formed two competence centers to exploit the knowledge developed by the EU-Truck people during the Uranus implementation in Italy. The focus was on making the people involved in Italy during the 2004-2008 period available to the US branch of Alpha rather than trying to transfer the knowledge from EU-Truck to Agri-US via documents. In line with Huang and Newell (2003) who collected

Theme	Description
1. Cross functional teams and projects	In 2008 two main cross-department teams were formed: the software competence center (IT people and people from different organizational departments who are required to suggest functionalities and/or evaluate changes) and the functional competence center (cross department team that concentrates on process change). Those teams are formed by people belonging to EU-Truck and Agri-US
2. Flat structure	The structure of the competence centers was very flat: this made it easier to manage people without using many hierarchical levels between the project manager and the workers
3. Leadership	Although the leadership theme is very popular in the management literature, it is often taken for granted. In our narrative leadership involves the capacity to motivate and commit people, especially to working flexibly
4. Team members flexibility	The competence centers were formed by team members that assumed multiple roles rather than being specialized in one particular task
5. Commitment	The commitment of the people working in the competence centers was helpful to develop personal relationships and develop common practices. Moreover, committed team members are available to do extra-work during the weekend or at night
6. Project managers' involvement in HR processes	The opportunity for the project manager to manage key HRM processes, such as hiring, career, and salary was a relevant issue for the success of the competence centers

Table II.
Constructs affecting interactions between EU-Truck and Agri-US

data on four large-scale projects, cross-departmental teams help make knowledge available across widely dispersed projects. The cross-departmental teams that formed the competence centers gradually emerged as V-CoPs, where situated learning was shared between the European and the US members. With the IT managers operating as coordinators, "end-users" (i.e. people from sales and marketing) provided inputs that allowed the system to be tailored to the users' needs in the USA but drawing heavily on the prior experiences in Europe that were shared through the competence centers. For instance, the end-users (non IT people) involved in the functional competence center at EU-Truck explained the difficulties encountered during the initial implementation of Uranus, in 2004-2005. In turn, the IT people (software competence center) were aware of the specific needs of the different departments that, due to frequent interactions that they had with the end-users in Agri-US, could be also be customized for the people in the USA.

Theme 2: flat structure. The flat structure of those cross-departmental teams indicates that informal relationships were dominant in the competence centers. Hildreth *et al.* (2000, p. 30) suggest that "It is possible for a team to become a CoP as informal relationships begin to develop and the source of legitimation changes in emphasis". Legitimation, in CoP arises spontaneously as the members earn their status in the community. The flat structure of the software and functional competence centers seems to have encouraged this spontaneous process of status generation of the people involved.

Theme 3: leadership. Although CoP "organize themselves, meaning they set their own agendas and establish their own leadership" (Wenger and Snyder, 2000), it is not excluded that leadership can be "imposed", as long as it is acknowledged and appreciated by the members (Wenger, 1998). The members of the competence centers seem to have been positively affected by the leadership of the project managers who encouraged the members' involvement in the project. For instance, the project managers' leadership helped the teams to develop common practices. Wenger (1998) suggests that leadership should have intrinsic legitimacy in a community of practice and "managers and others must work with communities of practice from the *inside* rather than merely attempt to design them or manipulate them from the *outside*" (Wenger, 1998, p. 7). This is what happened in the competence centers: the managers were aware that they could exercise power; however, their efforts were addressed to creating a comfortable environment to promote collaboration between the members.

Theme 4: flexibility. Although members' flexibility has not emerged as a relevant theme in literature on CoP, we suggest that this is because generally communities of practices are not associated with teams (Hildreth *et al.*, 2000), where organizational roles are formalized. However, our empirical investigation shows that members' flexibility encouraged social interactions. This is in line with the study of Barrick *et al.* (1998) who operationalized team members' flexibility as the degree to which team members can complete each other's task and found that flexibility is often associated with social cohesion.

Theme 5: commitment. In a CoP, membership "implies commitment to the domain" (Wenger, 2005, p. 1). This suggests that the active participation of the people involved in the competence centers encouraged the development of informal interactions during the project since CoP take place when members are "engaging in join activities, creating artifacts, adapting to changing circumstances, renewing interests, commitment, and relationships" (Wenger, 2000, p. 3).

Theme 6: project managers' involvement in HR processes. This last theme might not appear to be aligned with the idea of the spontaneous formation of CoP; in fact,

the managers acknowledged that their power over the competence centers' members was an issue that was associated with the success of the competence centers. It appears that the involvement of the managers in HR processes such as defining careers and managing salaries was a source of power that was used to stimulate workers to do a better job rather than control their activities.

Our analysis suggests that these six themes developed over time. While the competence centers were created at the start of the US project, the dynamics between the Italian and the US groups of people evolved as the people involved learned how to work together – and this learning process involved making mistakes and learning from these mistakes. In 2004, the main difference between the teams in Italy and in the USA was that the EU-Truck teams were already operating as CoP (as per what we highlighted in the previous paragraphs); in fact The EU-Truck CoP developed during the period 2004-2008, when they implemented Uranus. By contrast, the teams in Agri-US did not represent an established CoP in 2004, when the project to implement Uranus in the USA started. Indeed, it may be the case (and future research will need to study this) that this absence of a CoP in the USA was helpful in the formation of the cross-organizational V-CoP because there were no established practices, here related to implementing ES, in the USA; if such a CoP had existed in the USA it would almost certainly have developed situated practices different to those in the EU-Truck CoP, that may have made it difficult for the V-CoP to emerge. We suggest that, in the period 2008-2009 the Italian "side" of the competence centers was able to make available the knowledge accumulated in the first implementation of Uranus in EU-Truck. This knowledge was not transferred. Rather, the development of joint groups that worked together for two years allowed tight collaboration and most importantly an exchange of ideas and practices. The informality of the collaboration promoted a deep cross-fertilization between the Italian and the US people involved so that they became V-CoP that were able to share and create new knowledge – that drew from EU-Truck previous experience but this was not just a replication of that knowledge but rather represented new situated knowledge.

One may argue that CoP, being spontaneous, should be self-organized; however, as noted in Wenger (1998, p. 7), "Just because communities of practice arise naturally does not mean that organizations can't do anything to influence their development". In other words, we argue that, on the one hand, the competence centers were created to establish a contact between the Italian and the US "communities" to support the implementation of Uranus in Agri-US. However, over time, the competence centers became virtual contexts where people were able to interact, produce ideas, and discuss issues associated with their activities in a very constructive and collaborative way. And the themes that we have previously identified seem to have helped the creation of the informal environment where the competence centers could each become V-CoP in which knowledge was jointly created as those involved practiced together.

In sum, our findings suggest that while the software and the functional competence centers were created to promote knowledge transfer between EU-Truck and Agri-US, over time, two CoP were formed that allowed knowledge to be jointly re-created. Figure 2, which draws from our previous model (Figure 1), shows the two communities of practice that emerged.

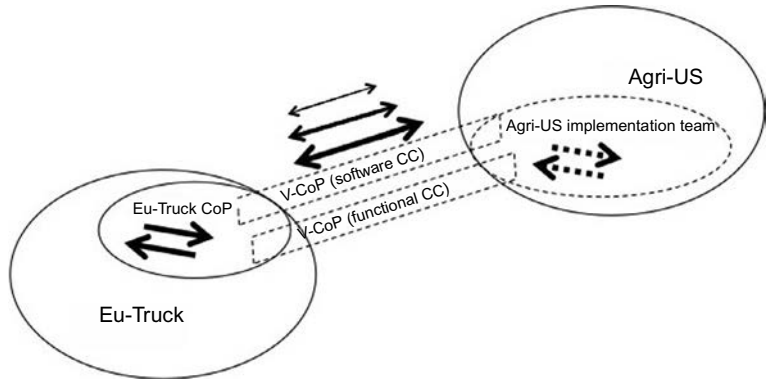

Figure 2.
Development of V-CoPs in Alpha

So what! What was the advantage for Alpha in promoting collaborative work between EU-Truck and Agri-US?

Figure 3 shows the timeline of Uranus implementation in Alpha and highlights that when the system was mirrored, Agri-US benefited from a higher "starting point" in terms of the integration of the system with existing processes and activities. In other words, much of the knowledge embedded in the ES system implemented in EU-Truck was helpful to recreate similar knowledge in the competence centers.

Figure 3 shows that the efforts put into managing the virtual competence centers and encouraging the sharing of working knowledge from EU-Truck to Agri-US had positive effects in terms of having a working system in Agri-US in a relatively short time. Although we believe that the implementation phase of an ES is a never-ending process (Elbanna, 2006), we acknowledge that, at Agri-US, the point of "usability" of the system was reached quickly because the creation of the two V-CoP were able to support the recreation of knowledge in Agri-US that allowed them to learn more quickly to exploit the functionality of the ES.

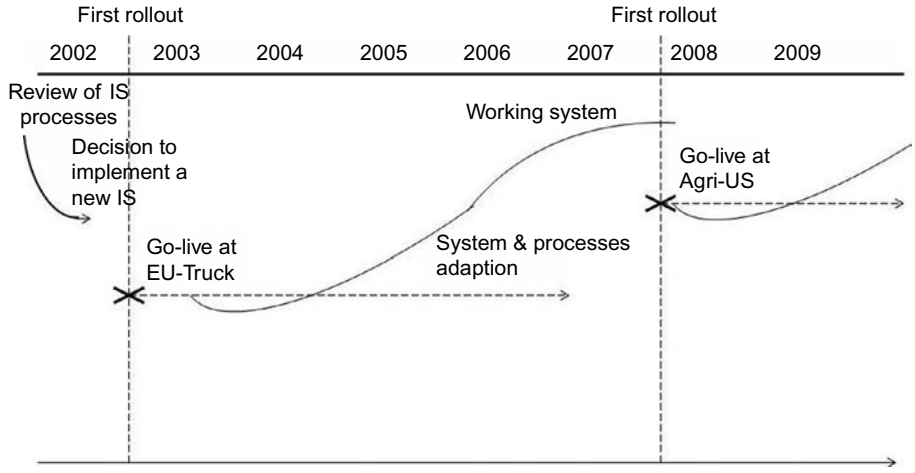

Figure 3.
Timeline of the implementation of Uranus at EU-Truck and Agri-US

Conclusions

In this paper we have explored knowledge management issues in large-scale projects using a community-based approach, which implies that knowledge is not easily shared and cannot be transferred since it applies to a specific context. However, our case study documents that management can encourage the formation of V-CoP if, along with the creation of virtual project teams (i.e. the competence centers), they promote informal interaction between the team members, encourage commitment, and put together "the right mix of people" who belong to different organizational departments but have a certain degree of flexibility and are "open minded" so that can easily interact and develop new ideas. Moreover, our case and discussion show that in 2004 at EU-Truck there was an established CoP (while this was not the case in Agri-US). Our discussion suggests that the formation of a V-CoP was facilitated by the absence of a cohesive and established CoP in the Agri-US implementation team; future research will be needed to verify this proposition. All those factors seem to have supported virtual communities where people were able to socially recreate working knowledge virtually. Another contribution of our paper is to develop a broad narrative that describes the processes that led to a successful project. As suggested by Packendorff (1995) and Soderlund (2004) there is a lack of in-depth case studies of successful projects in the project management literature and they highlight the positive impact of this kind of research from a theoretical and a practical point of view.

We acknowledge that we did not explore the interaction between the two V-CoP (i.e. between the software and the functional teams) and we acknowledge that, in order to implement the ES these two groups needed to interact to align the technical and functional characteristics of technology (Galliers, 2004; Chan and Reich, 2006). However, our choice was to concentrate on the formation of CoP rather than focus on issues associated with IS implementation. Nevertheless, we believe that understanding how the technical and the functional communities communicated is also interesting to understand the extent to which different CoP can, virtually, overcome context-specific barriers. In turn, we suggest that future research can focus on this theme.

Finally, in terms of the relevance of our research for practitioners, we believe that our fieldwork findings should be useful to IT managers and VPs wanting to replicate large-scale IS, especially in cross-country settings.

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