# WORKING TOGETHER IN THE SPACE BETWEEN EXPERTISE AND IGNORANCE

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## Abstract:

This paper examines the phenomenon of interdisciplinary collaboration to critically appraise the widespread idea that working together requires the integration of knowledge. We build both on the concepts of common ground/grounding and interactional/contributory expertise to analyze in two case studies how common ground evolves in practice. We find that building common ground is a continuous process of both developing common knowledge *and* dissecting differences (dependencies) in knowing and of both confirming *and* questioning legitimacy of experts (positioning own expertise and admitting ignorance). We further discuss the relationship between personal and communal common ground and refine our theorizing in the context of interdisciplinary collaboration by distinguishing grounding activities specific to tasks characterizations.

## Keywords:

Knowledge integration, common ground, learning across boundaries, interdisciplinary collaboration

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## 1 INTRODUCTION

Interdisciplinary collaboration is traditionally considered to be very beneficial for organizations. Spanning various professional boundaries and domains of expertise allows groups and organizations to better tackle with the complexity of tasks (Grant, 1996), to more swiftly adapt to fast changing environments (Thompson, 1967), and to develop novel perspectives and enhance innovation (Powell, Koput, & Smith-Doerr, 1996).

For cross-disciplinary collaborations to be beneficial, the assumption is that diverse and highly specific forms of knowing have to be integrated through coordinated and conjoint activities (i.e. Eisenhardt & Santos, 2000; Grant, 1996). Knowledge integration, in turn, is only possible if collaborators share a minimal 'mutual knowledge' or 'common ground' (Bechky, 2003; Carlile, 2004). In his classical distinction of three forms of collaboration, Thompson argued that when the situation is unpredictable and there exists a reciprocal interdependence in a group, coordination is achieved by 'mutual adjustment' (Thompson, 1967). More recently, Alavi and Tiwana analyzed situations in which knowledge is distributed and found that a 'mutual understanding' - a form of knowledge that is shared among people and that is known to be shared (Alavi & Tiwana, 2002) - has to be developed to make collaboration possible. Grant (1996), Carlile (2004), and Bechky (2003) all equally refer to the importance of 'common knowledge' or 'common ground' for integrating expertise across professional boundaries. Grant, for example, argues that if knowledge is very diverse and specialized among collaborators, there is little common knowledge and it lacks the necessary complexity and substance, which is why communication becomes poorly effective and knowledge cannot be integrated (Grant, 1996: 380).

While the idea that collaboration requires some form of 'sharing' is widely accepted, it is not without problems. This is especially the case in the context of cross-disciplinary collaboration. For one thing, little is known about what is supposedly shared, how the sharing comes about, and how it evolves over time. In the few cases when the actual sharing process is thematised, as for example in the symbolic interaction tradition (Bechky, 2003) and the study of boundary situations (Carlile, 2004), authors rarely emphasise that a good collaboration thrives in the narrow space between knowledge and ignorance, e. g., when sharing and not sharing are finely balanced. Yet this seems quite noticeable in cross-disciplinary situations. In these contexts, there is little interest in experts acquiring in-depth knowledge of their collaborators' specialized areas of expertise (Eisenhardt et al., 2000) or becoming members of the others' communities of practice. Swan (in these proceedings of OLKC 2008), for example, describes interdisciplinary collaborations in the biomedical context, where collaborators - rather than integrating knowledge and developing common ground - carefully manage and affirm professional boundaries. A similar situation was described by Gherardi and Nicolini (2002) who show that discursive practices across communities of practice aim not only at negotiating shared meanings and interests, but also at surfacing, and tentatively holding down, dissonances and conflict. Thus, in the context of interdisciplinary collaboration, the idea of sharing understood as an all or none condition looses significance. Rather, we are faced with a grounding process which deals both with

developing common knowledge (building expertise) *and* with dissecting differences in knowing (i.e. acknowledging own ignorance in a certain field of expertise and the legitimacy of other's expertise).

In this paper, we will inquire into this relational space between expertise and ignorance and ask, first, *what forms of common ground are developing in cross-disciplinary collaboration*? Second, *what are the processes and practices through which common ground is evolving*? This latter aspect about grounding practices is particularly important in cross-disciplinary settings because common ground is often difficult to develop and collaborations are characterized by misunderstandings (Bechky, 2003), by hardly reconcilable conceptions or 'thought worlds' (Dougherty, 1992), and by diverging interests (Carlile, 2004).

In order to shed light on the two questions above, we will build on two different bodies of knowledge. First we refer to Clark et al.'s processual theory of 'grounding' practices in discourse and the development of 'common ground'(Clark, 1996; Clark & Brennan, 1991; Isaacs & Clark, 1987). Over the years, these authors developed a robust and mature body of research on how speakers understand each other through a variety of discursive grounding practices. We will integrate this approach with Collins & Evans (2002) discussion on the difference between 'interactional' and 'contributory expertise. As we shall see, the authors suggest that situations of cross-disciplinary collaboration require a type of expertise that is different from that necessary to contribute competently in a specific field of expertise. In the paper we will use these two approaches in combination to analyze two case studies of product development, one in the context of bioengineering and the other in the context of information technology. The cases are used to engage in theorizing about how specific forms of common ground are developing within cross-disciplinary collaboration.

The choice of these interpretive lenses means that the attention of this paper is especially on the discursive practices of building common ground. This narrow focus is a deliberate choice given the intricacy of the process of collaboration. We are however fully aware that other elements are critical in supporting the process of collaborating across disciplines. For example, we have discussed elsewhere the central role objects play a in supporting the cooperation among experts from different backgrounds (Nicolini, Mengis, & Swan, 2008). Objects provide means of communication and understanding (Bechky, 2003; Carlile, 2004) they fuel the pursuit of the common project (Knorr Cetina, 1997), and often constitute the common reference around which the collaboration unfolds (Engeström & Blackler, 2005; Terssac, 1992). Their relative absence from our narrative is therefore motivated by analytic purposes only and should not be construed as a theoretical statement. Object and discursive practice work together to sustain cross-disciplinary collaboration and it is only for clarity's sake that we discuss them separately.

## 2 THEORETICAL BACKGROUND

According to the communication theorists Clark and his colleagues common ground and the collective activity of grounding are key aspects not only of communication, but of coordination and collaboration more generally (Clark, 1996; Clark et al., 1991; Clark & Marshall, 1981). All collective actions, say these authors, "are built on common ground and its accumulations" (Clark et al., 1991: 127) and in the absence of common ground,

"individuals' differing perspectives, beliefs, assumptions, and views of the future are most likely to collide and thus immobilize" collective action (Fahey & Prusak, 1998: 258). Common ground comprises not only 'mutual' knowledge, but also 'mutual' beliefs, 'mutual' assumptions, and 'mutual' awareness (Clark et al., 1981). On the one hand, common ground can be reasonably assumed if communication partners belong to a same community, such as an occupation, a nation, a linguistic community, a hobby, or a religion. Next to this '*communal common ground*', '*personal common ground*' develops on the basis of collaborators' recollections and interpretations of jointly lived experiences and actions, such as previous conversations or shared undertakings (Clark, 1996). While communal common ground is more static, personal common ground develops dynamically with the ongoing interactions as it builds on linguistic co-presence (references to objects that have been discussed in earlier conversations) and physical co-presence (objects that are present to the various collaborators and to which can be referred).

Central to the idea of common ground is that the established mutuality is always only *assumed*, i.e. common ground is the context that communication partners can reasonably assume to be sharing among them (Krauss & Fussell, 1991). In this sense, common ground is neither a substance nor a stable state as much as a provisional achievement rooted in communication.

Rather than focusing on 'common ground' as a static asset, Clark and his colleagues investigate in fact the *ongoing communicational process* of *grounding* through which participants continuously try to reach the mutual belief that they have understood what the contributor meant to a degree that is sufficient for their current purposes (Clark et al., 1991: 129). According to Clark et al., when communicating with others we continuously, and mostly unconsciously, look for negative and positive evidence to disconfirm or confirm this belief. A contributor is attentive, for example, that his/her vis-à-vis pays continued attention (i.e. through eye gaze), that his/her next turn is relevant to the previous one (i.e. a question is followed by a meaningful answer), and he/she is sensitive to the others' signs of acknowledgement (i.e. 'really', 'uh huh') (Clark et al., 1991: 131-132).

The grounding techniques that communication partners use depend on the *purpose* or task to be accomplished with the communication and on the *medium* of communication (Clark et al., 1991: 136). Clark and Brennan, for example, discussed the techniques of 'grounding references', which are particularly important if a reference to a person or object has to be well established. They include, for example, indicative gestures (i.e. pointing to an object), alternative descriptions (i.e. A: 'The women we met at the bar'; B: Amanda Bartlett?), or trial references (A: 'Do you stay at Hotel Swilton?'; B: 'Yeah, Hotel Hilton'). In the context of interdisciplinary collaboration, as the colleagues stem from different areas of specialization, they use a set of specific grounding techniques to continuously assess their work mates' expertise, and to supply and acquire information (Isaacs et al., 1987). Relative expertise and ignorance are displayed, for example, by the types of references interaction partners make in passing such as their use of technical terms or their skill in explaining and exemplifying a state or event (Isaacs et al., 1987: 29). Direct and indirect questions are a more explicit means to assess expertise (e.g. are you an engineer?) or to gain new knowledge (e.g. why have you placed the meter just below the hanging?).

Grounding techniques also vary depending on the medium, through which collaborators interact. In face-to-face interactions, people can draw on a wide range of

evidences to develop their common ground: they are co-present and share the same physical environment (co-presence), they are visible to each other (visibility), can communicate through speech (audibility), and receive messages the moment they are sent (contemporality). Written forms of communication lack most aspects of the above, yet provide other advantages to develop common ground, such as reviewability (they can re-examine each other's messages) and revisability (they can modify messages before they are sent) (Clark et al., 1991: 141).

In sum, the literature on common ground suggests that communicators and collaborators continuously develop and verify the evolving common ground between them. They do so by engaging in a variety of grounding activities specific to the purpose of their collaboration (the task) and the media through which they interact. The common ground that is developing is both communal and personal.

While the theory of common ground is a powerful tool for investigating the process of building common ground among speakers and people involved in a joint enterprise, it fails to take into account, among others, that in certain situations there is no direct relationship between the robustness of common ground and the benefits for the participants. It is therefore not true that the stronger the common ground the better. This becomes apparent if we consider the situation in which the collaboration is between carriers of different forms of expertise.

The case is discussed at length by Collins and Evans (2002). The authors note that in situations of cross disciplinary collaboration participants can find themselves in roughly three positions with regards to one's familiarity in the field of expertise of one's interaction partner: 'no expertise', 'interactional expertise', and 'contributory expertise'. Their categorization originally stems from the context of social science studies as they investigated into the kind of expertise a sociologist needs of his field study in order to analyze a social phenomena.

The situation of 'no expertise' is that of the total novice or, in their case, that of the scholar who enters the field to study a phenomenon without any prior knowledge on the field. *Interactional expertise* denotes the sufficient expertise of knowledge domains across the disciplinary boundary to make interesting and meaningful interactions and collaborations possible. Collins and Evans argue that this is the ideal case of science (and organizational) scholars. Finally *contributory expertise* describes the expertise necessary and sufficient to contribute to the content of another area of expertise (2002: 254).

According to Collins and Evans (2002), in order to collaborate with people from another area of expertise, one does not forcibly need 'contributory expertise', but merely requires 'interactional expertise' combined with experience of contributory expertise in some related area (2002: 257). In addition, interactional expertise is not a precondition for gaining contributory expertise. Farmers, for example, gain in their yearlong experience a considerable contributory expertise in ecological and environmental issues (i.e. they know about the effect of acid rain on their plants), but lack the interactional expertise to share their knowledge with environmental engineers. On the other hand, if a person has interactional expertise of their collaborators' domain of expertise (i.e. environmental engineers having interactional expertise of farming), he/she will not automatically strive to gain contributory expertise (gain in-depth knowledge about farming). We can thus specify

that in interdisciplinary collaboration, a context in which both communality and specialization are necessary, common ground builds on interactional rather than contributory expertise.

One can see, then, that Clark et al.'s work on common ground and Collins and Evans' categorization of expertise nicely complement each other. On the one hand Clarke's theory of common ground provides some depth to the discussion of different types of expertise given that, for example, Collins and Evans leave the idea of contributory expertise totally unpacked. On the other hand, the categorization of different types of expertise foregrounds the possibility that different grounding practices and tactics are in place when the degree of novelty of the task is particularly high, or when the speakers carry very heterogeneous expertise as in the case of *interdisciplinary* collaboration. In addition, attention to the status of the participants and their interests foregrounds the importance of professional identity and organizational hierarchy in building common ground. Differences in interests lead, in fact, to relational challenges and political behaviour that are not addressed in the theory of common ground. Whenever interests and the protection of disciplinary boundaries are taken into account, common ground ceases to look like the consensual collaborative attempt to develop shared understandings and becomes instead a subtle game of navigating between, and acknowledging the value of, ignorance and expertise.

## 3 METHODOLOGY

The research design sets up qualitative analysis of two explorative cases using a mixed method approach. The approach includes both within-case and cross-case analysis and aims at theorizing on common ground in interdisciplinary collaboration rather than engaging in theory testing (Eisenhardt, 1989; Yin, 2003). Because our aim is to engage in theorizing, we will organise the discussion of the two cases around conceptual arguments and interweave the empirical material from the two cases, rather than presenting them in a sequential manner.

*Sampling*: For the theoretical sampling (Glaser & Strauss, 1970) we have considered both similarity and variation to allow for cross-case analysis (Eisenhardt, 1989). Both cases deal with product development projects, in which experts of various fields collaborate. The specialization is such that it would take years for collaborators to develop in-depth knowledge of each others' fields of expertise. In both cases, dependency among collaborators is generally considered to be reciprocal, although it is at times perceived to be more of a sequential nature and one type of experts (i.e. sensor specialists, IT-specialists) are considered to be 'suppliers' of the others. This hierarchy is more formalized in the IT/insurance-case where the IT department is to support the insurance business. Cases differ further with regard to the degree of novelty and ambiguity to which the projects are exposed. In the biotechnology case, there is more novelty as a bioreactor of this type has never been produced before and involves many ambiguities in the interdependencies of work processes.

*Data collection and analysis*: For both cases, the data were collected through multiple data collection methods (Eisenhardt, 1989). In the first case we combined observation, ethnographic interviews (Spradley, 1979), semi structured interviews, and the

analysis of project documents and scientific papers produced during the initiative. After a round of initial interviews, one of the authors spent several days in each of the involved laboratories observing the daily routines of the project work. This author also attended most of the monthly project meetings (five were taped) and less formal gatherings. Interviews were repeated with all the project members 3 times throughout the entire process of the project and we conducted a total of 23 interviews. The analysis was conducted using practices of thematic analysis (Miles & Huberman, 1984). Two authors independently engaged in open coding (Glaser, 1998) and after identifying recurrent themes we compared notes, discussed possible meaning, and went back to the data.

For the second case, we combined data gained of semi structured interviews, site visits, and of project and communication documents. In total, we conducted 14 interviews both with IT analysts as with managers from the business line, each lasting from 45 minutes to an hour. All interviews were audio-taped and transcribed word-by-word. As a second source of data, we qualitatively analyzed the communication documents circulating between IT analysts and the business line (which included working reports, presentations, and the like). We were able to stick around the site of work of IT analysts during three days, joining them during coffee breaks and lunches. However, we did not have the chance to directly observe meetings or analyze email exchange and our considerations are, for these forms of communication, limited to the statements of the interviews. We analyzed data by coding the transcripts of the interviews first openly by adding tags with comments or categories to the single quotes of the interviewees and to the collected communication material. We used tables (Miles et al., 1984) to further structure coding categories.

### *3.1 Contexts of Study*

The first case involves the collaboration amongst an interdisciplinary group of scientists of a major university in the UK who aimed to develop a bioreactor for controlled stem cell growth. Using a purpose made integrated monitoring system and a complex experiment design, they set up to shed light on which parameters influence stem cell culture growth in view of generating reproducible, well-characterized ‘designer’ tissues that meet the strict regulatory criteria for future clinical applications. This endeavour required the integration of expertise of scientists from different at least five or six disciplinary backgrounds (from electronics to bio processing and proteomics. The core project team was composed of three subgroups - sensor specialists, electronics specialists, and bioengineers. They worked rather independently on subparts of the bioreactor (i.e. on the electronic board, the sensors, or on the experiments on stem cells) and met each month for the discussion of agreed milestones. In between these meetings, the group collaborated informally via email, phone calls, and mutual visits.

The second case deals with the collaboration between IT analysts and insurance specialists who are part of one of the world’s leading insurance companies, headquartered in Switzerland. The IT specialists develop IT applications and systems that support the typical insurance business workflows and processes such as compiling offers, managing customer information, consulting clients, calculating risks, verifying costumer claims, or analyzing and reporting financial numbers to the CFO. The projects are relatively complex because a new application has to be integrated into a thick web of existing applications. In addition, the information system has to cover the complexity of country specific laws,

detailed regulations, meticulously defined procedures, and processes. Most collaborations are initiated by the business line, whose insurance specialists contact the IT department with a request to support the automation of a business process by IT or to change existing IT systems. A considerable part of the project is dedicated to the joint definition and refinement of the request (e.g. workshops, interviews, elaboration of business concept, technical concept, scope contract) and is characterized by frequent interaction. During the development of the application, IT analysts more independently and interact bilaterally if questions arise. During the testing phase, communication between the business line and IT intensifies again to track and correct errors.

## 4 BUILDING COMMON GROUND

Consider the following extract from one of the meetings of the scientists' group. In a previous segment the sensors' expert agreed to 'go first' and turned up the computer and the projector. She is now partly turned towards a PowerPoint slide and partly towards the rest of the group:

Sensors' expert: Just to remind you, during our last meeting I found that there were three types of electrodes which would be potentially used for monitoring of the culture in the bioreactor, and it was agreed that one type of electrode would be useful for other experiments…The main criterion of selecting the sensor was their performance in the environment, which consisted of a high level of BSA. This graph clearly shows that the electrode with a negatively charged performed the best. Just to check the response of the electrodes and their sensitivity during measurement, an injection of an additional amount of ammonia ions was done and the electrodes were responding quite nicely.

So this was done for three electrodes… this type, or this type or this type …the ones on the market were PCB only, carboxyl only …and negatively charged domain only these were existing... Only one electrode survived this test, let's say, and for this one the PEB was covalently attached to the membrane – none of them well it was run for almost two weeks, so I don't know if…

Bioengineer and project leader: This is two weeks, right?

Sensors' expert: Yeah.

The extract is a typical example of the process of grounding. First of all, the speaker – as she is going first in this meeting - draws on linguistic co-presence by summarizing the current state of the last conversation and recalling the events so far (see the utterance: 'just to remind you'). She also reiterates some of the elements of the communal common ground, that is, the set of background facts and assumptions that the participants presupposed when they entered the common activity (see, for example, the use of the term 'BSA' for bovine serum albumin, a nutrient substance commonly used in cell and microbial culture) (Clark, 1996).

The segment also illustrates Clarke's two basic conversational grounding practices, namely presentation and acceptance (Clark et al., 1991: 129). In the presentation phase the sensors' expert presents an utterance for the group to consider. She assumes that someone in the group will give her the necessary confirmation that what she said was understood.

Such positive evidence is provided by the project leader in the next turn, which thus becomes the acceptance phase of the exchange. The response constitutes evidence of grounding in more than one way: first, the speaker initiates a relevant turn; second, the speaker confirms the understanding in that the utterance 'this is two weeks, right?' is not an authentic question as much an acknowledgement; third the speaker demonstrates continued attention, another typical form of positive evidence of grounding.

Finally, the vignette also reminds us that common ground is often achieved through the use of material referents and visual technologies (Bechky, 2003; Gergle, Kraut, & Fussell, 2004). In fact, the sensor expert is de facto speaking with the aid of the PowerPoint slide, which is silently but ostensibly doing some of the work of explaining.

Scenes like these were commonly observed in group meetings, informal gathering, and dyadic interactions across the two projects. In fact, in both our case studies common ground emerged as a central concern for the participants. The project leaders in the bioreactor group often brought up the issue during interviews and informal conversations among them and with the researchers. The issue was also constantly present to those involved in the IT activity. Consider for example the following comment from a senior insurance specialist who, during an interview, drew two intersecting circles on a piece of paper and outlined:

> "It is most important that the two sections are not completely disjoint. Intersections are needed and the IT analyst has to know something from the work of the insurance specialists and vice versa. If the knowledge and context are completely different, the translation work is huge. On the other hand, if the intersection is too large, one or the other is superfluous. (..) The intersection of the two understandings of the piece of information is thus relatively small and this is really the central point".

### *4.1 Building Common Ground as Learning*

One can observe that building common ground resembles to some extent the process of learning described by situated learning theories (Lave, 1988; Lave & Wenger, 1991; McLellan, 1995). Consider for example Figure 1. In the photo sequence we observe the sensor expert explaining to the biochemist how she calibrates the sensors before starting the experiment and how the sensors needs to be inserted into the bioreactor by pressing them through the rubber lid. The scene, which we cannot describe in details for lack of space, constitutes a clear example of instructional interaction, as suggested by the posture, language use, and use of artefacts. The sensors' expert (the researcher with purple gloves) shows how the procedure is done using a verbal commentary of what she does, a typical instructional technique. The other colleague observes attentively, asks questions, and then tries the manoeuvre by herself under the supervision of the expert colleague.

**Figure 1: Instructional Interaction in Cross-disciplinary Collaboration: the Sensor Expert Explaining to the Biochemist Requirements of how to Handle Sensors**

This way of building common ground was frequently observed or reported in both projects. The researchers in the scientific project made a special effort to spend sometime in each other lab to familiarize with each other's practices. In the insurance case, the IT experts were sent to the business line for internships. During two to four weeks, IT experts observed the insurance specialists doing their work and also took over parts of their work themselves. As one of our informants put it:

> "They might not be a 100% productive, but they see very specifically on what the business unit is working. There is something in this concreteness which is really a key success factor for the comprehension."

The IT specialists grasped not only some of the basics of the insurance business, but more importantly they gained a concrete impression of the working mode of the insurers and saw the tangible implications of the applications they were designing.

This form of developing common ground resembles the type of learning of apprentices, who becomes acquainted with the tasks, vocabulary, and organizing principles of the community through peripheral activities and observing. There is, however a substantial difference. This form of apprenticeship differs from the one described by Lave and Wenger (1991) as the aim here is not to become a 'legitimate peripheral participant' of the other community (whether the sensor makers or insurers) in view of gaining full mastery of the trade. While the process is similar, the practical logic is different. As pointed out by the senior insurer in the quote above, the goal here is to develop the sufficient interactional expertise to understand the dependencies of their work, without acquiring substantial expertise of the community of the insurers.

It is our claim that the process of developing common ground in cross-disciplinary conditions is characterized by some specific strategies and practices which differ from other contexts. This can be summarized by the idea that common ground levels off somewhere in-between not knowing enough and knowing too much. In order to comply with Clarke's principle of the least collaborative effort (the principle according to which participants try to minimize their collaborative effort) participants thus need to use specific micro strategies tailored to the specific situation. The main characteristic of these strategies and practices is that the effort is directed both at gaining shared understanding, articulating differences in knowing, and negotiating the mutual position and legitimacy of the knowledge claims. In interdisciplinary collaboration the challenge is that of developing both common (professional) and private grounds, so to speak; part of the effort is that of sanctioning and qualifying both what is known and what is not known, so that both expertise and ignorance enter the building of common ground.

### *4.2 Interactively Developing Interactional Common Ground*

The observations of our two case studies suggest that building common ground with an interactive, instead of contributory intent, focuses the effort in particular directions and issues. Three in particular emerged from our data: the need to develop a shared vocabulary; the need to learn how to ask questions; and the need to be able to identify dependencies and interactions. Although we do not claim that these three practices are sufficient to completely characterize the building of interactional common ground, we believe they constitute a useful starting point.

In the first place, interactional common ground is based on learning each other's language, becoming proficient in the reciprocal technical jargon, and developing a shared vocabulary. In one of our cases, for example, we observed several misunderstandings derived from the fact that IT analysts and insurance specialists "often use very different terms for expressing the same or (laughing) for something else" (*insurance specialist*) (cp. Bechky, 2003 on different use of terminologies). Isaac and Clarke (1987) suggest that knowledge of domain specific references (i.e., the capacity to mutual reference through proper names) is commonly used by expert to recognize their colleagues and distinguish them from non experts. The thick expert jargon and the use of technical terms thus make collaborators aware of a lack of common ground and invites repair actions. However, the efforts to repair the lack of jargon-based common ground differ substantially from what one would expect in a canonical learning situation. For example, during the conversation captured in Figure 1, the sensor expert used several times expressions such as 'all you need to know' and 'what matters' when explaining some of the things she was mentioning. The biochemist, in turn, candidly admitted later that 'she didn't understand all what the sensor expert did say', adding, however, that this 'didn't matter', as she got enough understanding to continue doing her own work.

A similar situation applies in the IT case. This clearly emerges from the following interview extract:

> "The people from the business side have very little time and want to be as little involved as necessary. So we have to come up with intelligent means of communication that allows each one of them to inform himself on a level of expertise and detail that is interesting to him. Or also, we ask how we can present complex issues in a simple manner and give the reader the possibility to deepen certain aspects." (*IT manager*)

The practices to develop common ground in cross-disciplinary situations thus provide ways for the others *not* to know and to inform themselves on a level of detail, which is suitable for them. In this vein, for example, the IT specialists proposes their technical concepts in hypertext structures that allow the reader to change the linear flow of the text, jump within the document and focus only on those aspects, which are most pertinent to him/her. In such flexible forms of communication, differences were valued and it was acknowledged that the one side of the knowledge boundary did not know exactly what aims or needs to be known a the other side.

One may add that because of the clear 'territorial' status of technical words (they clearly belong to a specific camp and they either need to be learned in order to collaborate, or they can be consensually left black boxed), it is the apparently more simple terms that are often the trickiest ones. In the IT project, for example, a common understanding of terms such as 'work steps', 'task', 'process' was often wrongly assumed. The misunderstandings was uncovered only much later in the process. In the words of one of our informants:

> "Over and over again, we were confronted with the fact that we had received an assignment from the business line and the IT-technician took it as such and started to process it the way he had understood it. He then tested it and sent it to the production. As a result, the people from the business line were exasperated: 'We want it this way only for this one particular case. For all the other cases, we want it completely differently.' We had too many misunderstandings". *(IT-expert on the development process of an IT application before larger process changes were introduced)*

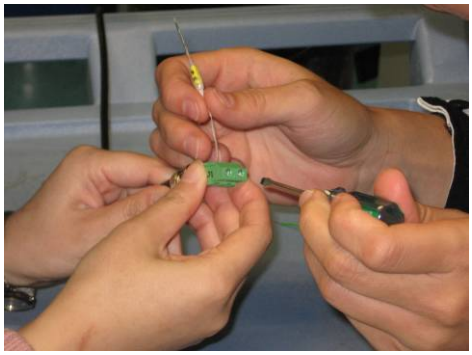
A second element of interactional common ground deals with learning enough of the other field in order to be able to *ask relevant questions*. In the extract above, the IT analysts realized that insurance specialists lacked the sufficient expertise to make meaningful questions across the knowledge boundary, and had difficulties in defining their needs, as exemplifies the following quote of an insurance specialist

> "Information is something, which I do not know yet. And frankly, how can I pose the right questions on something of which I do not know that it exists?"

From such experiences, IT-experts and insurance specialists changed the process through which the insurers from the business line convey their need to the IT analysts. Because insurance specialists lacked the interactional expertise to define their needs upfront in a standardized change request form, IT experts started a project with an elaborate process characterized by extensive face-to-face meetings and recurrently writing down tentative, yet binding shared understandings of the insurers' requirements. They organized, for example, a set of meetings, workshops, and conducted interviews with the insurance specialists at the beginning of a project. They then defined a first request in a written business concept, on which basis a first high level technical analysis is conduced by IT analysts. The business concept is then 'translated' in a technical concept, in which technical solutions and options are identified.

This leads us to the third and final critical aspect of interactional common ground which emerged from our two case studies. This has to do with learning to *recognize dependencies and interactions* and to see them 'from the other side', so to speak. A case in point is the major problems which emerged in the bioreactor project around the connectors between the sensor and the electronic module which registered and computed the bio-information. During one of the meetings the sensors' expert and one of the biochemists agreed that a 'clip' would be fitted to the end of the computer cables so that it could be connected to the sensors. However, as the electronic engineer at that point had no sufficient knowledge of the actual practice of connecting a clip with a sensor, he fitted the electronic unit with very robust cables and standard commercial plastic clips (see Figure 2) which he carefully choose according to the criteria relevant to his practice (reliability and durability of the materials). As it turned out, however, the cables clips were way too big for the sensors and ended up creating all sort of troubles to the experimenters. For example, the wires exiting from the sensors were way too thin for the connections. In several occasions the wires either snapped or the connection was faulty, thwarting experiments that took weeks to set up and that run for weeks at a time.

**Figure 2: Troubles at the Interface**



The case, which is commonly observed in situations where different forms of expertise meet, is exacerbated here by the fact that the project is highly experimental and hence it is not possible to build common ground on past experience or initial knowledge. The common ground is in fact a shifting ground. Building common ground in such situations thus requires a special effort of iteratively aligning understandings in face-to-face interactions and holding them down in variety of more stable artefacts. It also requires

continuously developing, testing, and redefining the presumed common ground. Sharing is no longer seen as a 'stable intersection', but an ongoing practice of assuming, challenging, and redefining a common understanding. In the case of the insurance specialists and IT analysts, for example, this meant developing the sufficient interactional expertise that allows them not for articulating a request upfront, but recognizing it when it gradually becomes visible (Weick, 1995). The interdependencies emerged only in the ongoing and reiterative process characterized by collaborative reflection in talk (i.e. meetings) and action (doing analysis, writing concepts) (Weick, 1995; Weick, Sutcliffe, & Obstfeld, 2005)..

### *4.3 Grounding by Positioning and Categorizing: Legitimating Ignorance*

One of most interesting evidences emerging from our two case studies is that in cross-disciplinary situations the development of common ground deals not only with the development and maintenance of shared practical understanding, but also with the relational quality of knowing. The relational aspect becomes evident, first, in how grounding practices both discursive and institutional practices of positioning expertise and legitimizing ignorance between collaboration partners.

Consider the following short exchange between the sensor's expert and another member of the bioreactor project derived from one of the project meetings:

| | |
|---|---|
| Bioengineer: | The one question I have for you is, let's say you did get contamination, did you see the ammonia increase at all? |
| Sensors' expert | Ammonia, but what do you mean? |
| Bioengineer: | They should start producing some ammonia because they're metabolizing. Did you see any? |

If you were a biochemistry of biology student and asked the same question as the sensors' expert, you'd likely fail the test. Novice biology researchers know, or should know, that production of ammonia is one sure sign of contamination. Yet, the question is not heard here as a lack of knowledge. The sensors' expert is in some way legitimated to be ignorant. We claim that the recognition of expertise goes hand in hand with the definition of 'legitimate ignorance' and is a critical resource in achieving common ground in cross-disciplinary situations. It requires an ongoing collective work of membership categorization (Fitzgerald & Housley, 2002) in terms of who should know what and who can be ignorant about what. This constitutes a critical, albeit rarely addressed part of the work of building common ground in interdisciplinary contexts. The construction of membership categorization in terms of specific knowledgeability is obtained as an in-situ achievement of the members practical actions, mostly in conversation. The observation of the first stages of the projects (or of the moments when new members joined the team) revealed that most of the discursive activity aimed at asking and answering questions (Berger & Bell, 1988). These questions helped participants, among others, to locate each other in the landscape of knowledgeability performed by the activity at hand. Introductionary questions such as about previous experiences, papers, and current projects, should thus be read not only in social and psychological terms, but also as a form of positioning which was clearly heard in

this way by the newcomers who used clear markers of mastery in their presentations such as 'I have experience of this and this but not really of that'.

Through these games of knowledge positioning participants thus establish provisional assumptions of each other expertise which necessarily also imply the symmetrical acceptance of ignorance. This processual and always provisional mutual attribution operates then as device which orients both the way in which utterances are heard and how the conversations flow. Just as legitimated novices are entitled to ask naïve questions, the sensor expert above is legitimated to ask a naïve question in virtue of her status. She is, so to speak, legitimately ignorant and legitimated to receive the minimum necessary information so that the collaborative conversation can proceed. Although the bioengineer does clear up the problem by explaining that 'they should start producing some ammonia because they're metabolizing', he does so without starting a side sequence (Jefferson, 1972), which is the canonical way of solving grounding problem. In so doing, he is doing three things at the same time: he strengthens the common ground, he reconfirms the division of knowledge within the group, and reaffirms the claim of specialized knowledge for himself, his group and his discipline.

Ignorance was not only discursively, but also institutionally legitimized. In the IT case, for example, 'middlemen' or boundary-spanners (Levina & Vaast, 2005) were installed to coordinate the work of IT experts and insurance specialists. Such middlemen were the "business support", a group of 'interactive specialists' who backed both the insurance specialists and the IT-people in their IT-application projects. They had a duplex qualification in both insurance and IT (either in training or professional expertise). While they served as translators and transformers between the IT experts and insurance specialists, their function also legitimized that the IT specialists were and continued to be ignorant about the insurance business and the insurance specialists scarcely knowledgeable about IT. Of course, this situation can be a double edged sword as the middlemen's presence lead the two parties to be reluctant to develop common ground and prevents innovation opportunities which emerge from 'creative abrasion' among different bodies of knowledge (Leonard-Barton, 1995).

Finally, the legitimization of ignorance and the discursive and institutional negotiation of a specific division of knowledgeability go hand in hand with the attribution of contributory expectations. The division of expertise becomes a moral order in that the reciprocal acknowledgement of ignorance implies the acceptance of a form of mutual dependence. Attributing mastery and refraining from developing common ground in cross disciplinary situation rises the expectation that those who claimed and were granted control of a specific area of expertise will then deliver. This is a crucial aspect of collaboration in that the lack of common ground also implies the lack of criteria for judging the source of other people's difficulties or failures. The flip side of this state of affairs is that the unfulfillment of task expectation can be easily (mis)understood as the breach of a moral obligation. Both in the IT and science projects problems with the delivery of expected results were quickly framed in moral and judgmental terms. In the science project, for example, the difficulties of developing a sensor which would withstand the severe environment in which it was used (sensors are usually immersed in a substance for a few seconds or minutes, not left there for weeks) were discussed by the other groups either as moral failures (they are not working hard enough) or in terms of lack of capability (they do not know what they are doing). This had serious consequences in that a new sensor expert

was brought aboard, with the imaginable consequences on the group dynamics. Interestingly enough, when asked about these difficulties, the sensor expert stated that the other groups had severely underestimated the difficulties of her work saying the 'they think a sensor is just a wire…what it would take to make a wire…'

In sum, in conditions of cross disciplinary collaboration, establishing the social division of knowing is critical in establishing common ground in at least two ways: it helps making inferences on the nature of ignorance; and it helps people accept the mutual dependency that is inherent in collaborating with people whose capability we are unable to judge. It is in this sense that trust, understood as a form of calculated bet on someone else's capabilities, is a fundamental lubricant of cross-disciplinary collaboration.

### *4.4 Building on Personal and Institutional Common Ground*

The evidence derived from our case studies help qualifying another fundamental aspect of how common ground is developing in interdisciplinary collaboration: in view of the sparse communal common ground in terms of belonging to the same community of practice, collaborators increasingly build on personal and institutional common ground.

As we indicated above, Clark (1996) makes a conceptual distinction between communal and personal ground, which he regards as different resources for reaching agreement and common ground. While *communal common ground* is something that rests largely on community co-membership, *personal common ground* is based on 'joint perceptual experiences' and 'joint actions' (Clark, 1996: 112), which include gesticulation, observed actions, and other features of the social setting in addition to talk. According to Clark (1996) both types of ground are mobilized in the attempt to build common ground, so that at any point in time common ground is a combination of different 'strata' of the two (p. 119). Moreover, to some extent the two are substitutable – for some practical purposes one can substitute personal for communal ground and vice versa.

In our cases on interdisciplinary collaboration, communal common ground in terms of belonging to the same community of practice was sparse. Because of this lack, grounding efforts often relied on a personal dimension. Consider, for example, the following comments by one of the IT experts:

> "The most critical issue is to develop an amicable relation with the person to whom you would like to convey some knowledge. In workflow projects, for example, one steps in the garden of the insurers. There, many fears are present and we have to convey that we don't want to take away anything from them, that we only want to help them to do their work quicker and more effectively. But, see, there we already have to be cautious because implicitly we say that, today, they don't do it quick and effective enough. It's really about mutual respect. You have to talk on the same level, not from top to down or specialist to non-specialist. We thus always have to nurture a good relationship, personally and professionally. "

Because collaborating across disciplines always requires dealing with the existing topology of legitimate knowledgeability and ignorance, the calculated bet on someone else's capabilities cannot be made without a well-working personal relationship. IT experts have to build on personal common ground with insurance specialists as the latter are not experts on IT and so have to trust that the implications of the new or changed IT

applications will not threaten their current ways of knowing and doing. The only basis on which to build such trust was personal, not communal common ground.

The above quote further suggests that the role of personal common ground is particularly important also because the boundaries with which IT-analysts and insurance specialists have to deal are not only semantic (differences in understandings and perspectives), but also pragmatic or political (differences in interests) (Carlile, 2004). Thus, grounding activities have to deal not only with developing a mutual understanding, but also with envisioning what was 'at stake' and what were the implications of the differences of knowing in practice.

To the extent that building common ground requires negotiating the space between expertise and ignorance, the experts in both case studies needed some additional markers which help them to participate in the same enterprise without sharing a communal ground in terms of belonging to the same community of practice. We suggest that these makers are provided, at least in part, by institutions. Institutional classification, such as the attribution of titles and professional recognitions, is an additional mechanism to legitimise experts vis-à-vis non experts. Institutional categorizations are, among other things, devices for establishing the reciprocal level of expertise and, in turn, orient the interaction among speakers. Institutional markers prevent people to misinterpret the type of ignorance, for example treating a peer who is versed in a different expertise as a novice. It is for this reason that our informant above insisted that "it's really about mutual respect. You have to talk on the same level, not from top to down or specialist to non-specialist". Institutional common ground is thus a very specific form of communal common ground and can grant the status of legitimate ignorant, a status that differs substantially from both that of legitimate peripheral participant (Lave et al., 1991) in that it divorces authority from knowledge, granting the right to be treated as peer from a position of ignorance. In cross-boundary situations the challenge is to deal with the fact that authority may be associated both with legitimate ignorance as well as legitimate mastery. In this sense, as we argue below, building common ground in cross disciplinary situations is a political effort through and through

### *4.5 Grounding as a Political Process, not a State*

As it emerges from our discussion and example above, building common ground in condition of cross-disciplinary collaboration is not the creation of a stock of common knowledge or a type of substance that is possessed by those involved. Asserting that the participants in a common endeavour share knowledge or 'have' common ground is misleading, in that common ground is not a place where things are stored or something that can be possessed. In a similar way, Clark's idea that idea that common ground accumulates during an activity (Clark, 1996: 44-48) is misleading and potentially counterproductive. Building common ground is in fact a continuous and precarious process, a type of work which builds on a variety of resource used strategically by participants. Common ground is thus contingently achieved and necessarily provisional. Above all, the process is inherently political.

In the bioreactor case, for example, the political dimension of attribution of ignorance and expertise emerged during the turmoil around the failure of the sensors' group to deliver

results in line with the needs and expectations of the other groups. Two of the senior researchers (who happened to be good friends) met separately and agreed a variety of strategies to put pressure on the sensor groups but only initially from the outside, as they described it ('We need to press them to deliver but we need to do it from the outside…', *senior bioengineer*). As they put it, they were all too aware that putting too much pressure would be heard as judgment of incompetence and would constitute a breach of the agreed domain of discretionality granted to the other group ('you cannot enter other people's expertise because then they become really cross', *senior bioengineer*). This was confirmed in some of the meetings when the senior sensor researcher, invited to discuss the matter, repeatedly assured others that he would take care of things, de facto cautioning others from entering his own turf. As mentioned above, the issue was later solved by reinforcing the sensors' team, a solution which was politically satisfactory in that it promised to solve the extant practical problems without destabilizing the project politics. From this example one can see then the mutual positioning within the field of expertise and ignorance constitutes thus also a pattern of reciprocal empowerment. Such pattern is carefully negotiated in the early stages of any cross disciplinary effort; the reciprocal attribution of legitimate expertise and ignorance are subsequently subject to monitoring and can be withdrawn or changed when the necessary conditions apply. In this sense, the change of initial condition of the opening of new possibilities does not constitute an occasion of accruing common ground as much as an opportunity for its re-negotiation.

## 5 CONCLUDING REMARKS

This paper examined the phenomenon of interdisciplinary collaboration to critically appraise the widespread idea that working together requires the integration of knowledge and that collaboration requires some form of 'sharing'. We argued that these ideas are problematic especially in the context of cross-disciplinary collaborations. The idea of sharing fails in fact to take into account that finding ways of collaborating is a dynamic process and that in conditions of cross-disciplinary collaboration participants mainly strive to gain what we described as interactive expertise. While the process shares some similarities with learning through apprenticeship and legitimate peripheral participation, it differs substantially in that the participants are not interested in becoming proficient in each other field of expertise so that common ground levels off somewhere in-between not knowing enough and knowing too much. Building common ground with a view of acquiring interactive expertise focuses in particular on the effort to develop a shared vocabulary, learn how to ask questions, and identify dependencies and interactions. We suggested that, in turn, this process has a marked moral and political dimension in that establishing common ground requires legitimating ignorance and hence establishing a patter of mutual expectations and obligations. Building common ground is in turn a process of negotiation through which knowledgeability and ignorance are legitimately imputed; claims of control of specialized knowledge are made, tested and defended; personal and group reputation are put at stake. Conflict is thus never far away so that common ground can hardly be considered a stable state and should be instead always conceived as a provisional and ephemeral compromise achieved through a variety of in situ practices that constitutes one of the critical aspect of the work of collaborating. Although our study is of limited scope and will require further development, we believe it goes some way to demonstrate that much is to be gained if we substitute the idea that sharing is a premise of

collaboration with the more processual view of common grounding as a continuous process of both developing common knowledge *and* dissecting differences, affirming one's own expertise and admitting ignorance, confirming *and* questioning legitimacy of experts.

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