INTERACTING AND INTERRELATING IN PROJECTS - EXPLORING THE INDIVIDUAL-COLLECTIVE DYNAMIC IN TEAMWORK

Cecilia Frohm[a]
Lars Lindkvist[b]
Fredrik Tell[c]

[a,b,c]Department of Management and Economics,
Linköping University, Sweden
[a] cecfr@eki.liu.se
[b] larli@eki.liu.se
[c] frete@eki.liu.se

Session A-7

Abstract

Skilful planning and the reliance on frequent face-to-face interaction is often emphasised as preconditions for successful project work in literature on project management and product development. Our case study observations of a project involving the development of a new stacker, however, contrast with such a view. Here, most project work was carried out individually and as a matter of routine, complemented by interactive instances, such as project meetings and ad hoc problem solving interaction. Moreover, instead of a shared project goal or a shared knowledge base, the material stacker stood out as an artefact of great significance in achieving activity and knowledge coordination. Inspired by literature on sense-making, we propose a simplified model of the individual-collective dynamic in such contexts, and differentiate between processes of interacting and interrelating. Finally we discuss its coordination properties as a matter of cognitive feasibility and economizing on cost.

Keywords: project, teamwork, sense-making, coordination, distributed knowledge.

Interacting and Interrelating in Projects
- exploring the individual-collective dynamic in teamwork

Cecilia Frohm[a]
Lars Lindkvist [a]
Fredrik Tell [a]

[a] Department of Management and Economics
Linköping University, Sweden
cecfr@eki.liu.se
larli@eki.liu.se
frete@eki.liu.se

Abstract

Skilful planning and the reliance on frequent face-to-face interaction is often emphasised as preconditions for successful project work in literature on project management and product development. Our case study observations of a project involving the development of a new stacker, however, contrast with such a view. Here, most project work was carried out individually and as a matter of routine, complemented by interactive instances, such as project meetings and ad hoc problem solving interaction. Moreover, instead of a shared project goal or a shared knowledge base, the material stacker stood out as an artefact of great significance in achieving activity and knowledge coordination. Inspired by literature on sense-making, we propose a simplified model of the individual-collective dynamic in such contexts, and differentiate between processes of interacting and interrelating. Finally we discuss its coordination properties as a matter of cognitive feasibility and economizing on cost.

Keywords: project, teamwork, sense-making, coordination, distributed knowledge

Suggested track: A Managing organizational knowledge and competence

1 Introduction

1.1 The case story problematic

This article takes an empirical point of departure in an in-depth study of a project that was set the task to develop a new stacker (Frohm, 2002). The study lasted one year, covering the project's entering into the development phase until its completion. The project comprised a project leader and twelve team members with different functional backgrounds. Generally the project turned out to be a successful one. Our observations of how such competent concerted action was brought about were

however quite puzzling – fitting squarely neither with images of project work as a matter of close, preferable face-to-face based, teamwork, often encountered in the project management and product development literature, nor with the emphasis in project management literature on the importance of shared goals and careful planning.

First, many project members opined that most project work was actually done individually and as a matter of "routine", with little or no contact between project meetings. The routine character of project work, however, was not so much a matter of adhering to formal, organizational routines, but rather the application of their own idiosyncratic, individual routines. Certainly, although not very frequently, project members also interacted with others in ad hoc problem-solving, and in such cases they usually encountered only one of their "neighbours". Unsurprisingly, in the light of the discussion above, quite a few felt there was actually no project group or team at all. In sharp contrast, however, some of the interviewed were almost euphoric in celebrating the very good "team spirit" and "project culture" prevailing in this project.

Second, although the project goal was specified in fairly detailed technical terms, project members' accounts of this goal were quite vague. While clearly admitting this, stressing that clear goals was a *sine qua non* in project work, no one said s/he liked to see greater clarity as to the project's goal. However, many of them simultaneously maintained that there was a "consensus" among participants about what to achieve. The status of the specified goal as a "shared" goal is thus being compromised, raising a question as to its coordinative role and we need to consider what else that is shared that may have a coordinative power.

Third, most of them thought of project meetings as a means of "control", where project members' responsibilities were publicly expressed and where their reports of progress, delays, and so forth were issued to the project leader. When discussions and communicative interactions did take place, decisions were seldom taken. Instead their impression was that the same problems re-entered the scene over and over again, and many actually found the meetings quite boring. While most were appreciative of these meetings, their significance as an arena for generating a shared knowledge base or the like was not noticed by any of them.

If this project had become a failure, several explanations might have been put forward, e.g. the lack of teamwork, the lack of a shared goal and lack of shared knowledge

base. However, rather the opposite is true. The product developed exceeded the most optimistic sales scenario. After completion, project members were very satisfied with the way in which project work had been undertaken, arguing that it was the best project they had ever participated in, with good relations between project members from different departments. However, none of them could really understand why it worked so well.

At the background of this scenario this paper explores the issue of how activity and knowledge integration was achieved. The explanatory framework suggested portrays this problematic as a matter of coordination in the context of individualized or distributed knowledge. In conceptualising the implied individual-collective dynamic, we rely on literature about sense-making processes and mechanisms of knowledge integration. Below, we start by noticing the emphasis on planning and close face-to-face interaction, advocated in much literature on project management and product development, and continue with outlining some basic features of the framework we wish to develop in this paper.

1.2. Outline of framework and interpretation

Firms operating within dynamic industries, characterized by fast changes in customer preferences and/or technology, appear to increasingly organize their developmental activities in projects. To stay competitive in such pace-rewarding competition, firms use project groups hoping to bring about fast and focused product development effort (Hobday, 2000; Lindkvist et al, 1998; Lindkvist, 2004). In the vast normative literature on project management, the message is that great care should be taken to clearly specify project goals, engage extensively in planning, make up a well-specified schedule and clear work breakdown structure and the like. (see e.g. PMI, 1996; Lock, 1996). While many have heavily criticized the overly rationalistic view presented in that planning-oriented literature, arguing that it underestimates uncertainties and politicking (see e.g. Lundin & Söderholm, 1995; Engwall, 1995; Sahlin-Andersson 1996; Lindkvist & Söderlund, 2002) little effort has however been devoted to developing alternative concepts of what processes are going on in projects and what means and mechanisms may be used in bringing about competent concerted action.

Similarly, in literature about product development, successful performance is often associated with promoting direct and extensive communication between members from different functions. This is clearly spelled out for example in the vast literature dealing

with simultaneous engineering (Eisenhardt & Tabrizi, 1995) and in the Nonaka & Takeuchi (1995) "rugby approach", under which "the product development process emerges from the constant interaction of a multidisciplinary team whose members work together from start to finish" (p. 242). As discussed in Allen (1977) co-location is a highly efficient way of promoting communication among engineers. In the more general literature on teams it is often suggested that in order to have a "high-performing team" (Katzenbach & Smith, 1993), its members should cooperate closely. What distinguishes such a team from just a "real team", is that members are not only "equally committed to a common purpose, goals and a working approach for which they hold themselves mutually accountable", but also "deeply committed to one another's personal growth and success" (op cit).

The image of project or product development work promoted in the above literature is thus one of good performance resulting either from skilful planning apriori or from relying on a tightly knit and more or less constantly interacting team. Neither of these explanations seems fitting in the context of our case study observations. In our analysis we acknowledge that those involved were certainly working very much alone, but they were simultaneously involved in a "social practice" (Weick, 1995; Weick & Roberts, 1993). While conceiving themselves as working in solitude (which they were in a physical sense), project members were in effect also working as members within a communal project. Inspired by the literature on sense-making, we also present a simplified model of the individual-collective dynamic in such contexts. Basically, this models differentiates between processes of "interacting", taking place in meetings and other collective settings, and processes of "interrelating", referring to situations wherein individuals carry out work separated from other project members.

We then penetrate the coordination properties of this model, using the two criteria of "cognitive feasibility" and "comparative cost" (Grandori, 2001). Based on an analysis of the degree of knowledge differentiation, knowledge complexity and conflict of interest involved in this project context, we here discuss the model's feasibility properties, in terms of what mix of integration mechanism it allows for. We also briefly comment on the model's economizing properties, noticing its way of relying only limitedly on expensive integration mechanisms. We argue that experience accumulation through routines and knowledge articulation can be feasible integration mechanisms in projects characterised by distributed knowledge (cf. Tsoukas, 1996; Prencipe & Tell, 2001; Zollo & Winter, 2002). The oscillation between instances of interacting and interrelating

enables such relatively inexpensive mechanisms, substituting the more expensive forms of codified rules and face to face interactions (Grant, 1996).

2 Method

The empirical basis for this paper is a qualitative case study of a development project aimed at developing a new stacker. The empirical material was collected during one year, from the project's entering into the development phase until its completion (Frohm, 2002). In case-based research, the choice of empirical case is a crucial one. According to Merriam (1994), the process of choosing the case is one of finding a case that is relevant as an example of the phenomenon the researcher is interested in. Another criterion is to find a case enabling good access over an extended period of time. When starting the collection of empirical data, unstructured interviews were undertaken with the project manager and the managing director of the development department respectively, in order to grasp the general background of the project and its context. Moreover, semi-structured interviews (Merriam, 1994) were undertaken with all project members including the project manager.

In addition, being present at project meetings allowed us to follow the project during an extended period of time and to observe action when it happened and provided insight into the situated character of interaction (Silverman, 1993). In total, twelve project meetings lasting for approximately 1.5 hours each and two design meetings, where design engineers met with the representative of the manufacturing department to discuss design solutions, were attended. Both interviews and the dialogues of project meetings were tape-recorded and transcribed in order to facilitate analysis. Besides interviews and observations, we also had access to internal documents of relevance to our case, e.g. project manuals.

3 The Stacker Case

ProLift is engaged in the manufacturing and development of warehouse trucks, being one of the leading actors of the industry worldwide. ProLift's sales approximate 1.2 billion USD a year and the company employs about 8000 persons in more than 70 countries. Our case study was undertaken at ProLift's development department, which is located at the company headquarter in Sweden.

Development activities are undertaken in two kinds of projects, module projects based on more advanced knowledge and technology and aimed at developing new parts that can be used when up-grading existing, or developing new, warehouse trucks. On the other hand, development projects are aimed at developing the mechanical design of the products, thus, the development project studied involves incremental rather than radical innovation. The development of warehouse trucks is handled in projects of recurrent nature, the average project lasting for approximately one year.

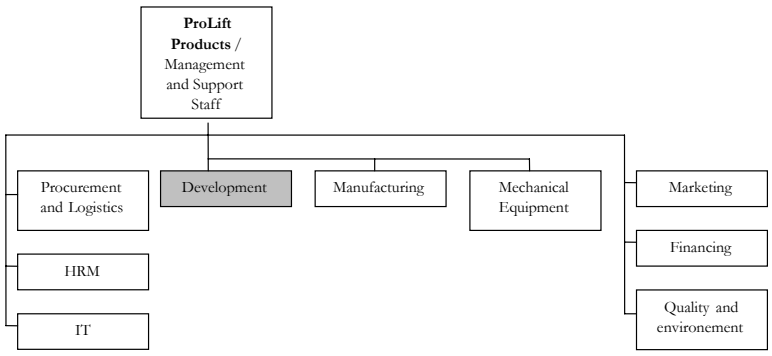

Fig.1. ProLift's organisation.

3.1 The project setting

3.1.1 The project organization

The development of a new stacker (one of several types of warehouse trucks), which was the aim of the project studied, was a venture involving a team comprising a project manager and twelve project members representing different competences. Project members, who were located at different functional departments throughout the organisation during project work, were selected from different sub-groups within the development department as well as from the IT, Manufacturing, Marketing and Quality & Environment departments respectively. Thus, project members' educational backgrounds as well as working experiences differed rather significantly. While some project members had university degrees, others had no formal education at all and while some had a long experience of working at ProLift, others were newly employed or consultants hired specifically for this project (see below). Most project members were only working part-time in the project.

The project team was free to choose technical solutions, while a steering committee comprised of top managers from different parts of the organisation defined the constraints in terms of time and budget. The project was organised around frequently occurring project meetings where all project members could discuss issues related to

project work. At these meetings, all project members were present, even those whose actual work did not occur until later in the project.

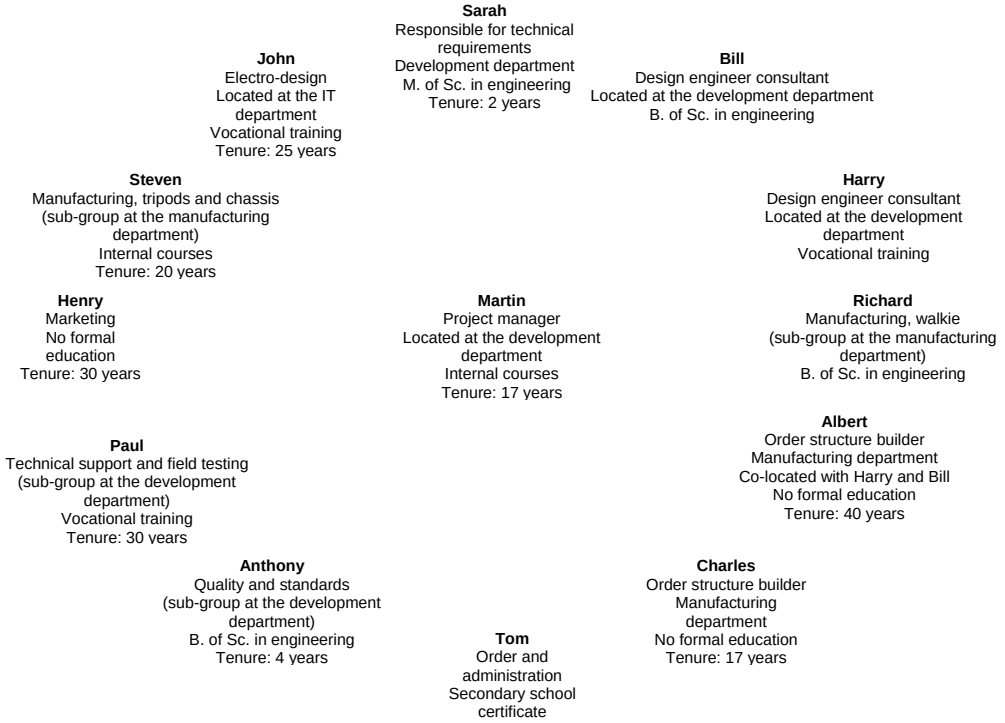

Fig. 2. The project team as comprised of team members representing different functional departments and competences.

3.1.2 The project goals

When entering the development phase the project goals were stated in a project specification, explaining in rather detailed technical terms the expected outcome of the project. From now on this goal must not be changed without the permission of the ProLift Product Council. The project leader provides his view about these goals as follows:

> The most important thing in order to reach a target is, first of all, that everybody agrees upon it. (Martin)

This is the reason why he always starts the development phase of every new project with an extended meeting lasting for a couple of days. He describes this meeting as one of “brainstorming and yellow notes” and adds that this time it was “very successful”. One might then expect that those individuals involved think there is a truly shared goal.

When interviewing project members, most of them underline the importance of a clear and shared goal and they all think there was a consensus with regard to the target in this case. However, when asked to recollect the goal/s they feel somewhat awkward and their accounts appear quite vague, as exemplified by the statements of Richard, Albert and Tom.

> … not very informed what the target is … but I suppose that the target is to get a better, more adaptable stacker and that we will be able to get a small pay-off from it. (Richard)

> I don't think that has ever been said ... that that is what we are supposed to do. Or maybe it has … but it is not very clear, It's more that we have to develop a stacker but it seems to be negotiable sometimes, different functionalities and so on … but is specified it is … I believe it is quite clear. (Albert)

> To make a stacker that satisfies the market so that our customers keep on buying, and we can produce and sell. (Tom)

There was some confusion with regard to the goals and project members readily admitted their difficulties when asked to describe the goals in more detail. Despite this, nobody was worried about it and no one said there was a need for increased clearness of goals or the like. Judging from the above quotes what was shared in members' perceptions of the project goals was that they should develop a "better stacker".

3.2 Project work

3.2.1. Distributed competences

Formally the project team comprised a certain number of members assigned to reach the project goals. With Albert being the only exception, project members stayed at their functional departments where they were located throughout the project, except when they attended meetings or approached others in trying to solve problems that had emerged. However, the project leader, the person responsible for technical requirements, the two design engineers, and one of the order-structure builders, were placed in close proximity in the same office building. The responsible for technical

requirements, together with the design engineer consultants constituted an important sub-group, comprising the technical core of the project. However, this does not mean that the project was run in a top-down fashion. Market and manufacturing considerations were often vital, and as frequently emphasized, the project was likely to fail if any of the members did not do his/her job.

> Probably you would get problems whoever you disregarded. (Richard)

Thus, most project members had different functional backgrounds, but the overlap in competences between Sarah and the other in the technical core was no doubt far greater than between them and people from the marketing department, order and administration and other non-technical departments. Differences in professional-educational-departmental background, however, say little about how task-relevant competences overlap. Many project participants, like the project leader, had a long experience from working at different departments within the company, and to a fairly great extent, those with long tenure and experience were autodidacts, not paying too much attention to formal devices such as documented routines or procedures. As a result, in this project context much knowledge is gained as experiential knowledge, and stays quite tacit and individual to its character. Charles exemplifies this;

> I have been working in project more or less the whole time. They have grown bigger, more people are involved and they have become a bit more organised than they were before, since I have been along for such a long time. Everybody knows…you have that book to follow and you know better what to do…Well, even if I don't know what's in it. But I know by experience what has to be done. (Charles)

Taking into account that the project did not require such a high level of technical knowledge, and that some project members had considerable experience of new stacker development, then promotes the picture of generally fairly good possibilities for interpersonal and interdepartmental communication and the development of a shared knowledge. However, it is one thing to be able to achieve this, but quite another to actually engage in such activity. In this project, members in the core group would no doubt have developed some degree of shared knowledge, for the others it was deemed sufficient to be informed of what others are doing.

> Each and every one knows what they are doing …So it is not important to know the same thing, … you must know what you are doing and then, the other things, are more like information. (Harry)

Knowledge is thus distributed, not because it would be impossible in principle to erect a strong basis of shared knowledge, but because other mechanisms are preferably relied on.

3.2.2. Individual routine work

While certainly no one expressed any need to distance themselves from the project, their sense of being part of a team varied significantly. Some, like Albert and Paul, were highly appreciative, pointing at the possibilities of being able to get help in case of problems, to provide room for discussion and so forth.

> What I feel most is that it is a team that is working. … I felt that you worked together for something. Nice atmosphere. Everybody supported each other and so on. That's what I believe is the biggest difference, that you work in a team and it's fun to work in a team. (Paul)

However, other members' opinions were in sharp contrast. Like Tom and Steven who recognised little team spirit and emphasised that this was not a project characterised by close cooperation.

> Team … I have the impression that everybody works at his place. You work a little with everybody but most of all you work by yourself … and then together with your little group [at the department] and then you just go down [to project meetings] and give a report of what you have. […] Everybody knows that they are members of the project but that's it. You go on as usual because you know that this is only for a limited period of time and … then it's gone". (Tom)

> Well everybody … you're expected to take care of the task you have been allocated and I think they all do that. Nothing much happens between meetings. They drive their race, the participants. (Steven)

Moreover, as noticed by Richard, you not only work alone most of the time but most work is also seen as routine work. It is not however, a matter of following the

organizational routines, encoded in the Project Management Manual. Instead, routine work signifies the “automatic” way in which individuals carry out their everyday work guided by their knowledge and experience within a specific area. The prevailing pattern of individual routines is thus very much something that has evolved over time without being promoted by conscious design.

> I think that everyone has a well-defined task and it’s not by chance that it looks the way it does but an inhabituated pattern. (Richard)

Somewhat surprisingly, people do not seem to think much about coordination in their daily work. Even when they are de facto engaged in matters that involve interdependencies, work is still very much thought of as quite simple routine. This may be exemplified by the Engineering Change Order (ECO) procedure, where suggested changes are represented in drawings etc., which are distributed to all interdependent units.

> For me there is nothing difficult. I just draw and get things together as soon as possible. (Bill)

3.2.3. Interactive problem-solving

Although the great emphasis which members put on project work as individual, routine work, there were certainly also occasions where members met in face-to-face interaction and communication. When unexpected problems turned up, project members approached others to discuss and sort out what might be done about them. People then talked to their fellow team members, most often those being directly influenced by their work, i.e. their “neighbours” as they suggested. Very often only two people engaged in such problem-solving as illustrated below.

> I had a problem with the hydraulics and electronic things and then I went down to him [John] and we discussed how we would be able to do it in order to get a simple drawing of the cables and assemble it. And then I made an outline to him and he drew the wires and I made it in the CAD and then we got it pretty well together. (Bill)

Sometimes several project members were involved. What often happened in this discussion was that participants went back to the older versions and drawings of warehouse trucks to find clues of how to deal with new problems. In a discussion

between Martin, Sarah, Harry, Richard and Henry regarding problems with the emergency stop button Sarah's explanation has such grounding.

> I had a look at the old machine, what it looked like today and the reason why ... (Sarah)

But obviously often the recollection of previous stacker solutions can be more limiting than enlightening. Bill, who declares that he is often using drawings of predecessor stackers, to get a picture of what is expected of him, notices that this may not always work very well.

> Because that's difficult, I don't always know…. Because you use the old stacker very much and then you don't always know what the new one looks like. That's a problem. Because you don't know everything about stackers, then you go and have a look at old drawings and you look at the structure of the drawing and then it turns out that it doesn't fit with the one we have made and they come and ask you things: "Should it really look like this?" (Bill)

3.2.4. Informative meetings

Project meetings constitute the only arena where all project members meet face-to-face at the same time. Project meetings are often described as instruments of control, where the project manager, being in chair, compares results and outcomes to planned actions and makes a note whether accomplished or not, before he passes around the table and lets everyone talk about their accomplishments and problems.

> Project meetings can be of different types but most often it's just a kind of report-giving, status. It's an instrument of control of the project. To see if it follows the plans and there are some decisions which cannot be taken if the project manager is not present. (Martin)

Many project members complain that those meetings are both boring and too time-consuming. Moreover, they say, decisions are seldom taken but the same issues are brought up over and over again. Yet many of them acknowledge their importance to project work. Information about project progress and other project members' undertakings is shared, providing a picture of "what is going on".

> They [the meetings] are of great importance. Otherwise we would never meet. … would not have a clue what is going on … (Sarah)

> Otherwise [if I hadn't attended project meetings] I may do something that is supposed to be done but maybe it should not have been done that way. Then I have to remake part of it. (Charles)

Project members use the information given at project meetings to reflect upon their own role and undertakings and how it relates to what their fellow team members are doing. At project meetings, project members get a kind of shared experience of the situation at hand and problems encountered. However, as illustrated in the quotation below, this has not to do with establishing a shared knowledge base, rather participants only seek for clues that are relevant for their own work.

> There is often somebody who has thought a bit and then you sit down to discuss in the team. Somebody says something and someone else says something else and you think AHA! That has to be done!" (Harry)

> … you discuss and maybe you get an idea from somebody … what to look for. (Albert)

These meetings are however less of an arena for problem-solving. As already illustrated, problems are typically solved individually, in dyads or in smaller group interaction. Instead meetings provide project members with news or ideas, or simply the information of who to ask if a certain type of problems appear.

> … more to know about the problem. And if you do some part that is related to that … then you start thinking. (Bill).

> I know who to ask if I have a problem. (Albert)

4. Concluding discussion

4.1. Lonely teamworkers?

A striking feature of the Stacker project is the almost unanimous view that most work is carried out by lonely individuals – and as a matter of routine. Morever, the perception of the routine character of work does not refer to it being guided by encoded

organizational routines, instead members think of them as individually held and routine ways of working. Then, how may we think of those involved as a cooperating team, able to successfully develop a new stacker as a communal outcome? How can we conceive of their activities and individual knowledge bases as integrated or coordinated?

Generally we may think of such a project as an undeveloped group with a developed mind as suggested by Weick & Roberts (1993). Instead of constituting a well-developed group in the classical sense, operating on the basis of a strong cognitive and emotional unity, we may think of the group in terms of "well-connected" individuals. Collective competence in such a group is then reached in a self-organizing fashion, provided that its members hold a representation of the social field, what others know and how their activities may be interrelated. However, in our case it is not evident what these representations are, or what the important preconditions or mechanisms for generating them are.

4.2. Shared goal, shared knowledge?

Despite the fact that there was a rather clearly stated goal set a priori and despite the project leader's view of the importance of having a shared goal, most project members could not give a clear account of the project's goal and some noticed there seemed to be space left for "negotiations" as to what functionalities was targeted. While they all thought it was important to have a shared goal, no one said they wanted to see efforts to clarify goals. There are some indications that they thought other members had a more clear view of goals, but for themselves as individual members they were quite content by knowing that they were going to build "a better stacker". As a result it is hardly possible to attach very much weight to the establishment of "shared goal/s" as an activity and knowledge integrating force.

Neither is it easy to find any more energetic attempts at generating a shared knowledge base, facilitating activity coordination. Certainly, the various instances of ad hoc problem-solving did result in some "interface learning" among specialists, but those interviewed did not point to this as a very significant way of generating shared knowledge. Meetings may also constitute important arenas for generating consensus on vital matters among various specialists. In this case, however, meetings were more a matter of reporting on project progress, delays, problems encountered, etc. amounting to an exposition of experiences rather than as a means to reach communal

understandings. As suggested earlier, due to the relatively low level of technical knowledge, much more of this could have been achieved, but as it seems, this would have come at too high a cost. Such a coordination cost interpretation resonates with the idea in Weick (1995) that “shared meaning is not what is crucial for collective action, but rather it is the experience of the collective action that is shared”.

4.3. Shared artefacts?

Project members often refer to the circumstance that they “know by experience what has to be done”. Sometimes this is a statement about their repeated experience of carrying out their own task in previous development projects and sometimes it refers to “inhabituated patterns” of their interaction. Some project members have been around for a long time and know several of their fellow team members as well as people outside the project, as to what are their roles and experiences. For them, knowledge of specific persons and the general social context provides with important material for forming representations, from which they are able to contribute individually and often quite routinely. However, when we look at those individuals constituting the technical core, we notice that Sarah, assigned with overall technical responsibility, has only been there for two years, that the two design engineers are in-sourced consultants, and that Richard, main responsible for the links to production, has recently finished his university studies. This is not to say that for the core sub-group in the project, their knowledge of other members and the general social context is a completely insignificant factor in shaping their representations. Rather, we suggest, this is far from the whole story.

In our interpretation, the Stacker itself may be seen as a powerful actor in this context. Members repeatedly maintain that they “know what a stacker is” and they often “go back” to drawings of older versions of stackers when problems appear. As it seems it is also their profound knowledge about what a stacker is that is guiding them in identifying interdependencies among stacker parts and sub-systems, and what actors and departments need to be involved. Their shared knowledge of what a material stacker is thus constitute vital input for generating, within each individual, a guiding mental representation or picture, allowing them to engage in development work alone or in interaction. In theoretical terms the stacker thus constitutes a historically evolved artefact, which in a sense has a life of its own, as an actor in the process (Latour, 1996). Such a stacker artefact, or rather the sequences of previous stackers, also has a narrative quality, making it easy to recollect. The stacker may therefore be seen as a

special kind of boundary object (Star, 1993) from which project members are able to establish a relevant representation without extensive knowledge of other members and departments.

4.4. Interacting and interrelating – a model

As a way of summarising the discussion so far, we suggest a simple model, distinguishing between instances of interaction, where individuals meet face-to-face, and instances of interrelating, where the individual is working alone. In the models' right side we picture the individual, as a person able to subordinate, represent and contribute alone, more or less consciously. Still such lonely work represents social activity. "Being careful is a social rather than a solitary act" as phrased by Weick & Roberts (1993, p. 373). Based on their representations, individual project members are able to engage in a kind of retrospective sense-making, where they, based on past experience, understand the situation at hand and take care of much of what occurs (Weick, 1995). In our case, the stacker stands out as an important artifact, which contributes to establishing individual representations that are "shared" to a great extent among project members. In other words, the material stacker and the mental representations it engenders, has considerable coordinative power, allowing for activity and knowledge integration although the individual most of the time is working in solitude.

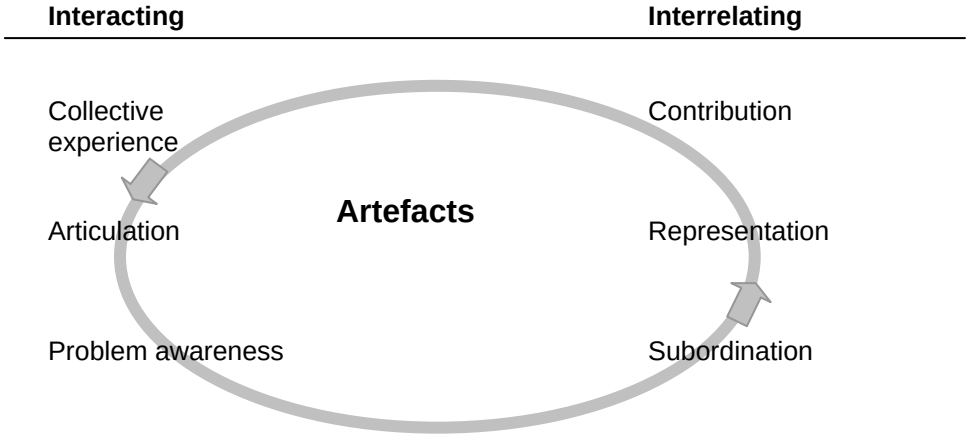

Fig. 3. The interacting-interrelating model.

However, this is only half the picture. As suggested above the project meetings as well as ad hoc problem solving interaction, are needed in order to deal with extraordinary events, calling for face-to-face interaction and re-establishment of sense. At the left side we thus picture the notion of "interacting" as a matter of sharing experience,

articulation and problem awareness. This side provides with accounts and articulations of unexpected or extraordinary events and experiences, providing with new material for the re-establishment of sense. In our case study, meetings and ad hoc problem solving interaction involving face-to-face interaction, provide empirical referents here. In sum, the below model displays project work in our case as an iteration between instances of interaction and interrelating with the Stacker artefact as an actor in the dynamic interplay between the both sides.

4.5 Knowledge integration in project work

How do our findings square with previous observations of knowledge integration in the context of project work? The empirical case described in this paper contrasts in some vital respects to the typical integration problematic encountered in project-based settings, where task heterogeneity is high, causal ambiguity is high and task frequency is low (Prencipe & Tell, 2001). In project-based contexts thus conceived, one would expect high knowledge integration investments in order to overcome cognitive obstacles (Zollo & Winter, 2002). For instance, knowledge codification practices make sense as they represent cognitive effort in analyzing cause-effect relationship, annotating them in symbolic form (Foray and Steinmueller, 2001). The observations in the Stacker case rather seem to indicate low task heterogeneity, high causal ambiguity and high frequency. According to our analysis, this knowledge setting allows for a number of viable knowledge integration mechanisms. Therefore, we argue, comparative cost considerations turn increasingly important (Grant, 1996; Grandori, 2001). Relying as much as possible on inexpensive specialized routines based on predominantly tacit experience accumulation, rather than expensive codification of knowledge or face-to-face communication in project meetings then makes sense under norms of rationality.

First, despite differing educational backgrounds and organizational home bases, the degree of knowledge differentiation and heterogeneity of task experience was relatively low in the project group developing the stacker. Although the backgrounds of project members varied, they had few problems in communicating. Moreover, project members with little previous experience and consultants contracted from outside well understood problems discussed by fellow project members. Generally, as noted by Grandori (2001: p. 390) "…knowledge-differentiation is expected to generate communication impasses and potential for conflict in judgments". Knowledge differentiation may emanate in diverging "thought worlds", erecting substantial communication barriers in cross

functional development teams (Dougherty, 1992). If knowledge differentiation is high, this may call for integration mechanisms based on explicit articulation and codification of knowledge (Zollo and Winter, 2002). Since such differentiated knowledge can not be coordinated by a central agent, direct communication between project members may be a necessary tool for integrating knowledge. In the Stacker project, by contrast, non-differentiated knowledge in combination with the shared representation of the stacker (the artifact), allowed for high degrees of physically distributed work. Such mechanisms are less expensive than excessive codification into rules and procedures or formal face-to-face project meetings for solving problems.

Second, increasing complexity of projects calls for increasingly sophisticated knowledge integration. Complexity can be distinguished as computational (the number of elements and interdependencies between them) and/or epistemic (the difficulty of establishing valid and reliable knowledge, in terms of e.g. observing and diagnosing causal links) (Grandori, 2001). In the Stacker case, computational complexity was quite high. Although project members operated primarily individually, there were important technical interdependencies. Some of the computational complexity could however be dealt with by resorting to hierarchical decomposition of tasks. The causal ambiguity implied by epistemic complexity may be encapsulated in tacit knowledge (Reed & deFillippi, 1991). Each individual in the Stacker project, responsible for his/her task, developed a tacit understanding of that particular sub-package of the project. The development of "hidden" competences in the Stacker project increased overall epistemic complexity as it hampered transparency. Even if causal relationships and interdependencies among components and activities existed they got obfuscated. Complexity can be analyzable, allowing for a priori design, or systemic, requiring continuous coupling between sub-processes (Lindkvist et al, 1998). Knowledge integration in such systemic, or high, complexity settings is supported by frequent communication, whereby non-understood interdependencies (computational complexity) as well as tacit assumptions (epistemic complexity) can be revealed through articulation and reflection. In situations where causal ambiguity hindered project progress in the Stacker case, project members resorted to face-to-face interaction in order to overcome such obstacles. This illustrates that part of the explanation of the project's success may lay in the oscillation between the interacting and interrelating processes. While both processes are indeed necessary, none of them is sufficient on its own.

Third, task frequency affects the knowledge that can be generated and retained in the organization (Zollo & Winter, 2002). Increasing frequency and repetition in the organization allow for the development of routines that can be enacted almost automatically when facing a recurring event. The smooth functioning of routines creates the possibility for automatic behavior, which requires less attention and effort on behalf of the skilled worker. Routines also allow for efficient specialization and coordination (Grant, 1996). As noticed by Nelson and Winter (1982: 105) "While each organization member must know his job, there is no need for anyone to know anyone *else's* job. Neither is there any need for anyone to articulate or conceptualize the procedures employed by the organization as a whole".

In the Stacker case, frequency of experience was relatively high. For instance, the project did not include that much novelty and many similar projects had been conducted previously. As discussed by Davies and Brady (2000), developing efficient capabilities in such project-based settings, makes it important to look for "repeatable solutions", utilizing previous experience in different phases of a project. Experiential learning in a high-frequency context may emanate in the unreflective learning associated with various myopic behavior such as path-dependency, competence traps and neglect of conflicting observations across time and space (Levinthal &March, 1993). Interviewees also indicated that previous technical solutions were used as templates when problems occurred in the project. However, when unforeseen events occurred, the project group was reassembled in order to bring in new information and perspectives from the entire project team. Again, this supports our notion that interrelating and interacting is equally important, and that there is a dynamic relationship between these two processes.

5. Epilogue

Our findings thus suggest that conceptualizations of successful project work as relying on frequent face-to-face interaction, a shared goal and shared knowledge base may be misleading. In contexts where development projects are recurrent and the differentiation of knowledge is relatively low, project work may well be successfully undertaken without much communication or interaction between project members, even when substantial computational as well as epistemic complexity prevail. Artifacts and a dynamic interplay between phases of interaction and interrelating may then be highly significant in achieving activity and knowledge integration, as shown in our

model. As a result much project work may be undertaken individually, and yet be a matter of teamwork.

References

Allen, T. (1977): Managing the flow of technology, MIT Press, Cambridge

Davies, A. and T. Brady (2000): Organisational capabilities and learning in complex product systems: towards repeatable solutions, Research Policy, 29, 931-953

Dougherty, D. (1992): Interpretive Barriers to Successful Product Innovation in Large Firms, Organization Science, 3 (2), 179-202

Eisenhardt, K.M. and B.N. Tabrizi, (1995): Accelerating adaptive processes: Product innovation in the global computer industry, Administrative Science Quarterly, 40 (1), 84-110.

Engwall, M. (1995): Jakten på det effektiva projektet, Stockholm: Nerenius & Santérus

Foray, D. and W. E. Steinmueller, (2001): Replication of routine, the domestication of tacit knowledge and the economics of inscription technology: A brave new world?, paper presented at the DRUID Nelson and Winter conference, Aalborg, Denmark

Frohm, C. (2002): Collective competence in an interdisciplinary context. Licentiate Thesis.
Department of Management and Economics, Linköping university.

Grandori, A. (2001): Neither hierarchy nor identity: Knowledge-governance mechanisms and the theory of the firm, Journal of Management and Governance 5 (3), 381-399

Grant, R.M. (1996): Towards a knowledge-based theory of the firm, Strategic Management Journal 17 (Winter special issue), 109-122

Hobday, M. (2000): The project-based organization: An ideal form for managing complex products and systems?, Research Policy 29, 871-893.

Katzenbach, J.R., & D.K. Smith, (1993): The wisdom of teams: Creating high-performance organization, Boston: Harvard Business School Press

Latour, B. (1996): Aramis or the love of technology, Harvard University Press, Cambridge

Levinthal, D. A. and J. G. March, (1993): The myopia of learning, Strategic Management Journal, 14 (Winter Special Issue), 95-112

Lindkvist, L. (2004): Governing project-based firms: Promoting market-like processes in hierarchies, Journal of Management and Governance, 8 (1), 3-25

Lindkvist, L. and Söderlund, J. and Tell, F. (1998): Managing product development projects: On the significance of fountains and deadlines, Organization Studies 19, 931-951.

Lindkvist, L. and Söderlund, J. (2002): What goes on in projects? – On goal-directed learning processes, in K. Sahlin-Andersson and A. Söderholm (eds.) Beyond project management – New perspectives on the temporary-permanent dilemma, Copenhagen: Copenhagen business school press
Lock, D. (1996), The essentials of project management, Gower, Hampshire

Lundin, R. and A. Söderholm (1995): A theory of the temporary organization, Scandinavian Journal of Management 11, 437-455.

Merriam, S.B. (1994): Fallstudien som forskningsmetod, Lund: Studentlitteratur

Nelson, R. R. and S. G. Winter, (1982): An evolutionary theory of economic change, The Belknap Press of Harvard University Press, Cambridge, Massachusetts

Nonaka, I. and H. Takeuchi, (1995): The knowledge-creating company – How Japanese companies create the dynamics of innovation, Oxford University Press, Oxford

Prencipe, A. and F. Tell. (2001): Inter-project learning: processes and outcomes of knowledge codification in project-based firms, Research Policy, 30 (9), 1373-1394

PMI. (1996): A guide to the project management body of knowledge, Upper Darby: The Project Management Institute.

Reed, R. and R. DeFillippi, (1991): Causal Ambiguity, Barriers to Imitation, and Sustainable Competitive Advantage, Academy of Management Review, 15 (1), 88-102

Sahlin-Andersson, K. (2001): I styrbarhetens utmarker, in I Sahlin, (ed.) Projektets paradoxer, Lund: Studentlitteratur

Silverman D. (1993): Interpreting qualitative data: Methods for analysing talk, text and interaction, SAGE Publications, London

Star, S.L. (1993): Cooperation without consensus in scientific problem solving: Dynamics of closure in open systems, in S. Easterbrook (ed.) CSCW: Cooperation or conflict, Springer Verlag, London

Tsoukas, H. (1996): The firm as a distributed knowledge system: A constructionist approach, Strategic Management Journal 17 (Winter special issue), 11-25

Weick, K.E. (1995): Sensemaking in organizations, SAGE Publications, London

Weick, K.E. & Roberts, K.H. (1993): Collective mind in organizations: Heedful interrelating on flight decks, Administrative Science Quarterly, vol. 38, 357-381

Zollo, M. & Winter, S.G. (2002): Deliberate learning and the evolution of dynamic capabilities, Organization Science 13 (3), 339-351