

Capturing Tacit Knowledge in New Product Development: A Study of Post-Project Reviews

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ABSTRACT

An important way to capture the knowledge generated by new product development teams is to conduct post-project reviews. This paper describes a detailed study of the role that such reviews play in generating and disseminating tacit knowledge within an R&D environment. Tacit knowledge is generally acknowledged to be a challenging topic to research and so case studies were conducted using multiple sources of data. The research identifies the main factors that influence the generation of tacit knowledge at post-project reviews, such as the atmosphere and the discussion methods chosen. Although the study is exploratory and further research is needed, the results have implications for managers who want to positively influence the generation and dissemination of knowledge in R&D departments.

KEYWORDS

New product development; knowledge; learning; post-project reviews

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INTRODUCTION

It is widely recognized that research and development (R&D) is *the* function of the business that is most dependent on knowledge and “nowhere is organizational learning more critical” (Lynn, 1998, p74). Research generates knowledge on technologies, whereas new product development (NPD) teams convert such knowledge into innovative products. If NPD teams learn from previous projects, then product innovation can be faster (Saban, et al, 2000), and mistakes that were made in the past can be avoided (Tidd, et al, 2001). From the various mechanisms that can support learning in NPD, post-project reviews (PPRs) have been recognized by both practitioners and researchers as having great potential (e.g. Williams, 2004; Armbrecht et al, 2001). However, few studies of PPRs have been conducted systematically, most have failed to build on the theoretical frameworks from organizational learning, and so reliable guidance to managers on how to utilize PPRs is lacking.

In this paper, we describe selected results from an exploratory study and derive a theoretical model of the factors that influence the effectiveness of PPRs. The five main sections of this paper cover:

- The relevant literature, including what has been written on learning in NPD, the role of PPRs, and the insights that can be gained from an organizational learning perspective.
- The research question and the development of our research design.
- The empirical results from our five case studies.
- How the results led to a theoretical model of the factors that influence the learning from PPRs.
- The limitations of our work and, most importantly, the implications for researchers and NPD practitioners.

Overall, we hope this paper will stimulate researchers to conduct more empirical studies of knowledge and learning in NPD. Through such research, scholars have a real opportunity to make significant contributions to both theory and practice.

THE LITERATURE

New Product Development

Top managers recognize that new product development is a core competence (Harmsen et al, 2000) and the “product innovation literature... has progressively highlighted the importance of knowledge management as the main source of long-term competitive advantage” (Corso et al, 2001, p348). Consequently, knowledge in the context of NPD were chosen as the focus of our study.

New product development generates vast amounts of knowledge—not only about the product and technology but also knowledge about the processes used by the NPD team (Cohen and Levinthal, 1989). To constantly improve NPD, organizations depend on the ability to learn from previous projects (Gupta and Wilemon, 1996; Nonaka and Takeuchi, 1995; Wheelwright and Clark, 1992). If organizational learning occurs, it leads to a change in the way in which subsequent problems are investigated (Michael and Palandjian, 2004), it helps to avoid the repetition of mistakes (Tidd et al, 2001), and supports knowledge retention (Jensen and Sandstad, 1998). Learning can be said to have occurred when an organization uses knowledge to solve or prevent problems and this can lead to competitive advantage (Ambrosini and Bowman, 2001).

There is broad agreement that because NPD is a knowledge-intensive activity, particular mechanisms are needed to stimulate the creation and transfer of knowledge (e.g. Mehra and Dhawan, 2003). The main reason that particular mechanisms are needed is that there are two types of knowledge: “explicit” and “tacit”. Explicit knowledge is easy to explain and document, whereas tacit knowledge is difficult to articulate and exists at a subconscious level (Nonaka and Takeuchi,

1995). In a later section, we will discuss tacit knowledge further because of its particular importance in NPD (Thomke and Fujimoto, 2000; Mascitelli, 2000).

“Project learning is too important to be left to chance or to the initiative of motivated individuals” (Schindler and Eppler, 2003, p225). Therefore, various mechanisms are used to capture the lessons learnt by NPD teams. These include checklists (Riek, 2001); close interaction between members of the NPD team (Mascitelli, 2000); experts who are willing to share their knowledge (Mehra and Dhawan, 2003); producing databases of lessons learnt (Bartezzaghi, 1997); micro histories [half-page informal project descriptions] (Schindler and Eppler, 2003); and learning histories [10-20 page documents telling the detailed story of a project] (*ibid*). Further mechanisms include conducting reviews at each stage of NPD (Kotnour and Vergopia, 2005); post-project reviews (Busby, 1999); and knowledge officers responsible for inter-project learning (Schindler and Eppler, 2003). From all these mechanisms, PPRs have been identified as being highly effective, by a number of authors over the past decade (e.g. Bowen et al, 1994; Thomke and Fujimoto, 2000; von Zedtwitz, 2003; Kotnour and Vergopia, 2005).

Post-Project Reviews and NPD

A PPR is “a formal review of the project which examines the lessons which may be learnt and used to the benefit of future projects” (Lane, 2000). Ideally, a PPR should be a meeting shortly after the product launch, where core team members objectively discuss how the project was conducted and what could have been improved. The discussion should stimulate knowledge which, if disseminated effectively, will help future NPD projects to be more successful.

Although practitioners and academics have frequently stressed the importance of PPRs, it has been noted that few organizations actually conduct them (e.g. Bowen et al, 1994; Huber, 1996). In addition to these anecdotal observations, there have been a number of empirical studies of the usage of PPRs. Boag and Rinholm (1989) found that only two companies in their sample of 33 small and medium-sized high technology companies in the US and Canada used formal reviews (6% usage). Menke (1997) found that less than 25% of 79 R&D organizations surveyed in the US used PPRs. Goffin and Pfeiffer (1999) mentioned that only 25% of their 16 case study companies in Germany and the UK used them. A survey of 63 Swiss companies by von Zedtwitz (2003) found that 19% used PPRs frequently. Saban et al (2000) discovered that 56% of the 212 companies they studied in the USA employ formal review processes for NPD projects. In the most recent empirical study, Hoegl and Schulze (2005) investigated 94 NPD teams at international companies and found that approximately 80% of them used reviews. The studies mentioned cover different types of companies, different geographies, and span a period of sixteen years. Overall, the evidence is inconclusive but it appears that PPRs are perhaps becoming more frequently used.

Whether companies use PPRs is one issue but more important questions are: *Are PPRs perceived as valuable?* And *how are PPRs best managed?* In a previous paper (Koners and Goffin, 2007a), we sought answers to the first question. Within the limitation of our sample, we found that engineers and NPD project leaders perceived PPRs to be a useful mechanism for promoting individual and team learning. PPRs were perceived to trigger insights that were of more value than reading what is documented in reports or databases. Social interactions with colleagues were seen as essential, as the minutes of PPRs and checklists of lessons learned do not always reflect the depth of discussions.

The answer to the second question (*how are PPRs best managed?*) can be extracted from the ten main empirical studies on PPRs conducted from 1991-2007. These are summarized in Table 1 and there are a number of salient points to be noted. Firstly, several of the papers are based on either single case studies, or were not conducted in a systematic fashion. For example, Wheelwright and Clark (1992) gave almost no details of their methodology; and von Zedtwitz (2003) used a convenience sample of managers at a seminar. Secondly, despite the relatively weak empirical base of most studies, the authors still make general recommendations as to how PPRs should be

managed. Thirdly, the majority of papers do not take account of the tacit component of knowledge (this is indicated in the fourth column headed “Details / Critique of Methodology”).

Our last paper (Koners and Goffin, 2007b) was designed to consolidate the findings of previous studies and build on them. This led to five case studies being conducted using multiple sources of data and extensive data triangulation—steps which were necessary to increase the internal validity of the study. The eight recommendations shown in Table 1 were made within the acknowledged limitations of our sample (*ibid*).

Thomke and Fujimoto (2000) recognized that PPRs are not necessarily effective at transferring tacit knowledge. Therefore, the right-hand column of Table 1 is labelled “Supports Tacit Knowledge?” and gives a very simple indication as to which of the recommendations given by each study will support the generation and dissemination of tacit knowledge. For example, Smith’s recommendation to consider not only negative but also the positive aspects of projects could “potentially” stimulate tacit knowledge. In contrast, the recommendation from Williams to use causal mapping would “probably” generate tacit knowledge, as causal maps are known to probe deeply (Ambrosini and Bowman, 2001). It can be seen that few of the recommendations on how to run PPRs are specifically aimed at stimulating and disseminating tacit knowledge. This led us to focus on how tacit knowledge can be generated and transferred through PPRs.

In 1992 McKee stated, “academic research on innovation has a strong learning orientation. The problem is that much of the work that has been done is not organized in terms of underlying learning theory” (McKee, 1992, p243-244). Unfortunately, in many ways his statement remains true today and NPD researchers need to consider what can be learnt from the organizational learning literature.

The Organizational Learning Literature

The organizational learning literature focuses on the concept of “knowledge” and how it can be generated and transferred. Nonaka published extensively on explicit and tacit knowledge and his ideas relate back to Polanyi’s famous quote, “we can know more than we can tell” (Polanyi, 1962, p4). Although it is possible to distinguish between explicit and tacit knowledge in theory, they are hard to differentiate in practice (Lam 2000; Brown and Duguid, 1991). Nonaka concluded that knowledge always has a tacit component that is generated and shared through interaction. “In project work... a great deal of the know-how required is tied to knowledge that is not written in documents but realised through the expertise and understanding of the project personnel” (Koskinen et al, 2003).

Table 1: Previous Empirical Studies of PPRs (Listed Chronologically)

	Reference	Empirical basis	Details / Critique of Methodology	Recommendations on how to conduct PPRs	Supports Tacit Knowledge?
1.	Wheelwright and Clark (1992)	Various case studies	<ul style="list-style-type: none"> ▪ Few details given of the selection of cases, or how they were studied ▪ Tacit knowledge not specifically considered 	<ul style="list-style-type: none"> ▪ Discussion should cover: <ul style="list-style-type: none"> - Project background - Pre-project activities - Project team's performance - Project management issues - Senior management review and control - Prototyping and testing 	<ul style="list-style-type: none"> ▪ Potentially
2.	Smith (1996)	Anecdotal examples from nine companies	<ul style="list-style-type: none"> ▪ No details given ▪ Apparently no systematic approach ▪ Tacit knowledge not specifically considered 	<ul style="list-style-type: none"> ▪ Assign a reviewer ▪ Define a review process ▪ Identify strengths ▪ Constructively balance positive and negative findings ▪ Focus on process improvements ▪ Back up the discussions with data ▪ Use metrics 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially
3.	Duarte and Snyder (1997)	Single case study - Whirlpool	<ul style="list-style-type: none"> ▪ Action research ▪ Claims to use a model from organizational learning – but it is unclear how ▪ Tacit knowledge not specifically considered 	<ul style="list-style-type: none"> ▪ Document what went well and what needs improvement – at every stage in the process ▪ Discuss openly what happened and why ▪ Focus on the assumptions and the process used by the team ▪ Obtain multiple interpretations and a systems perspective ▪ Suggest a range of options for improvement 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially
4.	Busby (1999)	Observation of 4 PPRs at 3 companies	<ul style="list-style-type: none"> ▪ Discourse analysis used but little trail of evidence ▪ Tacit knowledge not specifically considered 	<ul style="list-style-type: none"> ▪ Use causal maps to stimulate insights ▪ Examine the historical perspective ▪ Encourage examination of a wider perspective ▪ Identify root causes and not just superficial symptoms ▪ Make sure learning is applied ▪ Invite managers from other projects to help dissemination 	<ul style="list-style-type: none"> ▪ Probably ▪ Potentially ▪ Potentially ▪ Potentially ▪ Potentially
5.	Lilly and Porter (2003)	Two stage research in various organizations	<ul style="list-style-type: none"> ▪ Mail survey of 49 companies ▪ Exploratory interviews with 16 managers in 8 companies ▪ Focus of research is explicit knowledge; tacit knowledge not specifically considered 	<ul style="list-style-type: none"> ▪ Formalized review procedures lead to objective learning ▪ Considering multiple perspectives is very important ▪ Conduct multiple reviews as the project progresses ▪ Learning needs to be disseminated 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially
6.	Schindler and Gassman (2000); Schindler and Eppler (2003)	Action research in nine multinational companies	<ul style="list-style-type: none"> ▪ Semi-structured expert interviews ▪ Half-day follow-up workshops ▪ Gives almost no details of the 	<ul style="list-style-type: none"> ▪ Conduct reviews as each project milestone ▪ Use a neutral moderator ▪ Use drawings / diagrams to capture the lessons learned graphically 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially ▪ Potentially

			<ul style="list-style-type: none"> methodology ▪ Apparently no use of the recognized approaches to action research ▪ Tacit knowledge not specifically considered 	<ul style="list-style-type: none"> ▪ “Ensure a collective, interactive evaluation” ▪ Get commitment to apply the insights gained ▪ Instigate a “project knowledge broker” 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially
7.	Williams (2004)	Single case study - NCR	<ul style="list-style-type: none"> ▪ A causal map including the main events of the project was drawn by the researcher ▪ Tacit knowledge not specifically investigated 	<ul style="list-style-type: none"> ▪ Causal mapping by the NPD team can lead to insights ▪ Comparisons between causal maps and project metrics may be useful 	<ul style="list-style-type: none"> ▪ Probably ▪ Potentially
8.	von Zedtwitz (2003)	Convenience sample of 63 R&D managers at a seminar plus interviews at 13 companies	<ul style="list-style-type: none"> ▪ Survey questionnaire ▪ Semi-structured interview ▪ Tacit knowledge not specifically considered 	<ul style="list-style-type: none"> ▪ Set clear goals for PPRs ▪ Have a professional, independent facilitator ▪ Ensure the team prepare for the PPR ▪ Set the right environment / allocate the right time ▪ Involve all key stakeholders ▪ Produce a clear summary document 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially ▪ Potentially
9.	Kotnour and Vergopia (2005)	Case study of the NASA organization in the US	<ul style="list-style-type: none"> ▪ Action research ▪ Tacit knowledge considered indirectly 	<ul style="list-style-type: none"> ▪ Regular reviews can increase learning ▪ Different levels of learning should be targeted: sharing facts and improving a particular project; and improving the organization’ s capability ▪ Data analysis and presentation tools can help learning 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially ▪ Potentially
10.	Koners and Goffin (2007a and 2007b)	5 case studies in Germany	<ul style="list-style-type: none"> ▪ Used multiple data sources – interviews, repertory grid analysis, and observation of PPRs. ▪ Tacit knowledge considered and investigated 	<ul style="list-style-type: none"> ▪ The value of PPRs needs to be clearly communicated in R&D organisations by senior management ▪ The timing, location and duration of PPRs should be carefully chosen to maximize learning ▪ The core NPD team and selected additional participants (e.g. suppliers) to give multiple perspectives ▪ A skilled moderator can create the right atmosphere and guide the discussions better than a project leader ▪ PPRs should be prepared by the moderator and project manager ▪ The knowledge generated must be disseminated ▪ PPRs should be used to identify where the experience from the completed project is relevant to current projects. ▪ Management needs to encourage informal interaction between NPD teams and the use of the metaphors and stories to disseminate learning. 	<ul style="list-style-type: none"> ▪ Potentially ▪ Potentially ▪ Potentially ▪ Potentially ▪ Potentially ▪ Probably

Social interactions are essential for knowledge transfer and the transfer of tacit knowledge is an essential component of learning complex tasks (Nonaka, 1996; Howells, 1996). Communities of Practice are groups of people who are informally bound to one another by exposure to a common class of problems (Wenger and Snyder, 2000). This exposure leads to a high degree of common knowledge, understanding and language, and experience which supports the fast and efficient transfer of knowledge. Project teams can be considered an embryonic form of a Community of Practice (Sense and Antoni, 2003).

There is some controversy as to whether tacit knowledge can be converted into explicit knowledge (Cook and Brown, 1999). By definition, tacit knowledge cannot be clearly expressed, documented, or understood using direct questions. Therefore it is difficult to study tacit knowledge empirically (Wong and Radcliffe, 2000). Traditional interview techniques are not suitable as individuals cannot necessarily articulate their thoughts on complex or ambiguous topics (Ambrosini and Bowman, 2001). However, the discussion in the literature has largely been at a theoretical level and unfortunately has failed to make empirical inroads into the understanding of tacit knowledge. For example, although Cook and Brown (1999) argue that we must strive to understand tacit knowledge, their empirical evidence is only three cases, which they “briefly sketch” (*ibid*, p394) in a purely descriptive way. More systematic approaches are needed to grapple with tacit knowledge and repertory grid technique from psychology appears to have the potential for this (Goffin, 2002; Reed, 2000). Metaphors and stories have also been recognized in the literature as indicators of the generation and exchange of tacit knowledge (Cook and Brown, 1999; Nonaka, 1994).

A metaphor is a “figure of speech in which a word or phrase denoting one kind of object or action is used in place of another to suggest a likeness or analogy between them. A metaphor is an implied comparison, in contrast to the explicit comparison of the simile. Metaphor is common at all levels of language and is fundamental in poetry” (Encyclopaedia Britannica, 2005). Storytelling, on the other hand, is defined as “an exchange between two or more persons during which past or anticipated experience was being referenced, recounted, interpreted, or challenged” (Boje, 1991, p8). People use metaphors and stories when explaining experiences which they are otherwise unable to express (Lakoff and Johnson, 1980; Srivastva and Barrett, 1988; Mascitelli, 2000). Furthermore, metaphors and stories have been identified as supporting tacit knowledge generation within groups (Gherardi, 2000).

Table 2 summarizes eight papers which identify specific mechanisms for generating and transferring tacit knowledge. From this table it can be seen that the empirical basis for these recommendations is weak: two studies are based on single cases; two papers are purely theoretical; and the studies based on direct questioning are unlikely to generate insights into tacit knowledge. The recommendations are all very similar and appear to relate back to the widely quoted ideas from Nonaka: tacit knowledge is best transferred through informal contact; and its transfer is supported by the use of metaphors and stories. It is useful to note that few of the papers listed in Table 1 made similar recommendations to those in Table 3 (once again demonstrating that NPD researchers have not capitalized on the organizational learning literature).

For researchers who want to investigate knowledge and learning effectively, the challenge is that the organizational learning literature includes few studies that test the concepts and theories purported. We are not alone in this observation: “How organizations learn... has been the subject of many theoretical analyses but limited empirical work” (Michael and Palandjian, 2004, p268). Even Nonaka said that his theory “has been constructed mainly on the basis of hands-on research and practical experience of Japanese firms” (Nonaka, 1994, p459).

Table 2: Mechanisms to Facilitate Tacit Knowledge Creation and Transfer

	Reference	Empirical basis	Mechanisms for tacit knowledge creation and transfer
1.	Nonaka and Takeuchi (1995)	Various anecdotal examples from NPD organizations	<ul style="list-style-type: none"> ▪ Use of metaphors and analogy ▪ Use of dialogue and discussion; ▪ Use of ambiguity and redundancy
2.	Stenmark (2001)	Theoretical discussion only, applying Nonaka's ideas to IT.	<ul style="list-style-type: none"> ▪ Rich modes of discourse including analogies, stories, metaphors
3.	Hernandez-Serrano et al (2002)	Construction of a library of cases illustrating NPD issues and experience with students using them	<ul style="list-style-type: none"> ▪ Relating and listening to stories helps to think, explain, understand, remember and memorize
4.	Chou and Wang, (2003)	Survey	<ul style="list-style-type: none"> ▪ Face-to-face interaction and willingness to share experiences with the team ▪ Express knowledge in metaphors or analogies
5.	Li and Gao (2003)	Theoretical discussion only	<ul style="list-style-type: none"> ▪ Social interactions among members of the organization ▪ IT only useful to support human communication
6.	Neve (2003)	Interviews in two 'knowledge intensive' organizations	<ul style="list-style-type: none"> ▪ Narrating experiences to validate thoughts ▪ Interacting in dialogues which aids to formulate thoughts and tacit skills ▪ Knowledge increases when groups question each other and interpret the different opinions
7.	Roth (2003)	Single case study in R&D organization	<ul style="list-style-type: none"> ▪ Shared experiences and stories ▪ Brainstorming sessions
8.	Skovvang and Kaskgaard (2003)	Single case study in software company	<ul style="list-style-type: none"> ▪ Informal face-to-face knowledge sharing ▪ Project teams should 'step back' and analyze project performance.

Summary

Based on the literature, it can be seen that there is a need for further research because:

- NPD is a knowledge-intensive activity but previous investigations have largely ignored the tacit dimension of knowledge.
- PPRs appear to be an important mechanism for knowledge generation and transfer but our understanding on how they can be utilized is limited. Researchers have mainly focused on what can be documented and easily exchanged between NPD personnel, i.e. explicit knowledge.
- Organizational learning researchers have recognized the importance of tacit knowledge but have not made empirical inroads.
- The usage of metaphors and stories has been recognized to indicate that tacit knowledge is being generated and transferred.

RESEARCH DESIGN

Research Question

The gaps identified in the NPD literature and the insights gained from organizational learning led to a detailed study of how PPRs are perceived and how they are managed (Koners and Goffin, 2007a and 2007b respectively). Here we present new data focused on the following two questions:

- 1) *What recommendations can be made to managers on how to stimulate the generation of tacit knowledge in PPRs?*
- 2) *How can managers disseminate tacit knowledge from PPRs in an effective way?*

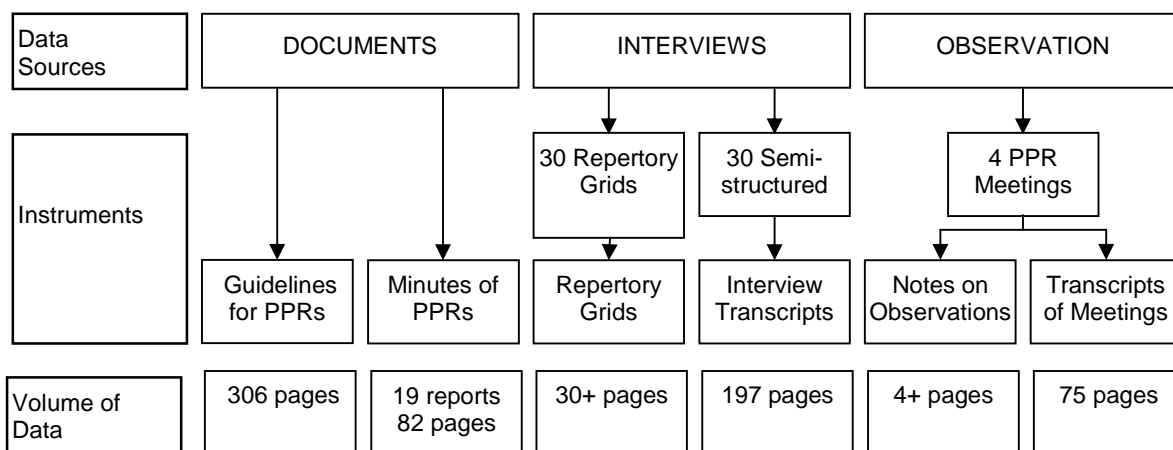
Methodology

In-depth case studies were selected as the most appropriate approach for our overall exploratory study for four main reasons. Firstly, case studies are useful when exploring complex social phenomena in real-life contexts (Yin, 1994). Secondly, the limited amount of previous research on PPRs means that themes and patterns need to be identified rather than confirmed (Eisenhardt, 1989). Thirdly, case studies enable the investigation of formal as well as informal processes within an organization (essential because of the social nature of knowledge generation). Finally, multiple sources of data can be used within the structure of case study research (Hartley, 1994).

Sample

The sampling frame chosen was the 50 largest companies in the south of Germany, a high-tech region which accounts for the highest number of patents and R&D investments per capita in Europe (Staatsministerium Baden-Württemberg, 2006). These companies were contacted by letter and five which conducted PPRs agreed to give access for the research. The five companies will, for reasons of confidentiality, be designated EngineeringCo, AppliancesCo, MedCareCo, MachineryCo and PublishingCo, (the pseudonyms indicate the industries in which they are active).

Figure 1: Overview of Data Sources



Data Sources

Due to the complex nature of tacit knowledge, three sources of data were used (Figure 1):

- *Documents:* these included companies' NPD process documentation (which give guidelines for PPRs) and 19 minutes from PPRs.
- *Interviews:* six interviews with NPD team members (engineers, project managers, etc.) were conducted at each company, using both a structured and semi-structured approach. A repertory grid (structured) interview was used as this technique is particularly useful when interviewees find it difficult to articulate their views on complex topics (Goffin, 2002). This method identified

key “lessons learned” from projects. The second part of each interview used a semi-structured questionnaire on how PPRs are organized and perceived and included open-ended questions such as: “*How do post-project reviews support the learning from projects from your point of view?*”

- *Observation*: one PPR was observed at four companies (access for observation was not possible at PublishingCo). Notes were taken on the way each PPR was conducted, the atmosphere, and the interaction. The total of 15 hours of discussion was recorded and transcribed.

Figure 1 indicates the large volume of data that was collected (e.g. 197 pages of interview transcripts) and, per case, this typically required 5 non-consecutive days of on-site visits.

Data Analysis

The analysis of the rich data set was conducted in four main stages:

- 1) *Document Analysis*: the five PPR guidelines were checked to see if they gave any recommendations, direct or indirect, about the creation and dissemination of tacit knowledge. The 19 minutes of PPR meetings were also checked to see if any mechanisms such as social interaction were mentioned, and checks were made on whether metaphors and stories had been documented.
- 2) *Interview Analysis*: the transcripts of the semi-structured interviews were checked to see where respondents had directly or indirectly made comments about how PPRs would influence tacit knowledge generation and dissemination. Furthermore, the usage of metaphors and stories during the repertory grid interviews was analyzed.
- 3) *Analysis of Observations*: the field notes were checked for insights into the atmosphere observed. The transcripts were analyzed to check on how the PPR was conducted, the location chosen, and the usage of metaphors and stories.
- 4) *Data Comparison*: a detailed picture emerged from comparing and contrasting the data from the different sources and the five cases. (Note there was some iteration between stages.)

KEY FINDINGS

Documentary Evidence

In companies’ guidelines for PPRs, very little evidence was found suggesting how to stimulate and disseminate tacit knowledge. The term “tacit knowledge” was not found in any of the guidelines. The guidelines for AppliancesCo said that PPRs should be off-site and, after the formal meeting, there should be a team dinner. MedCareCo’s guidelines stated a PPR should be characterised by the “*joy of having finished the task*” and stressed the importance of a good atmosphere. However, nothing more specific was found in the guidelines.

Similarly, almost no evidence was found in the 82 pages of documentation, corresponding to the 19 minutes of PPRs that were coded. Again, the term “tacit knowledge” was not found. The minutes of one PPR at EngineeringCo described the atmosphere as “*factual, fair and open*”. No further indications on the location, atmosphere or any other factors that might influence tacit knowledge generation and dissemination were found. Only four metaphors and stories were identified in the 19 minutes of PPRs. All four of these were found to be simple metaphors which carried no indication of whether there had been important discussions around them. An example from MachineryCo was: “[It is] *Not clear who is supposed to give the green light*” (metaphor underlined), and was used in summarizing a point about the lack of clarity of approvals during projects.

Interview Evidence

Semi-structured Interviews

In contrast to the documents, the semi-structured interview transcripts were found to include substantial evidence on how interviewees perceived that PPRs can generate and disseminate tacit

knowledge. Specifically, the transcripts provided evidence on how knowledge is generated in discussions (including the value of having different perspectives); the importance of the right atmosphere; the role of the moderator; how interaction spreads the results; and the influence of management.

PPRs were perceived to facilitate the generation of knowledge, because discussion exposes points which individuals may not have previously recognized. *"Of course there are always some issues that everyone is surprised about how they develop into big problems during the PPR discussion, or vital elements without anyone realizing this before"* (Interviewee 4, AppliancesCo). The presence of the whole project team and not just R&D was perceived as important in bringing together different perspectives: *"I think the effect that you learn something during the meeting only happens with departments which do not deal closely with development, such as controlling, marketing, these kinds of departments"* (Interviewee 2, EngineeringCo). An indication of the value of discussions but the difficulty in trying to capture them in the minutes of the meeting was also found: *"During the discussion the real important points emerge within the team - you will never find these points in minutes or databases"* (Interviewee 7, AppliancesCo).

The atmosphere of PPRs was perceived to be important, if good discussions were to result. Interviewee 2 of AppliancesCo said: *"There are certain issues that only come up at the end in the review, because only then you have the time and piece of mind to actually think about causes and consequences"*. (Triangulation with the documentary evidence showed that AppliancesCo's guidelines stressed the importance of running PPRs away from the normal workplace, in order to have uninterrupted discussions.) One interviewee thought that something about the atmosphere in a PPR was unique saying: *"I do not send out reports, I would pass on the moods [from the PPR]. More in the hallway and in the canteen than in official meetings"* (Interviewee 3, MachineryCo).

Interviewees gave the impression that a more effective discussion is possible if the moderator is not a member of the project team. *"The moderator can help with the method, that sort of support. So this person from the training department joins the meeting, follows the day and might help if the discussion and dialogue dies"* (Interviewee 6, AppliancesCo). Overall, the use of external moderators was very well accepted at Appliances Co, whereas the other case companies relied on the project managers to be the moderator. The key role of the moderator appears to be to add structure to the discussion, because otherwise some people only focus on the problems that occurred in projects [*"My aim is to document the mistakes that we made..."* (Interviewee 4, EngineeringCo)] and miss the opportunity to learn from things that went well [*"In order to learn from... the positive and negative things"* (Interviewee 6, MedcareCo)].

There were lots of statements from interviewees indicating the importance of social interaction in knowledge transfer. From 29 comments about how the results of PPRs can best be disseminated, 19 were found to mention social interactions (whereas 10 mentioned the importance of documents). For example, Interviewee 2 at PublishingCo said: *"You cannot really write down experiences, even if you try. This is almost impossible and it would be a huge book."* Another important finding was how several interviewees perceived dissemination to take place. *"The PPR results stay in the heads of the project team and it might be that the same things happen again in the next project, but then these people will remember what was discussed"* (Interviewee 5, EngineeringCo). Presentations and informal interaction were perceived as better ways to disseminate knowledge than using reports. Interviewee 4 of MachineryCo said: *"I always prefer to do personal presentations after the PPR took place, because only the interaction between people can really transfer the knowledge gained during the meeting"*. Similarly, Interviewee 2 of Appliances Co. said: *"I hope that we will find a way that replaces the written minutes, because they are useless. We probably have to do it more on an informal personal level to make it happen"*. A good summary of project-to-project learning was given by Interviewee 5 at EngineeringCo: *"Those who participated [in the PPR] have taken away something new and if they are in the next project they might get up and say - attention please - we had this before."* A very similar point was made

by Interviewee 3 of MachineryCo: *“I think I can only disseminate lessons learned if I register them myself and then use them again in the projects I work in. And like that [I can] pass the experience on to my colleagues”*.

It was mentioned by some interviewees that the combination of a PPR with a social event was important for motivating the NPD team. *“We always try to invite the team for dinner in connection with the PPR. This is usually outside of the normal working hours, but the company then accepts to pay the meals. In fact, this is one of our reasons to conduct the PPR. Not the only reason, but an important one”*, was stated by Interviewee 5 of MachineryCo (and triangulation with observational data at MachineryCo showed the value of the interaction at the dinner).

The interviewees provided evidence on how the presence of senior managers at a PPR can either support or disrupt open discussion. At PublishingCo, the atmosphere was clearly influenced by the presence of senior management. Four out of six interviewees stated that an open and positive discussion was not possible when senior managers were present. In contrast, at AppliancesCo, interviewees perceived it as positive that senior managers were invited to the last hour of PPRs, when the teams present their results. Senior managers also take part in the social events after PPRs, in order to show their appreciation of the achievements of NPD teams (this was confirmed at the PPR observed at AppliancesCo). Interviewees from MedCareCo and MachineryCo said that senior management take part in PPRs which are of particular strategic importance.

Repertory Grid Interviews

These were used to identify the lessons that interviewees perceived they had learnt from the projects they had previously worked on. From the 30 repertory grid interviews conducted, a total of 35 metaphors or stories were identified in the data. Examples (with metaphors underlined) included, *“This was our biggest ever belly flop”* (Interviewee 6 at PublishingCo) and Interviewee 5 at AppliancesCo, who stated that *“you cannot build a pick-up, a truck and a convertible at the same time, in his explanation that setting realistic product specifications was critical. The same interviewee also mentioned during the interview that *“in some difficult situations during a project you have to go through the valley of tears”*. The use of metaphors and stories by interviewees in their explanations of the lessons they had learned indicated that they have tacit knowledge about the previous projects on which they have worked.*

Evidence from Observations

From our field notes and the transcripts of the PPRs, a number of points about the atmosphere, the moderation, and the usage of metaphors and stories were identified.

It appeared that the effectiveness of PPRs depended on the atmosphere. PPRs are typically held in company meeting rooms but AppliancesCo uses their training centre, which is about 15 km away from the team members' regular workplace. This location is chosen on purpose to ensure uninterrupted discussions and that none of the NPD team are tempted to use the breaks to check e-mails, or make telephone calls. During the observation of the PPR at AppliancesCo it was clearly noticeable that, due to the external location, the discussions continued during the coffee and lunch breaks and there was a relaxed atmosphere. PPRs at AppliancesCo and MachineryCo were observed to be followed by a meal for the team and management, which celebrated the end of the project. At MachineryCo, the whole PPR took place in a *Biergarten*, the atmosphere was very informal and the NPD team all used the “Du” when talking to each other. (In German, “you” has two forms: “Sie” [formal, respectful] and “Du” [informal; used with family and friends and sometimes close colleagues.]) A more formal atmosphere was found at MedCareCo, where interviewees described their PPRs as *“professional”* but it was observed that participants did not feel at ease when asked to explain certain problems which they encountered during the project. One of the project managers also mentioned to the researcher that he found PPRs nerve-racking because even the tiniest details needed to be documented. *“In extreme cases, our PPRs are pure stress because we only think about*

the forms that need to be filled-in, instead of discussing our experiences" (MedCareCo project manager).

Different approaches to moderation were observed. The project leader at EngineeringCo focused on what went well and the problems that occurred. At AppliancesCo, the external moderator took a number of perspectives and used various diagrams to stimulate discussion. His comprehensive approach is illustrated by his introduction to the meeting: *"...we can now start with our analysis phase. I have prepared two groups of questions. One goes into the direction of what was particularly helpful in the project and what should be transferred to other projects or what were the particular strengths of the project. And the other one is what should be improved in other projects, what needs to be changed, and where the weaknesses are. So you see these are two completely different objectives and questions. I suggest that we collect points for both aspects. I will give you some cards with two different colours to keep the positive and negative aspects apart. In addition, I also want you to draw a so-called "satisfaction curve" on this big flipchart here. The x-axis is the time and the y-axis is the degree of your personal satisfaction."* The cards from the team's brainstorming were observed being sorted into positive and negative issues, then posted on the wall, and then they were used by the moderator to support the discussions during the whole meeting. In addition, the "personal satisfaction curves" drawn by all participants were often referred to during the discussion in order to highlight personal feelings and the related experiences from the project.

From the transcripts of the four PPRs observed, a total of 55 metaphors and stories were identified. These ranged from the experiences of the NPD team (*"Cooperation with our sales colleagues was like in a good marriage" MachineryCo*), to the problems encountered (*"If we had problems we had to juggle with several balls, but we always had a safety net as well"* EngineeringCo). Experiences were very often described with stories which were automatically clear to all participants, but not to the researchers. For example, during the PPR at AppliancesCo one of the participants mentioned that: *"He [the project manager] was almost like a shepherd's dog and kept circling the project like a herd of sheep."* Some minutes later in the discussion, another participant of the PPR then referred back to this statement and said *"...yes, this is again the example with the herd of sheep."* Although of the metaphor was repeated, the researcher present was uncertain about what was being discussed until one of the participants explained that the metaphor referred to the project manager who was very focused on the project objectives and guided ('herded') the work of the project team very conscientiously. Another example of the difficulty for the researchers to fully understand the meaning of metaphors is the following quote from the PPR at AppliancesCo: *"It was like this mole game. You hit one on the head and somewhere else four or five other ones appear."* Although this particular metaphor caused a lot of laughter amongst the PPR participants, it was not clear to an outsider. Thus, the researcher needed to ask the project manager after the PPR about the metaphor. He explained that moles were a metaphor for problems, and once one problem was solved by the NPD team they were quickly faced with four or five new ones popping up. (In Germany, there is a well-known children's board game where the aim is to stop moles constantly digging mole-hills on an otherwise perfect lawn.) This metaphor shows how NPD project teams have shared experiences and language that enables the transfer of tacit knowledge. The use of particular metaphors and stories also appeared to be closely linked to the working culture of the NPD team (and ethnographers stress the importance of vocabulary and language in culture).

Data Comparison

As mentioned earlier, the data analysis was iterative and involved extensive triangulation. The findings from the analysis of each of the data sources were compared and contrasted, as summarized from Table 3.

The analysis of the number of metaphors and stories in the data is shown at the top of the table. It can be seen that very few metaphors and stories were found in the documents, whereas the repertory grids appeared to stimulate a larger number. In the PPRs observed, metaphors and stories were relatively frequently used (55 in the 4 PPRs observed corresponds to approximately one every 20 minutes). It is evident that metaphors are often used in PPR discussions, but are almost entirely absent from the minutes produced. In the repertory grid interviews, where the interviewees discussed previous NPD projects, their usage of metaphors and stories shows that had acquired tacit knowledge from working on these projects.

Table 3 indicates that, at the five companies, the main way in which the knowledge generated at PPRs is disseminated is through the minutes being distributed. There did appear to be some emphasis on generating social interaction but not on the value of metaphors and stories for capturing NPD learning. There are two drawbacks to relying on documentation: firstly many interviewees recognized the limitations of written documents for disseminating lessons learnt and, secondly, the stories and metaphors which were observed to be a lively and important part of PPR discussions appear not to be documented. Therefore, the associated learning appears not to be captured and disseminated. Table 3 also shows that both the interviews and the observational evidence indicate that there are various factors that influence the effectiveness of PPRs. These include the different perspectives brought to the discussion, the right atmosphere, interaction and the influence of management (these points were found in the observational data – see column 3 in Table 3). It can also be seen (column 4) that the observational data provided corroborative evidence for this.

Table 3: Comparison of the Findings from Each of the Data Sources

Category of Evidence	Documentary Evidence	Interview Evidence	Observational Evidence	Conclusions
Number of Metaphors and Stories	<ul style="list-style-type: none"> Only 4 simple metaphors were found to be documented in the 82 pages of PPR minutes 	<ul style="list-style-type: none"> 35 metaphors and stories were identified from the repertory grids (a technique that is known to probe deeply into interviewees' knowledge) 	<ul style="list-style-type: none"> 55 metaphors and stories were identified from the PPR observations 	<ul style="list-style-type: none"> Metaphors and stories appear to be an important part of PPR discussions and reflect something of the culture of the NPD team
Other Evidence	<ul style="list-style-type: none"> Very little evidence in the guidelines that the case companies focus on tacit knowledge generation and transfer Scant evidence in the 19 PPR minutes that emphasis is put on the atmosphere and social interaction Main dissemination channel is for the PPR minutes to be distributed to other teams 	<ul style="list-style-type: none"> Substantial evidence on how PPRs can influence the generation and dissemination of tacit knowledge (e.g. many comments on the difficulty in documenting the important learning) Interviewees perceived the importance of: <ol style="list-style-type: none"> Knowledge generated in team discussions Having different perspectives The right atmosphere The moderator Interaction to spread the results Management's influence 	<ul style="list-style-type: none"> Many of the metaphors and stories were used in discussions on technical issues Other stories and metaphors appeared to form part of the NPD team's own language, humour and culture The moderator at Appliances Co. used a variety of approaches to stimulate discussion The presence of management can be perceived as positive (AppliancesCo) or negative (e.g. PublishingCo) 	<ul style="list-style-type: none"> The factors which could apparently influence the generation and dissemination of tacit knowledge at PPRs are: <ol style="list-style-type: none"> The moderation The methods used to guide discussions The atmosphere Social events linked to the PPR Use of metaphors and stories Management's attitude and presence The management of tacit knowledge requires a subtle approach Tacit knowledge and generation appear to be interlinked and therefore cannot be treated separately

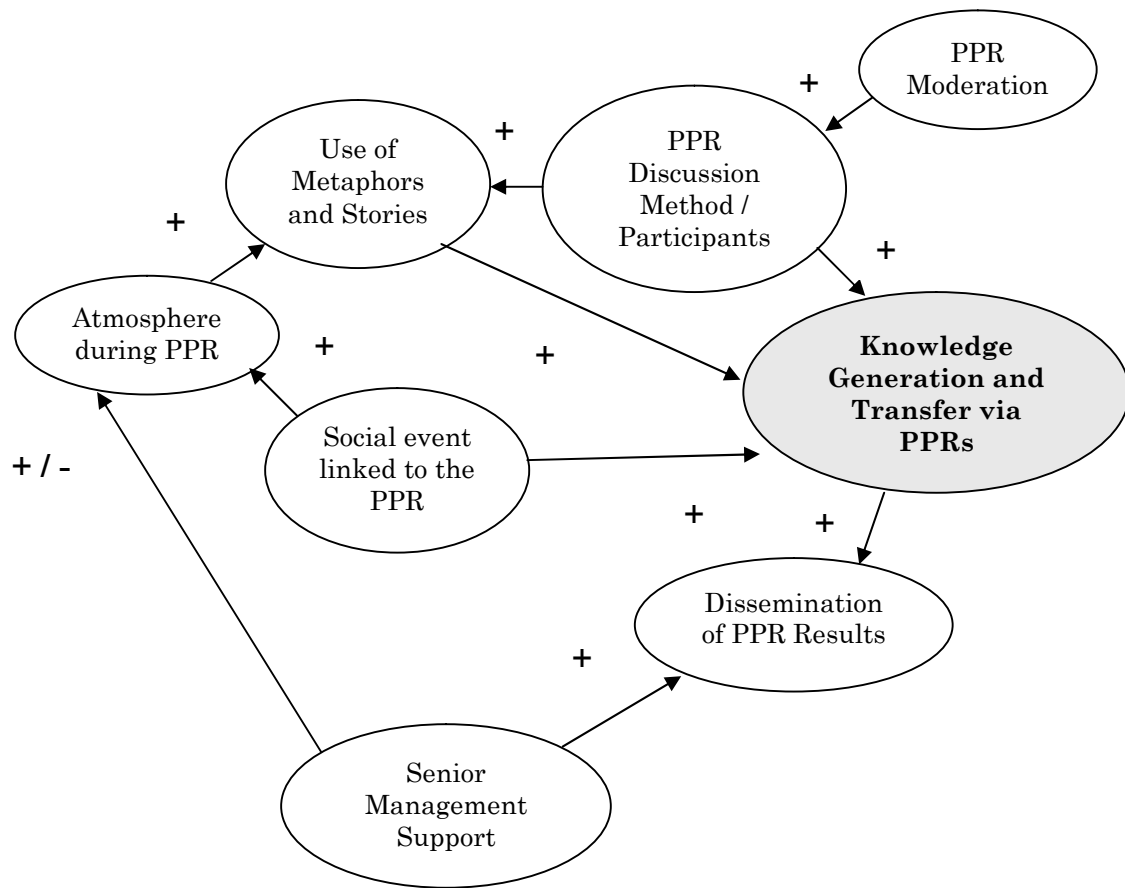


Figure 1: Conceptual Model of Knowledge Generation and Transfer via PPRs

DISCUSSION AND CONCLUSIONS

New Theoretical Insights

Although the results from five case studies cannot be generalized, the research does allow us to generalize to theory. Various factors appeared to be of importance for creating and transferring knowledge through PPRs.

Comparing the results from the literature review (Tables 1 and 2) with the empirical findings of this research (Table 3) allows us to propose a tentative conceptual model of the factors that appear to influence knowledge generation and transfer through PPRs. Figure 1 shows that three factors—social interaction, the use of metaphors and stories, and the method for discussion—are all likely to directly lead to the generation and transfer of tacit knowledge. The usage of metaphors and stories is dependent on both the atmosphere (which can be positively influenced by a social event) and by the type of discussion guided by the moderator. Both the amount of knowledge generated in the PPR and the role of management are important in determining how the learning is disseminated. In addition, the role of management can have a positive or negative impact on the atmosphere in PPRs.

As we discussed earlier, most of the recommendations given in previous studies of PPRs are not focused on the generation and dissemination of tacit knowledge. This is an oversight, as tacit knowledge is such a potent source of competitive advantage (Ambrosini and Bowman, 2001). Figure 1 suggests that interacting factors influence the degree to which tacit knowledge is generated and disseminated through a PPR. This in turn suggests that the management of tacit knowledge

within the NPD environment requires subtle approaches. It is interesting that we based our research on two separate questions but now we perceive that the generation and dissemination of tacit knowledge cannot be considered in isolation. Effective dissemination starts at the generation stage. The culture of the organization in which a PPR takes place will be a key contextual factor to consider as this impacts the atmosphere in discussions, is dependent on senior management, and the role allocated to the moderator. A “blame-free” environment appears essential but such a culture appeared to be absent at PublishingCo. It is somewhat ironic that the aim of senior managers from PublishingCo in attending PPRs was to promote learning but their very presence appears to be a limiting factor. It has long been recognized that tacit knowledge is a challenging topic to research effectively but now it is becoming clear that it is even harder to manage effectively.

Limitations and Suggestions for Future Research

Although we used multiple data sources to maximize internal validity, our research has a number of limitations and, as only five cases were conducted, the findings cannot be generalized. It should also be recognized that our investigation of tacit knowledge used metaphors and stories as a proxy measure. This is recommended in the literature but, as no similar previous empirical studies were identified, our use of this proxy measure was exploratory. Learning from the shortcomings of our own study allows us to make a number of recommendations for future research and to generate two research propositions.

Our findings on tacit knowledge generation and transfer need to be tested based on a wider sample of companies and there is still much to be learnt about PPRs. In further studies, steps would need to be taken to enhance the way in which metaphors and stories are used as a proxy for the generation and transfer of tacit knowledge. Discourse analysis on the usage of metaphors and stories should be used to develop a deeper understanding of their role. This should bring insights into whether the *usage of metaphors* and the *usage of stories* are equivalent, as this is not clear from the literature. NPD team members’ perceptions of what they have learnt from specific metaphors and stories should also be checked after a PPR has been observed. Such a study should also probe into how conscious NPD team members are of their usage of metaphors and stories. It would be interesting to investigate whether, if NPD teams are deliberately prompted to use metaphors and stories by a moderator, this generates tacit knowledge. (Metaphors and stories are a component of several creativity techniques.)

In addition to studying how tacit knowledge is generated in PPRs, there is a plenty of scope for looking at whether such knowledge is disseminated more widely than the direct attendees. Our research showed the drawbacks of written documentation as a dissemination tool, and the challenge that companies face in transferring tacit knowledge. Therefore, an investigation of how metaphors and stories are used outside of PPRs (e.g. to pass learning to other project teams) is necessary. A key topic that needs to be researched can be formulated as:

Proposition 1: Even PPRs that produce tacit significant knowledge do not necessarily lead to organizational learning, unless companies specifically focus on disseminating tacit knowledge (and utilize mechanisms other than written reports).

To really understand the way inter-project learning occurs, it will be necessary to understand company culture. Therefore, ethnographic research would appear to be a promising approach to the study of knowledge and learning in NPD. From our exploratory study, an exciting area to research can be expressed as:

Proposition 2: Organizations with a “blame-free” culture are more likely to generate and disseminate tacit knowledge in their PPRs than more formal, hierarchical companies.

Recommendations for Practice

Although our research was only conducted with five companies, the insights on tacit knowledge generation and transfer are important for practitioners. Managers responsible for NPD should ensure that effective PPRs are held and, using the insights from Figure 1, steps can be taken to move the focus from explicit knowledge to tacit knowledge generation. Specifically:

- Ensure that PPRs have the appropriate atmosphere.
- Use professional moderation to guide effective discussion and to actively promote the usage of metaphors and stories.
- Consider how the presence of senior management can be used to motivate the NPD team and promote dissemination of the learning.
- Make usage of the metaphors and stories that NPD teams generate—they could be used to communicate key messages to other project teams.
- Do not rely on written documentation: use social events and informal interaction to maximize the dissemination of knowledge.
- Realize that there are other mechanisms in which knowledge from NPD projects can be stimulated and transferred (as identified in the literature review), and these should be used in combination with PPRs.
- Recognize that effective dissemination starts at the generation stage and that the PPR participants themselves may have the best ideas about how their knowledge can be effectively disseminated to colleagues.

SUMMARY AND CONCLUSIONS

This paper described an investigation of PPRs as a mechanism for the generation and dissemination of tacit knowledge. Using multiple sources of data at five companies it found that these organizations were focusing on PPR reports as the way to capture and share knowledge, thereby neglecting the tacit aspects of NPD learning, although many members of NPD teams individually recognized the limitations of written documentation. Metaphors and stories—a proxy measure for tacit knowledge generation and transfer—were found to be an intricate part of the discussions in the PPRs observed.

Tacit knowledge is an intuitively attractive concept that has caught the attention of management writers—as demonstrated by the abundance of papers that reference the work of Nonaka. However, as we have shown, this important concept has a weak empirical base. Although by definition tacit knowledge is hard to investigate, management researchers need to make robust empirical inroads. NPD researchers in particular need to drive our understanding of tacit knowledge beyond what the organizational learning community has, thus far, accomplished. A better understanding of the mechanisms for the generation and transfer of tacit knowledge in new product development is crucial for practice. Overall, the untapped potential for learning is significant because, as Interviewee 3 from EngineeringCo said, “*The result of a PPR is clearly a project team which is wiser than before the meeting*”.

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