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Managers' Perceptions of Learning in New Product Development

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ABSTRACT

Companies need to ensure that each and every new product development (NPD) project results in not only a successful new product but also generates learning for the organization. Post-project reviews (PPRs) are widely recommended as an appropriate mechanism to stimulate project-to-project learning in NPD teams. Surprisingly, empirical research on their potential to support learning in NPD is limited. This paper describes an investigation of how NPD personnel perceive the utility of PPRs and of their potential to create tacit knowledge. It is part of an intensive exploratory study of five companies, using a multi-facetted case study methodology. The results indicate that NPD personnel perceive PPRs to be a useful mechanism and also that social interactions and tacit knowledge seem to play key roles in NPD learning. For operations management researchers interested in product development, the study furthers our understanding of learning in NPD, indicates topics that need further investigation, and suggests suitable methodologies. For practitioners, the results indicate the potential for more effective team learning in NPD.

Keywords: new product development, post-project reviews, project management

INTRODUCTION

Managers responsible for new product development (NPD) need to constantly improve their processes and strengthen core R&D capabilities (Wheelwright & Clark, 1992). A post-project review 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) and such reviews are a potentially valuable method to capture the knowledge generated during the course of a NPD project. The importance of post-project reviews (PPRs) is frequently stressed by practitioners and academics, but rigorous research into how they are typically conducted, are perceived, or how learning occurs, is scarce.

Companies rarely conduct PPRs—as shown by a wide body of anecdotal evidence (e.g. Tidd et al, 1997) and a few empirical studies (e.g. Bowen et al, 1994; Huber, 1996; Saban et al, 2000). An opportunity for learning is lost when PPRs are not used and this can result in companies making very similar mistakes to those made in previous NPD projects (Tidd et al, 1997).

This paper describes how NPD personnel perceive PPRs and this is important because only if they are positively perceived, will the necessary motivation for learning be present. The research also investigated the role of social interactions and tacit knowledge in NPD. The scope of the literature that should be considered relevant to the study of PPRs is a salient point. Both the project management and NPD literature give useful pointers. The organizational learning literature is also relevant but, surprisingly, most researchers working in the NPD context have failed to apply this knowledge (McKee, 1992). In this paper we review all three literatures to identify gaps in the extant knowledge and gain insights into suitable methodologies. Next, we explain the choice of methodology and the actions taken to ensure validity. The results are then presented and the implications for practitioners and academics are identified, including ideas for further research.

REVIEW OF THE EXTANT LITERATURE

Project Management Literature

It was in the 1950s that the need to review the performance of projects was first recognized, at the same time as project management was emerging as a discipline (Weinberg and Freedman, 1984). Later, recommendations appeared on how to conduct reviews at the end of a project (e.g. Gulliver, 1987) and the advantages of PPRs became apparent. However, it has been identified that a limitation of the project management literature on PPRs is that most previous studies have not been conducted in a systematic fashion and so the validity of the recommendations is questionable (Koners and Goffin, 2005).

The literature identifies three main issues about PPRs. Firstly, much can be learnt from previous projects and this can help prevent similar mistakes being made again (Pitman, 1991). Secondly, disseminating the lessons learned across the organization is of critical importance (Ayas, 1996). This can be achieved by using databases of lessons learned, rotating personnel, and circulating written reports (Balthazor, 1994; Holtshouse, 1999). Thirdly, each and every project needs to contribute to the continuous improvement of the organization's processes (Prahalad and Hamel, 1990). However, the adoption of PPRs has been slow.

There are a number of recommendations in the literature on how best to conduct PPRs (e.g. Baird et al, 1999; Busby, 1999; Freedman & Weinberg, 1977; Schindler & Eppler, 2003). However, many of these are vague including "discourage glib categorization" (a recommendation given but not explained by Busby [1999]). Others are more specific. For example, Schindler and Eppler (2003) suggest a "project knowledge broker" should be responsible for transferring the lessons learnt within and between project teams. Such mechanisms are necessary as there are many individual and organizational barriers to learning in NPD.

The fact that few organizations conduct PPRs is the result of various factors. The pressure of current projects leads to a lack of time to reflect on past projects (Kotnour, 1999). Managers may be uncertain as to whether they can learn from project experiences (Boudes et al, 1998). Reviews often suffer from the reluctance of participants to critically evaluate performance, although most people genuinely want to review past projects (Gulliver, 1987). Experiences and insights from projects may be hard to share and difficult to capture in reports and databases (Durrance, 1998).

NPD Literature

Knowledge has become recognized as a key source of long-term competitive advantage in R&D (Corso et al, 2001). Consequently, the importance of learning from NPD projects is made by several authors (e.g. Bowen et al, 1994; Leonard-Barton, 1992; Liyanage et al, 1999). However, there has only been sparse application of the principles of learning theory to empirical studies of the NPD process—there is a need for more research into how learning can improve product development (Saban et al, 2000). Such learning can take place at the individual and organizational levels and there are many barriers to successful learning in NPD teams (Lindkvist, 2001).

It has been identified that PPRs are seldom used (Bourgault and Sicotte, 1998; Bowen et al, 1994; Wheelwright & Clark, 1992) but there have been few empirical studies of this topic. One study showed that only two out of 33 microelectronic manufacturers use formal PPRs (Boag and Rinholm, 1989). Goffin and Pfeiffer (1999) found that only four of their 16 case study companies used PPRs but failed to give details on how they were used. A survey of 63 NPD managers identified that only 3% of their organizations conduct a review after every project but the majority (94%) think their organizations should conduct PPRs (von Zedtwitz, 2003).

There are a number of papers which give recommendations of how to run PPRs (e.g. Duarte and Snyder, 1997; Lilly and Porter, 2003; Smith, 1996; Wheelwright and Clark, 1992). These are often based on small samples, or the personal experience of the authors. Similar to the project management literature, the recommendations given are seldom based on empirical data and so it is

unclear how valid they are (Koners and Goffin, 2006). Moreover, the focus of the NPD literature is on knowledge that can be written down, documented and easily shared. In our previous research we collated the findings in the literature and then collected empirical data to further the understanding of the characteristics of PPRs that influence their effectiveness. Fourteen different characteristics (see Table 1) were identified as pertinent, based on five case studies (Koners and Goffin, 2006). For example, the research showed that the timing of PPRs is important, as are the participants and the way in which such a meeting is moderated and the findings disseminated. Although this research gives insights into the way in which PPRs should be organized, there are other important issues. For example, there have been no studies of whether NPD professionals who participate in PPRs perceive them to be valuable and effective. Such studies are needed, as the motivation of individuals is a necessary but not sufficient condition for learning in NPD teams (Lindkvist, 2001).

	Characteristics of PPRs	Conclusions (based on five case studies and the literature)
1.	Objective of PPRs	• Closure is important. • Focus is normally on learning from mistakes – there is an opportunity to learn from successes. • PPRs support knowledge dissemination and this should be an objective
2.	Timing of PPRs	• Guidelines of about 6 months after market launch are not usually followed due to timing problems or other priorities. • Discipline is needed to ensure PPRs happen.
3.	Duration of PPRs	• Length of PPRs varies a lot which is also reflected in the results and depth of discussion
4.	PPR Participants	• Core team always needs to be present. • The presence of senior management at the presentation of the results both acts as a motivator and a means of disseminating the knowledge gained.
5.	Moderation of PPRs	• The responsibility for running and moderating a PPR is often given to the project manager. • Using a professional moderator (as used by AppliancesCo) appears to be a more effective way to challenge the team and generate more learning.
6.	PPR Discussion Method	• The setting, the questions asked by the moderator, and the visual aids used all appear to influence the depth of discussion and the learning generated.
7.	Location for PPR	• Separate meeting rooms are always used. • External rooms are sometimes deliberately chosen to facilitate open discussion and concentration outside of the company.
8.	Use of guidelines for PPRs	• Only one company uses its guidelines for PPRs, others do not have them, only use the compulsory part or do not use them at all.
9.	Preparation of PPR	• Preparation is largely based on the individual reflection of the team members in advance. • The moderator and project leader should prepare a specific agenda for the PPR.
10.	Atmosphere during PPRs	• Degree of openness and formality depends on participants and company culture “atmosphere” • Hard to measure but very important.
11.	Documentation of the results of PPRs	• PPR discussions should be documented but more effective dissemination is needed. • A presentation to senior management supports a wider awareness.
12.	Dissemination of PPR results	• Results are only received by the project team (i.e. the participants) and senior management. • Limited dissemination outside the project team – a missed opportunity.
13.	Creation of action points	• Action points are derived by all companies. • Follow-up is problematic if responsibility is not allocated to project manager.
14.	Agreement on improvement suggestions	• Two companies have a target for the minimum number of improvement suggestions. • All companies document them in their minutes. • Only one company presents them to the management.

Table 1: Fourteen Key Characteristics of PPRs (adapted from Koners and Goffin, 2006)

Just as managers’ perceptions of PPRs have been overlooked, so it is that most researchers have ignored learning theory when looking at knowledge creation in NPD (McKee, 1992). The work of Thomke and Fujimoto (2000) recognized the difference between knowledge in R&D that is

easy to share and that which is best transferred by close interaction. Thus, their research is at the vanguard of applying concepts from organizational learning to NPD but unfortunately it did not investigate PPRs.

Organizational Learning

There is a vast body of knowledge on organizational learning but little agreement as to what it really is and how it occurs (Chiva and Allegre, 2005). However, there are two concepts in the organizational learning literature that appear particularly relevant to NPD: the understanding of knowledge and the importance of social interactions for learning.

The concept of knowledge, and the differences between "tacit" and "explicit" knowledge relates back to Polanyi (1962) and his famous quote that "*we can know more than we can tell*". Explicit knowledge is what we can readily explain and document, whereas tacit knowledge is difficult to articulate and exists at a subconscious level. Although it is possible to distinguish theoretically between explicit and tacit knowledge, they are hard to differentiate in practice (Johanessen et al, 2001; Lam 2000; von Krogh, 1998). It should be noted that there is some controversy about whether tacit knowledge can be converted into explicit knowledge (Cook and Brown, 1999). However, the discussion in the literature has largely been at a theoretical level and has failed to make empirical inroads into the understanding of tacit knowledge

Studying tacit knowledge empirically is a problem area (Wong and Radcliffe, 2000). Consequently, the main problem with attempting to apply the concepts from the organizational learning literature to NPD is the difficulty to operationalize the constructs. However, metaphors and stories have been recognized in the literature as indicators of the generation and exchange of tacit knowledge (Cook and Brown, 1999; Nonaka, 1994). In fact, individuals use metaphors to help explain their intuition to themselves and share it with others (Crossan et al, 1999). The existence of metaphors and stories can be taken as evidence for that tacit learning is taking place (Gherardi, 2000). Despite the recommendations in the literature that metaphors and stories can be used as a measure, there is a notable absence of empirical work.

The organizational learning literature identifies the importance of social interactions for the transfer of knowledge. Tacit knowledge can only be transferred through detailed discussions among people from similar backgrounds and with common experiences. Communities of Practice (CoPs) 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 efficient transfer of knowledge. Project teams can be considered an embryonic form of a CoP (Sense and Antoni, 2003). CoPs theory views learning as a social phenomenon and claims that knowledge, particularly tacit knowledge, can only be produced and held collectively (Howells, 1996). It should be noted that several of the characteristics of PPRs shown in Table 1 relate strongly to social interactions (e.g. the way such a meeting is moderated, or held in an informal setting).

Conclusions on the Literature

Much of the literature on PPRs has discussed their importance, identified that few R&D organizations use them, and generated recommendations for how they should be organized. Overall, the key conclusions for the current research are:

- Although the key characteristics of PPRs have been identified, there are still many aspects about them that warrant detailed investigation;
- Both academics and practitioners stress the importance of PPRs but have not investigated whether managers directly involved in NPD perceive them positively. Such an investigation is important as, without personal motivation of staff, the capacity for learning will be limited;
- The tacit dimension of learning in NPD is poorly understood.

RESEARCH DESIGN

Learning can occur at the individual, project team and project-to-project level and more needs to be understood about the first two before the latter can be adequately investigated. The gaps identified in the literature led to an in-depth study of PPRs, covering a range of topics, including the characteristics of PPRs (Koners and Goffin, 2006) and the type of learning generated. This paper focuses on perceptions of PPRs, including their ability to generate knowledge. It sets out answers to the following research questions:

- *How do NPD professionals perceive PPRs?*

To answer this question we looked at what NPD professionals think of PPRs, what they want to achieve through them, how PPRs support learning, and perceptions of ideal outcomes and how learning can be disseminated.

- *Is tacit knowledge created during PPRs?*

To answer this we explored for evidence of tacit knowledge.

Case Study Methodology

Based on the exploratory nature of the research, in-depth case studies were selected. These are appropriate when researching complex social phenomena in real-life contexts (Eisenhard, 1989; Yin, 1994). Furthermore, they allow researchers to look at a wide array of variables and aspects (Hartley, 1994). However, we recognized the need to design the cases carefully to ensure sufficient rigour, through focusing on construct validity and internal validity.

Construct validity was addressed by using operational measures for the different phenomena under study. For example, it was necessary to find appropriate "measures" for the occurrence of tacit knowledge during PPRs. As tacit knowledge is hard to identify, the usage of metaphors and stories was taken as a proxy measure. (The use of metaphors and stories as a proxy measure of tacit knowledge in NPD may be controversial and this will be discussed later). Based on the way the organizational learning literature stresses the importance of social interaction, the data were also coded for such indications. These included looking for references to the way meetings were held, the atmosphere necessary, the company culture required and the like.

Internal validity refers to the reliability of a case study and whether the variables chosen for investigation are sufficient to explain the topic under investigation (Dane, 1990). Therefore, in order to maximize internal validity, multiple sources of data were used.

Data Sources

The collection of data per case typically required 5 full but non-consecutive days of on-site visits. These were spread over approximately 6 months and took place during the years 2003 to 2005. These visits were used for collecting documents, conducting interviews and observing a PPR. Following the completion of each case, an extra visit gave specific feedback to the company on its processes and suggestions for improvements (the feedback component was not part of the formal research design but was important in gaining the cooperation of the companies). The research was conducted by a native German speaker with support from an English native speaker who speaks fluent German. Figure 1 shows the data sources and data collection techniques used for the research. This approach allowed a high degree of data triangulation between the three sources of data: company documents, interviews, and observations of PPRs.

Company Documents

Copies of company confidential documents on PPR guidelines and the minutes of specific PPR meetings were obtained. A content analysis was conducted for PPR practices, documented lessons learned as well as metaphors and stories. The data coding recorded in documentation typically reflects explicit knowledge;

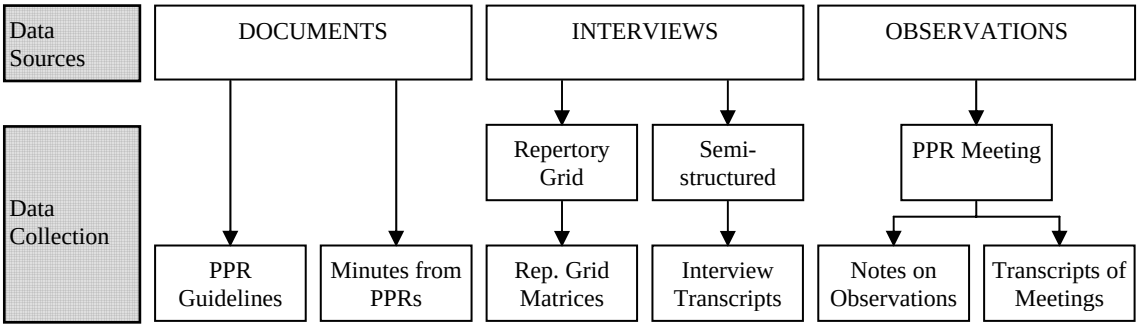

Figure 1: Multi-Faceted Design of Case Studies

Interviews with NPD Personnel

At each company six interviews were conducted with project participants with different levels of experience in the respective company. All interviewees were managers of NPD projects or were actively involved in NPD. The first part of each interview was based on repertory grid technique. This technique is especially useful in exploratory research settings (Goffin, 2002) and has been used previously to understand supplier-manufacturer relationships (Lemke et al, 2003). Repertory grid technique stimulated interviewees to contrast different projects on which they had worked. This elicited the lessons that they perceived to have learned from previous NPD projects. The particular advantage of repertory grid technique is it forces the respondent to think deeply and probes their tacit knowledge.

The semi-structured part of the interviews was based around the following six questions:

1) What do NPD professionals think of PPRs?
2) What do NPD managers want to achieve with a PPR?
3) How do PPRs support the learning from projects?
4) What is the ideal outcome of a PPR?
5) How should PPR results be disseminated?
6) What are possible alternatives to PPRs?

PPR Observation

An actual PPR was observed at four companies (one company refused permission) and this was analyzed using ideas from learning theory. Thus, meeting transcripts were analyzed with a particular focus on lessons learned, metaphors and stories as well as social interactions.

Sample

The sampling frame chosen was the 50 largest companies in Baden-Württemberg, Germany. This is considered to be a leading high-tech region because it accounts for the highest number of patents and R&D investments per capita in Europe (Staatsministerium Baden-Württemberg, 2001). Companies from different sectors were chosen, so that direct competitors would not be in the sample, which was an important aspect in gaining the co-operation and trust of the companies. The companies have been given disguised names and Table 2 summarizes the data collected at each site.

Case study no.	Turnover	Employees	PPR guidelines (NPD process documentation)	Minutes of specific PPRs	Interviews	Observation of a PPR
1 Engineering Co	> 1 Billion Euro	5.000	Yes	Yes, 5 sets copied	Yes - 6	Yes
2 Appliances Co	1,5 Billion Euro	7.000	Yes	Yes, 3 sets copied	Yes – 6	Yes

3 Medcare Co	1,3 Billion Euro	10.000	Yes	Yes, 4 sets on-site inspected	Yes – 6	Yes
4 Machinery Co	387 Million Euro	2.600	Yes	Yes, 4 sets on-site inspected	Yes – 6	Yes
5 Publishing Co	280 Million Euro	1000	Yes	Yes, 3 sets copied	Yes – 6	No (access refused)
				19 minutes	**30 interviews**	**4 observations**

Table 2: Overview of Case Study Data

Data Analysis

Case analysis was conducted by the authors in unison. It included cross-checking the data coding and ensuring that salient quotes, which often included slang and dialect, were translated appropriately into English. There were three stages:

- *Within-case analysis.* Data from each case were analyzed separately to give a complete picture of each company's approach to PPRs. The same analysis framework was used for each case and the research design ensured that a high degree of data triangulation could be performed. Part of this analysis was the collation of interviewees' answers to the semi-structured interview questions, looking for evidence of the importance of social interactions. Another vital part of the analysis was the coding of the minutes of PPRs, repertory grid data, and observation transcripts—in all of these the use of metaphors and stories was the proxy measure chosen.
- *Data reduction*. 2-3 page case descriptions were written on each company. The descriptions were then submitted to informants at the case companies to prevent observer bias (Lincoln and Guba, 1985) and to establish the credibility of the interpretation (Wallendorf and Belk, 1989).
- *Cross-case analysis.* Comparisons across the companies were made, to determine where similarities and differences existed and to identify a number of "best practices" (Yin, 1994). These comparisons effectively organized the results into the characteristics of PPRs (reported in Authors, 2006), and perceptions of learning (this paper). Further analysis is planned on the typical lessons learned in PPRs and NPD in general.

RESULTS

How do NPD Professionals Perceive PPRs?

Overall, 30 interviewees expressed their personal views on PPRs in the semi-structured interviews. The insights gained from these interviews are presented in Table 3. This includes the frequency of the different perceptions. Note that due to time constraints and the semi-structured character of the interviews, not all 30 interviewees provided answers to every question. Thus, the total number of responses (which is given in brackets) is always lower than 30. Furthermore, as some interviewees mentioned several different issues in response to one question, the sum of responses listed in Table 3 is in some cases higher than the overall total of interviewees given in brackets. To demonstrate the trail of evidence, we will discuss Table 3 in more detail.

		Empirical results	Practical recommendations based on responses
1	Judgements of PPRs	• **15 (out of 28) positive perceptions that PPRs cause team reflection and learning** • 9(out of 28) negative comments that PPRs do not take place or are missing top management support • **4(out of 28) neutral comments that PPR value depends on participants, culture etc.**	• Conduct PPRs for all projects • Communicate PPRs as the final and accepted project milestone • **Extend the circle of participants outside the core project team and include all project experts** • Support PPR importance with (partial) top management presence **and combination of PPR with a social event**

2	Personal objectives of PPRs	• 13 (of 23) focus on evaluation and reflection • **9 (of 23) emphasize learning** • 7 (of 23) suggest to find improvement suggestions	• Confirm PPRs as an important learning event • **Enable open atmosphere and foster constructive criticism and learning culture within the R&D organization**
3	PPRs and learning	• 23 (of 28) view PPR discussion as a trigger for generating personal reflection and shared insights • **2 (of 28) highlight that PPRs do not solve problems and are highly dependent from the company culture** • 3 (of 28) neutral comments that only future projects can show the learning effect	• **Prepare, structure and manage the PPR discussion in an optimal way, e.g. with the help of a moderator and visual aids** • **Allow sufficient time for in-depth brainstorming and reflection** • **Provide a supporting company culture that supports open discussions** • PPRs are a clear opportunity to achieve project-to-project learning
4	Outcomes of PPRs	• 15 (of 27) highlight documents like minutes or guidelines • 10 (of 27) propose action based results like checklists and open action points • **8 (of 27) prefer social interactions**	• Make sure that minutes are written for all PPRs • Highlight the need to document action items and improvement suggestions • **Recognize tacit results from PPRs and their value to the organization**
5	Dissemi-nation of results	• **19 (of 28) prefer social interactions** • 10 (of 28) mention documents as dissemination tools	• **Support exchange of tacit knowledge and experience via informal networks, job rotation and internal presentations** • Enable general access to minutes of PPRs and organized integration of PPR insights into guidelines and handbooks
6	Alternatives to PPRs	• **15 (of 29) suggest social interactions** • 9 (of 29) mention different forms of meetings as alternatives • 7 (of 29) highlight database alternatives	• **Ideas for other ways of sharing learning can augment PPRs – they do not have to be strict alternatives** • **Arrange regular meetings of project managers** • **Establish presentations of key experiences across projects and business units** • **Support close physical proximity between senior and junior staff so that "stories" can be transferred** • **Introduce godfather programmes or coaching processes for junior project managers** • Allocate clear responsibility for the update of databases and guidelines

Table 3: Summary of Empirical Results and Recommendations

1. What do NPD professionals think of PPRs?

The opinions on PPRs were grouped into positive, negative and neutral statements. PPRs were perceived by many interviewees as an ideal occasion at which to discuss what happened during the project. PPRs were perceived positively, because the presence of the development team enables projects to be considered from different viewpoints and because they can help to avoid similar problems in subsequent projects. PPRs were also appreciated as a source of ideas for future projects and giving formal closure to a project (thus avoiding that a project just "fizzles out", without a clear end). Other interviewees stated that PPRs provide an ideal opportunity to recognize and reward the performance of the team for the overall outcome of the project.

A perceived negative aspect of PPRs was the problem of time constraints. As NPD organizations generally face increasing pressure to come up with new innovative products, several interviewees mentioned the high pressure to finish a project and to move quickly to the next rather than spending time on a PPR.

Neutral statements included that the effectiveness of a PPR is very dependent on top management support and the culture of the NPD team. If the atmosphere within the team and within the NPD organization is not open to constructive criticism, then the outcome of a PPR will be

limited. Thus, it appears to be important that senior management clearly establish PPRs for all NPD projects and for them to be at least partially present at PPRs.

2. What do NPD managers want to achieve with a PPR?

The objectives that interviewees want to achieve from PPRs were found to fit into three categories; *evaluation*, *learning*, and *improvement*. The objective most frequently mentioned was that a PPR enables an objective evaluation of a project after the product has been launched. In this evaluation, every aspect of a project can be considered from different viewpoints and with an immediate exchange of ideas. Some interviewees indicated that they want to fully evaluate projects during PPRs. This means not only looking at the project outcome and its quality, but also referring back to the original objectives of the project and analyzing if these were met and to what degree. (These comments indicate that some PPRs are perceived to focus too tightly on project outputs, rather than the process.) It was perceived that project learning can result from either positive or negative experiences, from mistakes or from successful practices which were applied. Often, the objective of NPD professionals is not only to learn but to achieve improvements by applying the lessons learnt to future projects.

3. How do PPRs support the learning from projects?

Responses regarding how PPRs support learning were grouped into positive and negative statements. The majority - 23 interviewees - were positive about the role of PPRs in supporting learning. PPRs were perceived to facilitate the exchange of experience, because the discussion raises different viewpoints, which individuals may not have recognized on their own. This is achieved in that a PPR usually brings together the whole project team, and not only the core team. Thus, the pool of experience available is higher than in many project meetings where certain sub-teams discuss specific issues. Another positive aspect was that PPRs trigger personal reflections and lead to brainstorming within the team which does not happen during other meetings. *"There are certain issues that only come up at the end in the review, because only then you have the time and peace of mind to actually think about causes and consequences"* (Interviewee 2, Appliances Co.). It was also mentioned that the discussion during a PPR enables more transfer of know-how within the team than anything that might be formally documented and stored in databases. *"During the discussion the real important points emerge within the team - you will never find these points in minutes or databases"* (Interviewee 7, Appliances Co.).

Only two interviewees expressed clearly negative perceptions regarding the role of PPRs in supporting learning. One said that PPRs have limited utility in that they discuss problems and potential improvements but action issues are very seldom followed-up in a professional way. The second negative view was that PPRs are only effective if the company culture supports open discussion. Without this, PPRs were perceived as not being able to contribute to a learning organization at all. Neutral comments stressed that only the results of future projects would really show whether PPRs had resulted in lessons learned within the organization.

Overall, the majority of interviewees perceive the role of PPRs in supporting learning positively. Yet, it is also important to stress that learning depends to a high degree on the way the discussion is structured and moderated, the time a company invests for in-depth reflection during a PPR and the underlying company culture (this links to many of the points in Table 1).

4. What is the ideal outcome of a PPR?

Responses regarding the outcomes of PPRs were found to fit into three categories; *document*s, *action points* and *social interaction*. Overall, 15 interviewees thought that written summaries were an ideal outcome and mentioned minutes of PPRs, internal guidelines and checklists such as outputs. It is interesting to note that three of the 15 interviewees mentioned that only a document-based approach would work in their organization. For example, at MedCare Co. there are no

personal relationships with colleagues in other business units and so documents are essential. A project manager at Publishing Co. recommended documents as the preferable outcome of a PPR, because the company culture did not support personal and social interactions as a way to transfer learning. It is interesting to note that the interviewees did not recognize the limitations of documents (for example, tacit knowledge cannot be disseminated by documents). This means that many interviewees do not have an understanding of the different types of knowledge that can be created.

Ten interviewees went further than mentioning documents and expressed the view that identifying specific action points is important. Such action points should be allocated by a specific person to be completed by a specific date. The action points can be general improvement suggestions, the most important aspects to be considered in future projects or a checklist of remaining actions – all these are also considered to be a vital outcome of PPRs. In addition, eight interviewees recognized the problems of sharing results and suggested social interactions as the optimal outcome of a PPR. They emphasised that the outcomes of PPRs cannot be documented in an efficient way and that the team discussion during the PPR is most important. *"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"* (Interviewee 4, Machinery Co.).

5. How should PPR results be disseminated?

The responses about the dissemination of the results of PPRs were found to fit into two categories; *social interaction* and *documents*. A majority of responses (19 out of 28) stressed that results should ideally be disseminated informally through social interactions, since this is easier and more efficient than reading the minutes of PPRs. It was stressed that the best dissemination of the results of PPRs takes place when the participants apply their learning to subsequent projects. Alternatively, the results could also be given to a steering committee, with responsibility to disseminate the results within the wider organization. Other interviewees proposed presentations where PPR results and "stories" could be verbally presented by the project manager or team members to other members of the NPD organization. Some interviewees suggested the use of documents as part of the dissemination of the results of PPRs and said the project team plus senior managers should receive the minutes of PPRs. One of the perceived critical success factors for such a document, though, is that it should not be too long, because the problem of information overload was mentioned several times. Finally, interviewees suggested to integrate the results of PPRs into official NPD guidelines and handbooks. Such an approach was perceived to make it more likely that the experiences would be applied to future projects.

6. What are possible alternatives to PPRs?

The mechanism most often mentioned as a potential alternative to PPRs was social interactions, i.e. any kind of personal relationship within a department, project group or company which enables the informal exchange of ideas and experiences. For example, interviewees said that senior employees often gain a reputation for their know-how in a very particular area and are consulted by colleagues if questions in this area arise. One factor that supports these informal networks is the co-location of experienced colleagues with younger members of staff. Informal networks and personal discussion can work well and it was mentioned that they provide the easiest and quickest way to find answers to complex questions. However, it was mentioned that one-to-one discussions are on the one hand highly focused, but on the other hand they do not provide the same kind of insights as a PPR, because these combine the perspectives of the whole project team.

Another mechanism mentioned was *godfathers* - experienced project managers assigned to meet weekly with junior colleagues in order to discuss their current issues and answer questions (a formal way to stimulate the creation of networks). An alternative to PPRs which is based on social interaction is meetings of project managers. The frequency of these meetings, however, varied a lot

between the case companies. Some have the practice to meet each week, some every two or three months and some only once or twice a year.

Interviewees also perceived coaching meetings to be useful. In these, an experienced project manager discusses example problems with a group of junior members of staff in an informal session. Three out of the five case companies actively use databases to store project information and experiences. However, databases are most often used to store technical data like quality issues and how they were solved rather than the storage of experiences. Overall, the mechanisms mentioned were perceived not as strict alternatives, but as ideas that can augment PPRs.

The semi-structured interviews showed that social interactions are perceived as important for the transfer of learning within NPD organizations. Table 3 includes not only the frequency of comments but also gives practical recommendations based on the interviews. It can be seen that many of these are related to social interactions (as indicated by bold type). However, In addition to stressing the importance of interaction, the organizational learning literature emphasizes tacit knowledge. This was investigated by looking at a range of different data from the case studies.

Is Tacit Knowledge Created during PPRs?

Since identification of the use of metaphors and stories has been recognized as providing evidence for the creation and transfer of tacit knowledge, the data were coded accordingly. As shown by Table 2, the data consisted of the official minutes of 19 PPRs at the case companies, the results of 30 repertory grid interviews, and the transcripts and notes from direct observation of 4 PPRs.

Table 4 shows that a total of 94 metaphors and stories were identified (four in the minutes, 35 in the repertory grids and 55 were observed in the PPRs). For example, "*We always had clear rules of play in our team*" was found in the minutes of a PPR from Appliances Co. in the summary of a discussion about the positive aspects of a project. In a repertory grid interview a respondent said, "*In the past we had a marketing silo and a technical department silo and we have thrown our not very well defined wishes over the wall to the other silo and what we got in return was not what we wanted*" (Repertory grid interviewee 5, MedCare Co.).

Several metaphors and stories observed during PPRs were clear to the participants, but not to the researcher(s) present. In these cases, the discussion before or after a specific metaphor or story was used was hard for the researchers to understand. For example, during the PPR at Appliances Co. one of the participants mentioned that: *"He* [the project manager] *was almost like a sheepdog and kept circling the project team 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 the metaphor was repeated, the researcher was not clear of the meaning, although it had obviously been understood by the whole team. At that point, one of the participants quietly explained to the researcher that the metaphor referred to the project manager's keenness to successfully meet the project objectives and how he had monitored progress very closely throughout the project.

Case no	Case name	Metaphors found in minutes of PPRs	Number of minutes inspected	Metaphors used during repertory grids	Metaphors mentioned during PPR observations	PPR Length
1	Engineering Co.		5	5	14	2.5 hours
2	Appliances Co.	2	3	12	30	7.5 hours
3	MedCare Co.		4	5	6	2 hours
4	Machinery Co.	1	4	3	5	3 hours
5	Publishing Co.	1	3	10	n/a	N/a
	Total	4	19	**35**	**55**	15 hours

Table 4: Identification of Metaphors and Stories

Another example of the intimate nature of the discussions during PPRs was the use of a metaphor observed at Appliances Co.: *"It like was a game with moles. You hit one on the head and somewhere else four or five other ones appear."* This particular metaphor caused a lot of laughter amongst the PPR participants but it was not clear to what it referred. Thus, the researcher asked the project manager after the PPR about the background of this metaphor. He then explained that the moles were metaphor for problems, i.e. as soon as a one problem was solved by the team; then several others arose straightaway. This metaphor indicates that project teams may develop their own vocabulary (*moles = problems*), which is intricately linked with the transfer of tacit knowledge. Metaphors and stories also appeared to enliven and bring humour to discussions about complex technological issues, by making them easier to understand for those without detailed knowledge.

The observation of four PPRs enabled the researchers to recognize that the atmosphere at a PPR appears to influence the outcome. At MedCare Co., the PPR took place in a very formal and serious manner and did not include a lot of interaction between the participants. In contrast, the PPR of Machinery Co. took place in a beer garden and was run in a very informal manner. During the observation, the researcher noted that often a single metaphor or story was enough to trigger a long discussion.

Table 4 compares different types of data and thus gives a new perspective on learning from PPRs in NPD. The official minutes of PPRs were found to include only 4 metaphors and stories, whereas in the PPRs that were observed, metaphors and stories were used 55 times—on average every 16 minutes. Therefore, it appears that the social interactions in a PPR lead to the use of metaphors and stories that are not then documented in the minutes. (By omitting the metaphors and stories from minutes, companies may be missing opportunities for disseminating knowledge).

In the semi-structured interviews, many respondents indicated that they found interaction to be very important. However, the importance of tacit knowledge was not mentioned, perhaps indicating that the respondents were unaware of this concept. Obviously, it would have been inappropriate to ask them whether they perceived tacit knowledge to be important and so repertory grid technique was used to identify whether individuals' learning from NPD involved the generation of tacit knowledge. Repertory grid technique is known for probing deep into individuals' knowledge and so the transcripts for this part of the interviews were coded for the use of metaphors and stories. As shown in Table 4, the transcripts of the repertory grid interviews contain a total of 35 metaphors and stories. This indicates that working on NPD projects develops tacit knowledge.

Overall, it is evident that metaphors are used by interviewees in PPR discussions (as observed), but are almost entirely absent from the minutes produced. The repertory grid interviews indicate that individuals generate tacit knowledge from working on NPD. However, the social interaction between the experts present at a PPR appears to give the most support to the creation of tacit knowledge.

DISCUSSION AND CONCLUSIONS

Overall, most NPD personnel expressed a positive personal attitude towards PPRs and their impact on learning. This is interesting when considering that most R&D organizations do not conduct PPRs. Within the limitation of the exploratory current research, it was found that:

- NPD professionals who take part in PPRs do perceive them to be a useful mechanism for promoting individual and team learning in NPD (based on evidence from Table 3);
- Taking part in the discussions at PPRs is perceived to trigger insights that are of more value than reading what is documented in minutes, or stored databases. This can be clearly related to social learning theory. A comparison of the frequency of usage of metaphors and stories in the minutes of PPRs and in actual meetings provides support for NPD professionals' perceptions. It appears that the social interactions at PPRs do stimulate the creation and exchange of tacit knowledge (based on evidence from Tables 3 and 4);

- Documents like the minutes of PPRs and checklists are an important means of disseminating knowledge but they do not always contain all the aspects from the discussions (based on Table 3);
- The importance of social interactions for learning is stressed in the literature and this was matched by the perceptions of NPD professionals and observations of PPR discussions, particularly those held in informal settings (based on Tables 3 and 4);
- The results indicate that metaphors and stories form an important part of PPR discussions and are used (consciously or subconsciously) to stimulate or summarize key points, for example related to technical or project management issues (based on evidence from Table 4).

Limitations and Recommendations for Researchers

As with all exploratory research, this study has significant limitations. These are linked to the necessity of having to try and identify both the key constructs and suitable measures for them. The approach chosen to investigate tacit knowledge may be controversial to some readers, because one could argue that tacit knowledge cannot be operationalized. However, we argue that tacit knowledge should not only be discussed at a purely theoretical level. This paper intends to provide a first step in that it looked for empirical data on tacit knowledge in NPD. Unfortunately, as comparable data does not exist, it is not possible to judge whether the frequency of usage of metaphors and stories is particularly high, or not. Furthermore, the sample of five German companies is naturally not representative. However, as an exploratory sample, it allows our understanding of PPRs to be advanced. Later research will need to look to wider samples to establish externally valid results.

In Table 5 we summarize our conclusions, showing the approaches we took and how we think they can and should be enhanced in future research. For example, we relied on NPD professionals' perceptions of the importance of social interactions and think that additional approaches, such as longitudinal (ethnographic) observation will be necessary to gain a real understanding of interactions and learning. Similarly, the subjective analysis that the atmosphere of PPRs influences the results needs refining.

Tacit knowledge was investigated using a proxy measure—the frequency of usage of metaphors and stories. A categorization of the types of metaphors and stories used by NPD teams is needed, as is an understanding of what individuals perceive they have learnt from them. Researchers need to rise to the challenge and attempt to understand the role of social interactions and tacit knowledge in NPD better—by moving to develop effective approaches as suggested by Table 5.

	Construct	Approaches used in this study	Suggested additional approaches
1	Social interaction	• NPD professionals' perceptions of its importance • Subjective assessment of the atmosphere at PPRs by the researchers	• Longitudinal observation of how NPD professionals interact: frequency, depth, etc. • Need to measure the formality of PPR meetings in a more objective way
2	Tacit knowledge generation	• Frequency of use of metaphors and stories in documents, repertory grid interviews and in observed PPRs	• Semantic analysis of how metaphors and stories are used – to develop an understanding of the types of metaphors and stories used • NPD professionals' perceptions of what they have learnt from the usage of specific metaphors and stories • Identification of how metaphors and stories are used outside of PPRs (e.g. to

			pass learning to other project teams) • Comparison of individuals' perceptions of what they have learnt from a project before and after a PPR

Table 5: Suggested Operational Measures for the Constructs

In addition to focusing on operational measures related to learning, there is an urgent need for more research on PPRs and learning in NPD. Such research needs to fully consider organizational learning theory. In particular, the following topics need investigation:

- How many companies are currently using PPRs for stimulating learning in NPD? Here a representative survey is needed;
- A large scale survey is also needed to gather generalizable data of NPD professionals' perceptions of their PPR, in order to establish whether the findings from this exploratory research are representative;
- What are the lessons that NPD professionals learn from working on NPD?
- What would be suitable performance measures to determine the effectiveness of PPRs?
- How do PPRs support project-to-project learning?

For Practitioners

Based on the research results, a number of recommendations can be made which are all targeted at the improvement of learning in NPD:

- The importance of PPRs needs to be supported by top management, in order to ensure that they take place, have the right atmosphere, and company culture encourages constructive discussions;
- The time and effort invested in PPRs can bring better returns if the knowledge is disseminated to other project teams. Managers need to actively support this process, for example by job rotation, the creation of project teams with experienced as well as junior members, via informal networks, and through internal presentations;
- Typical lessons learned should be disseminated to other project teams in an easily assimilated form e.g. by presentations, checklists, and short minutes of PPRs;
- Tacit knowledge needs to be addressed. For example, PPRs could be combined with a "social event", in order to celebrate the team's achievements. The term social event can cover anything from a visit to a museum (Appliances Co), or a dinner (Engineering Co). These events could help in the generation and communication of knowledge;
- PPR discussions can be based around the use of metaphors and stories, as these appear to be important vehicles for the transfer of tacit knowledge within NPD teams.

Overall, the research gives new insights into learning in new product development teams. It demonstrates the potential of PPR's to generate knowledge and indicates the importance of interaction between NPD professionals to transfer knowledge. Minutes and databases of lessons learned have their place but as one interviewee said, *"You cannot really write down experiences, even if you try. This is almost impossible and it would be a huge book"* (Interviewee 2, Publishing Co.).

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