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Enabling knowledge integration in coopetitive R&D projects — The management of conflicting logics

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Abstract

This paper addresses the issue of how knowledge integration can be managed in coopetitive R&D projects. The findings from this study imply that knowledge integration in a coopetitive R&D project is not built on shared knowledge or a shared understanding of the content of project work but that knowledge integration is enabled by a shared understanding of the process of project work. Such understanding can be established by the use of mechanisms such as planning and process specification and presentation genres. These mechanisms support the process of knowledge integration while simultaneously putting constraints on what knowledge is exchanged and they can structure discussions when face-to-face communication takes place. The findings further suggest that, to avoid unintended knowledge leakages, individual and collective settings of project work should be clearly separated such that problem solving stays an individual activity while decision making still rests with the project team as a collective activity.

Keywords: Knowledge integration; Coopetition; R&D projects; Collaboration

1. Introduction

Knowledge, to an increasing extent, is distributed among firms. This implies that a single firm is rarely self-sufficient when it comes to the knowledge it needs to develop new products. Instead, to fully exploit its own resources and capabilities it has to engage in collaborative efforts with others (Arora and Gambardella, 1990; Cassiman and Veugelers, 2002). While collaborative relationships with suppliers and customers are most common among firms that establish R&D collaboration with external partners, some of them establish collaborative R&D relationships with their competitors,[1] with the purpose of accessing and integrating external knowledge (Tether, 2002; Un et al., 2010).

It has been suggested that coopetitive relationships, i.e. relationships between two or more competitors in which both "elements of cooperation and competition are visible" (Bengtsson and Kock, 2000:415), are beneficial as they support the exchange of knowledge between the collaborating firms (Osarenkhoe, 2010). In the growing literature on coopetitive relationships, the possibilities and problems of accessing and integrating knowledge have been discussed. Ritala and Hurmelinna-Laukkanen (2009) suggest that since competitors have more common knowledge between them than do non-competitors, they can more easily share and integrate their knowledge and thereby create new knowledge and products. They go on to suggest that "the effectiveness of competing firms in integrating their knowledge and resources to create innovations is built on lower levels of causal ambiguity and higher levels of absorptive capacity than are present in cooperation between non-competitors, which may be hampered due to diverging knowledge bases" (Ritala and Hurmelinna-

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[1] According to a study of R&D collaboration for product innovation, Un et al. (2010) found that approximately 3% of the firms reported R&D collaborations with competitors. Tether (2002) found that 15% of the firms included in his study collaborated with competitors on innovation.

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Laukkanen, 2009:823). This suggestion gains support in the line of argument promoted by Padula and Battista Dagnino (2007) who argue that the distance between the scientific and technological domains of the coopeting firms (their know what), the distance between their organizational systems (their know-how) and the distance between their dominant logics of operation (their know-why) have an impact on the extent to which their knowledge bases can be accessed and integrated. In case the divergence between the firms' know-what, know-how and know-why, is small, the possibilities to successfully access and integrate knowledge are increased. Thus, it appears that to engage in R&D collaborations with competitors would be particularly advantageous as the costs arising from attempts at over-coming barriers of understanding are reduced.

Investigating collaborative relationships with competitors, Un et al. (2010) conclude that such relationships are characterized by reduced ease of access to knowledge, when compared to R&D relationships with other types of actors. A plausible explanation to this is that competitors actively try to prevent knowledge transfers from taking place, for example by using contractual agreements and structures for increased control (Heiman and Nickerson, 2004; Simonin, 1999). Taking this into consideration, it has been claimed that the knowledge transfers taking place in many R&D collaborations between competitors are unintended and happen by default rather than by design (e.g. Hamel, 1991; Hamel et al., 1989). According to a study by Littler et al. (1995), the risk of giving away proprietary information was the greatest concern of the firms involved in R&D collaborations. To avoid the transfer of knowledge and know-how that is crucial to gain competitive advantage, competitors tend to collaborate on activities far from the customer, i.e. on activities that are closer to research than to actual development (Bengtsson and Kock, 2000). However, despite the risks of knowledge transfers associated with collaboration between competitors, the fact that a non-negligible part of primarily large, high-technology firms (Tether, 2002), engage in such relationships for the purpose of accessing and integrating their knowledge in the pursuit of research and development, remains.

Previous literature, although it recognizes the benefits of coopetition and discusses the role of knowledge sharing and integration to reach those benefits, says little about the mechanisms established to allow for knowledge integration to take place. While most previous research ignores the issue of appropriate mechanisms, Un et al. (2010:676) suggest that their research "builds on the assumption that once the firm has decided on one particular collaboration type, it will be able to establish the appropriate mechanism". Still, considering the need to balance the cooperative and competitive forces of a coopetitive relationship, establishing such mechanisms must not be a trivial task. This paper addresses the issue of how, by the establishment of mechanisms which take the conflicting logics of cooperation and competition into account, knowledge integration can be managed in a coopetitive R&D project.

The paper is structured as follows. In the next section, we review the literature on knowledge integration in projects. Thereafter follows a description of our research methodology and empirical data collection. We then present the empirical case study upon which this paper is based and submit our analysis. Conclusions and implications on knowledge integration in coopetitive R&D relationships are proposed in the final section.

2. Knowledge integration in project teams

Knowledge integration is defined as a goal-oriented process with the purpose of taking advantage of knowledge complementarities which exist between individuals with differentiated knowledge bases (c.f. Enberg, 2007). Knowledge integration is needed when knowledge is specialized and dispersed among individuals — in the case of coopetitive R&D projects, individuals who represent competing organizations. Knowledge integration can be enabled by the use of different integration mechanisms. In literature on knowledge integration, two main approaches can be discerned; one approach that emphasizes the need for knowledge integration mechanisms that are based on frequent communication and extensive knowledge sharing and another which suggests the reliance on structural mechanisms, and which downplays the need for communication and knowledge sharing.

Huang et al. (2001:161) suggest that the process of knowledge integration is "an ongoing collective process of constructing, articulating and redefining shared beliefs through the social interaction of organizational members". This is to suggest that the establishment of similarity in individual perceptions about the process, its content and problems is necessary to enable knowledge integration (Huang and Newell, 2003; Kleinsmann et al., 2010; Mitchell, 2006). To establish shared beliefs and perceptions involves the penetration of different boundaries to obtain knowledge, the expansion of different paradigms to achieve a shared understanding, and the re-configuration of organizational memory to create new organizational routines and knowledge (Huang et al., 2001). Further, knowledge integration requires the project members to "communicate, confront and anticipate different concerns, attitudes and perceptions" (Huang et al., 2001:168).

Newell et al. (2004) discuss the importance of bonding to enable knowledge integration, which requires strong levels of associability, trust and internal group cohesiveness. Nonaka (1994) suggests that knowledge integration builds on a process in which project members acquire each others' tacit knowledge through observing, imitating and practicing. Likewise, Boland and Tenkasi (1995) discuss the importance of perspective taking, which involves both the representation of one's own individual knowledge to assist individuals from other knowledge domains in recognizing and accepting different ways of knowing and the reconciliation of dissimilarities in knowledge and cognitive frames. To enable knowledge integration in the way suggested by the above-mentioned authors requires extensive communication and interaction among the project members. Nonaka and Takeuchi (1995:24) suggest that it involves "repeated time-consuming dialogue among members" of a project team and Carlile and Rebentisch (2003) makes it clear that knowledge integration benefits from close interaction.

Grant (1996) identifies common knowledge as a prerequisite for knowledge integration. The kind of common knowledge that he discusses however, is not essentially constituted by shared specialist knowledge. Instead, he suggests common knowledge in the form of a common verbal language (e.g. mutual adoption of codes), forms of symbolic communication (e.g. familiarity with the same computer software), a degree of commonality of specialized knowledge which allows the integration of knowledge beyond the most primitive level, shared meaning (e.g. cognitive schemas and frameworks) "as vehicles for molding, integrating and reconciling *different* experiences and understandings" (Grant, 1996:116, my emphasis) and recognition of individual knowledge domains. Kellogg et al. (2006) have contributed a study on how knowledge can be exchanged and integrated by the use of shared presentation practices, or genres, focusing on the form, rather than the content, of what is presented. "… expressing ideas and concepts in a particular form that can be used by others. This practice differs from translation which involves constructing shared meanings across communities. Rendering work legible, in contrast, requires articulation in a form that is tangible, observable, and readable by others, even if readings are multiple and differ from those intended by the author" (Kellogg et al., 2006:30). While Grant (1996) and Kellogg et al. (2006) are concerned with the need for common knowledge and knowledge sharing of a more limited kind than the authors referred to above, there are others who focus on structural integration mechanisms that presuppose almost no common knowledge or knowledge sharing.

Grant (1996) identified four different knowledge integration mechanisms; rules and direction, sequencing, routines and group problem solving and decision making. The first three of these "seek efficiency of integration through avoiding the costs of communication and learning", while the last one presupposes such costly communication and interaction and therefore be reserved "to unusual, complex and important tasks" (Grant, 1996:115). Schmickl and Kieser (2008) found that modularization, prototyping and transactive memory systems enable efficient knowledge integration, not only in incremental, but also in radical, development projects. Modularization, to a fairly large extent, enables the specialists involved in a project to work independently on a specific component as interfaces between the components are either standardized or "the design of interfaces can be accomplished in a stepwise fashion that, between steps, requires only limited knowledge of the design of interacting components" (Schmickl and Kieser, 2008:475). Prototyping is important in testing the interplay between different components, and specialists can concentrate on non-functioning interfaces and do not have to exchange knowledge on either the whole product or the whole design of a specific component. Further, transactive memory systems allow project members to localize relevant specialist knowledge. Sicotte and Langley (2000:1) found that formal leadership, planning and process specification, and the use of IT are integration mechanisms which have a positive impact on performance in R&D projects characterized by high uncertainty and/or equivocality while "the positive effects of horizontal structures [which are intended to improve communication] are apparently balanced out by their costs". Formal leadership acts on knowledge integration as leaders are able to motivate the project team and enhance its cohesiveness while planning and process specification acts on it by lessening the need for mutual adjustment and communication as every project member knows what s/he is expected to accomplish and when. Further, it is suggested that the use of IT enables knowledge integration as it speeds up communication and lowers its cost compared to face-to-face communication and interaction. Sicotte and Langley (2000) also conclude that the integration mechanisms mentioned act partly through their positive effect on horizontal communication.

To summarize our discussion we can conclude that two main approaches to knowledge integration can be identified in the literature. The first approach, also referred to as the cross-learning approach (Schmickl and Kieser, 2008), emphasizes the need to share specific knowledge and thereby establish a shared knowledge base. Okhuysen and Eisenhardt (2002:371) for example define knowledge integration in line with this approach, suggesting that knowledge integration is "both the shared knowledge of individuals and the combined knowledge that emerges from their interactions". In the second approach, the need for shared knowledge and understanding is downplayed. From the goal-oriented perspective to knowledge integration employed in this paper, it is not the shared knowledge which constitutes the primary goal of the process of knowledge integration, but to reach the target set for the project. From this perspective, shared knowledge is *potentially* important if the project team is to reach the target, but it needs not be a prerequisite for knowledge integration. Instead, from the goal-oriented perspective, the process of knowledge integration can rely on a variety of different knowledge integration mechanisms and which one to employ depends on the particular characteristics of the project (c.f. Grandori, 2001; Zollo and Winter, 2002). In coopetitive R&D projects, such characteristics consist of both competitive and cooperative forces simultaneously in play and thus the important question to answer is; considering that both competitive and cooperative forces are in play in a coopetitive R&D project, how can knowledge integration be managed?

With respect to the first approach, in many coopetitive R&D projects, it appears that the intensity of communication and the quite extensive knowledge sharing called for would not be acceptable (c.f. Doz, 1996). With respect to the second approach, the question arises whether the kind of impersonal and structural integration mechanisms suggested are enough to enable knowledge integration when the project members do not have any shared understandings or representations about different processes and ways of working. If this is the case: How do they support knowledge integration in a coopetitive R&D project? How do they balance the elements of competition and cooperation simultaneously present?

3. Methodology

Our research study was inductive and focused on generating theoretical insights into how, by the establishment of integration mechanisms which take the conflicting logics of cooperation and competition into account, knowledge integration can be managed in a coopetitive R&D project. A generalized aim was to generate theoretical insights on knowledge integration in a coopetitive context, based on an in-depth understanding of a particular case (c.f. Eisenhardt and Graebner, 2007). The Future Combat Air System (FCAS) project, which constitutes the empirical case of this study, is a coopetitive R&D project among five firms from five different countries — Alfa, Beta, Gamma, Delta and Epsilon.

In case-based research, the choice of case is crucial, and it is recommended to choose a particular case "precisely because it is very special in the sense of allowing one to gain certain insights that other [cases] would not be able to provide" (Siggelkow, 2007:20). The rationales for choosing the FCAS project are twofold. First, it involves competitors, and the collaboration revolves around products in which the firms involved compete fiercely on the market for defense equipment. Second, it is a coopetitive R&D project in the European defense industry, which is an industry where international collaboration of the kind conducted in the FCAS project is rare and in which, due to issues of national security, there are heavy restrictions on how information and knowledge can be exchanged. Although the insights from the FCAS project are particularistic with regard to time and place, they are useful to further our understanding of how knowledge integration can be managed in a coopetitive context where both cooperative and competitive forces are at play simultaneously (c.f. Alvesson and Deetz, 2000).

The study of the FCAS project was first initiated at Gamma during the autumn of 2008. To begin with, our aim was to obtain an overview and a general understanding of the FCAS project and its context, and we therefore had an informal meeting with the project manager from Gamma, who presented the FCAS project, its background, scope, organizational set-up and time plan. The project manager provided us with internal project documentation of a non-technical nature. To gain further understanding about the defense industry, we read literature on the development of the European defense industry during the last decade. We also found useful information of the particular program of which the FCAS project was a part, on the internet. Thereafter, interviews with the project manager, the project members and members of the project steering committee at Gamma took place. While the interviews with the project manager and project members focused issues of cooperation in daily project work and the tensions and difficulties that resulted from collaborating with competitors, the interviews with members of the steering committee (which was not particular to the FCAS project), centered on strategic issues related to R&D collaboration/coopetition, governance structures in R&D collaboration and particular challenges of the FCAS project. The average interview lasted for 90 min and all of the interviews were tape-recorded and transcribed to facilitate analysis.

In the first phase of the data collection, all interviews were conducted with representatives from Gamma. We then approached the manager of Gamma's work packages (see description of organizational set-up below) to access representatives from Alfa, Beta, Delta and Epsilon. In the second phase of data collection which took place in September 2009, we interviewed those representatives from Alfa, Beta, Delta and Epsilon – one from each firm – who were involved in work package 2. In total, this added up to four additional interviews. These interviews focused the same issues as the interviews with the project members from Gamma. The interviews lasted for an average of 60 min and were tape-recorded and transcribed.

Table 1
Summary of interviews.

Company	Interviewees
Alfa	Manager of the Department of Marketing and Business Development, likewise, project member of WP2, capability requirements
Beta	Manager of the Technical Department, likewise project member of WP 2, capability requirements
Gamma	Project members from Concept Department, cost predictions (leader of the LCC discipline) Operational analyst (involved in WP 2 and 3) Operational analyst (involved in WP 1 and 2) Operational analyst (involved in WP 2 and likewise member of the Gamma project steering committee) Manager of the Department of Operational Analysis (involved in WP2 and 3) Technical consultant (WP 3) Aviation systems (WP 2 and 4) Project manager (WP 2 and 4) Members of the Gamma project steering committee from Department of Business Development Department of Business Development Manager of the R&D Department Manager of the Department of Business Development, likewise a member of the program industrial steering committee
Delta	Project member involved in WP 2, capability requirement
Epsilon	Manager of the Department of Operational Analysis and Flight Performance, likewise project members of WP2, capability requirement

All in all, 16 interviews were conducted: one with the project manager at Gamma, four with members of the steering committee at Gamma and eleven interviews with project members. Of these eleven interviews, seven were conducted with project members from Gamma (see Table 1). This implies that the empirical description of the case is mainly built from interviews with representatives from Gamma. However, the interviews with the project members from Gamma's partner firms to a large extent validated the findings from interviews with people from Gamma, in that the descriptions of knowledge integration in the FCAS project were similar.

Based on the interviews and documents, a case description of the FCAS project was written. This case description was read and commented upon by the Gamma project manager.[2] An excerpt which described the organizational set-up of the project was read by the manager of the department of Business Development, likewise a member of the ETAP industrial steering committee. This resulted in some minor corrections in the description of the organizational set-up. This kind of member checking is a good way to establish the credibility of a qualitative study (Lincoln and Guba, 1985).

[2] The Gamma project manager who was initially interviewed had resigned in late 2008. The project manager who read the manuscript had been involved in the FCAS project for about 15 months at the time when she read the manuscript and she was not among the interviewees.

4. The FCAS project

The FCAS project involved five firms from five different countries — Alfa, Beta, Gamma, Delta and Epsilon. The target of the project was to identify and suggest advanced technologies for a future combat air system with the aim of reducing the risks and costs involved in combat air system procurement. The time-frame considered was post-2020. The establishment of the project, which followed a declaration from the Ministers of Defense of six European countries to collaborate on a joint study, served the interests of the partner firms well, and had a strategic significance for all of them. A primary reason was that the defense market was characterized by consolidation and reformation, and the prospects of acting alone in the future were poor, from both a financial and a competitive perspective.

A combat air system consists of an operative system and a co-operative system, the first of which includes manned and unmanned aircraft and the latter of which includes support systems, e.g. ground control stations, tankers, electronic warfare solutions, signals intelligence systems, airborne early warning and controls systems. The various components[3] are interrelated, and due to the number of components, there were many interfaces which had to be dealt with and fit together. Although, at the time of the study, the focus of the FCAS project was on building competence rather than on developing a physical product, the competitive forces of the project were fierce. The work in the project was based on a number of different scenarios to which the combat air system would have to respond, ranging from humanitarian operations to global war. Depending on the scenario, the system would have to include different components and those would interact in different ways. To be able to evaluate the different scenarios, as well as to propose the components and technologies needed to meet them, inputs from existing components and technologies, i.e. from existing products, had to be used. However, these were components and technologies by which the firms involved competed with each other on today's market. Therefore, although the time-frame considered for a physical product was post-2020 and the focus of the project was on research, rather than development, at the time of the study, today's competitive market situation had a significant impact on the project.

Despite the strategic significance granted to cooperation in the FCAS case, the competitive situation had a significant impact on the choice of knowledge integration mechanisms and on the process of knowledge integration.

> It means that when everyone keeps an eye on everyone else, not having perhaps a high level of trust, then you have to plan everything extensively and to formalize things. (Manager of the Business Development Department at Gamma).

The partner firms of the FCAS project had to constantly balance between the need to integrate knowledge to reach the target of the project, and the risk of unintended knowledge leakages, or more specifically, to balance the competitive and cooperative forces of their coopetitive R&D project when choosing what particular mechanisms to rely upon for knowledge integration.

4.1. The organizational set-up of the FCAS project

At the highest level of the FCAS project, was a board of senior managers who were responsible for strategic issues related to the project. Operational issues of the FCAS project were handled by a group of technical managers, one from each of the firms involved, and who acted as sub-project managers in two ways.[4] First, each of them was responsible for coordinating the work of a particular work package (WP), which ran across the firms. Second, they were responsible for coordinating the daily project work at the firm which they represented. Alfa served as the main contractor and coordinator of the project but the collaboration was described as a collaboration between equals and at each level of the project organization, representatives from each participating firm were included.

The project consisted of five interdependent WPs and a number of related sub-packages. The distribution of responsibilities for each WP was done on the basis of the competence and resources available to deal with the issues of a particular WP within a particular firm.

> …that's the way in which the distribution of WP:s was done. Which company was the best to deal with a specific WP, or what resources and competencies do the different companies have? So that you can make the WP and tasks the responsibility of the firm with the best capability to deal with it. (Project member and member of the project steering committee at Gamma)

Alfa assumed responsibility for WP1, Management, Gamma was responsible for WP2, Capability Requirements and WP4, FCAS components, while WP3, FCAS in the SoS[5] context was headed by Beta, with Delta assuming responsibility for some of its sub-packages, and WP5, Technology, was assigned to Epsilon. Although each partner firm was responsible for a separate WP or sub-package, all firms were represented on all the WPs.

In addition to WPs, there were a number of disciplines which were assigned on an equal basis among the participating firms. The disciplines were not specific to a particular WP but ran horizontally, which meant that each discipline supported all the WPs in issues which were related to its particular domain. Examples of disciplines included lifecycle cost calculations (LCC), sensor performance, risk and platform performance. As was the case for the WPs, the disciplinary groups consisted of members from all the different firms involved. Furthermore, the

[3] Component is here used to refer to the whole of a sub-system or product, such as e.g. an aircraft or a ground control system and not individual parts of these sub-systems or products.

[4] Gamma had chosen to include their technical manager/sub-project manager on the board of senior managers while the other companies were only represented by top managers on this board.

[5] SoS in this case refers to system-to-system.

project members suggested that within a specific WP or discipline, they depended upon each other to solve their tasks;

> We know different things. For example, I have a bit better understanding about technology than some others which means that I focus particularly on technology to make sure that we get correct information on technology while others are better on systems for example which means that they focus on getting a good model, good tools for systems evaluation. (Project member, Gamma).

The FCAS project was organized in phases, each lasting for a period of three to four years. Within each phase, there were several iterations between the different WPs which in some iterations followed sequentially upon each other while in other took place simultaneously. During the project, the project members were located at their respective home organizations, which is to say that the participants were co-located company-wise, but acted as distributed teams with respect to the WPs or disciplines in which they were engaged.

4.2. Knowledge integration in the FCAS project

The FCAS project relied extensively on formal and structural mechanisms for knowledge integration. To a large extent, these integration mechanisms were described in a statement of work which the project members often referred to as the most important guideline that they had in working with the FCAS project. The statement of work had been defined by the board of senior managers at the inception of the project.

The project members suggested that the statement of work made "everything crystal clear" as it defined the technical scope of the project, the technical interdependencies, WP inputs, WP outputs and deliverables.

> [In the statement of work] we're told exactly what we're supposed to do, actually down to every single meeting. These things are planned for years in advance or otherwise it wouldn't work so it's really extremely well planned for this project. […] For example, what are our inputs? Well, WP2 should get input from WP1, that, that and that and that data is to be used in these processes to do this and that and that. Then you're supposed to have a meeting here and at that meeting you're supposed to discuss the following things, bla, bla, bla and after that we want you to write a report with the following content etc. (Project member, Gamma)

As suggested by the quotation above, the statement of work defined, to a certain extent, the interdependencies and iterations between different WPs, or as one project member explained, it included a description of the process that showed how the "different black boxes were related". To be precise, it was the processes which constituted "black boxes", as the project members were not allowed to reveal information on processes, methods or tools used to solve the different tasks to team members from the partner firms. Consequently, no efforts were made to establish common processes or tools. Though the metaphor used by the project member was not straightforward, it showed that, in a project like the FCAS, where issues of corporate confidential information and national security put limitations on what information and knowledge can be shared, the statement of work constitutes an important mechanism to enable knowledge integration. In addition to facilitating the coordination of tasks, it was proposed, by defining interdependencies, inputs, deliverables and so forth that the statement of work contributed to a common interpretation of what was considered important for success.

It was suggested that the statement of work constituted a detailed plan to guide the project. Apart from defining technical interdependencies, inputs, outputs and deliverables, as described above, it also included detailed meeting schedules and related agendas. As a matter of fact, the only occasion when all the project members, including the project managers, met was at the monthly project meetings. Although all the project members were gathered in the same location simultaneously, each WP had its own session. The project manager of each WP chaired the session in which actions were followed up, the results and outcomes of work were discussed and work was distributed. The project members described the meetings in terms of planning rather than of doing work related to technical problem solving together.

> …the focus [on the project meetings] is to check what has happened and decide on what actions to take […] not actually working a lot but trying to focus the central issues and discuss them, listen to everyone's opinion and try to identify the differences between us. (Project member, Gamma).

While the project meetings offered an arena for communication and interaction and were appreciated by the project members who enjoyed getting to know their colleagues from the partner firms, the discussions, as suggested by the quotation above, were centered on the discussion of results and further planning of the work.

The results which constituted the basis for the discussion were presented according to a pre-defined form which stipulated its exact content.

> …predefined forms for reporting the results. We agree, often among the members of a particular WP, how we will report the results, and that is according to predefined and standardized forms. (Project member, Gamma).

The project members explicitly proposed that such forms were used to assure that sensitive or confidential information was not revealed. The forms had been elaborated by the board of senior managers at the beginning of project work. However, unlike the statement of work, they were not finally settled but were sometimes re-negotiated on the initiative of project members who suggested changes to them. Although these standardized forms were used, project members from the same partnering firm met to discuss and inspect each others' work and the way it was presented before it was sent out to their colleagues from partnering firms, in order to further ensure that sensitive information was not revealed by mistake.

4.2.1. Challenges of knowledge integration in the FCAS project

Although the integration mechanisms described did not encourage extensive communication, the project members' primary concern with regard to communication was not its lack. Instead, it was related to the content of the communication which focused on inputs, outputs, follow-up and planning. Important as these aspects were, corporate confidential information and sometimes, information that was classified due to the need to protect national interests, implied that project members were not allowed to discuss the origins of their results, nor the processes, methods or tools used to reach them. Both the project members and the managers commented upon this;

> We can't even talk about our methods or tools because there's too much corporate confidential information. (Project member, Gamma)

> …sometimes you realize these things, that you have to keep quiet about it and you can't share it with others. And sometimes, that's something which I realise that our partner firms do as well, they suddenly become cautious, but there is no way in which we can avoid it. (Manager of the Business Development Department, Gamma)

When not being able to share knowledge about products, which were to be included in the future combat air system, or on processes, tools and methods for problem-solving, the project members had two strategies. Firstly, they shared information which was not classified. Secondly, they focused on deliverables in terms of computational results which were shared using the predefined form described above. This indicates that the project members discussed outputs rather than inputs and deliverables rather than tools or processes. Below follows an account of what kind of knowledge could or could not be shared and how, in the statement of work, the interconnectedness of the different deliverables was illustrated.

> …defined clearly what the input and output were and then what's in between was a black box, we didn't describe that at all […]. Then you have descriptions of the process which shows how these different black boxes are related so that you know their interdependence. […] So we try to find a way of working where we focus on the results that we're to exchange and then how we arrived at them, whether we used a calculator or a supercomputer, that's not important. That's nothing we ask about… (Project member, Gamma)

Not surprisingly, the fact that knowledge exchange was constrained to such an extent as described, led to different interpretations and misunderstandings.

The fact that particular processes and tools could not be discussed also implied that specific ways of problem-solving were not revealed. One project member described how, in some of the partner firms, those specialized in LCC worked closely with engineers in order to get precise technical inputs for the calculations, while in other firms they were located with the marketing department and were used to working "close to the customer". This resulted in the employment of qualitatively different processes and tools and of quite different perspectives and interpretations.

> After having been working for some time together, we were supposed to compile the results and compare the different concepts from the different partners but we were not able to find any common ground for comparing and that all falls back on the fact that we do not have any common tools. (Project member, Gamma)

The above example can be interpreted as an example of how the ways to deal with the issues of communication described, i.e. to focus on outputs and results rather than tools and processes, aggravated the problem when the project members were not able to discuss and get beneath the surface of what appeared to be incommensurable results. In these cases, it happened that the project members turned to the hierarchy (i.e. the project managers of the WP:s or the board of senior managers) for a decision on what results to use as inputs in the next iteration of work, or on which interpretation of an agreement should guide the next part of the work. Thus, the board of senior managers had an extensive impact on the way in which project work was conducted in the FCAS project, not only by defining the statement of work, but also by the way in which they were consulted to solve specific disagreements.

5. Analysis and discussion

Knowledge integration in the FCAS project proved to be a challenging undertaking. Although the FCAS project constituted a cooperation of strategic significant for the firms involved, the competitive forces were fierce and had a major impact both on the choice of knowledge integration mechanisms and how the process of knowledge integration actually unfolded. As the level of trust between partners was low at the outset of the project, the choice to rely on more impersonal and standardized mechanisms and to structure the discussion at meetings by the use of forms for reporting results seems plausible. Still, considering the complexity of the project, i.e. the many interrelated components and sub-systems for which the project members were to identify advanced technology, it would have been reasonable to rely on more personal and less standardized knowledge integration mechanisms to allow the project members to more freely communicate and interact to solve problems and deal with interfaces (c.f. Grant, 1996; Zollo and Winter, 2002). To better understand the choice of knowledge integration mechanisms in the FCAS case, we will discuss how the knowledge integration mechanisms used balanced the elements of cooperation and competition that were simultaneously present, and the consequences that they had on the process of knowledge integration.

5.1. Balancing competition and cooperation in knowledge integration

Two knowledge integration mechanisms were particularly prominent in the FCAS project; the statement of work and the standardized forms used for reporting results. The statement of work constitutes an example of extensive planning and process specification (c.f. Sicotte and Langley, 2000) as it defined the scope of the project, the interdependencies between different parts as well as the expected WP outcomes and how they would constitute WP inputs in later phases of the project work. Unlike projects in which the competitive forces are not stressed, the project members could not openly share information about the interrelated sub-systems, components or technologies used and thereby deal with the different interdependencies. Therefore, the statement of work was important for project members as it enabled them to deal with the different interdependencies, but it was also important as it allowed them to create a *common understanding about the process* of project work.

The standardized forms for reporting results constituted a way to specify and control what content of project work was shared between project members from the different partner firms and to structure and limit the discussions at project meetings. The standardized forms can be conceived of as a presentation genre (c.f. Kellogg et al., 2006) that allows for multiple readings and understandings where individual project members interpret the information based on their own contextual knowledge about which kinds of processes, methods and tools might be used to solve specific problems and arrive at particular types of results. Thus, the standardized forms allow project members to make *individual sense of the content of project work* while the constraints that are posed on the process hinder them from trying to make common sense.

As a whole, the situation appears to be ambiguous and open to many interpretations, and in such cases "information that is constructed in face-to-face interactions that provide multiple cues" (Weick, 1995:99) is often needed. In this case, however, where competitive forces were strong such face-to-face interactions were of limited value, because the standardized forms were effectively used to structure the information around which such face-to-face interactions occurred. As witnessed by the project members, the meetings primarily focused on following up and planning, while joint problem solving, which could have been a way of making collective sense of the situation, did not take place at these meetings.

The statement of work and the standardized forms indirectly enabled top management control of both the process and content of knowledge integration. As already proposed, the statement of work and the standardized forms not only limit the knowledge on process and content respectively that was exchanged between project members from different partner firms, but as project members were well aware of the constraints which these mechanisms set, it also made it more difficult to *probe* for additional information and thereby, unintended knowledge leakages such as the ones described by Hamel (1991) can be avoided. Thus, the use of planning and process specifications and presentation genres, might have a reinforcing effect in coopetitive projects.

It follows from the discussion above that the use of planning and process specifications along with the standardized forms for reporting results enabled a shared representation of the project process (c.f. Kleinsmann et al., 2010) while effectively setting constraints on what content of the project work was shared, and thereby making more or less impossible the establishment of a shared understanding or representation of the content of the work (c.f. Huang and Newell, 2003; Mitchell, 2006). Under such circumstances, how can we understand the process of knowledge integration?

5.2. Integrating knowledge in coopetitive R&D projects

It has been suggested that the group constitutes a viable knowledge integration mechanism in settings where specialized knowledge is dispersed, and that the group integrates knowledge by means of problem solving and decision making (Grant, 1996). As has been shown by the FCAS project, however, there are various knowledge integration mechanisms which influence the process of knowledge integration at the group level. This suggests that although the group might be the primary level at which knowledge integration occurs, the process by which knowledge integration is enabled differs among groups, as different integration mechanisms are chosen as a result of particular circumstances. To understand knowledge integration at the level of the project team in coopetitive projects, we therefore have to focus attention on how various integration mechanisms impact on the process of knowledge integration.

Grant (1996) suggests that knowledge integration in complex projects, such as R&D projects, is best enabled by group problem solving and decision making, which implies that problem solving and decision making are activities that take place among a number of project members, i.e. in a collective setting. Furthermore, Enberg et al. (2010) and Nonaka and Takeuchi (1995), have described problem solving in R&D projects as a collective process which engages project members from different domains of expertise, who interact and communicate in order to jointly solve problems. In a coopetitive project where the competitive forces in play are strong such collective problem solving may not be possible due to the restrictions which have to be placed on project members' communication and knowledge sharing. Thus, problem solving in such settings has to be kept an individual activity, or an activity which is limited to take place between project members from the same firm to avoid unintended knowledge leakages. In such individual problem solving different alternative solutions are tested out on the basis of on-line assessments (Gavetti and Levinthal, 2000) made from experiments constituted, for example, by computer simulations which generate results. On the basis of this on-line assessment, the project member chooses the alternative which, based on this on-line assessment, came out best to be presented to the rest of the team, following the particular presentation genre decided upon.

As proposed by Enberg (2007), meetings in R&D projects, often center on making sense of results that different project members present to the project team and, on the basis of these, deciding on what to do next. While results reported using the specific presentation genre constitute the basis for decision making, these decisions cannot be grounded in common sensemaking, shared meanings or shared understandings of the content. Instead, each project member has to evaluate the results based on his/her contextual knowledge about processes, methods and tools, and judge the extent to which a particular alternative fulfills the requirement defined for the product of the project and in this way search for a satisfying option. Thus, each individual project member makes what Gavetti and Levinthal (2000) have referred to as an off-line assessment. This is to say that while decision making in coopetitive R&D projects may be a collective process at the group level, it is also a blind process, as the project members know little about each others' interpretations and the kind of knowledge and understanding upon which these are grounded.

From the perspective of authors who suggest that common knowledge, shared meaning, a common platform of understanding and the like are essential to enable knowledge integration in projects, the way in which knowledge integration in a coopetitive project has been discussed and conceptualized above, appears to be a problem (e.g. Adenfelt, 2010; Huang and Newell, 2003; Nonaka and Takeuchi, 1995). On the other hand, much previous research claims that shared meanings are not essential for collective action or knowledge integration (Crossan et al., 1999; Kellogg et al., 2006; Weick, 1995). Weick (1995) suggests that "shared meaning is not what is crucial for collective action but rather it is the experience of the collective action that is shared". Kellogg et al. (2006:39) use the concept of trading zone to "highlight how the local coordination of ideas and actions may take place despite differences in community purposes, norms, meanings, values, and performance criteria". Further, Crossan et al. (1999) suggest that action informs understanding, and that repeated decision making is made sense of retrospectively when people are able to see what they've decided (c.f. Weick, 1995). Following Weick's (1995) line of reasoning, it can be suggested that new aspects of a particular decision can be explored and taken into account on later occasions when individual problem-solving and collective decision making takes place. In this way, the process of knowledge integration in a coopetitive project, where constraints are put on communication and interaction, can be described as an evolutionary one which is built on retrospective sensemaking (Weick, 1995).

6. Conclusion

In this paper, we have explored the issue of knowledge integration in coopetitive relationships with a specific focus on how various knowledge integration mechanisms balance the elements of competition and cooperation simultaneously present in such relationships. In the face of fierce competitive forces within the scope of the project, it appears reasonable to rely on impersonal and standardized knowledge integration mechanisms. However, it is important to understand both the ways in which a specific integration mechanism supports knowledge integration, the way in which it inhibits unintended knowledge leakages and the consequences it has on the process of knowledge integration. In this paper, we have shed light on those issues.

First, it has been proposed that a statement of work, or more generally, planning and process specifications, supports knowledge integration by enabling project members to deal with interdependencies between different components, sub-systems, tasks or activities, and allows them to create a common understanding about the process of project work. Second, it has been suggested that the use of standardized forms for reporting results, or more generally, the use of presentation genres, supports knowledge integration as they enable project members to make sense of their tasks and structure their discussions (at for example project meetings), while simultaneously hindering the formation of a common understanding of the content of project work. Third, it was argued that the kind of mechanisms explored in this study indirectly enabled top management control of both the process and content of knowledge integration, and that their use might have a reinforcing effect in that project members know the constraints and limitations and therefore do not probe for additional information.

As was suggested, the use of integration mechanisms which put heavy restrictions on communication and on the knowledge exchange that is allowed to take place, impacts on the process of knowledge integration. With respect to this, we have shown how individual and collective activities should be clearly separated, such that problem solving stays with the individual while decision making, although a collective activity, should be based on individual interpretations of what particular alternatives mean and imply. The rationale behind this separation of problem-solving and decision-making, into two separate and distinct activities for enabling knowledge integration in groups, as opposed to one (c.f. Grant, 1996), is to avoid unintended knowledge leakages. As a consequence, however, knowledge integration becomes a blind process which can best be understood if we consider that over time, action informs understanding and that repeated decision making can be made sense of retrospectively when people are able to see what they have decided (c.f. Weick, 1995). Knowledge integration in a coopetitive setting like the one described here, can therefore be understood as an evolutionary process built on retrospective sensemaking.

The managerial challenge of knowledge integration in coopetitive relationships consists of finding knowledge integration mechanisms which enable knowledge integration at the same time as they effectively hinder the exchange of specific knowledge. To clearly define the constraints in terms of what knowledge about processes and content project members are allowed to share, while at the same time offering mechanisms which allow for a common understanding of the process, appears to be vital. As suggested by our case study, a common understanding of the process is enough for knowledge integration to be enabled and, contrary to what is often suggested, project members do not have to share an understanding of the content of the project work. This means that managers can rely on less communication and interaction-intensive mechanisms for knowledge integration and also try to structure the discussion which takes place at collective arenas, e.g. using standardized forms for reporting results or the like. Common understandings and interpretations, as was suggested in the case study, would make knowledge integration and project work easier on many occasions, but are not necessary.

The usual limitations associated with single case studies apply, and additional research into how knowledge integration is enabled in coopetitive R&D projects and in other contexts which are highly constrained in terms of the knowledge that participants are allowed to exchange, is needed. This study was conducted in the defense industry, which is an industry where people are used to adhering to norms of secrecy, as, by tradition, the defense industry is highly circumscribed due to issues of national security. However, in many other industries where coopetitive projects exist, people are not used to this kind of circumscription and therefore might be reluctant to work in accordance with the kind of mechanisms established to deal with the competitive forces, as they might experience difficulties integrating knowledge under the kind of circumstances thus created.

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